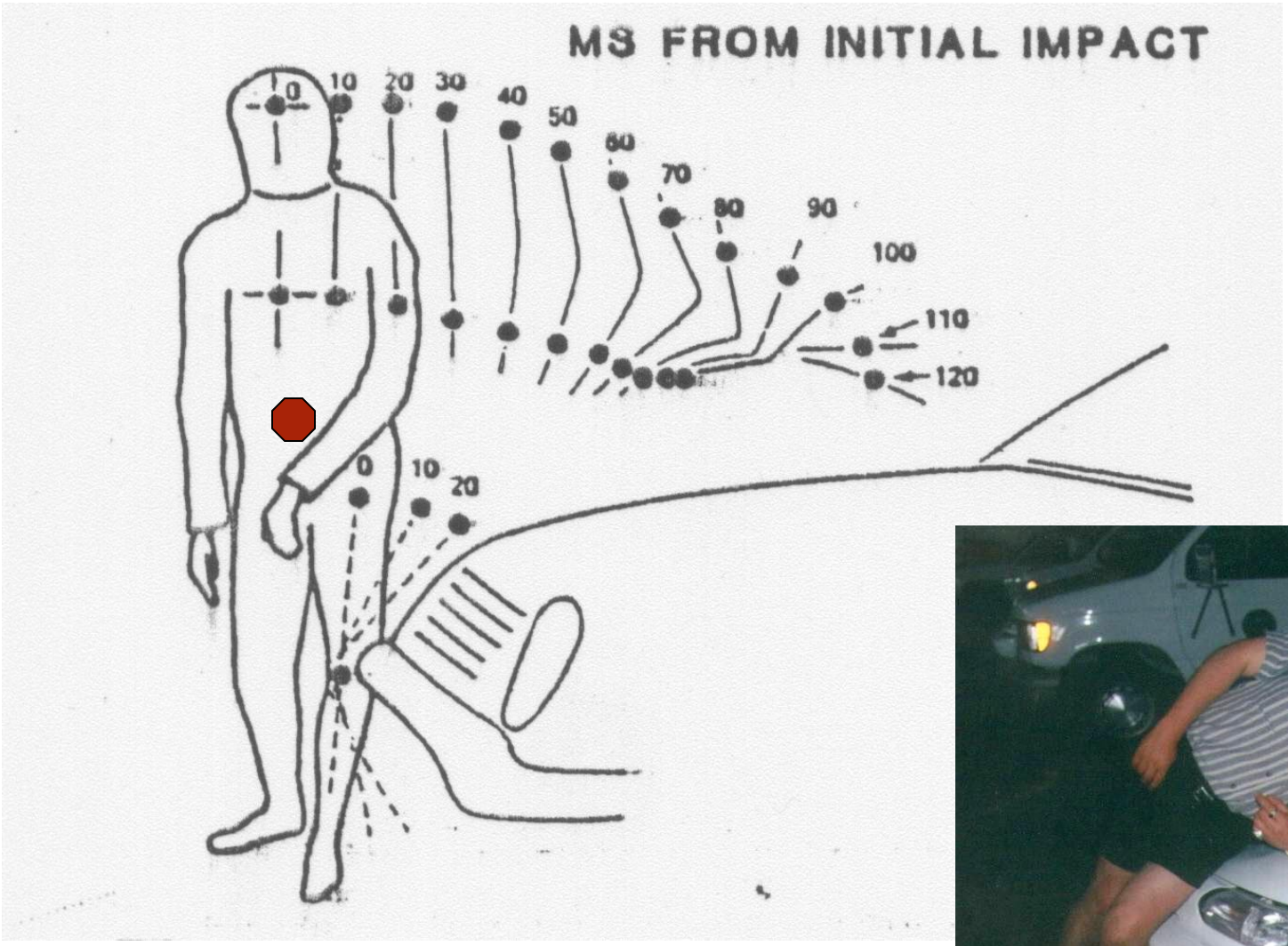


Pedestrian Collisions

..\..\Video clips\JaywalkingORM.wmv

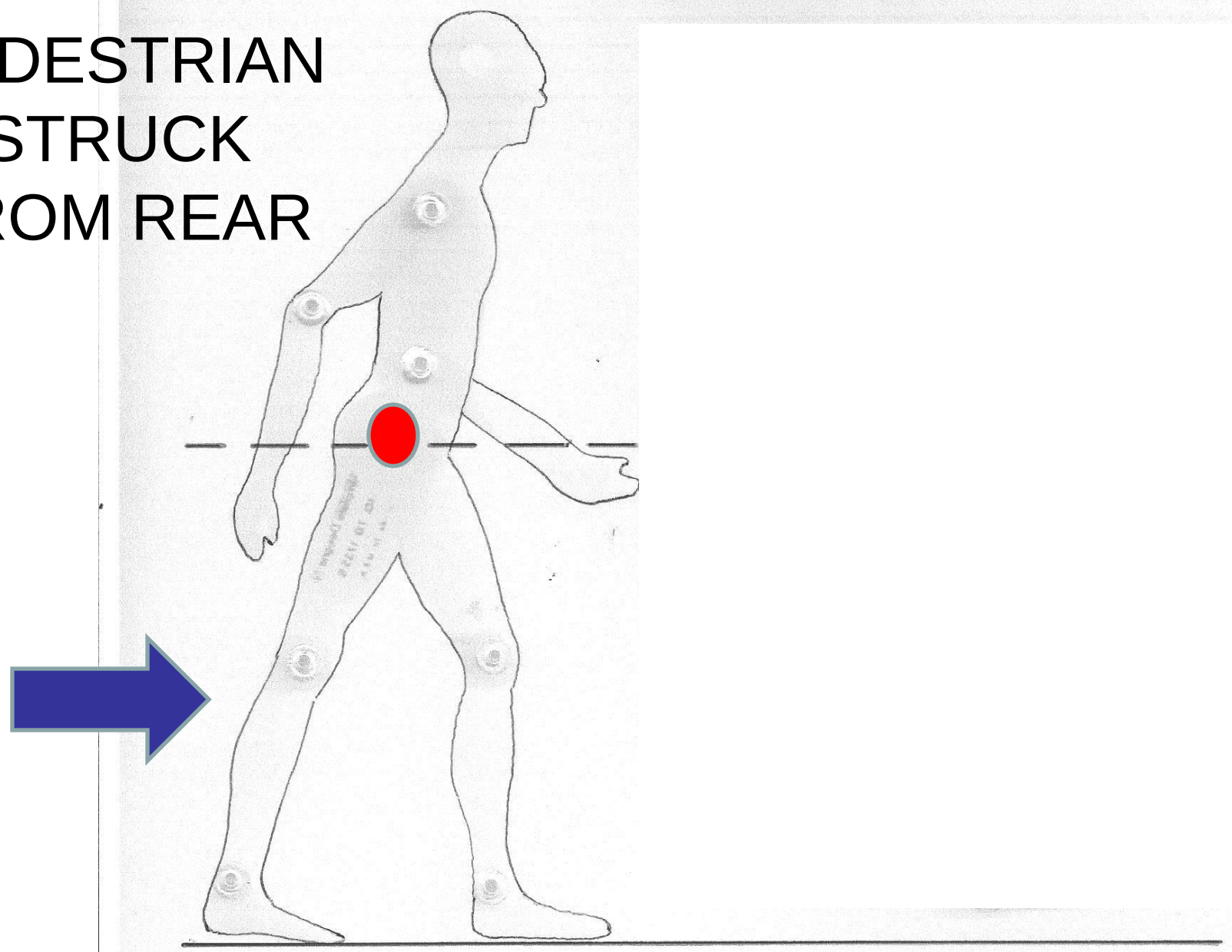
RECONSTRUCTION ISSUES:

- WHERE DID THE IMPACT HAPPEN
  (POI or AOI) ?
- HOW DID THE PEDESTRIAN GET THERE ?
- WHAT WAS THE VEHICLE SPEED ?
- WAS THE COLLISION AVOIDABLE ?

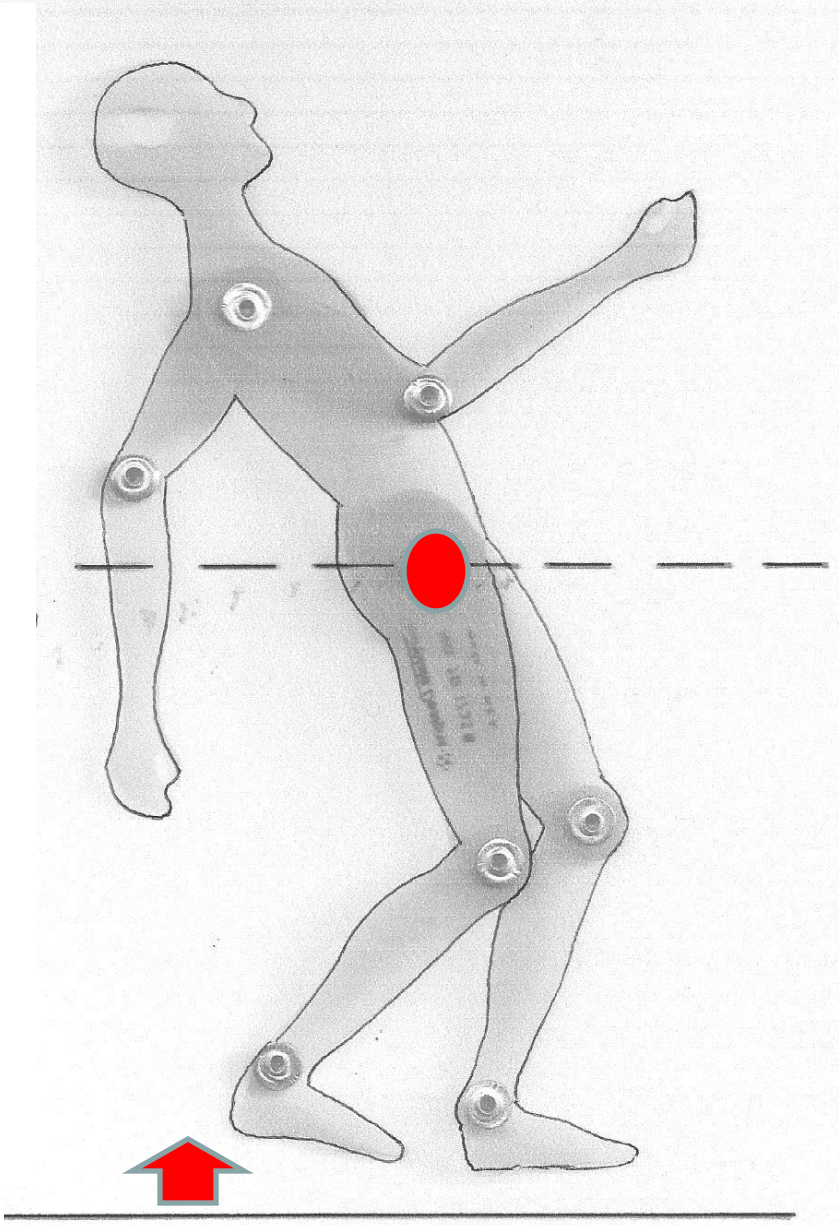
The impact may lift the pedestrian out of their shoes.

CSI

PEDESTRIAN STRUCK FROM REAR



4/1000 sec LATER

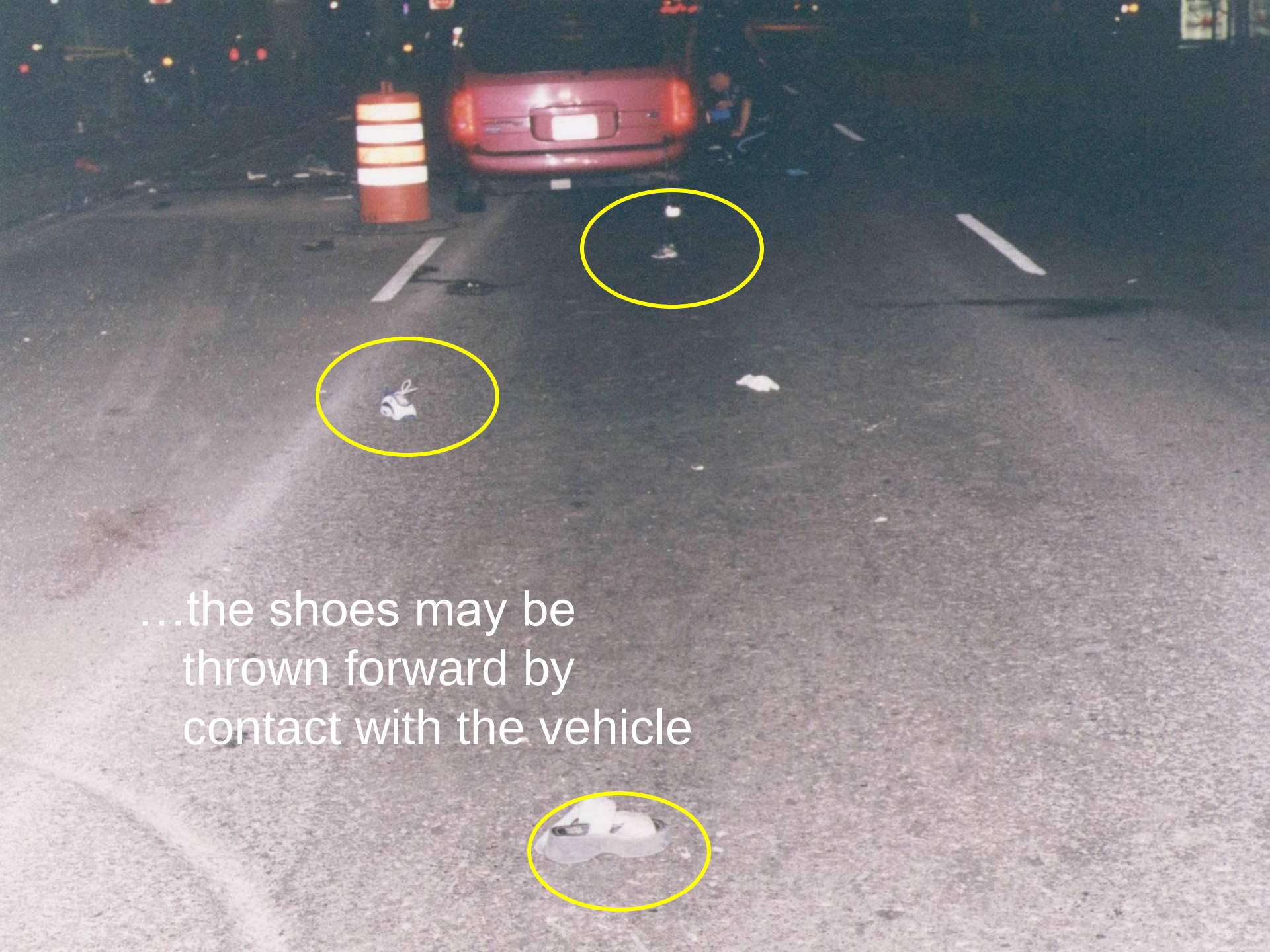


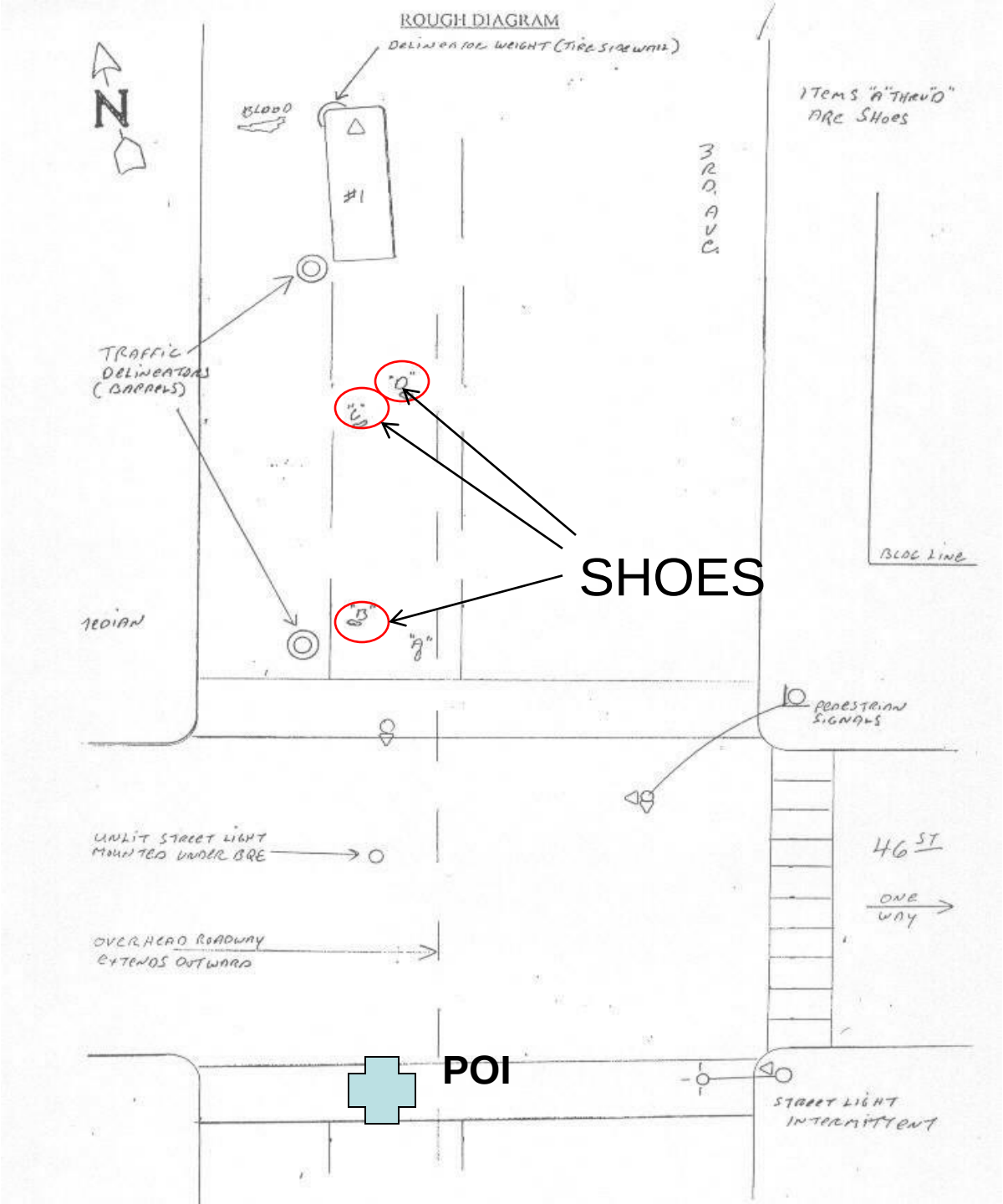
..\ped forward proj.wmv

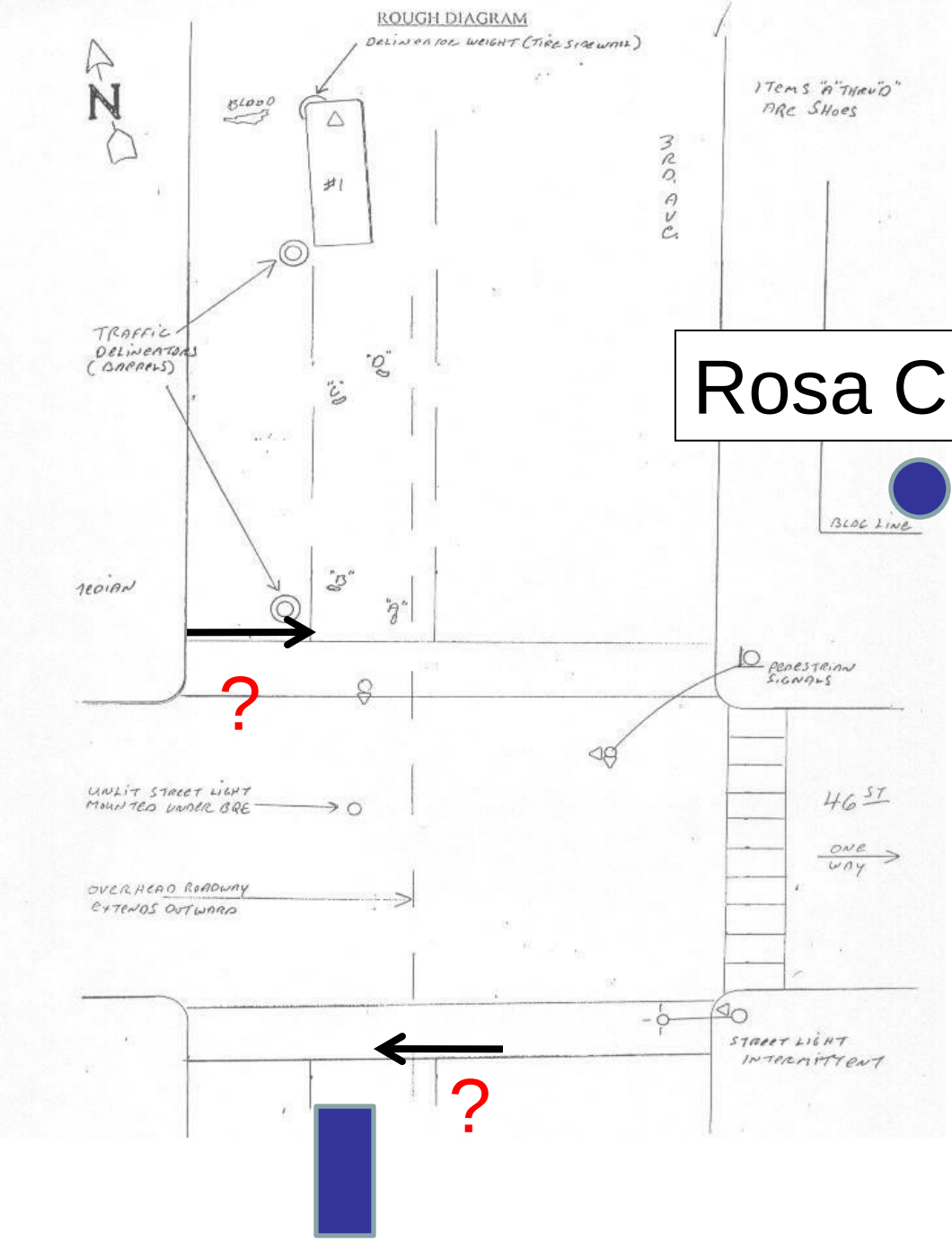
DEFENSE EXPERT MAKES FALSE STATEMENT ABOUT POINT OF IMPACT

Defense expert report:

"The point of impact can be determined by where the first shoe is located, as a pedestrian is usually knocked out their shoes by an impact with a car."

