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Pedestrian Vehicle Accident Reconstruction

DATE: 02/02/2022 FFEI File # 5792

FOR: Michael R. Hunt
Assistant State Attorney
Eighteenth Judicial Circuit of Florida
Brevard and Seminole Counties

Case : State v. Norris
21-55302 CF

DOI: 6/20/2021 Time of Incident: ~2:20 am

Location: Industry Road ~120 ft north of State Road 528 overpass

PREPARED BY: Srinivas Kadiyala, Ph.D., ACTAR & Elliot L. Stern, Ph.D., P.E.

NOTE: This is a preliminary report. The report contained herein represents preliminary findings and opinions to a reasonable degree of engineering probability based on facts available and analysis performed at the time of publication. The right is reserved to continue the analysis and amend or modify the opinions as new information and data becomes available through the discovery process.

I. BACKGROUND:

On January 5, 2022, Mr. Michael R. Hunt and Mr. Bill Respess requested that Florida Forensic Engineering, Inc. perform an accident reconstruction for a collision that occurred on 6/20/2021 at ~2:20 am involving a 2009 Chevrolet Impala driven by Ms. Suzanne Paige Norris. The Chevrolet Impala was traveling north on Industry Rd approximately 120 ft past State Road 528 overpass when it struck a pedestrian, Ms. Passion D. Lucas.

Inspections: (Jan 28, 2022)
1. 2009 Chevrolet Impala VIN 2G1WS57M9912693
2. Scene (daytime and nighttime)

Information considered relevant to traffic accident reconstruction include the following:
1. Traffic Homicide package and report

2. Traffic homicide photos including scene, vehicle, autopsy photos and evidence collected.
3. Sworn Interview Michael Baker
4. Sworn Interview Gary Horton
5. Scene mapping with FARO scans including geometric proportions & measurements of evidence markers
6. Body Cam footage
7. SDM image of 2009 Chevrolet Impala

II. CRASH INFORMATION & DESCRIPTION:

The 2009 Chevrolet Impala driven by Ms. Suzanne Norris was travelling north on Industry Road, Cocoa, FL approximately 120 ft north of the State Road 528 overpass when it struck pedestrian Ms. Passion D. Lucas (slides 2,3,4). In the area of the collision, northbound Industry Road is two-lanes that narrows down to a single lane with a turn lane to the left. The area of collision was in a designated work zone. The posted speed limit in that area is 45 mph located approximately 300 ft south of the area of collision. There were no sidewalks, cross walks, pedestrian signage, or lights in the vicinity of the accident location. The traffic homicide investigative report is consistent with photographic documentation of the scene evidence.

Ms. Suzanne Norris stated that she was driving home on Industry Rd and without warning her windshield exploded. She indicated that she continued to drive. After several hundred yards she turned around and came back. Upon arriving back at the scene, she saw a person lying in the middle of the roadway.

III. CRASH DYNAMICS ANALYSIS SUMMARY AND CONCLUSION:

Slides 3, 4 show the 1st piece of evidence as a shoe in the middle of the northbound lanes of Industry Road. All other debris found was further north and in positions shown. The final position of Ms. Lucas was 78 feet from the 1st piece of evidence.

Slide 6 depicts that the scene changed during the course of the investigation. Still from the BodyCam footage from RBS1 (earliest officer to arrive on the scene) show no evidence corresponding to Markers 18, 20, 21 depicted in scene photographs taken later.

Slides 7,8 depict the property damage to the Chevrolet Impala's front, windshield, passenger side of the hood and the passenger side A-pillar. The damage is consistent with the vehicle striking the pedestrian on the front passenger side, the pedestrian's body wrapping over the hood along the passenger side of the Impala and striking the windshield prior to being thrown forward with a minimal passenger side bias. Contact damage is visible to front passenger side of hood, windshield, and passenger side A-pillar. The front passenger side headlight assembly is broken. Examination of the bulbs indicate hot shock (i.e., the headlamps were lit at time of collision).

The lower body of the pedestrian contacted the bumper and the hood, and the upper body contacted the windshield and the passenger side A-Pillar. The location of the upper body contact on the windshield is in-line with the initial impact imprint on the front passenger side headlamp

and hood. This contact indicates that as the pedestrian's body rides up the hood into the windshield there is no lateral motion consistent with the pedestrian moving across the car front.

Slide 9 depicts the results of the pedestrian throw analysis after the collision. The speed of the Chevrolet Impala at impact that was computed is consistent with the documented physical evidence. As shown in Slide 3 and 4, the first evidence of collision was the shoe on the lane divider of the two northbound lanes and the pedestrian is approximately 78 ft north from there. Assuming the shoe to be near the area of impact, pedestrian throw calculations indicate that the Impala was travelling between 36 mph to 41 mph (average of 38.5 mph) at impact. There is no evidence of preimpact braking.

The Impala with a weight of 3793 lbs. incurred a ΔV of 1.17 mph because of collision with a 140 lb. pedestrian. The resultant impact force on the pedestrian was 2560 lbs.