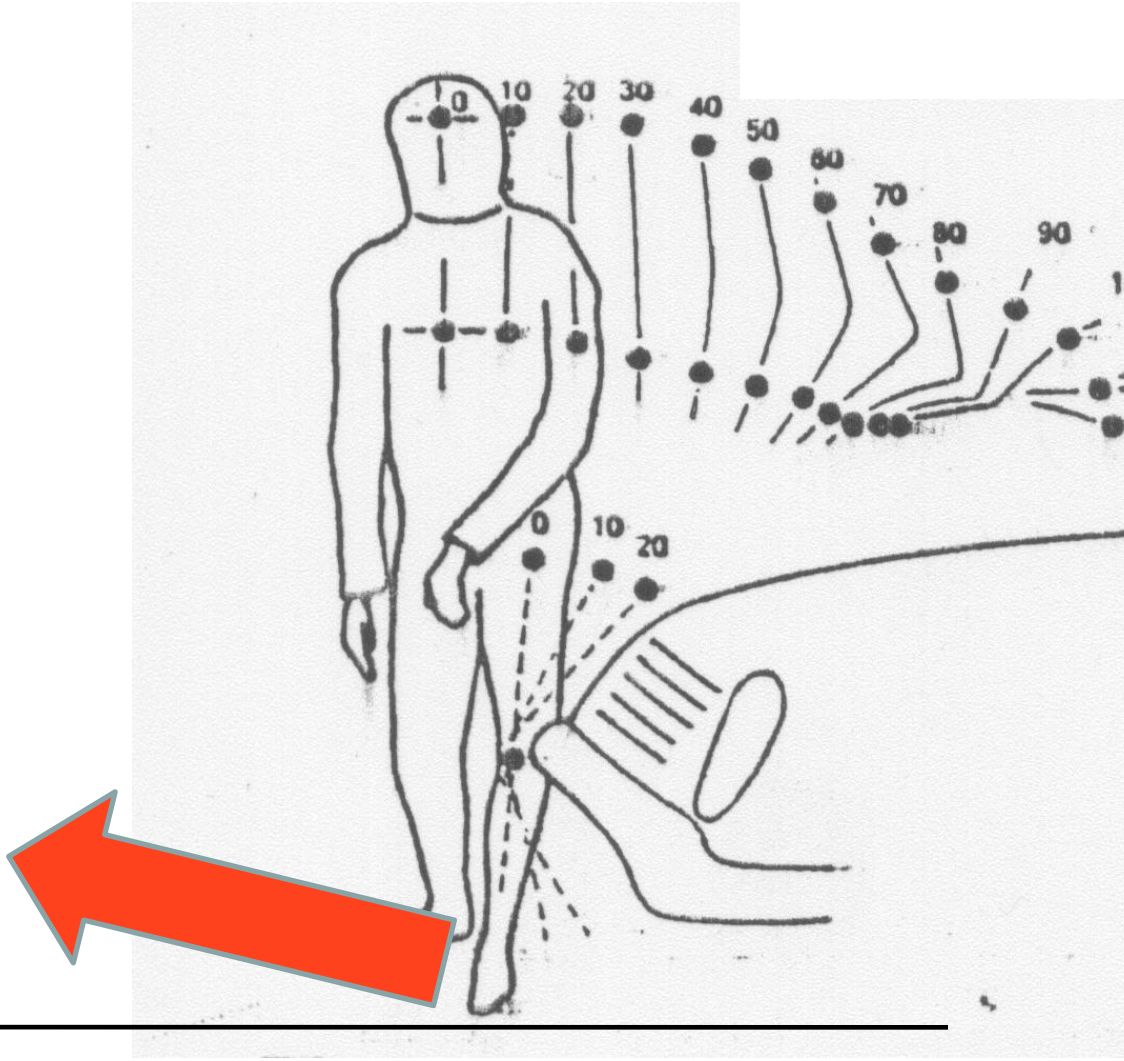

…the shoes may be
thrown forward by
contact with the vehicle


ROUGH DIAGRAM
DELINEATOR FOR WEIGHT (TIRE SIDEWALL)
N
BLOOD
#1
ITEMS "A" THRU "D" ARE SHOES
3RD. AVE.
TRAFFIC DELINEATORS (BARRELS)
"A"
"C"
"B"
"D"
SHOES
BLDG LINE
MEDIAN
PEDESTRIAN SIGNALS
UNLIT STREET LIGHT MOUNTED UNDER BRE
46 ST
ONE WAY
OVERHEAD ROADWAY EXTENDS OUTWARD
POI
STREET LIGHT INTERMITTENT



Rosa Cintron

SHOE IS THROWN



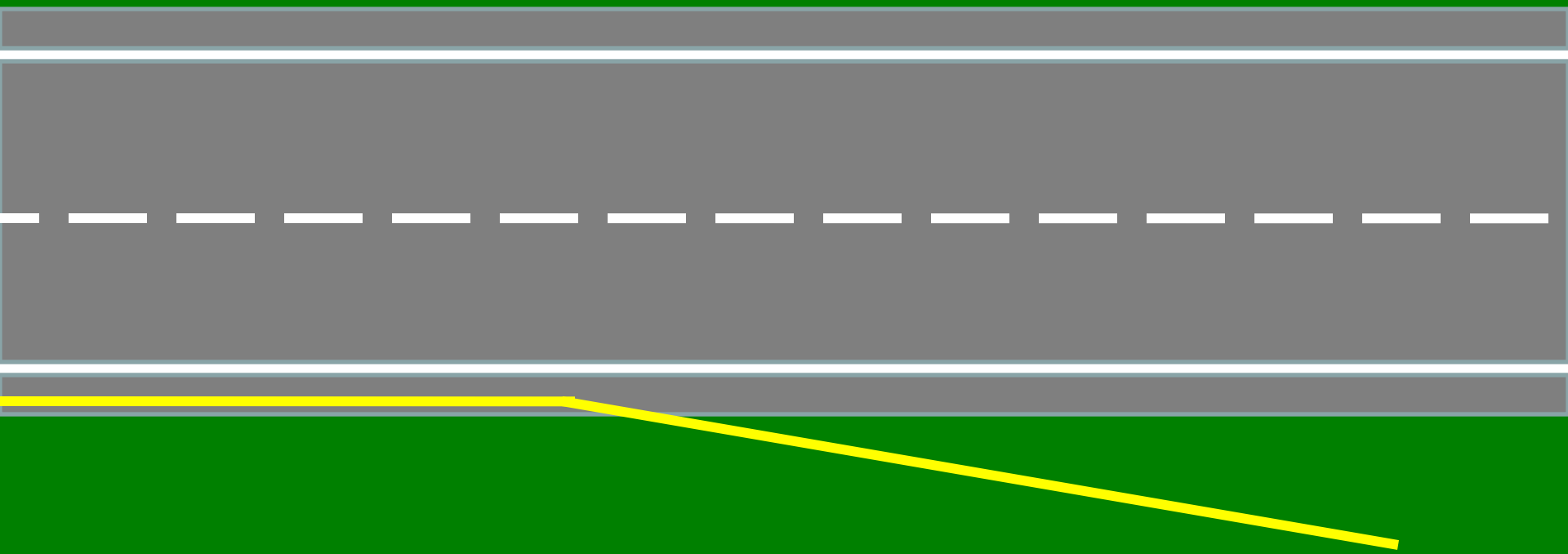
Defense expert report:

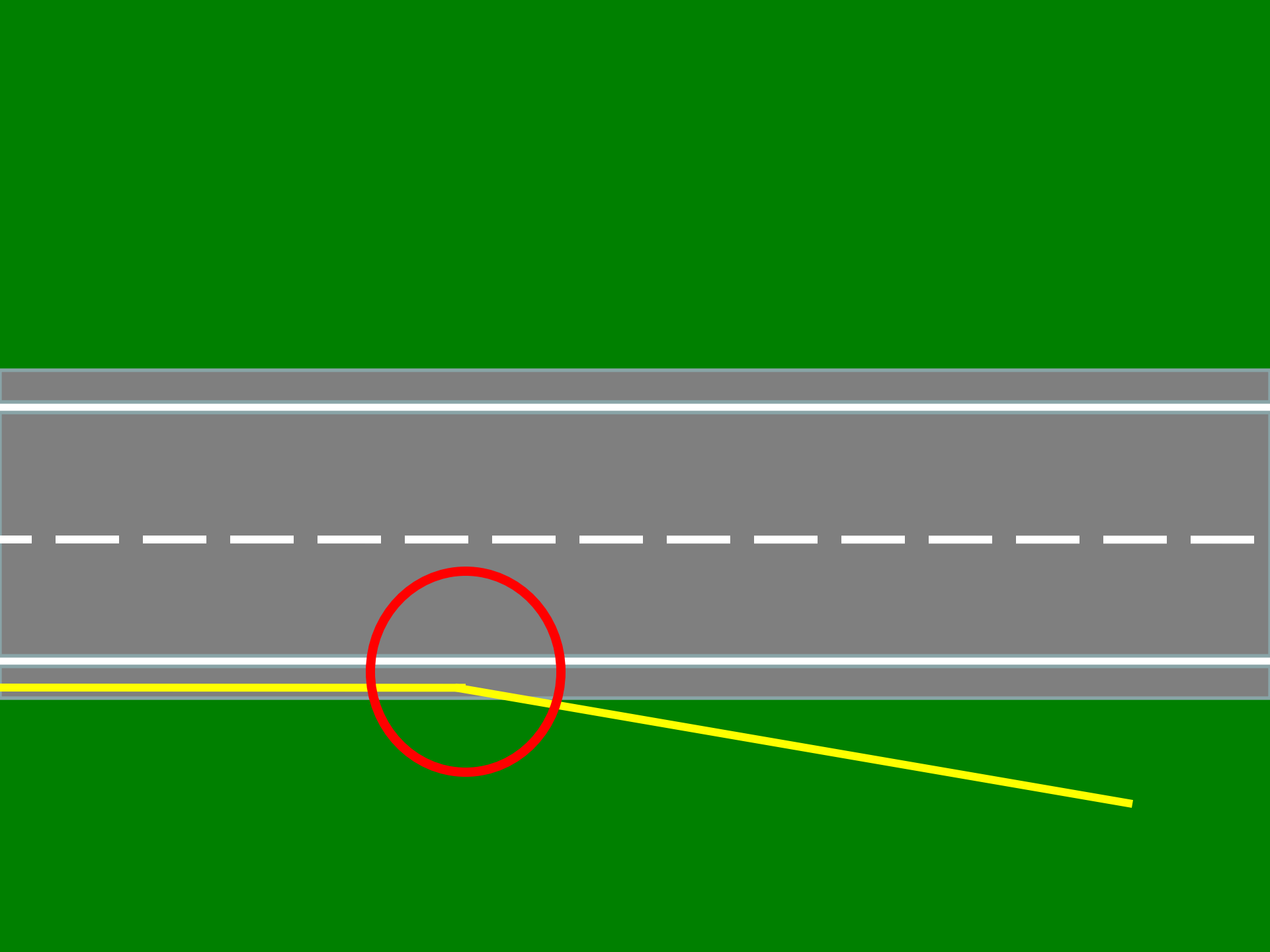
“The point of impact can be
determined ... wh... th... first
shoe is fo... ...rian
is usua...
shoes b... ...ar.”

BULLSCHTEIN

Garmin Forerunner 210 sport watch

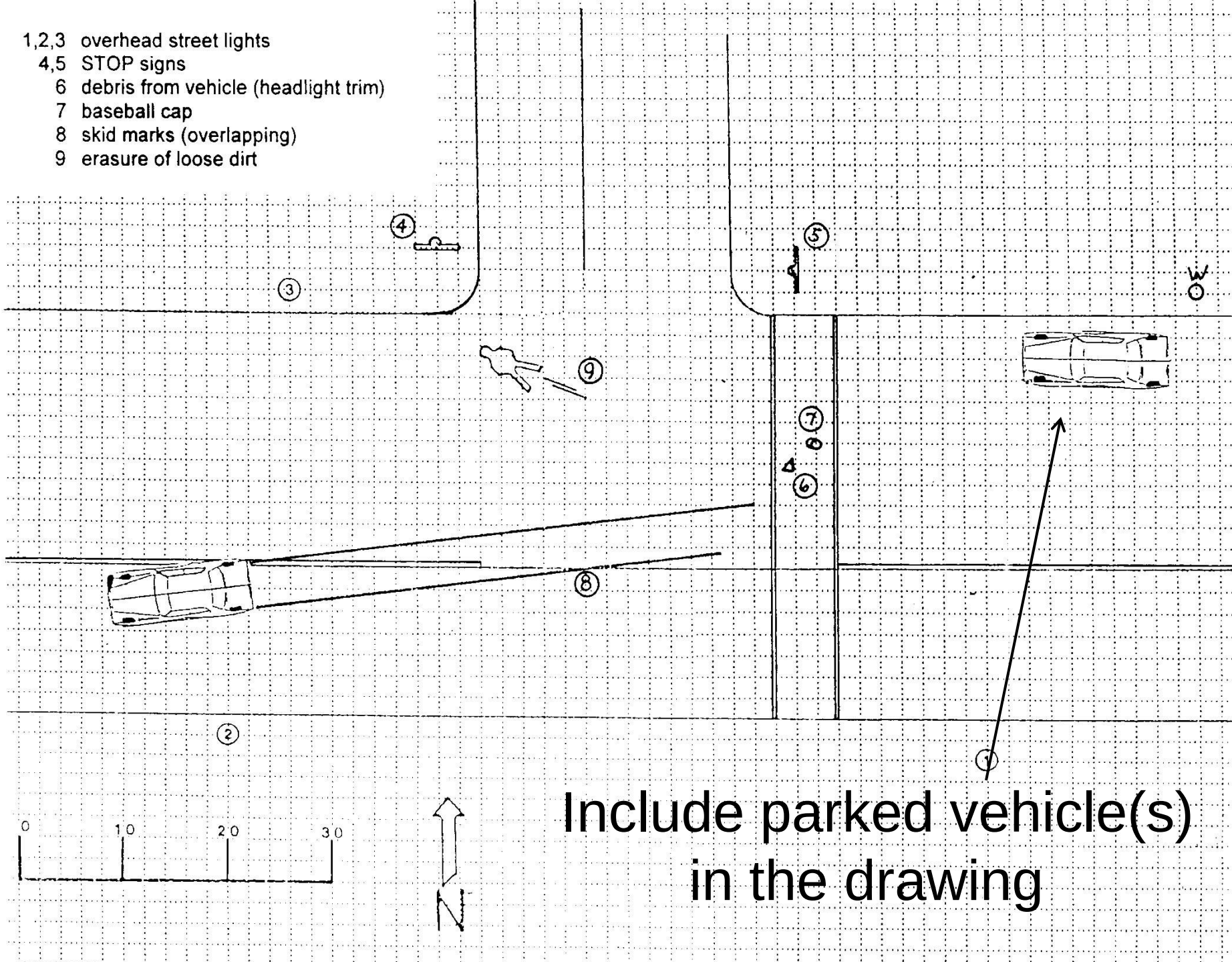
180 hr memory
USB connect to computer


Path of pedestrian



HOW DID THE PEDESTRIAN GET THERE ?

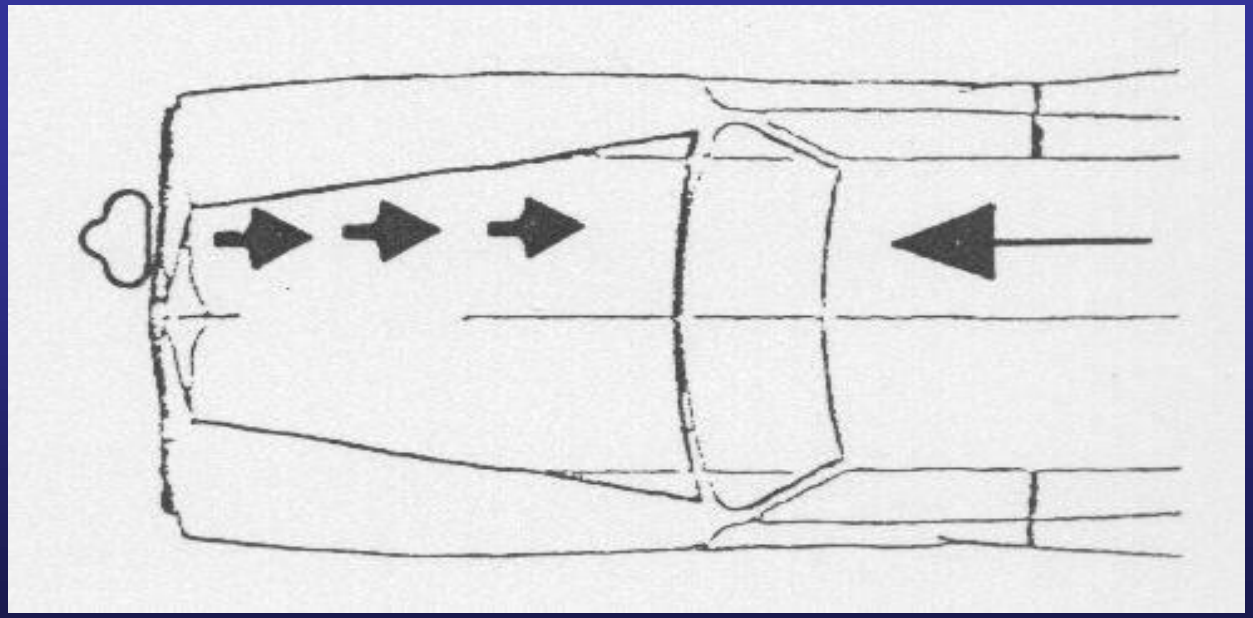
- EYE WITNESSES
- PATH OF PEDESTRIAN
- PEDESTRIAN INJURIES
- WALKING SPEED OF PEDESTRIAN
- PARKED VEHICLES ?


1,2,3 overhead street lights
4,5 STOP signs
6 debris from vehicle (headlight trim)
7 baseball cap
8 skid marks (overlapping)
9 erasure of loose dirt
0
10
20
30
N
Include parked vehicle(s) in the drawing

HOW DID THE PED GET THERE?

Pedestrian walking parallel to path of car, or

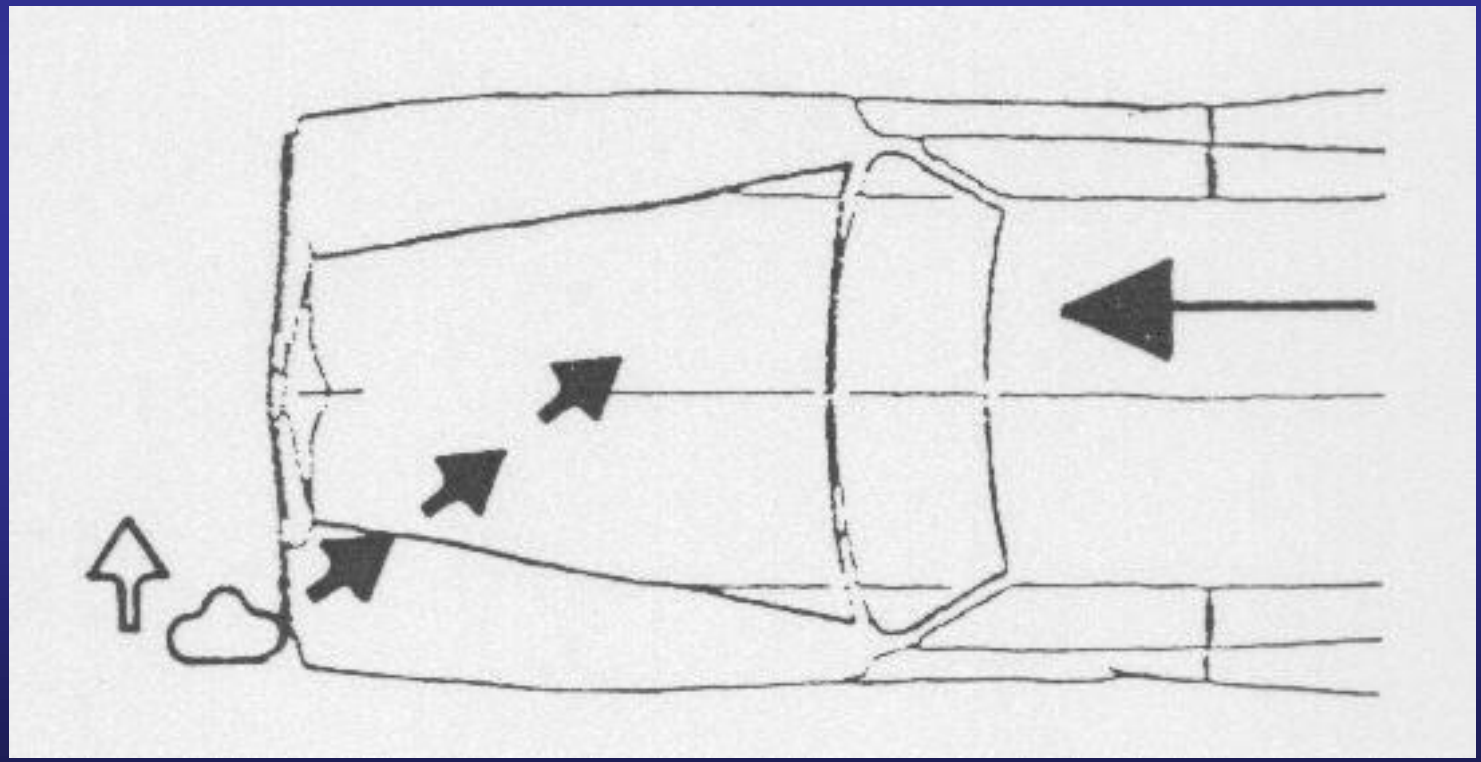
pedestrian stationary when struck

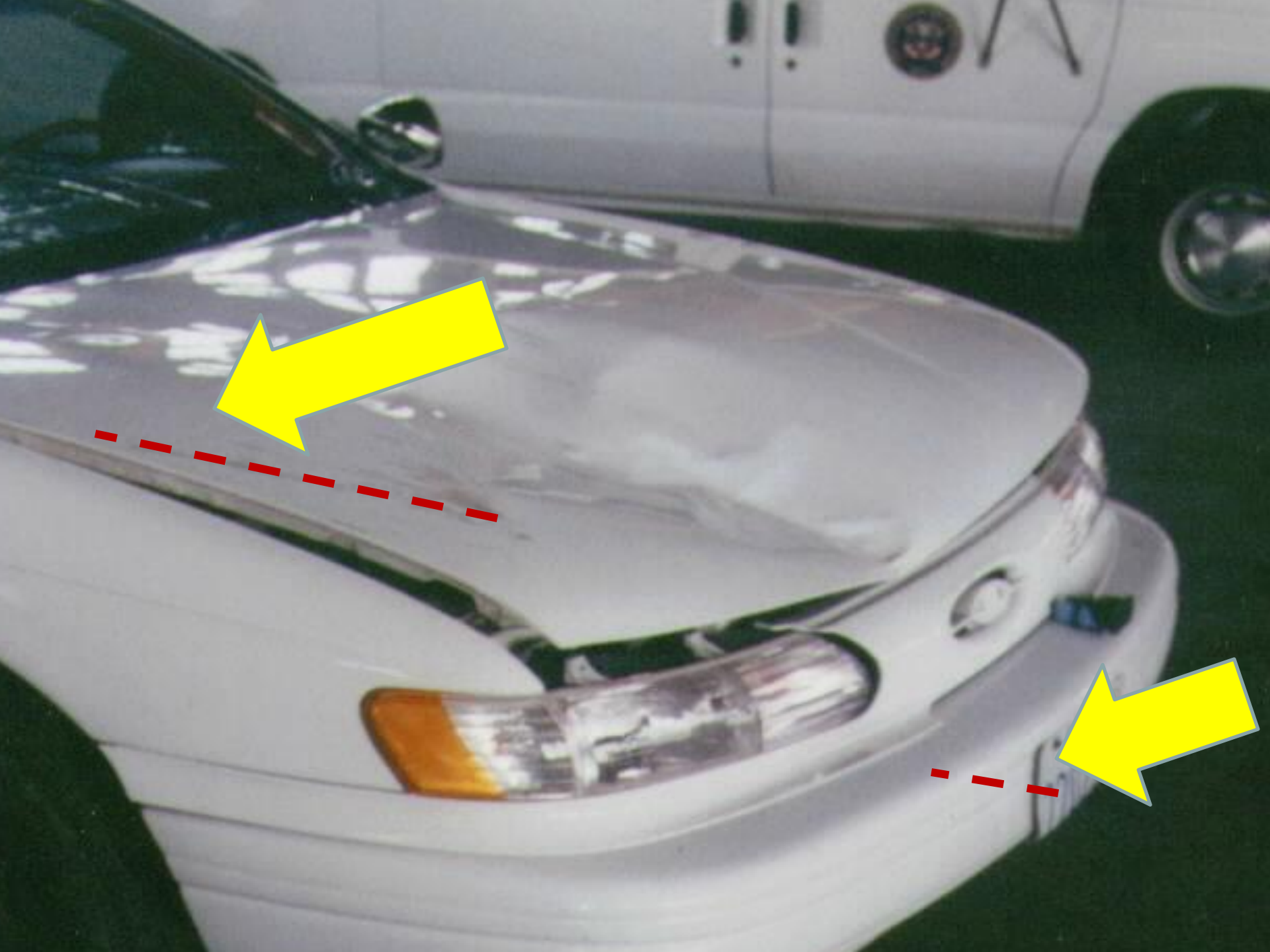


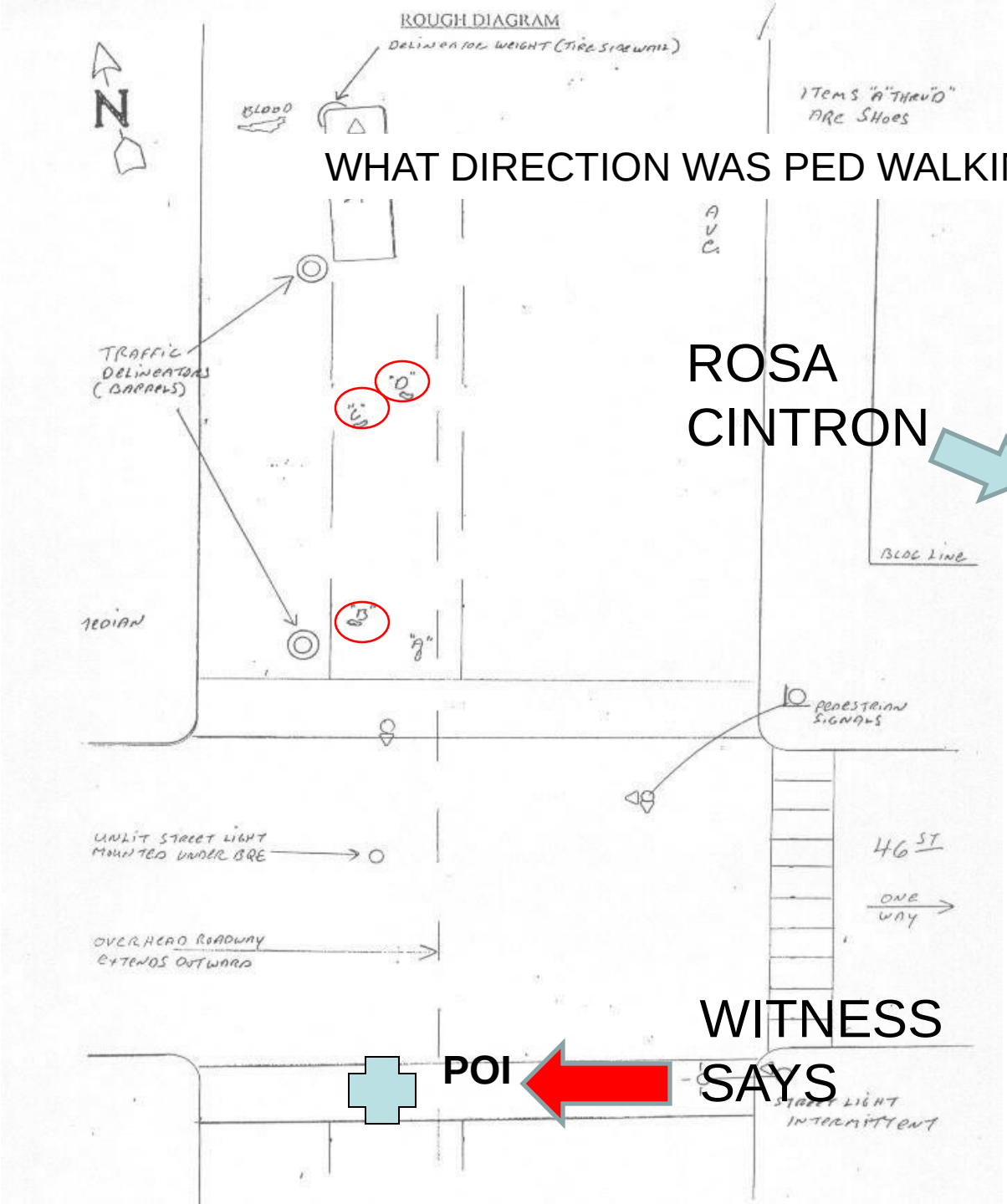
In line damages

HOW DID THE PED GET THERE?

Pedestrian crossing the path of the car






ROUGH DIAGRAM
DELINEATOR FOR WEIGHT (TIRE SIDEWALL)
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ITEMS "A" THRU "D" ARE SHOES
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WHAT DIRECTION WAS PED WALKING?
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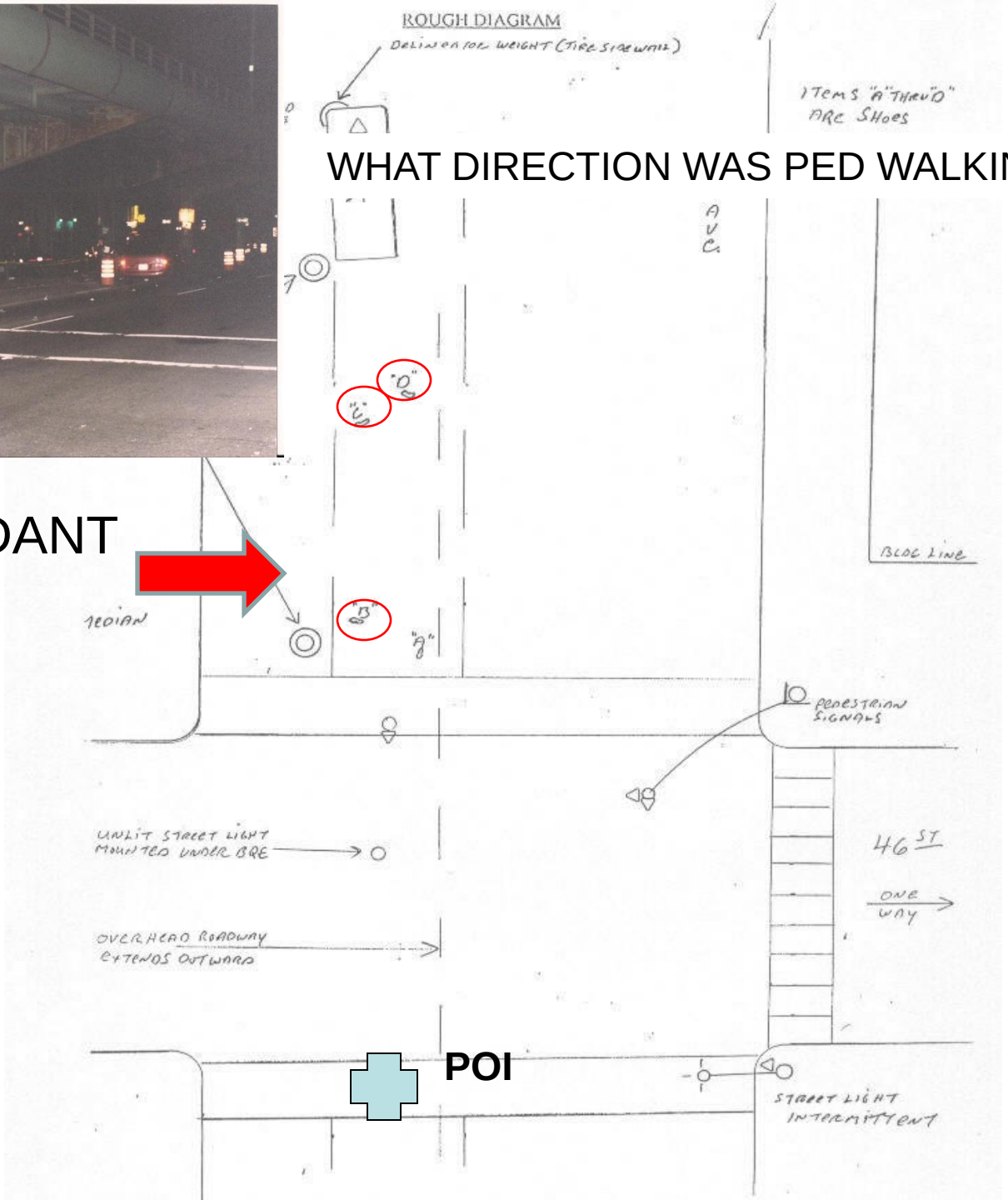
OVERHEAD ROADWAY EXTENDS OUTWARD
WITNESS SAYS
POI
STREET LIGHT INTERMITTENT



DEFENDANT SAYS

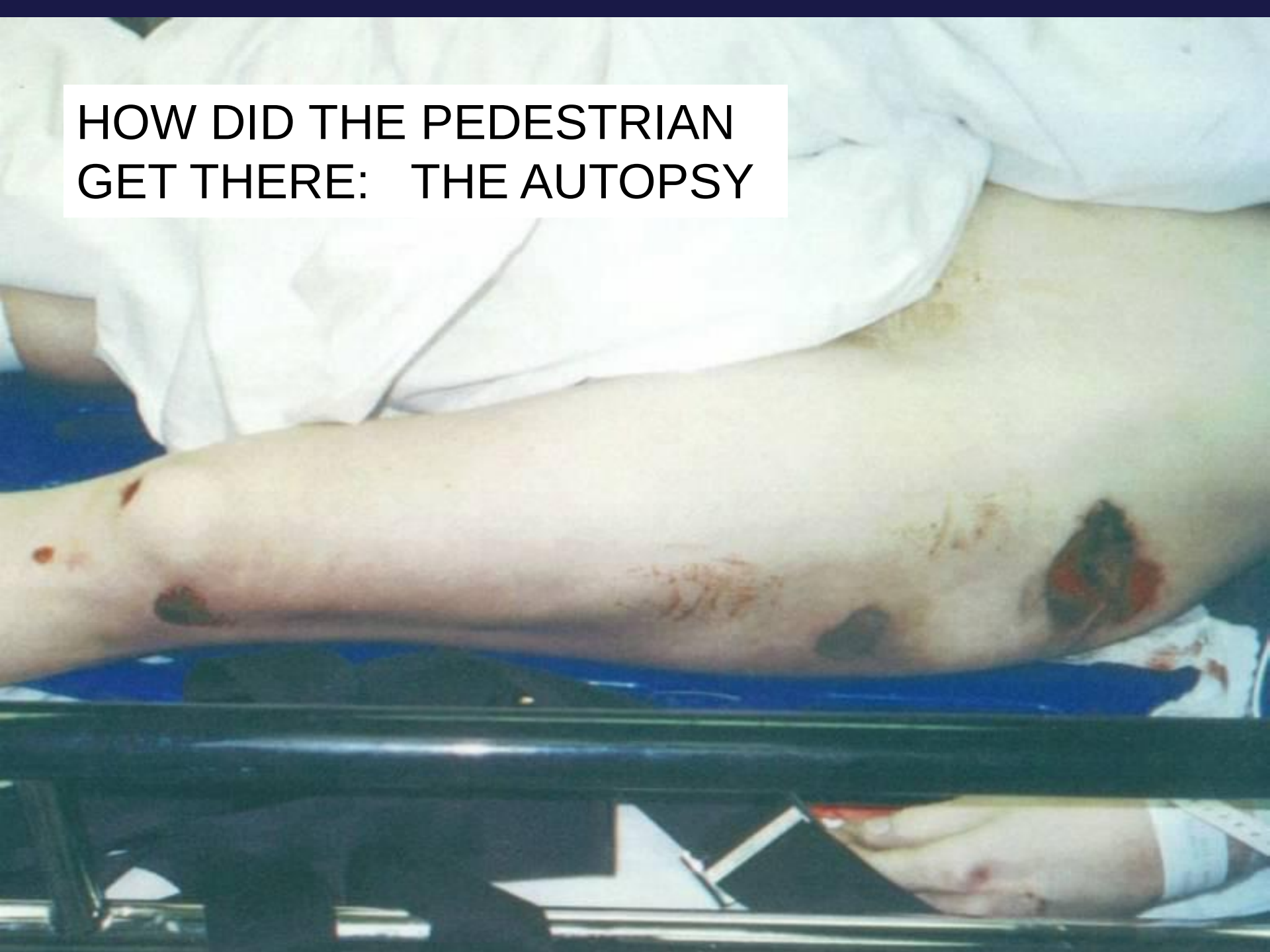

scrapes on bumper


scrapes on bumper

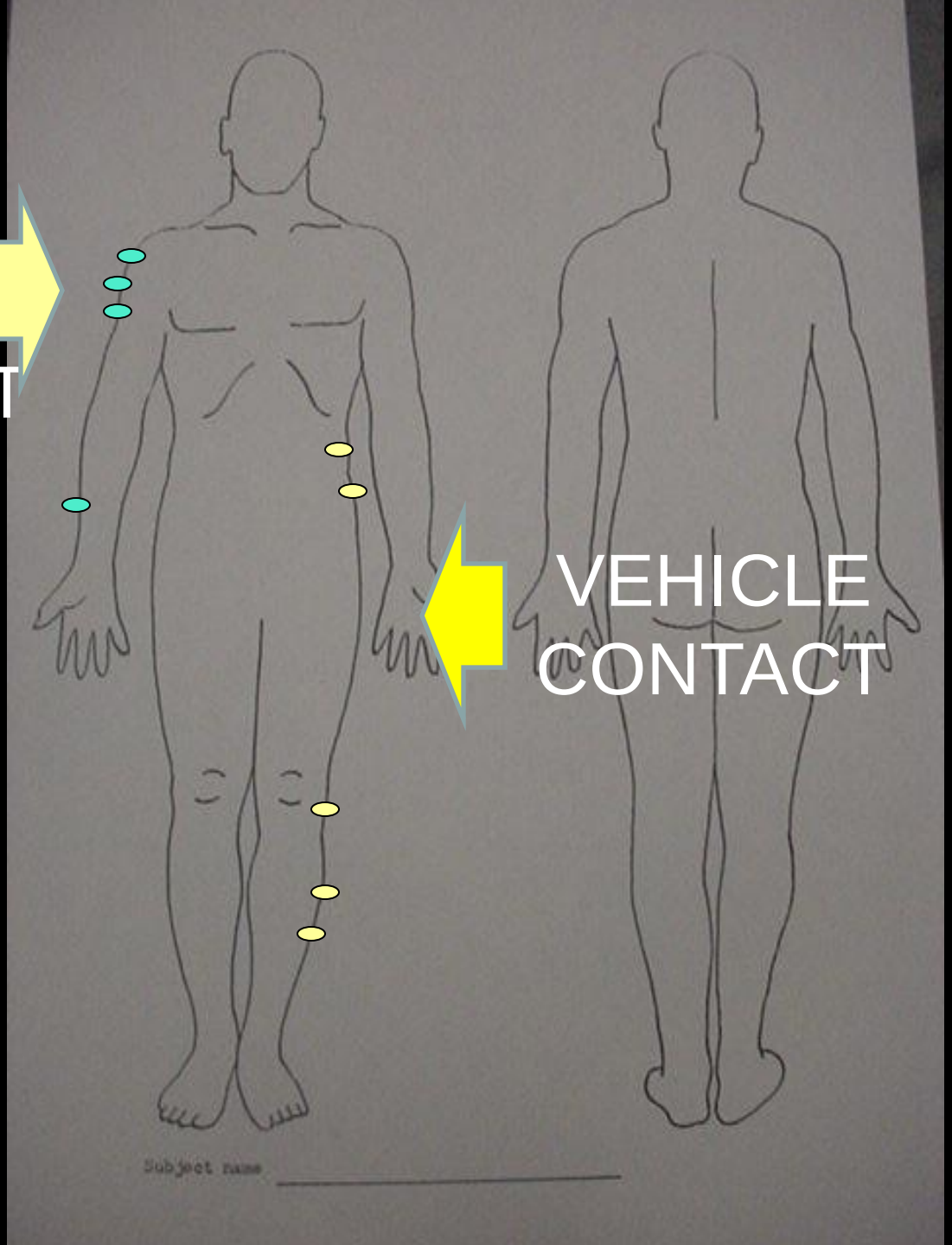

01P01422

The medical examiner or forensic pathologist may be a valuable witness.