There is no indication that the pedestrian went over the passenger side of the vehicle.

The imaging of the Chevrolet Impala SDM revealed that neither a deployment event nor a non-deployment event was stored in the SDM as a result of the subject collision.

The average recognition distance for drivers in moving vehicles to recognize objects along the roadside varies based upon a number of factors including ambient lighting, pedestrian movement, headlight type, pattern, object size, position left versus right and the shade of the object.

Slides 5,10-13 show that the area has no street lighting. The measured vertical light levels in the area of the collision were 0.07 lux to 0.24 lux and the measured horizontal light levels was 0.02 lux average. i.e., the area requires artificial illumination to illuminate terrestrial objects. Pedestrian visibility and recognition in the area of the collision is restricted as can be seen in Slide 11. The average recognition distance on an unlit road with vehicle headlights as calculated and measured was 155 ft (range between 100 ft to 200 ft).

Slides 14-15 show the calculated average PRT to be 1.9 sec with 85 percentile response in 2.6 sec. A vehicle travelling at an average speed of 38.5 mph (56.6 ft/s) will have travelled 107.5 ft (147 ft for the 85-percentile response) prior to initiating an avoidance maneuver such as braking or a braking and steer. The average recognition distance on an unlit road is 155ft for a pedestrian in dark clothing. Therefore, the initiation of an avoidance maneuver would be close to impact or after the impact has occurred on the passenger's side and is consistent with published values of response distances of objects entering from passenger's side into the headlight illuminated path from on-road experiments[1]. The evidence indicates in the subject dark unlit roadway this accident is unavoidable.

Summary of Analysis & Conclusions:

- Location of incident is characterized by roadway construction and an absence of sidewalks, crosswalks, and street lighting. (*Slides 2,3, 5, 10, 11*)
- Location of the collision between the Impala and the pedestrian is in the vehicular way (northbound lanes of Industry Rd).

[1] SAE 2013-01-0787 Determining When an Object Enters the Headlight Beam Pattern of a Vehicle

- Property damage & pedestrian throw calculations is consistent with Chevrolet Impala travelling 36 mph - 41 mph at impact. (Average 38 mph) (*slide 9*).
- Physical evidence pattern and pedestrian throw (*slides 3, 4*) is consistent with the Impala braking post collision.
- There is no evidence of pre-collision braking by the Impala.
- Property damage does not indicate pedestrian was moving laterally at appreciable speed across the front of Chevrolet Impala at impact. (*Slides 7,8*)
- The measured light levels in the area of collision:
  - Vertical – 0.07 to 0.24 lux average
  - Horizontal – 0.02 lux average
- Artificial illumination is required to illuminate terrestrial objects in area of collision. (*Slides 5, 10*)
- Average recognition distance in measured lighting conditions is 155 ft (range 100 – 200 ft). (*Slides 11-13*)
- Average PRT = ~1.9 sec; 85 %ile stopping distance is ~268 ft, 85 %ile stop and steer distance is ~231 ft. (*slides 14, 15*)
- This accident is unavoidable by the Impala driver. The pedestrian created the hazard by walking in the vehicular way.

The analysis results and conclusions herein represent the preliminary engineering analysis based on the information indicated and available at this time. The methods employed and results herein are provided to a reasonable degree of engineering and accident reconstruction certainty.

Srinivas Kadiyala, Ph.D., ACTAR
Principle Forensic Engineer

Reviewed by:

Elliot L. Stern, Ph.D., P.E.
Principle Forensic Engineer

02/02/2022
Date

Figures

Analysis

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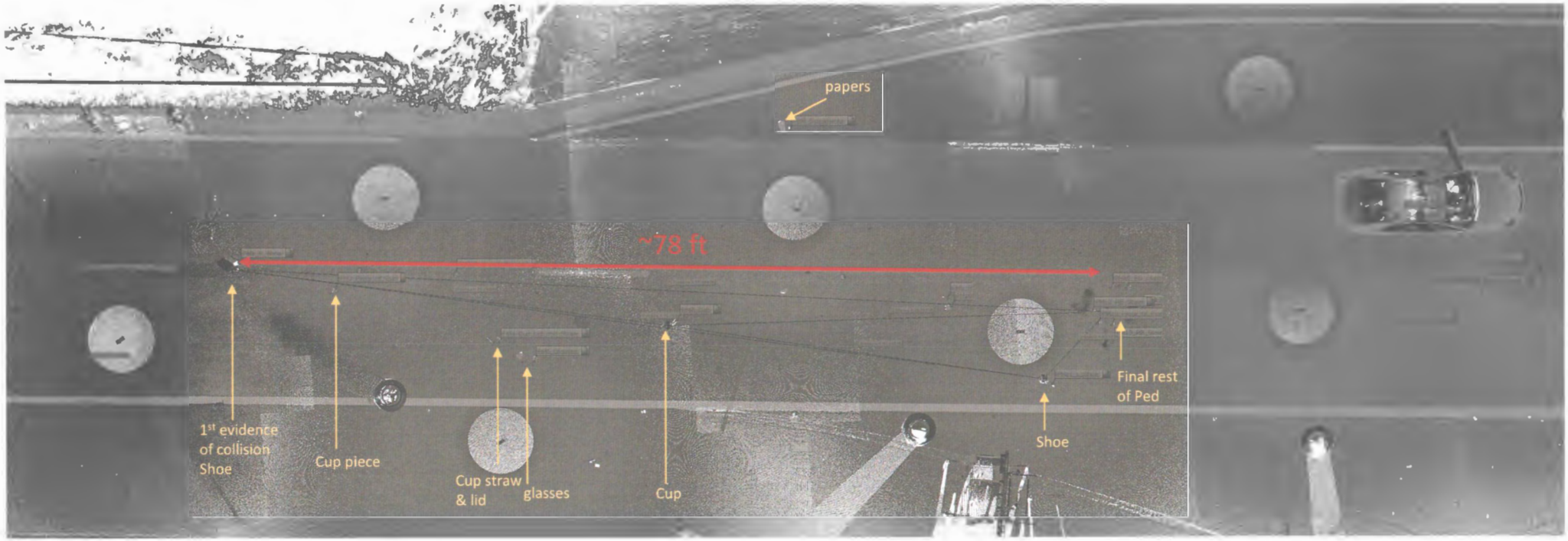
- This accident is unavoidable by the Impala driver. The pedestrian created the hazard by walking in the vehicular way.

Layout of evidence (from 3D laser scan data)




Layout of evidence
1
4

The area of the incident is not well illuminated (photos taken June 20, 2021)