HOW DID THE PEDESTRIAN GET THERE: THE AUTOPSY



ROAD CONTACT



VEHICLE CONTACT

CSI

How much time did it take for the pedestrian to reach the POI (AOI) ?

(pedestrian walking speed)

Walking speeds (ft/sec) for 30 yr old males:

	LOW (10^{TH} %ile)	HIGH (90^{TH} %ile)
Hermance	4.80	6.50
Thompson	3.39	5.53
Eubanks	4.60	5.80
Boise State U.	4.21	6.53
San Diego	4.80	6.50

?

5.8 ft/sec ← 90th percentile value

5.6 ft/sec

5.4 ft/sec

5.3 ft/sec

5.2 ft/sec

5.2 ft/sec

5.1 ft/sec

4.6 ft/sec ← 10th percentile value

?

?

5.8 ft/sec ← 90th percentile value

5.6 ft/sec

5.4 ft/sec

5.3 ft/sec

5.2 ft/sec

5.2 ft/sec

5.1 ft/sec

4.6 ft/sec ← 10th percentile value

?

20% fall outside the published range

Walking speeds (ft/sec) for 30 yr old males:

THERE IS NO SINGLE NUMBER FOR A HUMAN FACTOR.

		HIGH
He[illegible]	4.80	6.50
[illegible]	3.39	5.53
[illegible]nks	4.60	5.80
Boise State U.	4.21	6.53
San Diego	4.80	6.50

ALWAYS USE A

RANGE of values

Def expert will pick a single value!

WHAT WAS THE VEHICLE SPEED ?

TIRE MARK EVIDENCE (BRAKING)

INJURIES (forensic pathologist)

THROW OF PEDESTRIAN BODY

HEAD STRIKE ON VEHICLE ???

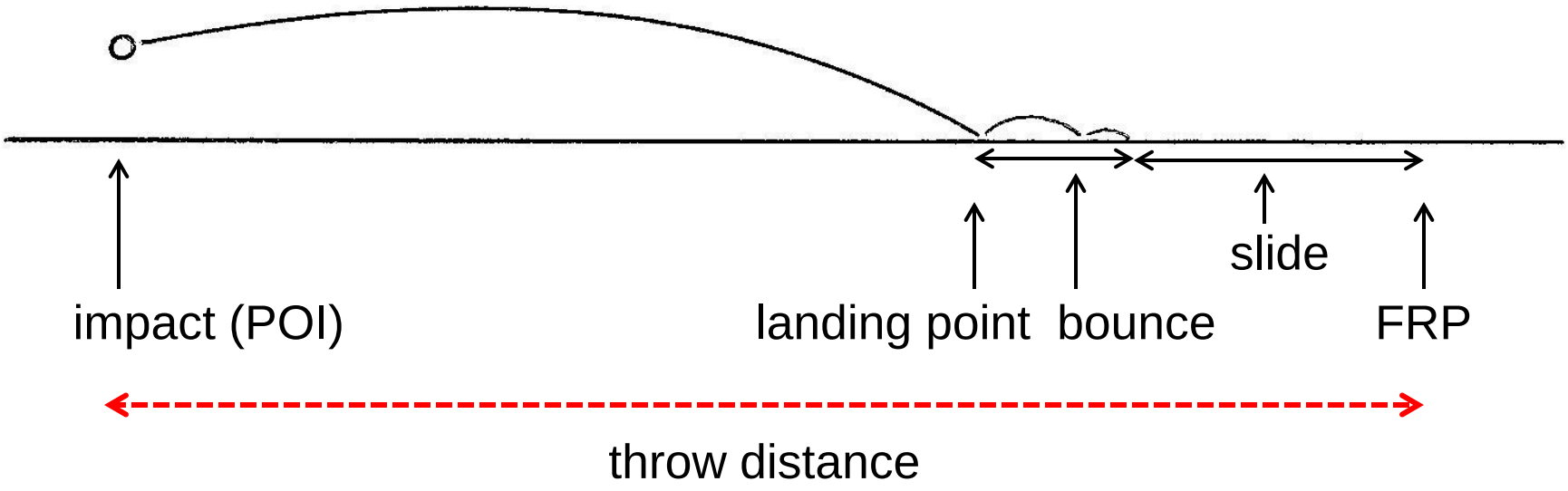
EVENT DATA RECORDER (“black box”)

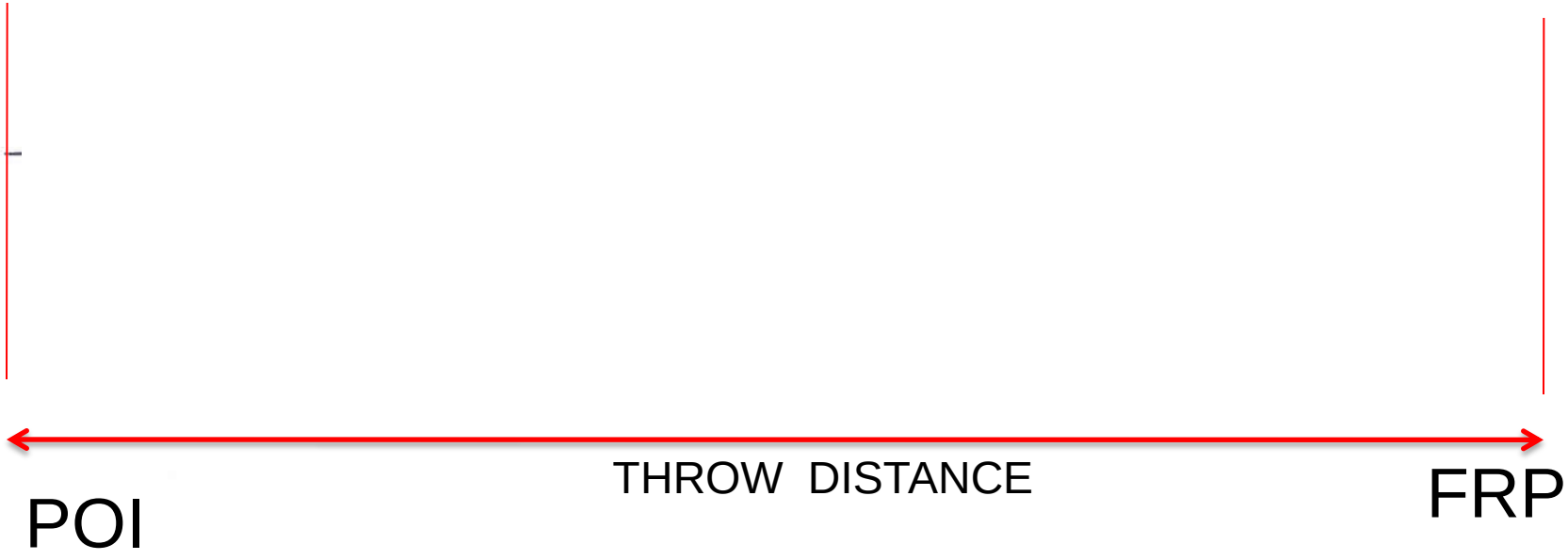
THROW OF THE PEDESTRIAN'S BODY

Basic theory: The faster the striking vehicle speed, the farther the body will be thrown.

..\..\Video clips\toll booth.wmv

Trajectory of pedestrian's body



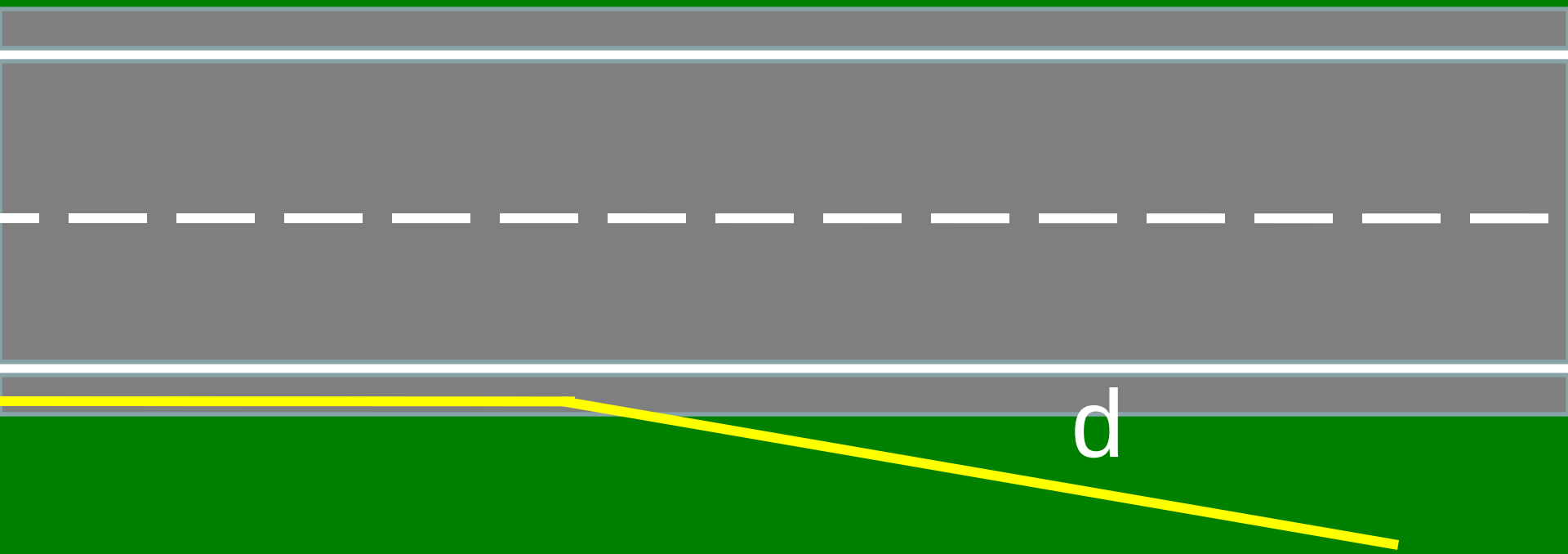

THROW DISTANCE
POI
FRP

The POI may be challenged

The FRP of the pedestrian may be challenged.

Garmin Forerunner 210 sport watch

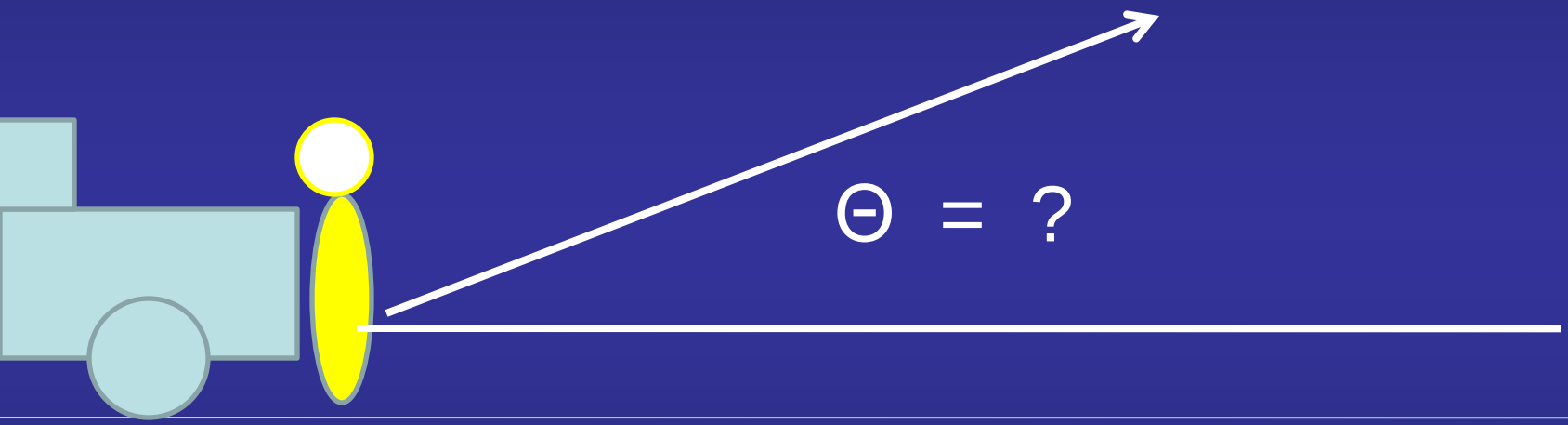
Throw distance from GPS data?



Path of pedestrian

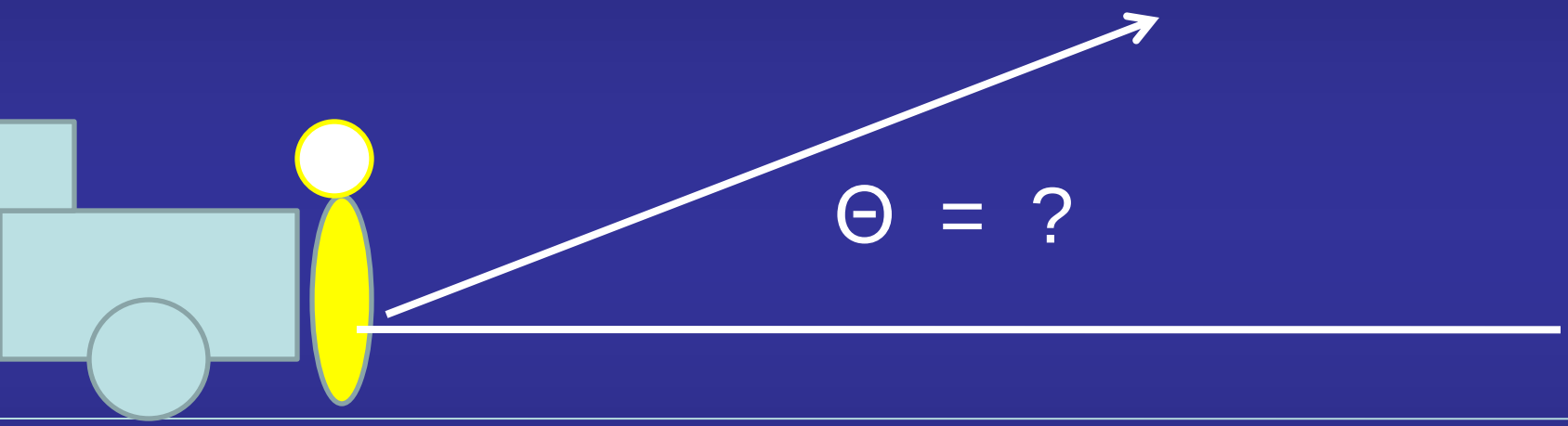

DANGER
MATH
ANXIETY
AHEAD

$$V = \frac{\sqrt{2 f g d}}{\cos \Theta + (f \sin \Theta)}$$



GENERAL FORM OF THE SEARLE EQUATION, 1983

$$V = \frac{\sqrt{2 f g d}}{\cos \Theta + (f \sin \Theta)}$$



THE THROW MUST BE UNINTERRUPTED

The general form of the Searle equation can be solved for a

MINIMUM SPEED

MAXIMUM SPEED

$$V_{min} = \sqrt{\frac{2 f g d}{1 + f^2}}$$

$$V_{max} = \sqrt{2 f g d}$$

$V_{min} = \sqrt{2 f}$

WRAP and FORWARD PROJECTION

$V_{max} = \sqrt{2 f g d}$

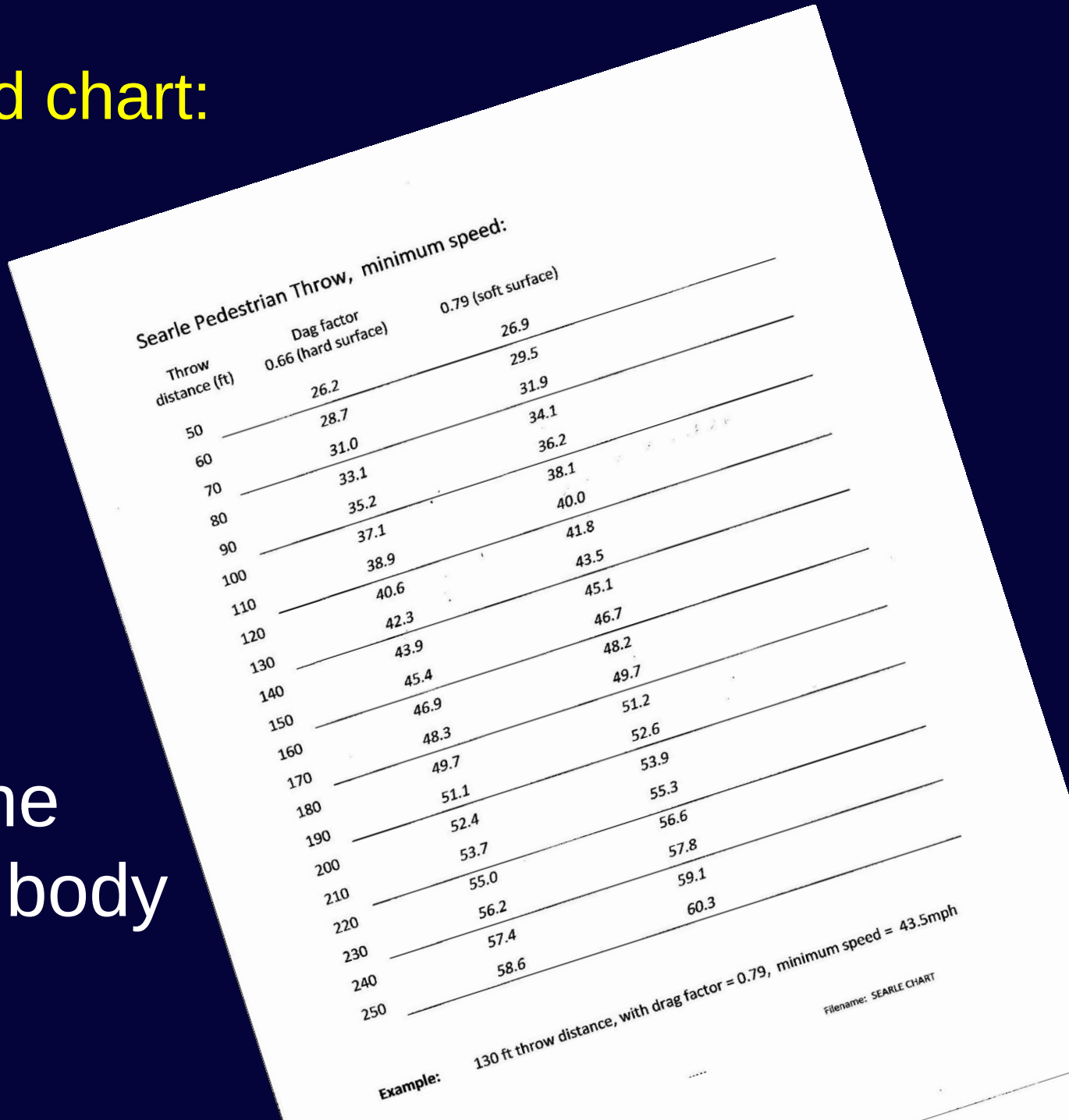
drag factor values from literature:

- Stcherbatcheff (combined air/ground) .40 – 71
  Collins .80
- Searle .66 - .79
- Limpert .7 – 1.2
- Eubanks, p. 93
- Becke
- Sch
- 1.1

For the Searle equation:
f = 0.66 hard surface
f = 0.79 soft surface

Searle Speed chart:

Speed of the pedestrian body



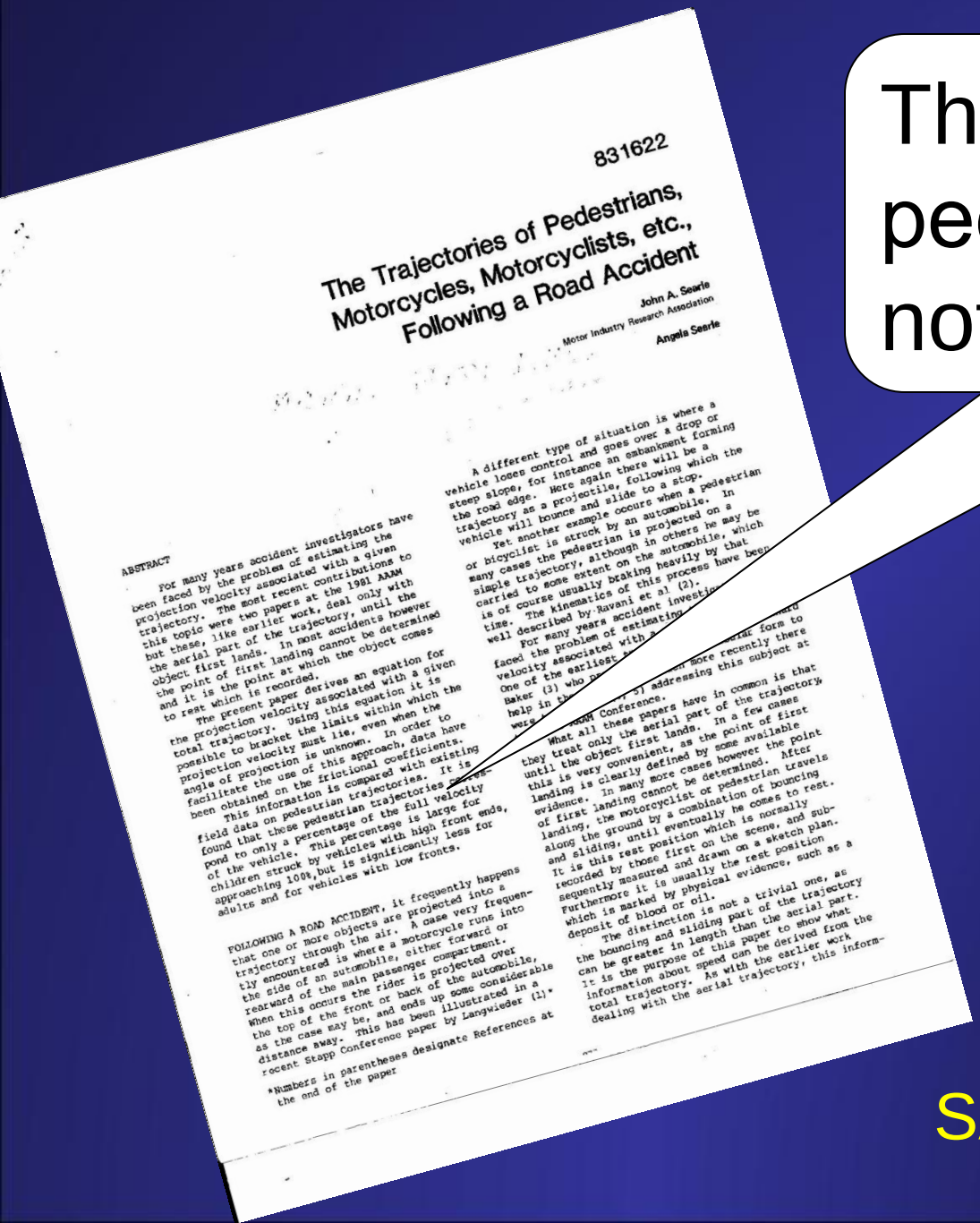
Searle Pedestrian Throw, minimum speed:

Throw distance (ft)	Dag factor 0.66 (hard surface)	0.79 (soft surface)
50	26.2	26.9
60	28.7	29.5
70	31.0	31.9
80	33.1	34.1
90	35.2	36.2
100	37.1	38.1
110	38.9	40.0
120	40.6	41.8
130	42.3	43.5
140	43.9	45.1
150	45.4	46.7
160	46.9	48.2
170	48.3	49.7
180	49.7	51.2
190	51.1	52.6
200	52.4	53.9
210	53.7	55.3
220	55.0	56.6
230	56.2	57.8
240	57.4	59.1
250	58.6	60.3

Example: 130 ft throw distance, with drag factor = 0.79, minimum speed = 43.5mph

Filename: SEARLE CHART

[..\..\Video clips\ped forward proj.wmv]



831622

The Trajectories of Pedestrians, Motorcycles, Motorcyclists, etc., Following a Road Accident

John A. Searle
Motor Industry Research Association
Angela Searle

ABSTRACT

For many years accident investigators have been faced by the problem of estimating the projection velocity associated with a given trajectory. The most recent contributions to this topic were two papers at the 1981 AAAM but these, like earlier work, deal only with the aerial part of the trajectory, until the object first lands. In most accidents however the point of first landing cannot be determined and it is the point at which the object comes to rest which is recorded.

The present paper derives an equation for the projection velocity associated with a given total trajectory. Using this equation it is possible to bracket the limits within which the projection velocity must lie, even when the angle of projection is unknown. In order to facilitate the use of this approach, data have been obtained on the frictional coefficients. This information is compared with existing field data on pedestrian trajectories. It is found that these pedestrian trajectories correspond to only a percentage of the full velocity of the vehicle. This percentage is large for children struck by vehicles with high front ends, approaching 100%, but is significantly less for adults and for vehicles with low fronts.

FOLLOWING A ROAD ACCIDENT, it frequently happens that one or more objects are projected into a trajectory through the air. A case very frequently encountered is where a motorcycle runs into the side of an automobile, either forward or rearward of the main passenger compartment. When this occurs the rider is projected over the top of the front or back of the automobile, as the case may be, and ends up some considerable distance away. This has been illustrated in a recent Stapp Conference paper by Langwieder (1)*

*Numbers in parentheses designate References at the end of the paper

A different type of situation is where a vehicle loses control and goes over a drop or steep slope, for instance an embankment forming the road edge. Here again there will be a trajectory as a projectile, following which the vehicle will bounce and slide to a stop.

Yet another example occurs when a pedestrian or bicyclist is struck by an automobile. In many cases the pedestrian is projected on a simple trajectory, although in others he may be carried to some extent on the automobile, which is of course usually braking heavily by that time. The kinematics of this process have been well described by Navani et al (2).

For many years accident investigators have faced the problem of estimating the velocity associated with a given [illegible]. One of the earliest [illegible] Baker (3) who [illegible] help in the [illegible] were [illegible] more recently there [illegible] addressing this subject at [illegible] Conference.

What all these papers have in common is that they treat only the aerial part of the trajectory, until the object first lands. In a few cases this is very convenient, as the point of first landing is clearly defined by some available evidence. In many more cases however the point of first landing cannot be determined. After landing, the motorcyclist or pedestrian travels along the ground by a combination of bouncing and sliding, until eventually he comes to rest. It is this rest position which is normally recorded by those first on the scene, and subsequently measured and drawn on a sketch plan. Furthermore it is usually the rest position which is marked by physical evidence, such as a deposit of blood or oil.

The distinction is not a trivial one, as the bouncing and sliding part of the trajectory can be greater in length than the aerial part. It is the purpose of this paper to show what information about speed can be derived from the total trajectory. As with the earlier work dealing with the aerial trajectory, this inform-

The speed is for the pedestrian's body, not the vehicle.

SAE # 831622

CRASH TESTS: 1983 - 1993

Field studies of pedestrian impacts (Aronberg, Bratten, Appel, etc.)

Each researcher developed an equation, based on the empirical data.

1993 – Searle validates his equation with the other researchers' data

SAE 2014-01-470 “Pedestrian Impact on Low Friction Surfaces”

The tests were done on snow or icy surfaces with *low f values*.

97 test collisions

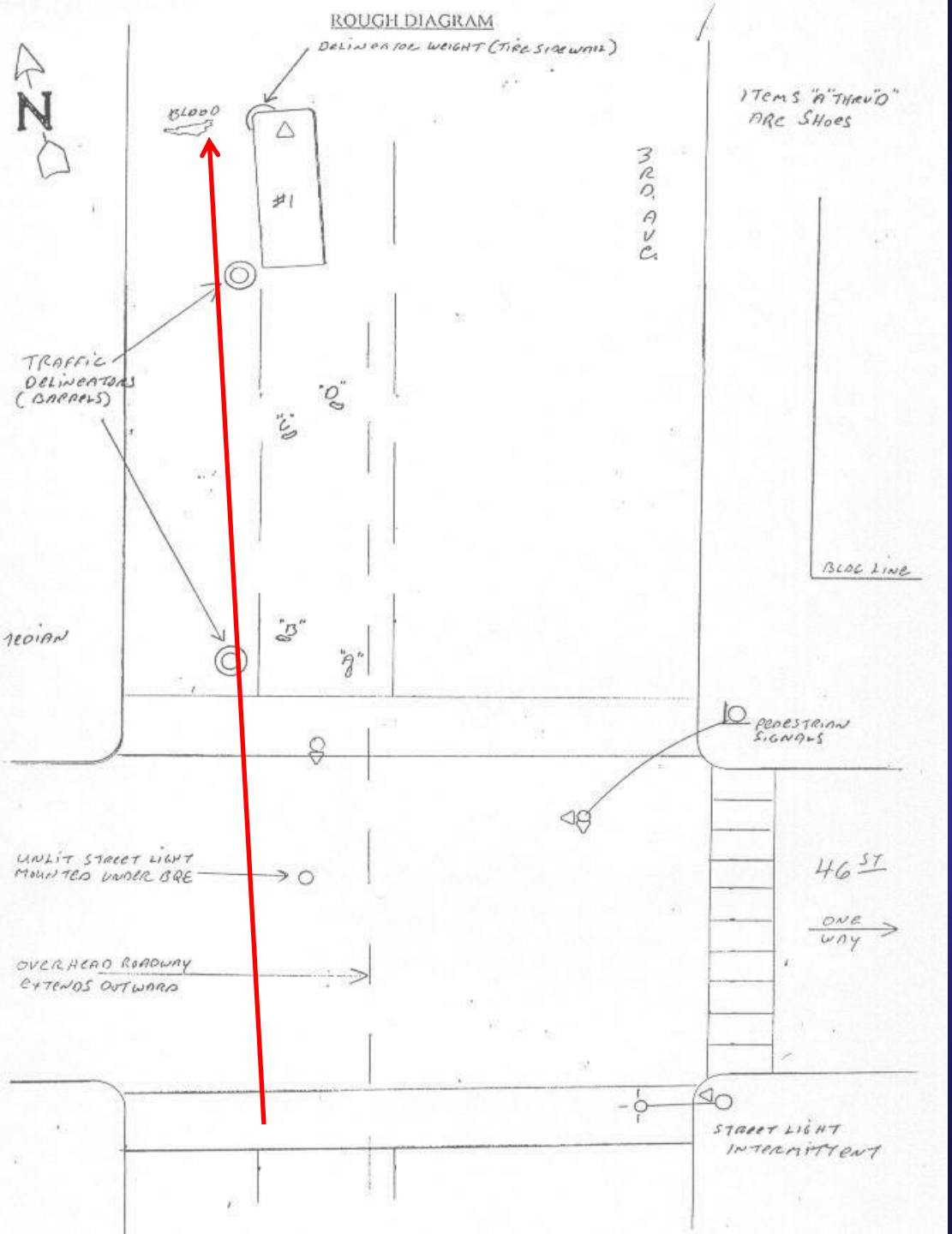
Searle calculation validated in every test

Validation of pedestrian throw equations:

- Using video of pedestrian collisions
- Videos show throw equations are valid

Forensic Science International, Volume 257, Dec 2015, pp. 409-412

Back to the case in Brooklyn


ROUGH DIAGRAM
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BLOOD
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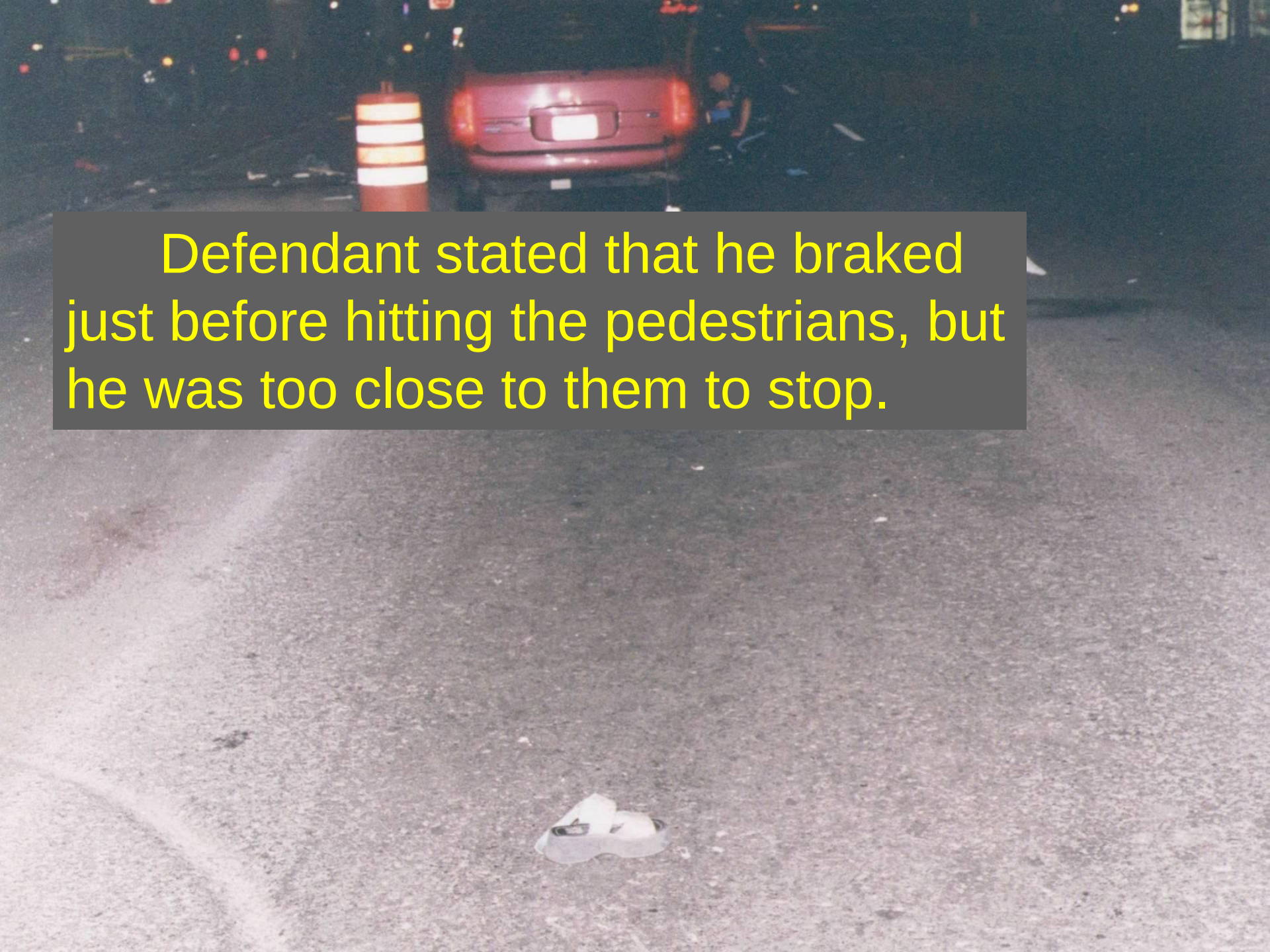
PEDESTRIAN SIGNALS
UNLIT STREET LIGHT MOUNTED UNDER BRE
46 ST
ONE WAY
OVERHEAD ROADWAY EXTENDS OUTWARD
STREET LIGHT INTERMITTENT

Speed from throw distance: (*without the math*)

Appel	55.0 mph
Searle	54.2 mph
Sterbatchoff	49.2 mph
Wood	53.8 mph
Bratten	51.3 mph
Limpert	54.2 mph


Defendant stated that he braked just before hitting the pedestrians, but he was too close to them to stop.

Speed from throw distance: (*without the math*)

Appel	55.0 mph
Searle	54.2 mph
Sterbatchoff	49.2 mph
Wood	53.8 mph
Bratten	51.3 mph
Limpert	54.2 mph

Speed from braking distance	52.4 mph

RESULT ONE:

DEFENSE EXPERT DID NOT TESTIFY

RESULT TWO:

NO CROSS EXAMINATION ON SPEED

RESULT THREE:

CONVICTION

Sent from the Internet (Details)

Sorry, this is my second request for info. Case going to trial soon!

I have a question for the group on a two pedestrian collision with one fatality. The police officer used the Searle Equation among others. He used a .66f
deceleration factor (reccommended by Searle) a 15 degree takeoff angle and a 125 and 163 foot impact to rest throw distance for the pedestrian. Using the Searle Equation he calculated a speed of 50 mph for the 163 foot distance and 44 mpf for the 125 foor diatance. He claimed that the Searle Equation reccommended between a 10 and 20 degree angle. According to Jerry Eubanks book (Pedestrian Accident Reconstruction and Litigation) a 33.4 degree angle is reccommended when using a .66f value to get minimum speed. There was no evidence of
braking (no skid marks) and exactly where impact took place (125 feet to 163 feet). He also reported other speeds as follows: Appel - 61 mph, Barzeley- 55 mph, and Collins 56 mph for the 163 foot distance and 54 mph, 47 mph, 49 mph respectfully for the 125 foot distance. It is unknown, but he probably used the same .66f for all the other equations that he used. This may be a mistake also. I don't know what he may have used for the pedestrian C/M.The pedestrians were impacted just as they stepped off of the center island. Impact occurred to the left of center of the vehicle (2000 BMW 328 ci. One head/windshield impact was low just left of center and the other was on the left A-Pillar at the roof line.

My question is: isn't the impact vehicle suppose to be braking in order to use the pedestrian formulas and if one does not have specific proof a takeoff angle shouldn't the angle that gives the lowest speed be used which in this case is 33.4 degrees? Just trying to get the driver's speed down a little" His minimum speed was calculated by police to be 44 mph. The speed limit for the roadway is 35 mph. The pedestrian who lived stated that they didn't see the vehicle before impact and both pedestrians were intoxicated. The driver was not under the influence.

You may also respond directly to my e-mail address.

Thanks for any assistance you can provide.

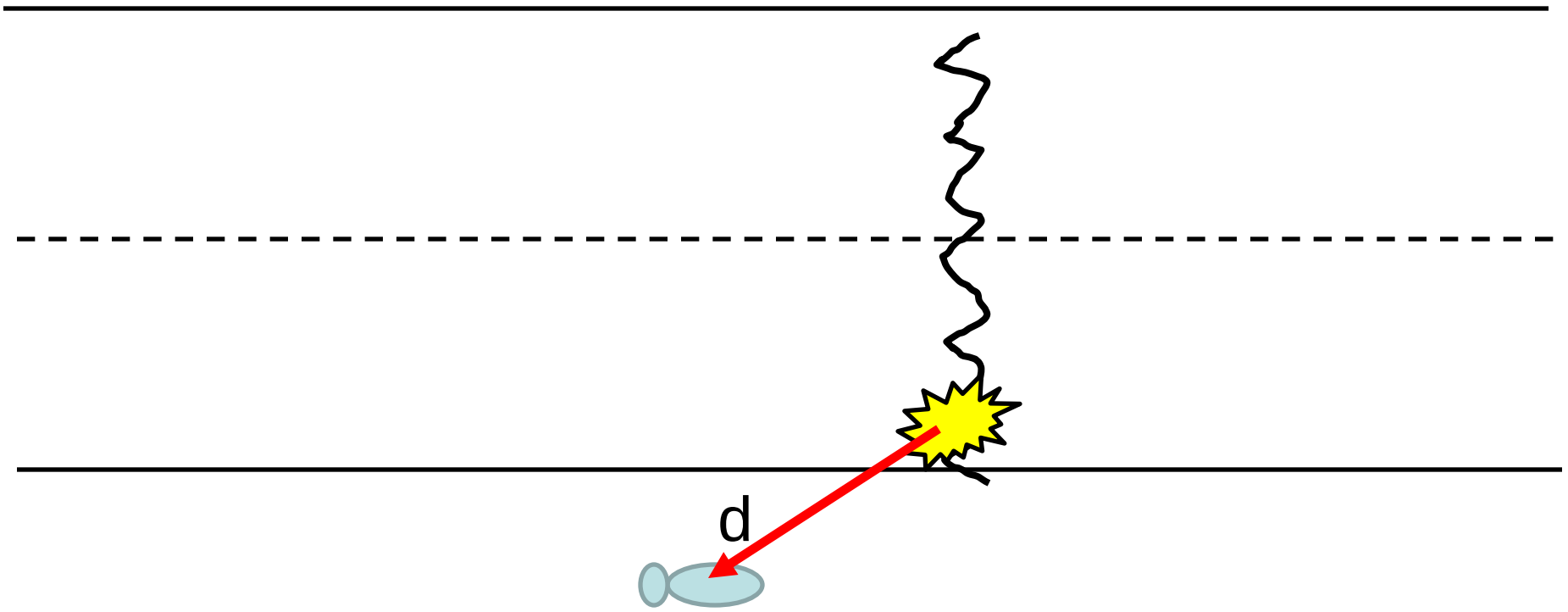
Just trying to get the driver's speed down a little.

[Non-text portions of this message have been removed]

Not a forward projection

..\..\Video clips\Deputy_hit.wmv

The evidence ***without*** the in-car video



$$V_{min} = \sqrt{\frac{2 f g d}{1 + f^2}} \qquad d \approx 15 \text{ ft}$$

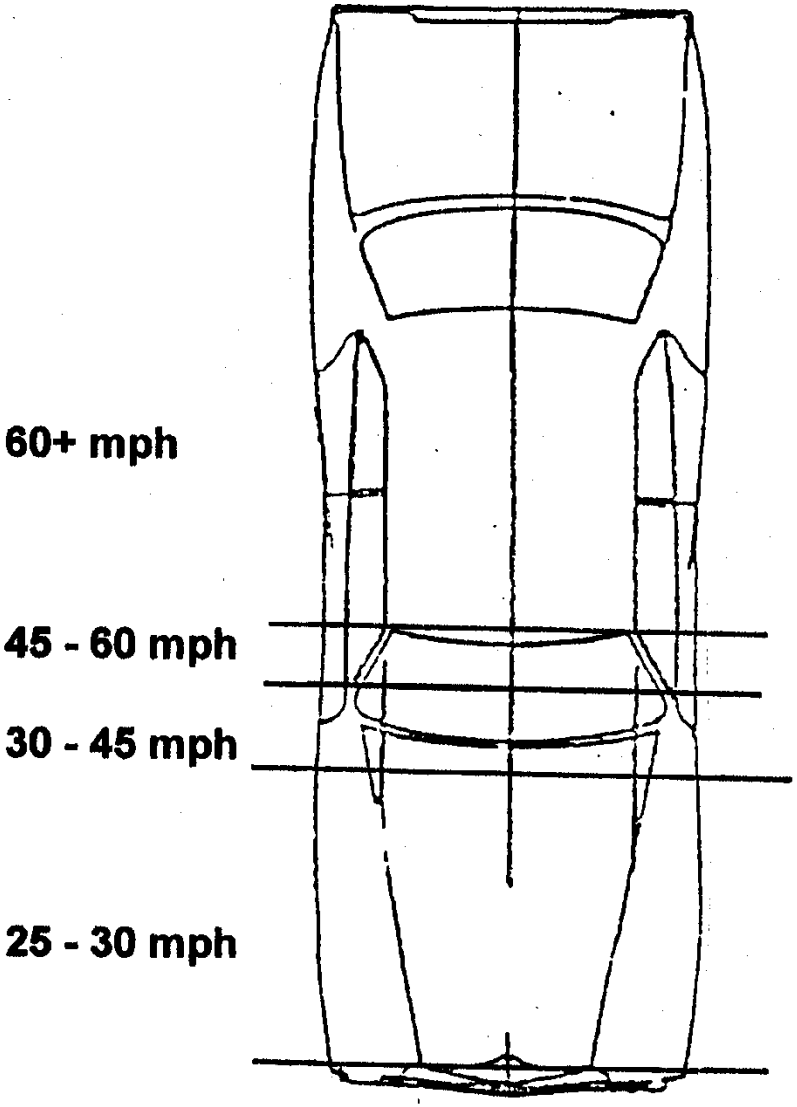
$$V_{min} = 22 \text{ ft/sec} = \mathbf{15 \text{ mph}}$$

DEFENSE:

EXPERT USES PUBLISHED CHART TO ESTIMATE DEFENDANT'S SPEED

PEDESTRIAN DYNAMICS:

Head Strike Locations v. Speed



CSI

Caviat:

"The head strike chart should never be used as the sole method of estimating vehicle speed."

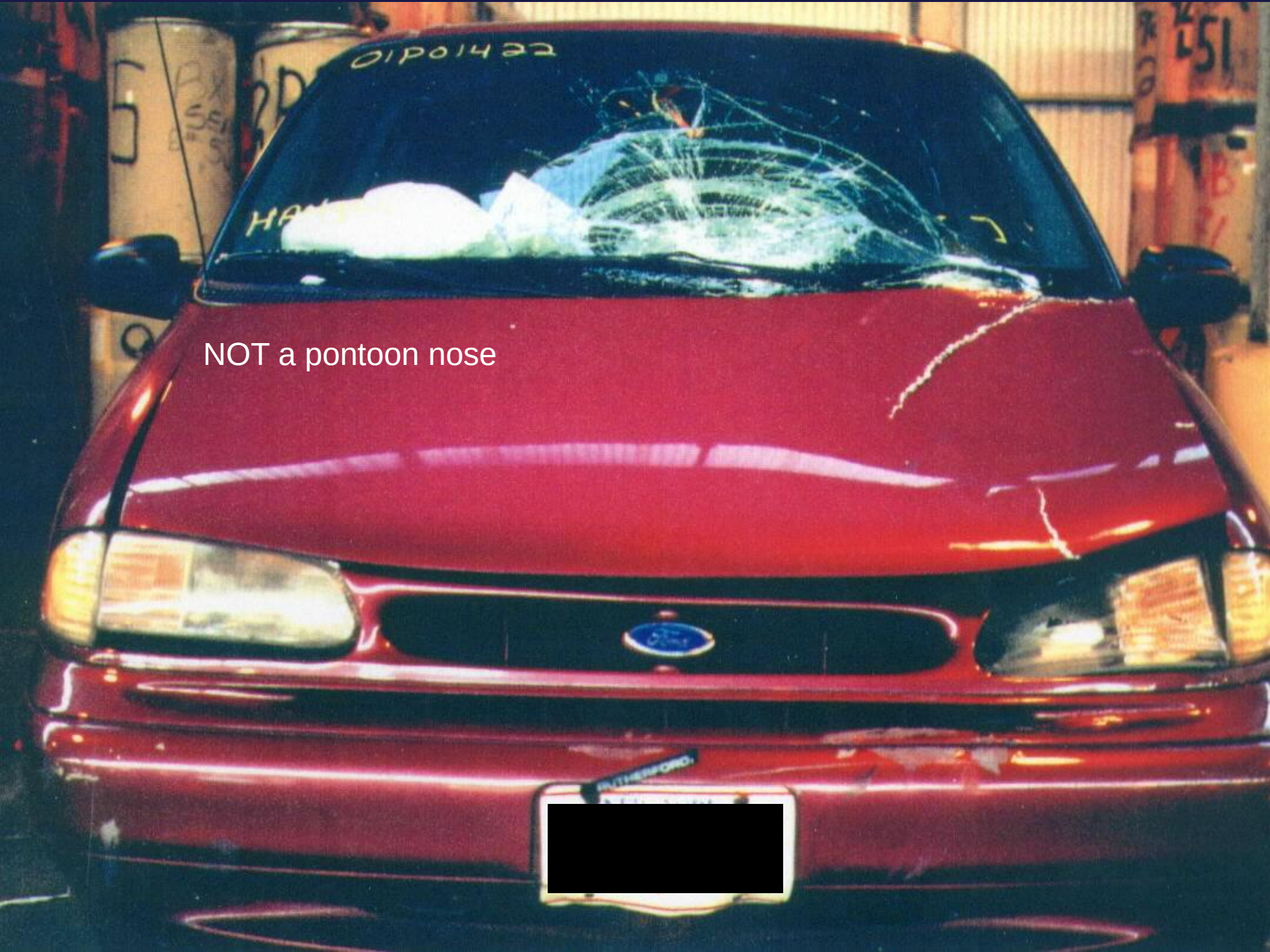
TESTING PARAMETERS:

TEST DUMMY IS 5’10.7” TALL

VEHICLE HAS PONTOON NOSE

Expert incorrectly applies head strike chart to estimate speed:

"Tests have indicated a head strike near the end of the hood/bottom of the windshield equates to a 25-30 mph impact speed. If I apply the general principle of impact strike locations, then the speed of the Windstar when it struck the pedestrian is between 25-30 mph."


NOT a pontoon nose

THE HEAD STRIKE CHART DEPENDS ON :

VICTIM HEIGHT

VEHICLE GEOMETRY

Current consensus is that the head strike chart may have limited usefulness!

Garmin portable GPS

24 hours of data speed every second downloadable with Cellebrite

A new source of GPS data:

Insurance

monitoring

VIDEO CAMERAS

store cameras
traffic monitors
parking lots
municipal buildings
parking garages
in-car cameras

..\..\Video clips\Dayton.mpeg

WAS THE COLLISION AVOIDABLE ?


Beware of the
human factors expert !

HUMAN FACTORS:

perception-reaction time

pedestrian walking speed

*use a **RANGE** of values*

Where does the analysis of avoidance start?

Point of First Possible Perception

(PFPP)

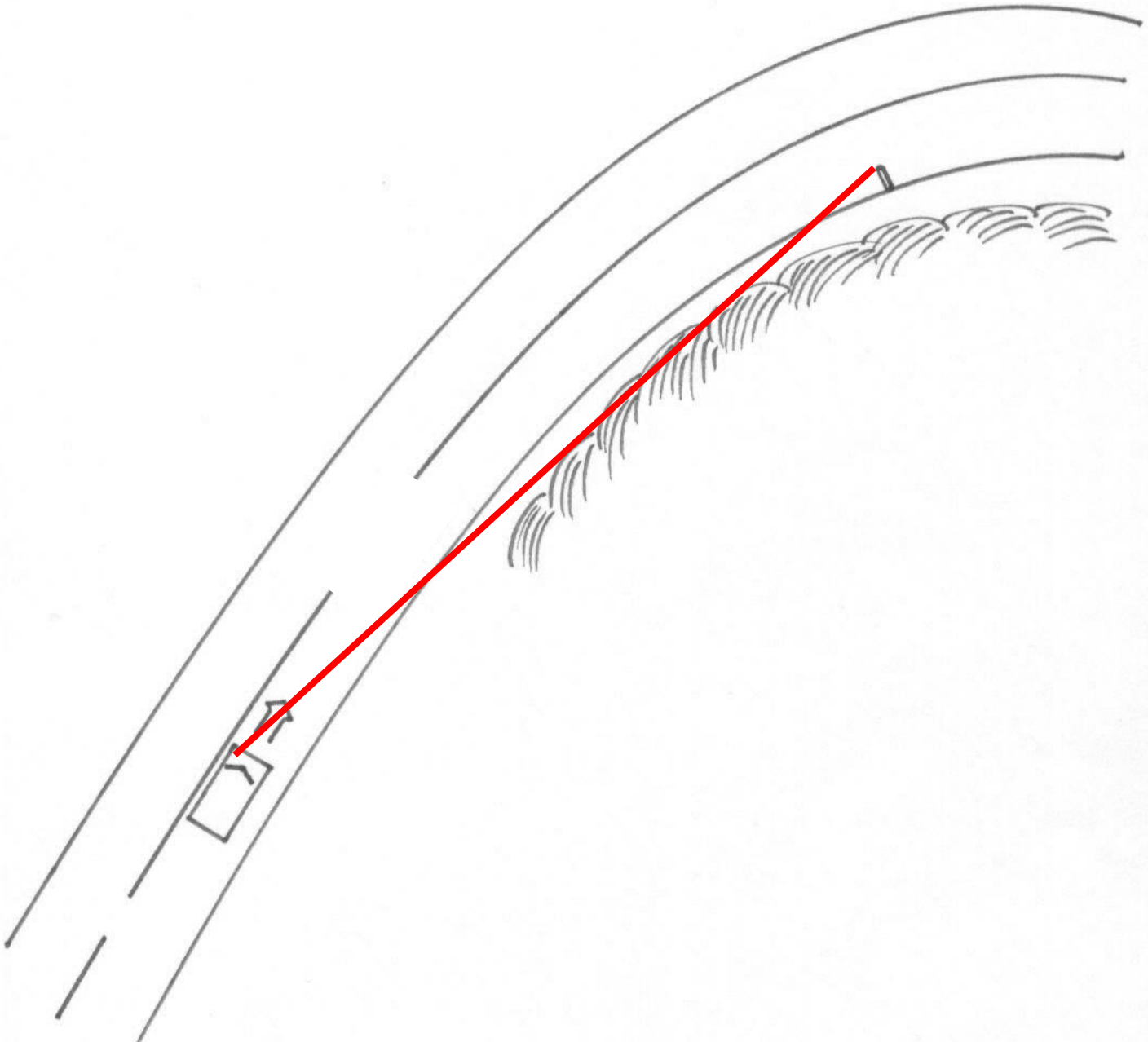
What is the point of first possible perception ?

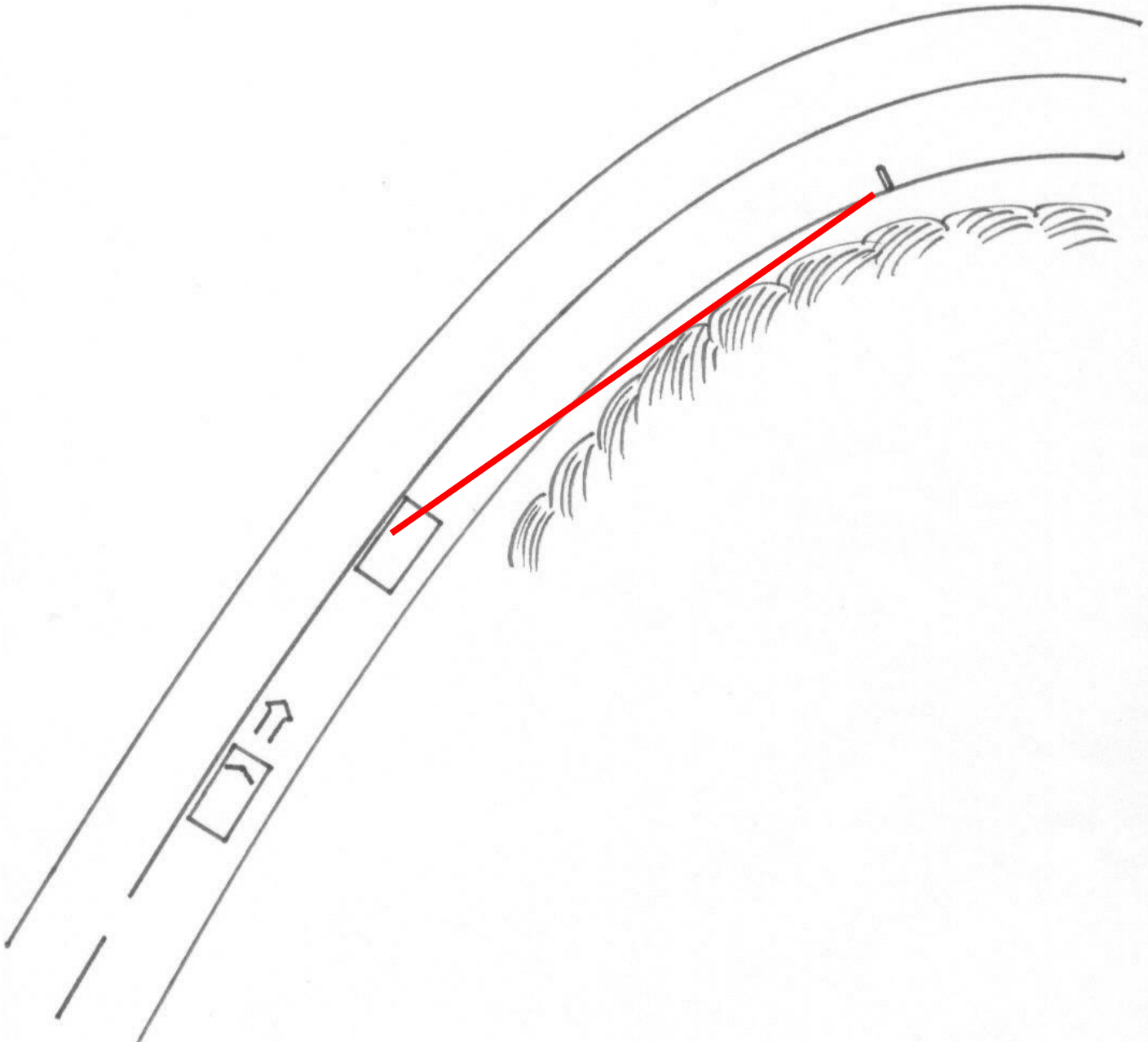
It is the vehicle location *WHEN THE DANGER PRESENTS.*

SIGHT DISTANCE

You are driving on a rural road …

Did you see the pedestrian on the right side walking toward you ?





POINT OF FIRST POSSIBLE PERCEPTION

may not be the same as

SIGHT DISTANCE

State v. Williams

- daytime pedestrian collision
- Williams traveling 65 mph in posted 35
- jogger assumed to be running at a speed of 10 ft/sec
- police determine PFPP at scene

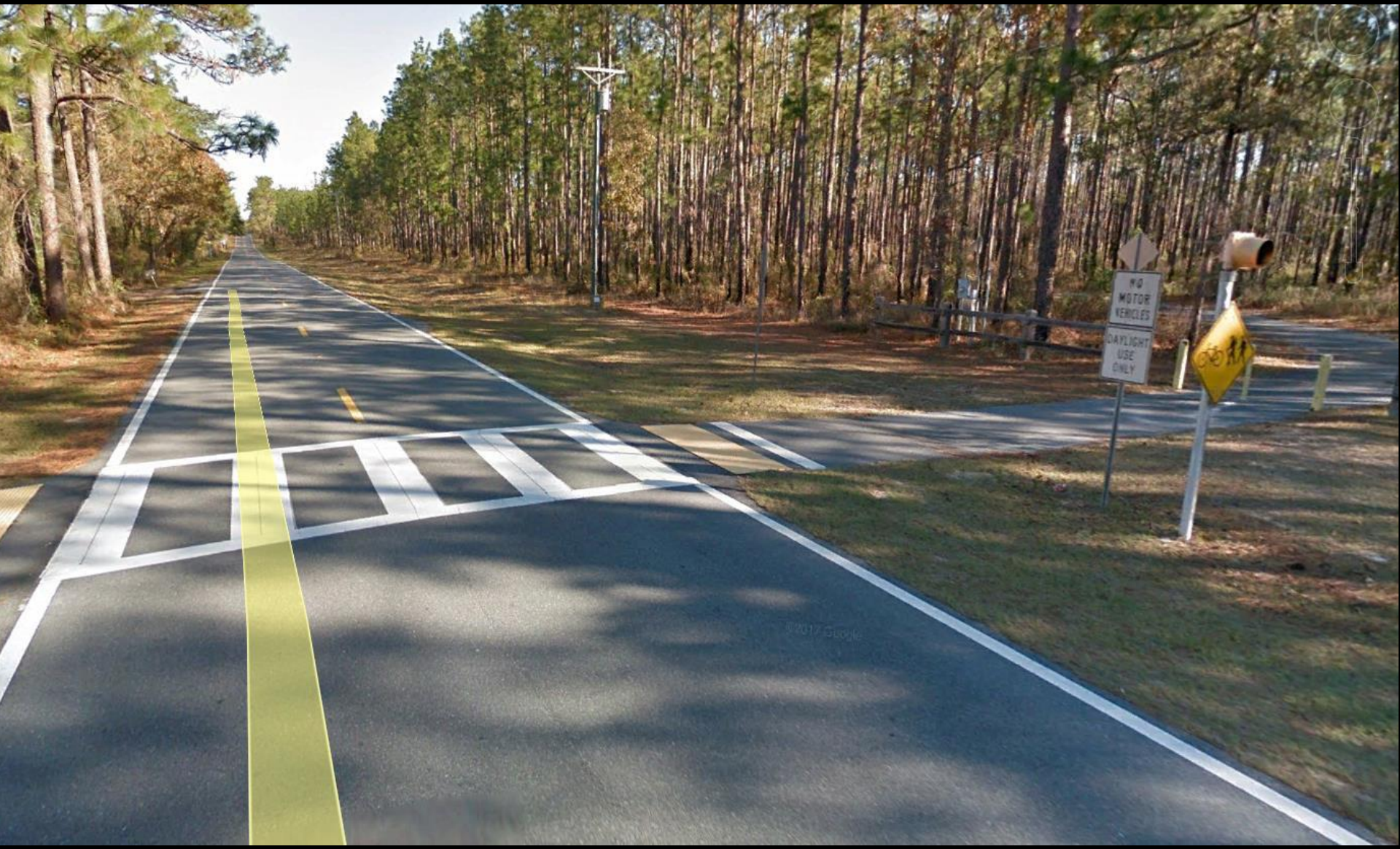
Police report:

"I could see the crosswalk from at least 240 ft East of the stop bar. From the defendant's elevated seating position in the truck the crosswalk was visible to [redacted] for a greater distance. With 240 ft of visibility, at the posted speed of 35 mph, the defendant had 4.66 seconds to initiate an evasive action."