Without flash

With flash

Evidence Markers 18, 20 & 21 are not related to the subject collision

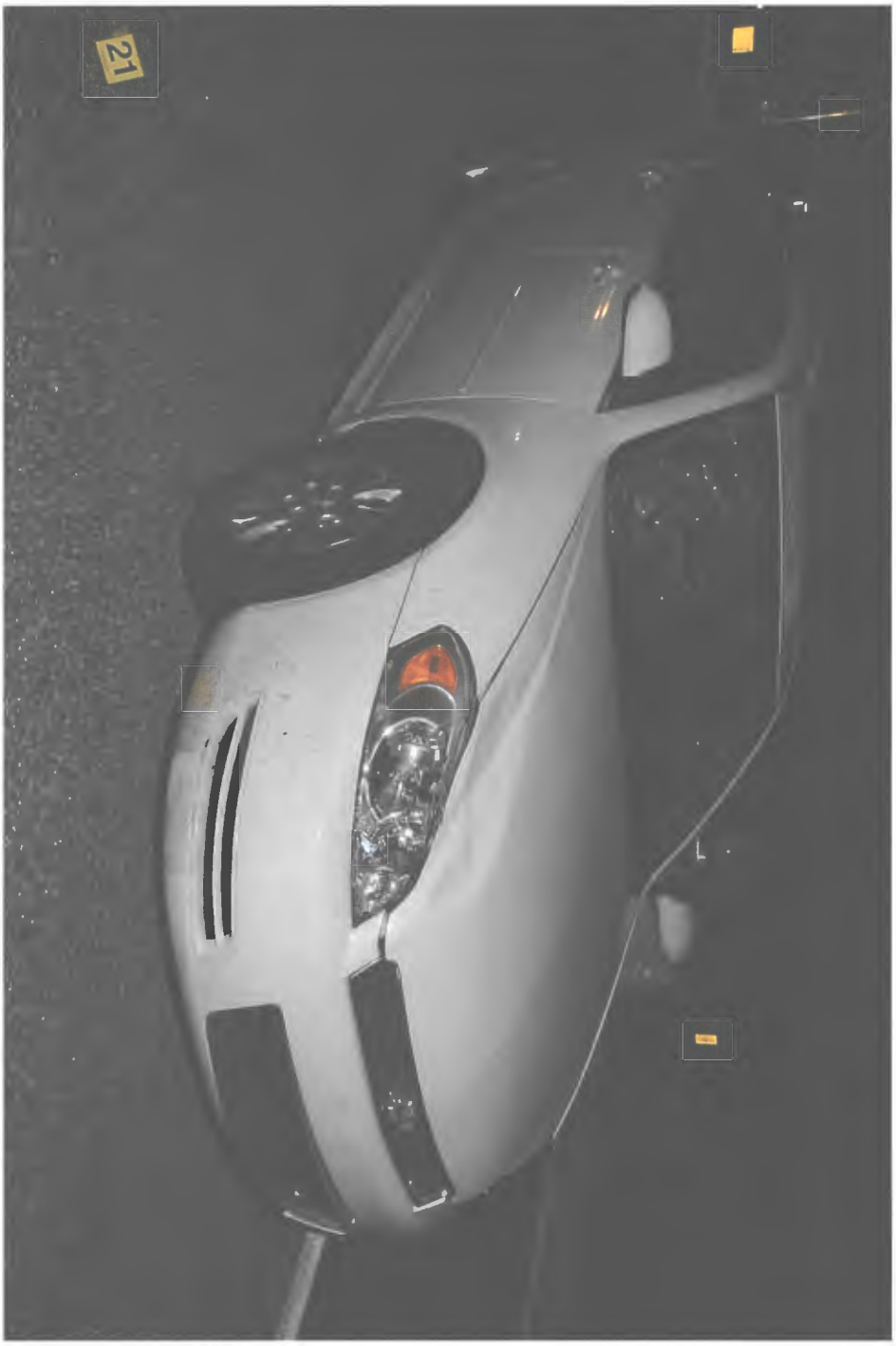
Scene photograph AMS_2706.jpg

Still from Bodycam footage RBS1

(Note: absence of marking consistent with markers 18, 20 & 21)

Property Damage is not consistent with pedestrian having significant lateral motion from passenger side to drivers' side at impact (i.e., pedestrian was not moving across car front laterally at impact)

Chevy Impala collision damage is not consistent with an avoidance maneuver of steer


21

Calculation of Impala speed at impact

(range ~36 mph – ~41 mph)

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VCRware™

Vehicle Crash Reconstruction Software

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NOTATION COORDINATES UNITS & VARIABLES

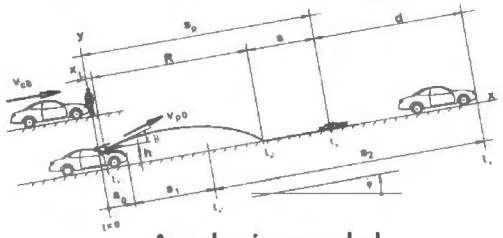
x	-		coordinate parallel to ground
y	-		coordinate perpendicular to ground

INPUT INFORMATION (KNOWNS):

a_2	0.70		deceleration of vehicle over distance s_2 g's
f_p	0.67		drag resistance coefficient of pedestrian over distance s
g	32.17	ft/s²	acceleration of gravity
h	2.95	ft	height of pedestrian center of gravity at launch t_0
s_1	0.00	ft	distance of travel of vehicle at uniform speed
v_{s0}	57.00	ft/s	initial speed of vehicle
	38.9	mph	initial speed of vehicle
x_L	2.00	ft	x-distance of pedestrian from initial contact to launch
α	1.00		ratio of pedestrian speed to vehicle speed at time of launch
θ	4.00	deg	angle of launch of pedestrian relative to x axis
φ	0.00	deg	road grade angle
μ	0.80		impulse ratio for pedestrian-ground impact
m_c	117.58	lb-s²/ft	mass of vehicle, weight / g
m_p	4.35	lb-s²/ft	mass of pedestrian, weight / g

OUTPUT INFORMATION (UNKNOWNS):

	54.97	ft/s	velocity of vehicle after impact with pedestrian
v_{p0}	54.97	ft/s	initial speed of pedestrian
R	30.91	ft	range of pedestrian throw launch to ground impact
t_R	0.84	s	time from impact to pedestrian initial contact with ground
s	43.67	ft	pedestrian ground contact distance impact to rest
s_p	76.58	ft	throw distance total distance from initial contact to pedestrian rest
t_p	2.65	s	total time of travel of pedestrian initial contact to rest
t_c	0.08	s	time of travel of vehicle to travel from initial contact to $s_0 + s$
s_0	4.15	ft	distance of travel of vehicle with pedestrian contact
s_2	67.07	ft	distance of travel of vehicle with uniform deceleration a_c
$s_0+s_1+s_2$	71.22	ft	total distance of travel of vehicle
t_c	2.52	s	vehicle travel time initial contact to rest
d	5.36	ft	distance between rest positions of vehicle and pedestrian

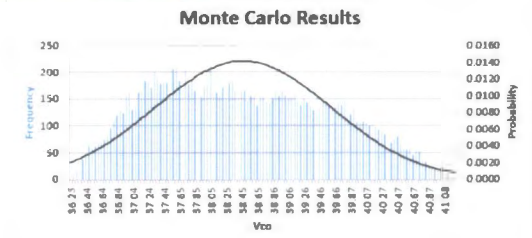


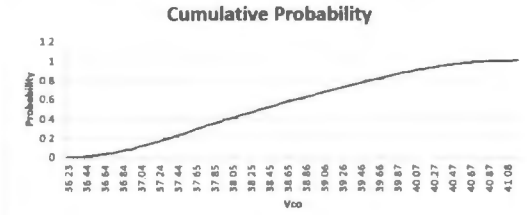
Analysis model

Analysis of pedestrian Throw Distance from Initial Conditions

Mean	Median	S. Dev	Min	Max	n	Corr. Coef.
38.47	38.39	1.14	36.23	41.20	15000	0.859

	Low	High
51% CI	37.51	39.40
95% CI	36.59	40.63
99% CI	36.38	40.97
51 % CI	36.81	38.67



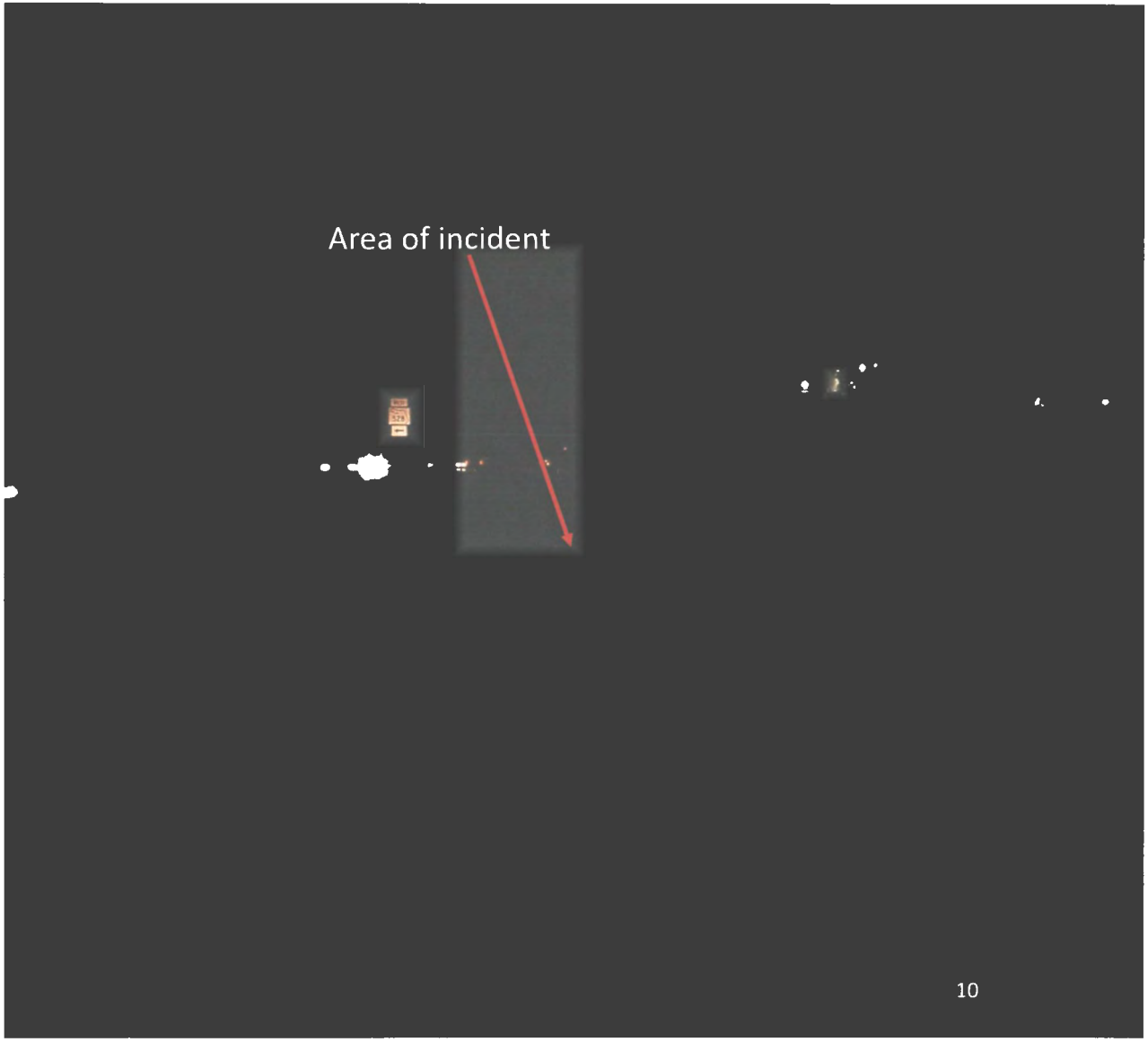


Reconstruction model

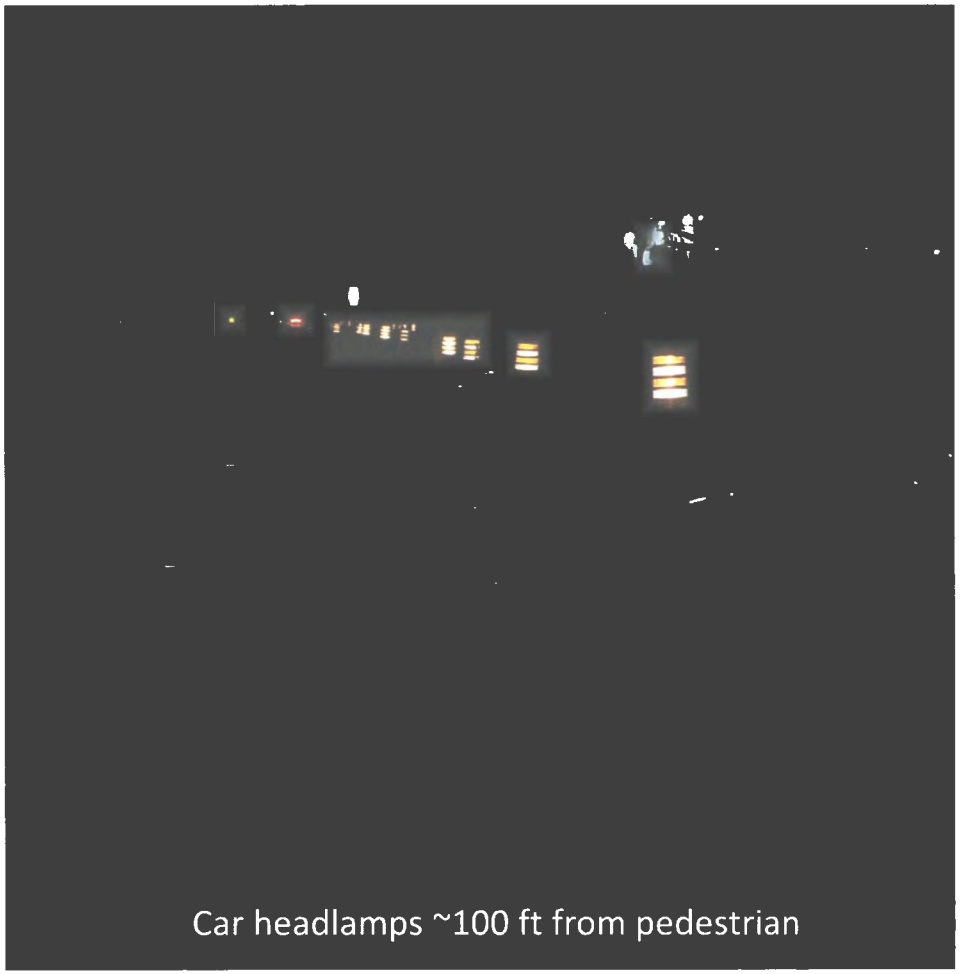
Calculation of vehicle initial speed from throw distance

The incident occurred at ~2:20 AM on June 10, 2021

- Date of Inspection 28th Jan 2022
- There is no street lighting in area of incident.
- The measured light levels in the area of collision:
  - vertical – 0.07 to 0.24 lux average
  - Horizontal – 0.02 lux average
- Artificial illumination is required to illuminate terrestrial objects in area of collision



Pedestrian visibility and recognition is restricted in the area of the collision



Car headlamps ~100 ft from pedestrian

Car headlamps ~200 ft from pedestrian

Passion D. Lucas

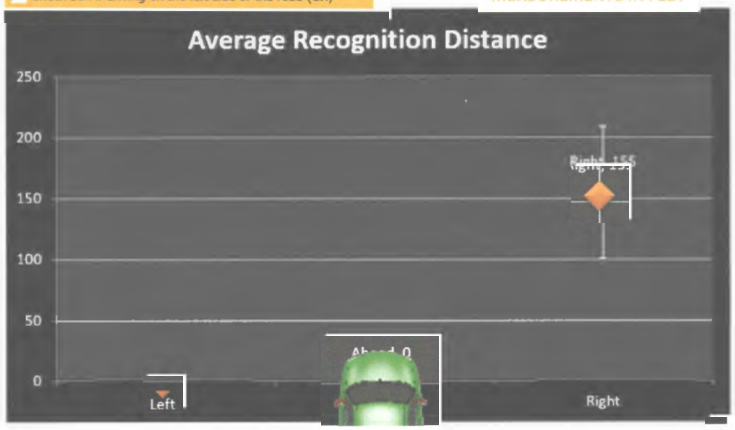
RECOGNITION DISTANCE ON UNLIT ROADS (2013)

Shown Object?	Not Shown Object Beforehand **DEFAULT**
Recognition or visible?	At Recognition **DEFAULT**
Experiment Type	Road or Traffic Study **DEFAULT**
Shade of the Hazard	Dark — 1.40 fc (15 Lux)
ADJUSTMENT INFO	☐ Check if some retrorefl. or lighting (but lacking a pattern)
Object	Pedestrian or other objects (incl. vehs) that don't fit 1 or 2.
Location of Hazard Info	the Passenger's Side of Road
Size of Hazard	Greater than 1 sq. metre (10 sq. ft.)
Movement of Hazard	Stationary Object
Button press dist.	2..3 ft

Avg. Button-press distance = 133 ft.
Avg. Recognition distance = 155 ft

☐ Check Box if driving on the left side of the road (UK)

MEASUREMENTS IN FEET



A Pedestrian or other objects (incl. vehs) that don't fit 1 or 2. that was larger than 1 square metre (3.3 sq. ft.) and was equivalent to a Dark shade was stationary and on the Passenger's Side of Road. This object did not have retroreflective materials or lights (but the object/pedestrian was not an illuminated pattern). If stationary and dark, there was no improvement. — This analysis accounts for drivers expectancy in several ways. First, this driver was not told of, or shown the hazard beforehand. Second, drivers have not implemented emergency responses until certain that an emergency exists. As is the case with real life drivers, this analysis assumes the driver would not respond with an emergency response until certain of the hazard (clearly discerned). Third, this analysis assumes that the recognition occured in an open road or in traffic.