240 ft from crosswalk

My comment:

At 4.66 seconds before impact, the pedestrian, running at a speed of 10 ft/sec, would have been 46.6 ft from the POI (out of sight).


NO
MOTOR
VEHICLES
DAYLIGHT
USE
ONLY

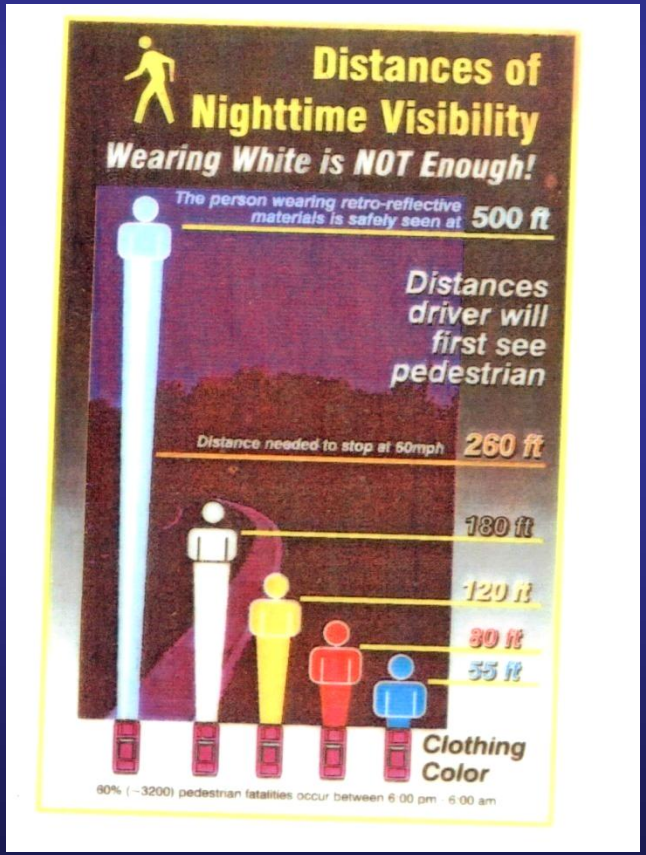
POINT OF FIRST POSSIBLE PERCEPTION

may be the same as

SIGHT DISTANCE

On a rural road the defendant approaches a pedestrian from behind who is in the travel lane.

Beware of the “one size fits all” number !



Investigation checklist:
Secure the pedestrian clothing.

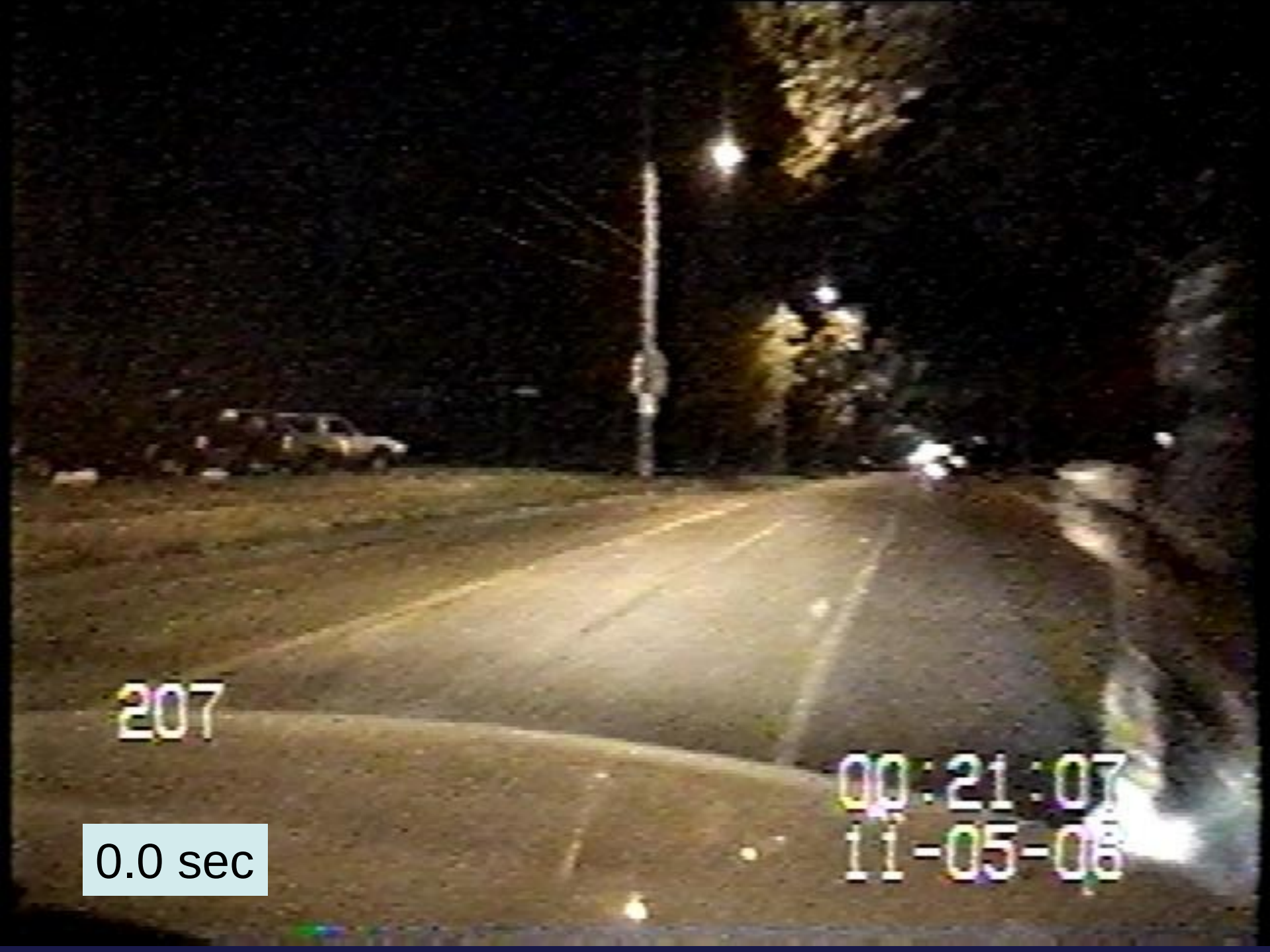
Hospital policy on pedestrian clothing ?

IN-CAR VIDEO

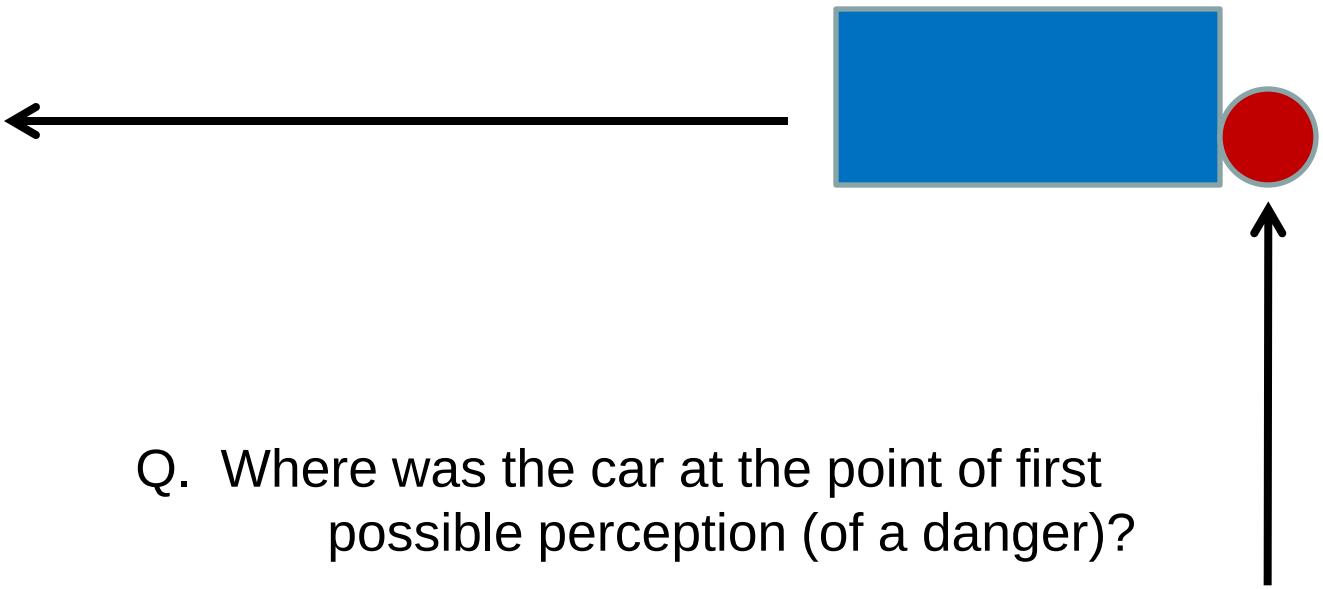
..\..\Video clips\LINCOLN PD.AVI


207
00:21:05
11-05-06
-2.0 sec


207
00:21:06
11-05-06
-0.6 sec

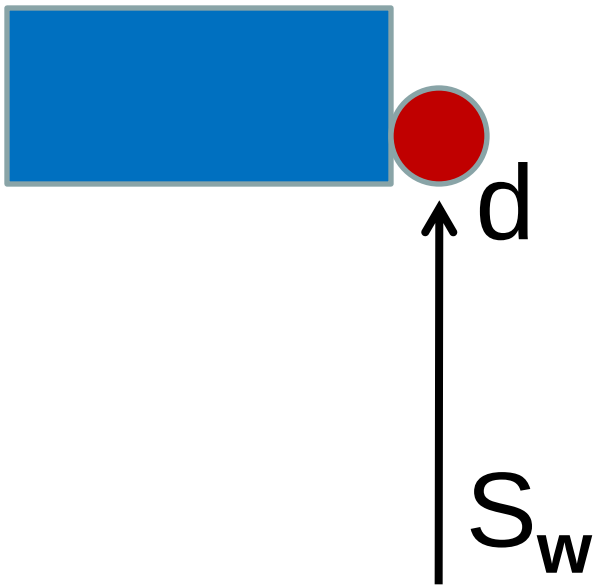

207
00:21:07
11-05-06
0.0 sec

Impact Configuration

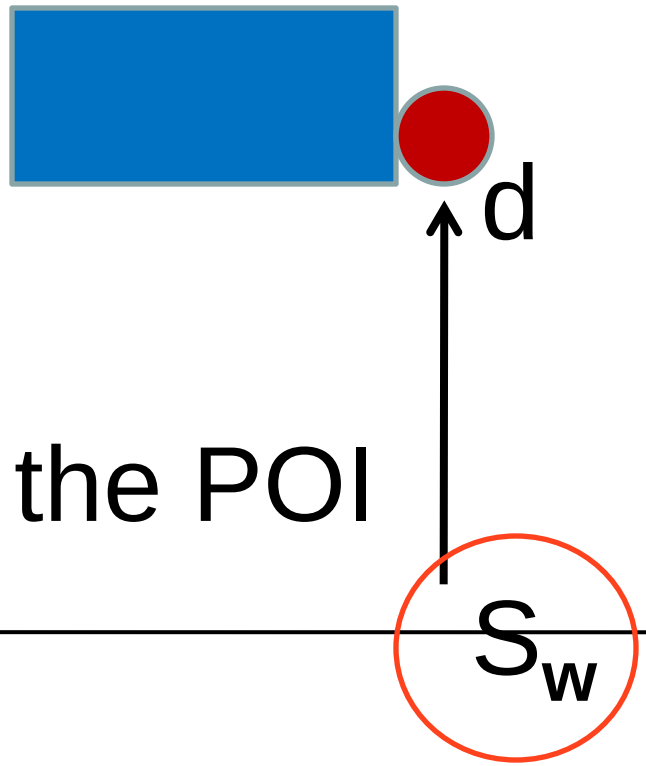


Q. Where was the car at the point of first possible perception (of a danger)?

Impact Configuration



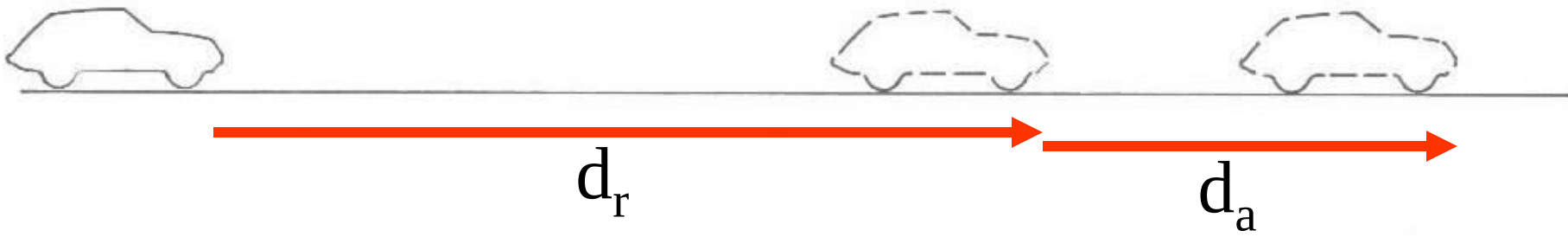
Impact Configuration



Backing the Car to the PFPP

use t_w to find d

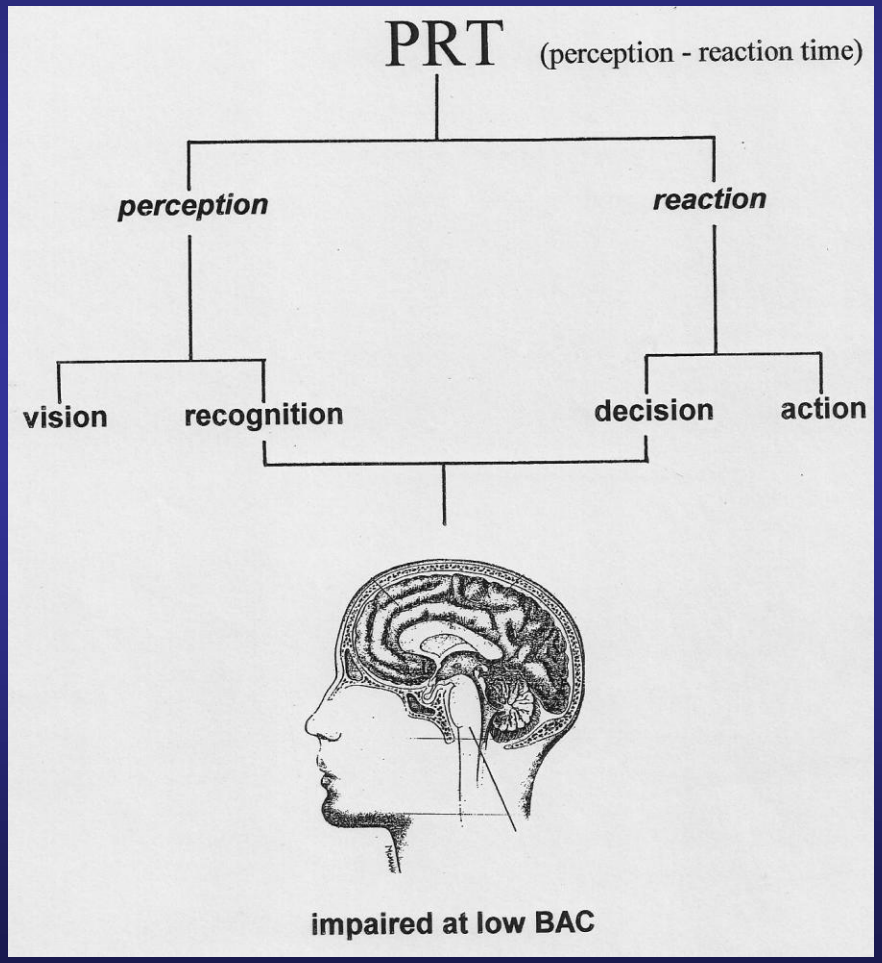
PHASES IN IMPACT AVOIDANCE



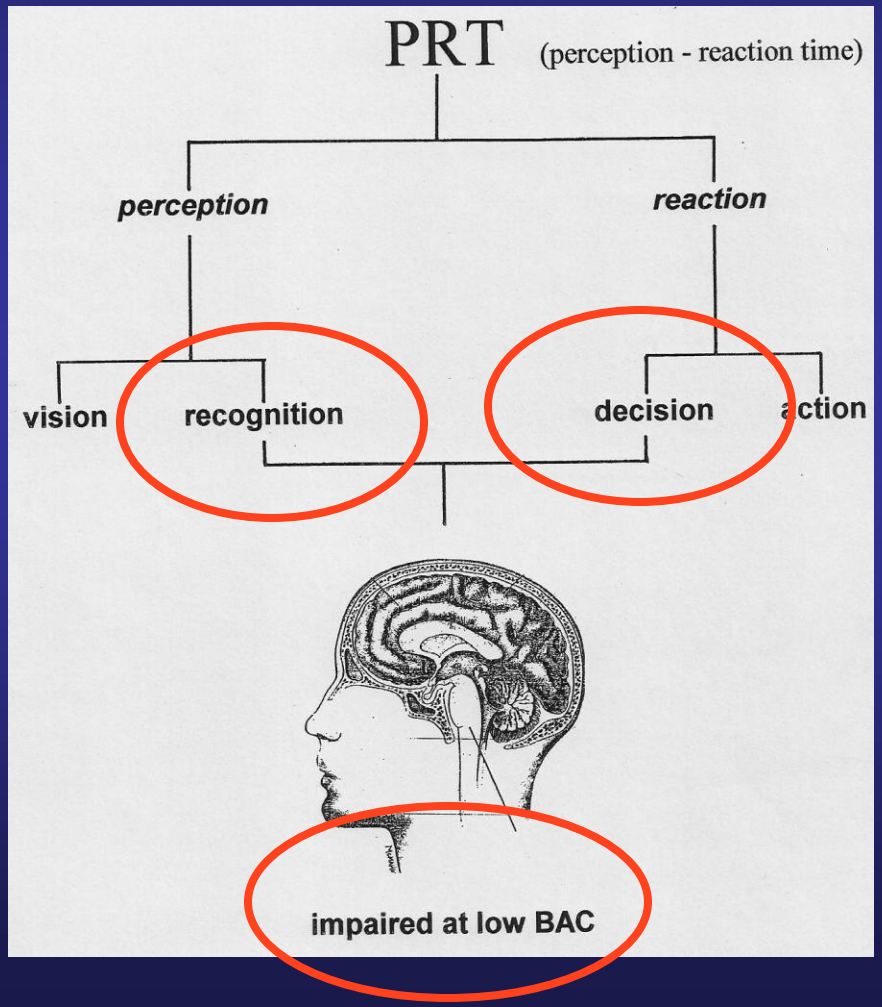
REACTION

VEHICLE AVOIDANCE

The PRT process (and impairment)



The PRT process (and impairment)



Recognition may not be as simple as you think!

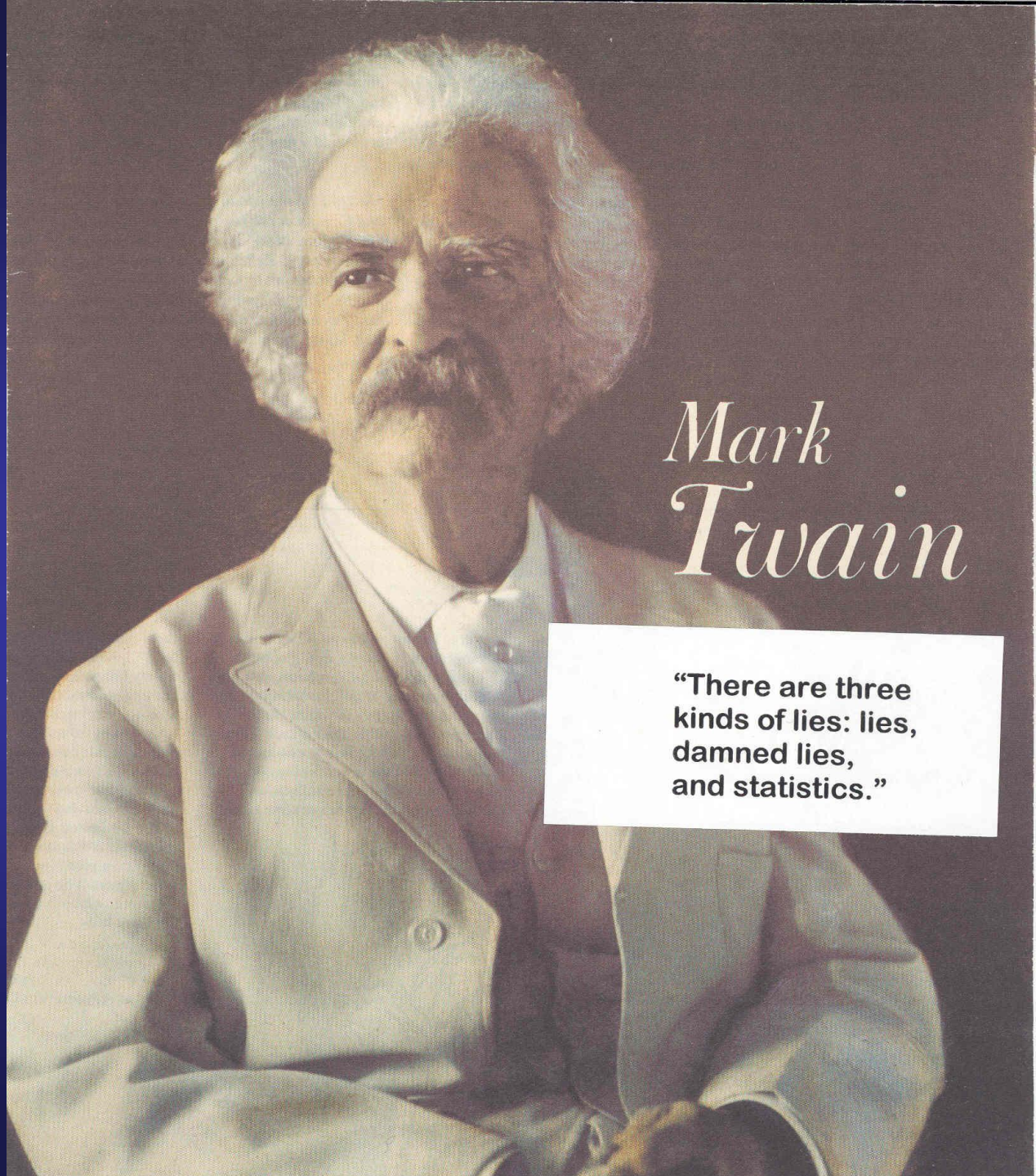
Jim Sobek
Clearly Visible Presentations, LLC

Jim Sobek
Clearly Visible Presentations, LLC

"There is no such thing as ***the*** human perception-reaction time."

Dr. Marc Green
visualexpert.com

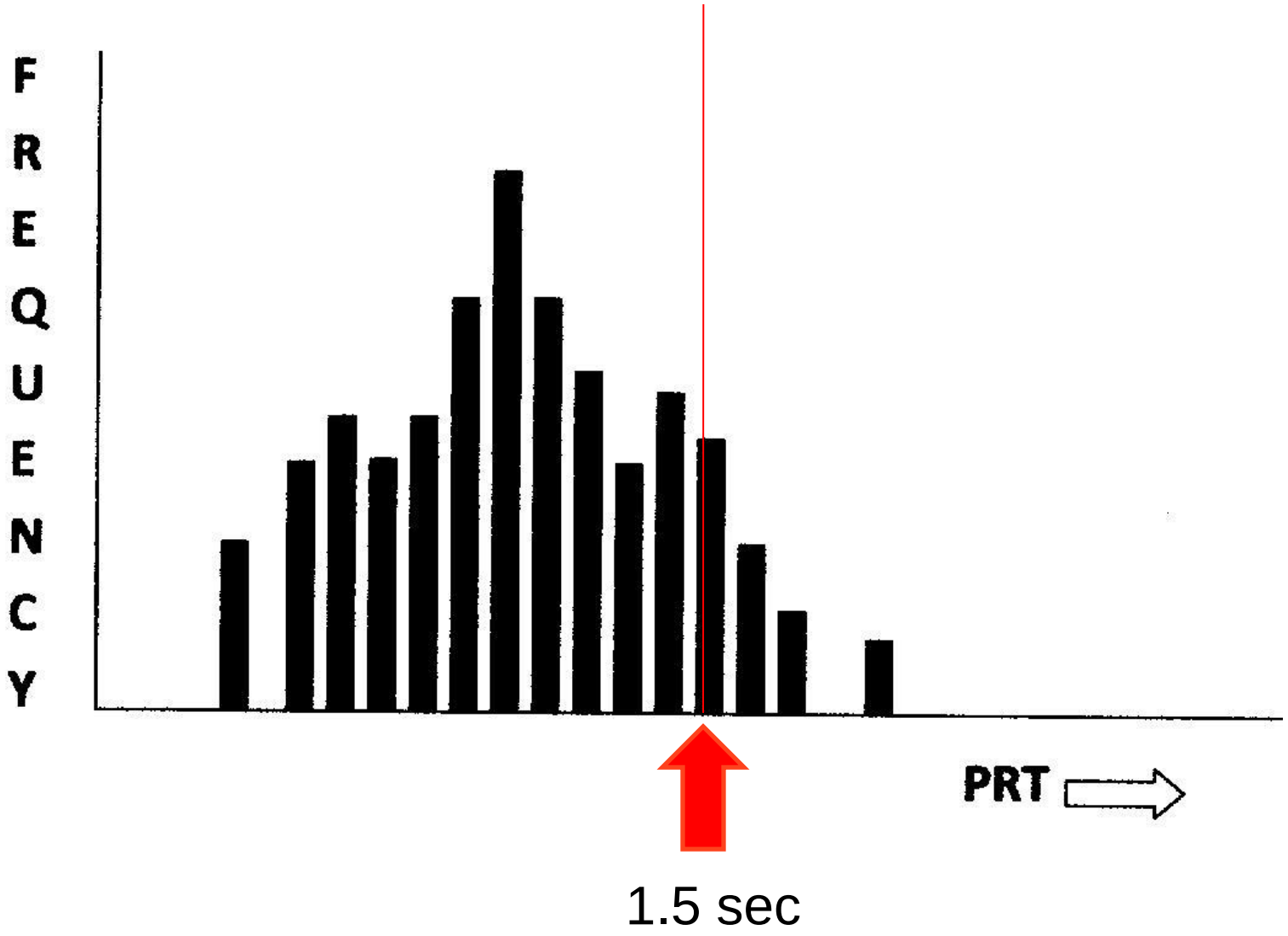
PRT is a statistical concept !


Mark Twain
"There are three kinds of lies: lies, damned lies, and statistics."

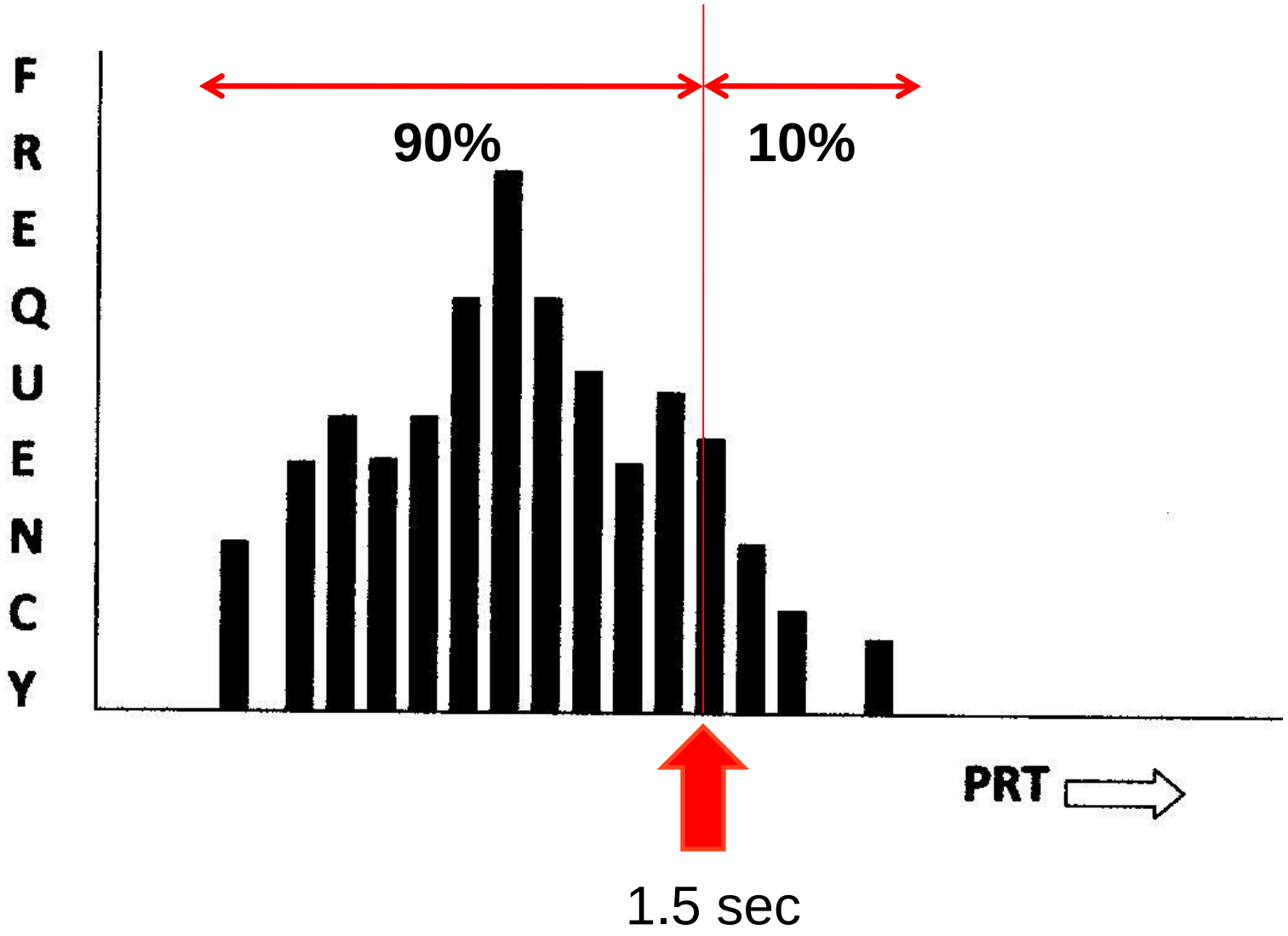
Paul L. Olson

“... is a good upper bound estimate, meaning that a substantial percentage (i.e. 85% to 95%) of reasonably alert drivers will respond within 1.5 (1.6) seconds.”

1.5 sec is the 90th %ile



1.5 sec is the 90th %ile



2.5 seconds “... large enough to include the time taken by nearly all (90% of all) drivers under most highway conditions.”

AASHTO Policy on Design Standards for Highways

How would you perform in a PRT test?

What is a reasonable **RANGE** of PRT values?

"The probable range of perception-response times for reasonably straightforward situations should be 0.75 to about 1.5 (1.6) seconds."

Paul L. Olson, Forensic Aspects of Driver Perception and Response, 1996, p. 187

WAS THE COLLISION AVOIDABLE?

COULD THE COLLISION BE

AVOIDED BY A SOBER DRIVER

OPERATING AT THE POSTED SPEED ?

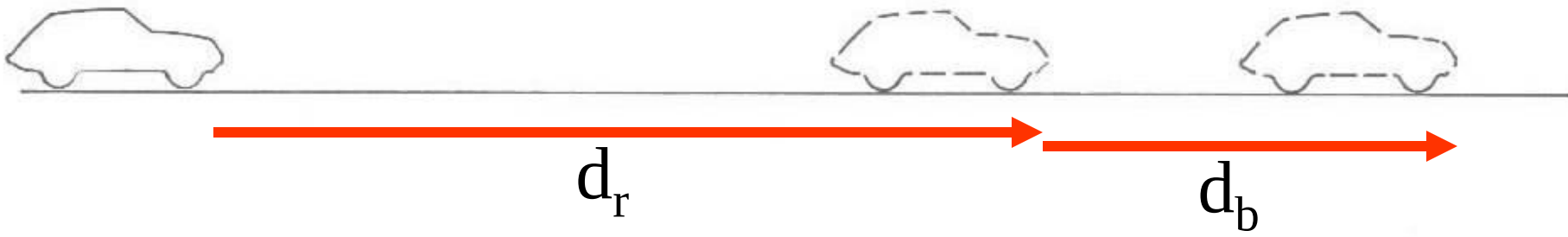
reaction distance:

the distance the vehicle moves during the operator's PRT

$$d = 1.47 S t$$

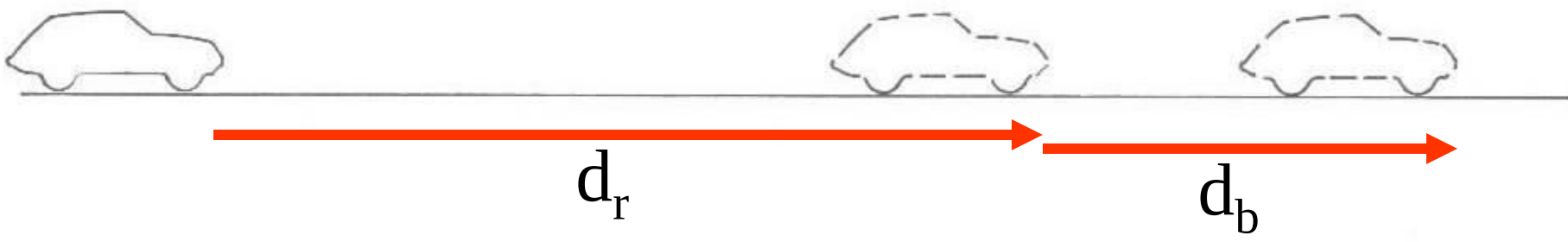
braking distance:

the distance it takes for the brakes to stop the vehicle



$$d = \frac{S^2}{30 f \eta}$$

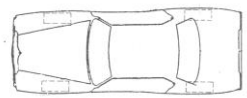
TOTAL STOPPING DISTANCE

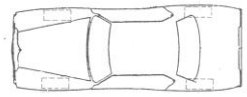


$$d_s = 1.47St + \frac{S^2}{30 f \eta}$$

TOTAL STOPPING DISTANCE

30 mph, sober 106 ft





50 mph, impaired 243 ft

Remember the walking speeds:

Thompson 3.39 - 5.53 ft/sec

The AVOIDANCE calculation starts by selecting a walking speed

Impact Configuration

d

$S_w = 3.39 – 5.53$

S_w

Impact Configuration

d

$t_w = d / 1.47\ S_w$

t_w =3.24–1.99 sec

S_w

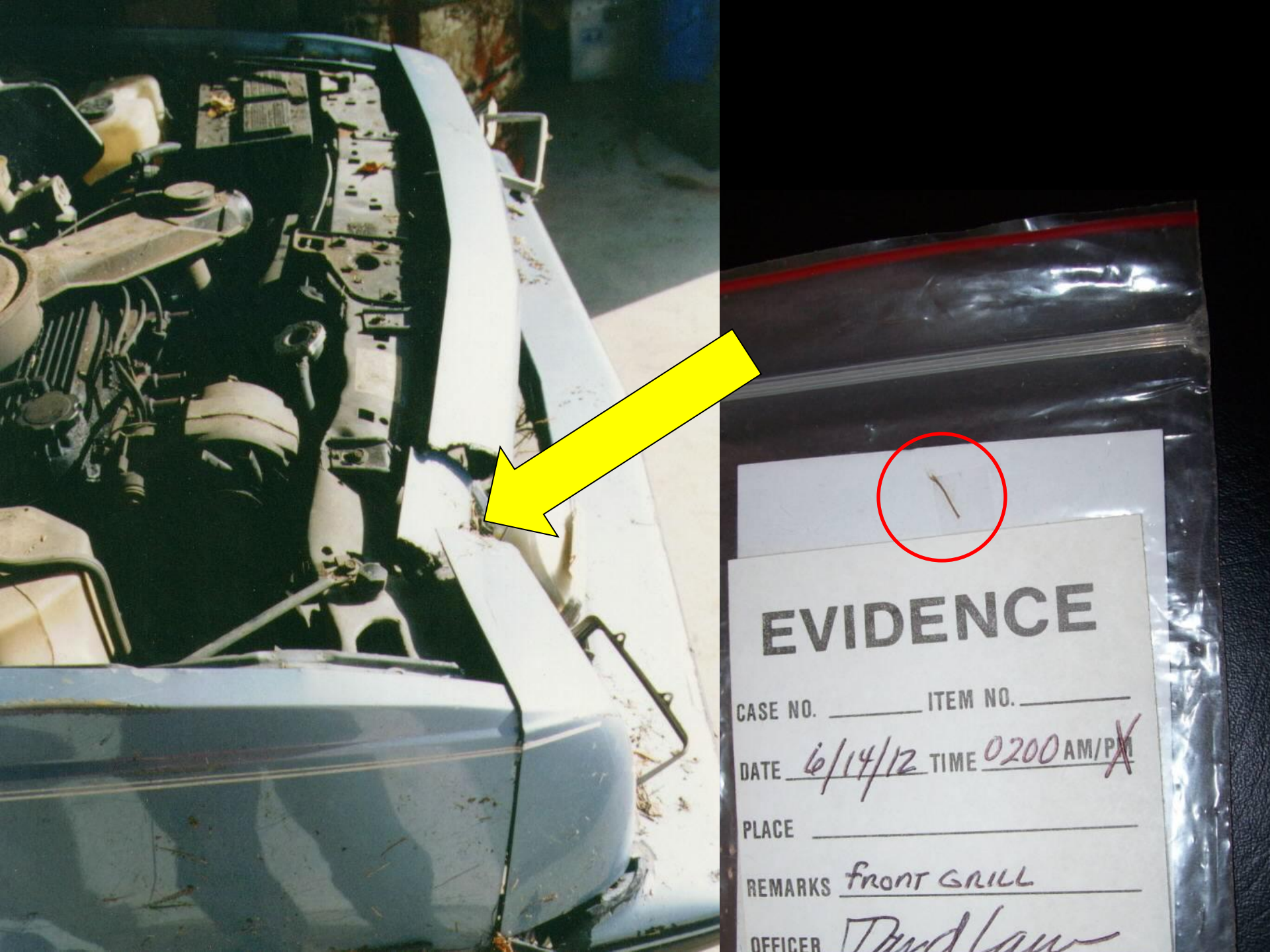
Backing the Car to a Prior Point

d (available distance)=190 –116 ft

stopping distance = 159 ft

DEFENSES:

- OPERATOR ID (hit-run)
- PEDESTRIAN AT FAULT
- GLARE FROM ONCOMING VEHICLE
- UNCERTAIN POI or FRP OF BODY
- CONTAMINATION OF CRIME SCENE


EVIDENCE
CASE NO. _____ ITEM NO. _____
DATE 6/14/12 TIME 0200 AM/PM
PLACE _____
REMARKS front GRILL
OFFICER

http://www.legalsciences.com

Podcasts & Radio

Prosecuting Pedestrian Collisions