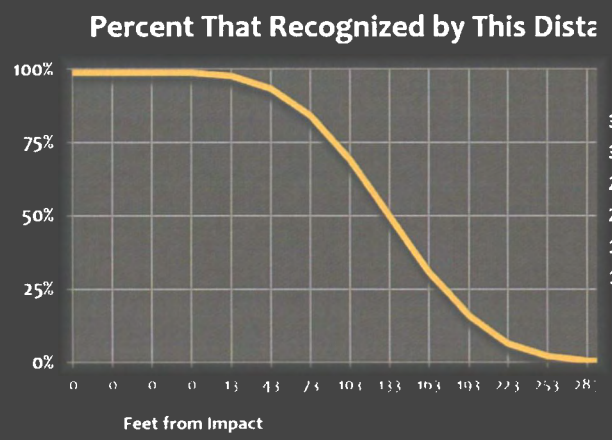
Recognition Distance = 14.1 x Shade - 21.803 x Location + 7.772 x Size - 1.869 x Lux + 29.5 x Shown -41.713 x Certainty + 88.517 + 15.8 x Veh - 33.2 x Odd Shape + 9.0 x Movement if Light shade

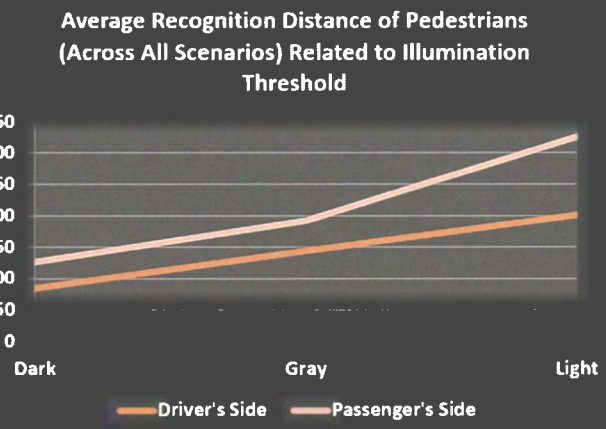
Recognition Distance = 14.1 x (1) - 21.803 x (0) + 7.772 x (1) - 1.869 x (15) + 29.5 x (0) - 41.713 x (1) + 88.517 + 15.8 x (0) - 33.2 x (0) + 9.0 x (0) = 40.6 metres or 133 feet

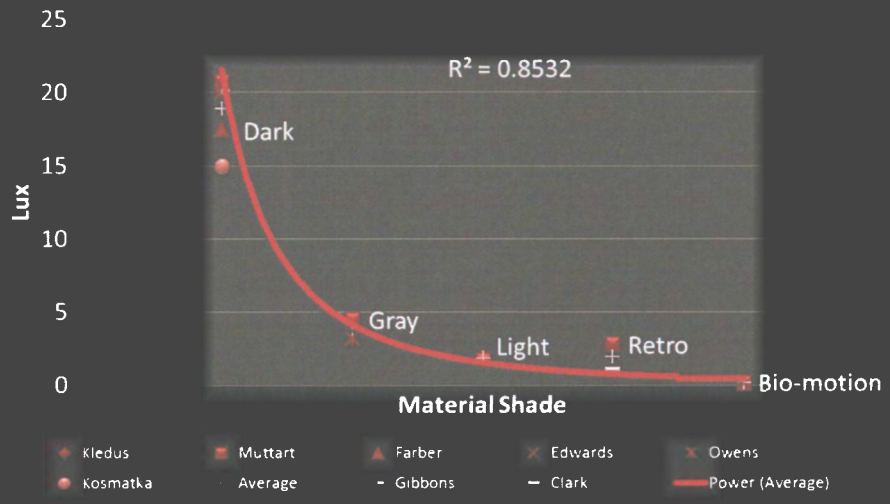
Muttart, J. W., Bartlett, W., Kauderer, C., Johnston, G., Romoser, M., Unarski, J., Barshinger, D. (2013). Determining when an object enters the headlight beam pattern of a vehicle. (Technical paper no. 2013-01-0787). Warrendale, PA: Society of Automotive Engineers.

Muttart, J. & Romoser, M. (2009). *Evaluating Driver Response and Ability to Avoid a Crash at Night*. Leicester, England; Proceedings of the Institute of Traffic Accident Investigators [ITAI] and the European Association for Accident Research and Analysis [EVU].

Button Press terminology - Many night recognition studies asked drivers to press a button, a horn, or make an utterance (i.e., a button press). Drivers first RECOGNIZED - then PRESSED A BUTTON (responded). The studies report when the driver pressed the button (or made a verbal utterance) after recognizing the object. Olson (2003, 2010) suggested that it would take participants 0.5 s to press a button once an object is recognized. Thus, when accounting for a 0.5 s button press time and the average speed of the studies (Muttart et al., 2013) 42.6 ft/s x 0.5 s = 21.3 ft. IDRR adds 21.3 ft (6.5 m) to the button press distance to find the


Percent That Recognized by This Dista
100%
75%
50%
25%
0%
Feet from Impact


Average Recognition Distance of Pedestrians (Across All Scenarios) Related to Illumination Threshold
350
300
250
200
150
100
50
0
Dark
Gray
Light
Driver's Side
Passenger's Side


25
20
15
10
5
0
Lux
R² = 0.8532
Dark
Gray
Light
Retro
Bio-motion
Material Shade
Kledus
Kosmatka
Muttart
Average
Farber
Gibbons
Edwards
Clark
Owens
Power (Average)

PATH INTRUSION

A: 5. Hazard & Appro Response Unknown ***DEFAULT***

EX: 4. Road/HI Fidelity Sim ***DEFAULT**

D: 1. Driving

E: 3.00 deg ☐ Calculate Eccentricity

Ln: 1. From Next Lane (TTC<3s.)

M: 1. Subj did not discern other unit stop

Tn: 0. SV Not Turning

Tr: 3. PRT Incl. .25-.3 s Latency (Pass. Car / M

Passion D. Lucas

Lt: 2. Night

O: 1. Response to one object

Tp: 1. Less info (i.e. straight road)

Hv: ☐ Check if hovering brake

Braking Adj + (413 x Tr) + 30E + 224Lt + 716O - 496Tp - 164M + 261Tn + 350(D - 1) + 7 eq 1

0 + (413 x 3) + 30x3 + 224x2 + 716x1 - 496x1 - 164x1 + 261x0 + 350 x (1 - 1) + 7 eq 2

		85th percentile response	
AVERAGE PRT	1.9 sec	2.6 sec	Individuals
Equation	1.8 sec		

	Min Avg	Max Avg
Resp to Pedestrian	1.6 Sec	2.6 Sec

Weighted average of 10 on-point studies of response to pedestrian path intrusions

RESPONSE TO PATH INTRUSION

Passion D. Lucas

Initial Speed 45.0 mph

Braking Response

Avg. Deceleration 0.70 Gx

Response Distance = ~ 1.9 x 45 x 1.467

Average Response Dist. 125 feet

~ 85th percentile response Dist. 171 feet

85th percentile response

Time to stop = (2*d/A)^0.5 = 2.9 seconds

Distance = (V x conv)^2 / (2 x A)

Distance to stop = 96.7 feet

TOT. STOPPING DIST. 221.7 feet

85th %ile STOPPING DIST. 267.7 feet

PATH INTRUSION

A	5. Hazard & Appro Response Unknown ***DEFAULT***	Passion D. Lucas	
EX	4. Road/HI Fidelity Sim ***DEFAULT**		
D	1. Driving		
E	3.00 deg	Calculate Eccentricity	
Ln	1. From Next Lane (TTC<3s.)	2. Night	Lt
M	1. Subj did not discern other unit stop	1. Response to one object	O
Tn	0. SV Not Turning	1. Less info (i.e. straight road)	Tp
Tr	3. PRT Incl. .25-.3 s Latency (Pass. Car / I	Check if hovering brake	Hv

Braking Adj + (413 x Tr) + 30E + 224Lt + 716O - 496Tp - 164M + 261Tn + 350(D - 1) + 7 eq 1

0 + (413 x 3) + 30x3 + 224x2 + 716x1 - 496x1 - 164x1 + 261x0 + 350 x (1 - 1) + 7 eq 2

			85th percentile response	
AVERAGE PRT	1.9 sec		2.6 sec	Individuals
Equation	1.8 sec			
		Min Avg	Max Avg	
Resp to Pedestrian	1.9 Sec	1.6 Sec	2.6 Sec	

Weighted average of 10 on-point studies of response to pedestrian path intrusions

RESPONSE TO PATH INTRUSION

Passion D. Lucas

Initial Speed 45.0 mph

Brake & Steer Response

Lateral Dist To Avoid 3.0 ft.

Avg. Lat. Friction (Gy) 0.18 Gy (See Lat. G Sheet)

Avg. Deceleration 0.45 Gx

Response Distance = ~ 1.9 x 45 x 1.467

Average Response Dist. 125 feet

~ 85th percentile response Dist. 171 feet

85th percentile response

Time to Steer = (2*d/A)^0.5 = 1.02 seconds

Distance = V x t x conv. - 0.5 x g x f x t^2

Distance To Steer = 59.8 feet

TOT. STEERING DIST. 184.8 feet

85th %ile STEERING DIST. 230.8 feet