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Forensic Engineering Analysis of Vehicle-Pedestrian Impact Using EDR Data and Reconstruction Software

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Abstract

This paper will analyze a pedestrian impact with a 2012 vehicle in a criminal matter. The driver of the vehicle struck the pedestrian before crashing into a chain-link fence and tree. The driver was arrested and charged with vehicular homicide and driving while intoxicated (DWI). The question was: Where was the pedestrian standing when she was struck? The airbag control module was downloaded by the prosecution expert. The speed, steering angle, and longitudinal/ lateral accelerations were recorded for a period of 5 seconds prior to algorithm wake-up as a result of a fence side-swipe and then algorithm enable (AE) for the deployment of the vehicle-side airbags after impacting a tree. The recorded data was input into Virtual Crash and PC-Crash (accident reconstruction software that uses Newton's laws of motions in analysis). The software allowed the time-distance-speed path of the vehicle to be visualized. The prosecution expert opined that the pedestrian was struck on the sidewalk a short distance from where she came to rest. This author was retained by the defense to determine the pedestrian's position — either in the roadway or on the sidewalk.

Keywords

Pedestrian, Crash Data Retrieval, CDR, computer simulation software, accident reconstruction, criminal, DWI

Case Description

The defendant driver was driving westbound on a service road between 1 a.m. and 2 a.m. on a Saturday morning after leaving a local bar. The accident description (per the police report) was as follows:

> *At the point of occurrence, motor vehicle one was traveling westbound on a parkway service road at an unsafe speed. Rear left tire was a spare. Motor vehicle lost control, mounted sidewalk on northwest corner, striking above stationary pedestrian. Motor vehicle then struck chain-link fence, a tree and did then re-strike the fence. Pedestrian was pronounced "dead" on scene by EMS. Operator of motor vehicle was removed to hospital and arrested for DWI by police officer.*

Based on the initial police report and diagram as shown in **Figure 1**, the driver was arrested on a DWI and was charged with vehicular homicide with a blood alcohol value of 0.17. The police accident reconstructionist took color photographs and rendered a sketch of how the event occurred.

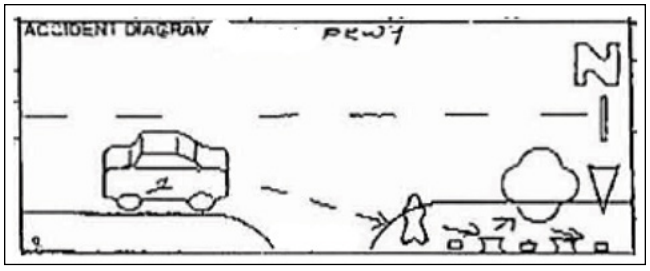

Figure 1
Police report diagram shows the vehicle traveling west. Then it veers to the north to strike the pedestrian standing on the sidewalk, strikes the fence, strikes the tree, and comes to rest west of the tree.

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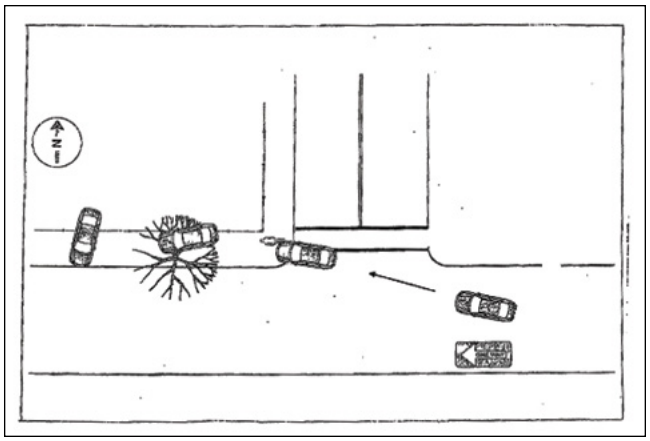

Figure 2
The sketch prepared by the prosecution accident reconstructionist is similar to the sketch in the police report in that it shows the deceased pedestrian being struck while standing on the sidewalk.

Portions of the grand jury hearing were acquired by the defendant's attorney, which described the prosecutor's expert witness opinion. He had been a police officer for 25 years, with 19 years as a highway accident investigation technician, 12 years as a trained accident reconstructionist from the Institute of Police Technology and Management (IPTM), and with recent yearly accident reconstruction training from Northwestern University. The court qualified him as an expert witness in vehicular collision reconstruction. The witness testified to the following:

a. Weather was clear and dry.
b. Vehicle was traveling west.
c. Driver lost control of vehicle and veered to right.
d. Vehicle drove up onto the northwest curb of the service road.
e. There were scrape marks on sidewalk from vehicle undercarriage.
f. After mounting curb, vehicle struck pedestrian, who was standing on the corner sidewalk.
g. Pedestrian was found lying prone on sidewalk.
h. One of pedestrian's sneakers was found under second parked car from corner.
i. Vehicle passenger-side view mirror found near stop sign pole.
j. After striking pedestrian, vehicle continued west and struck the chain-link fence.
k. Vehicle continued west and struck a tree.
l. After striking the tree, vehicle rotated counterclockwise and came to final rest beyond the tree with the rear of vehicle against the fence and the front on the sidewalk.
m. There was vehicle damage on the upper portion of passenger-side windshield.
n. The vehicle was traveling in excess of the 30-mph speed limit.
o. The pedestrian had injuries to her face.

The accident reconstructionist performed no measurements or calculations, nor did he use any reconstruction software to arrive at his opinion that the pedestrian was standing on the northwest corner of the sidewalk (as shown in **Figure 2**).

The pedestrian's head came in contact with the windshield, as observed by the spider pattern (see **Figure 3**), which appears to be bowing outward, on the passenger side of the defendant's vehicle. This bowing was probably caused by contact with the tree on the driver's side as the vehicle rotated into the tree.

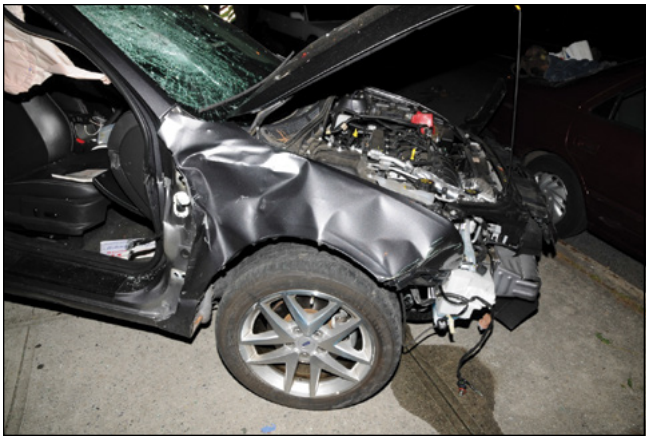

Figure 3
Defendant's vehicle in rest position on sidewalk. Notice the spider pattern on the windshield, which is a classic indication (as noted in the medical examiner's report) that the pedestrian's head struck the windshield at that point.

The medical examiner's report stated that the pedestrian had blunt trauma to the head, trunk, and extremities. According to this document, the left side of the victim's face, eyelid, nose, and upper/lower lips were contused. The scalp, left temporal, and all the bones of the anterior, middle, and posterior cranial fossa were fractured. The blunt trauma to the head and spider windshield pattern are consistent with the head striking the windshield. The Office of the Medical Examiner also reported that the pedestrian was last treated at a local hospital for psychiatric illness 10 days prior to her death and had a history of mental illness.

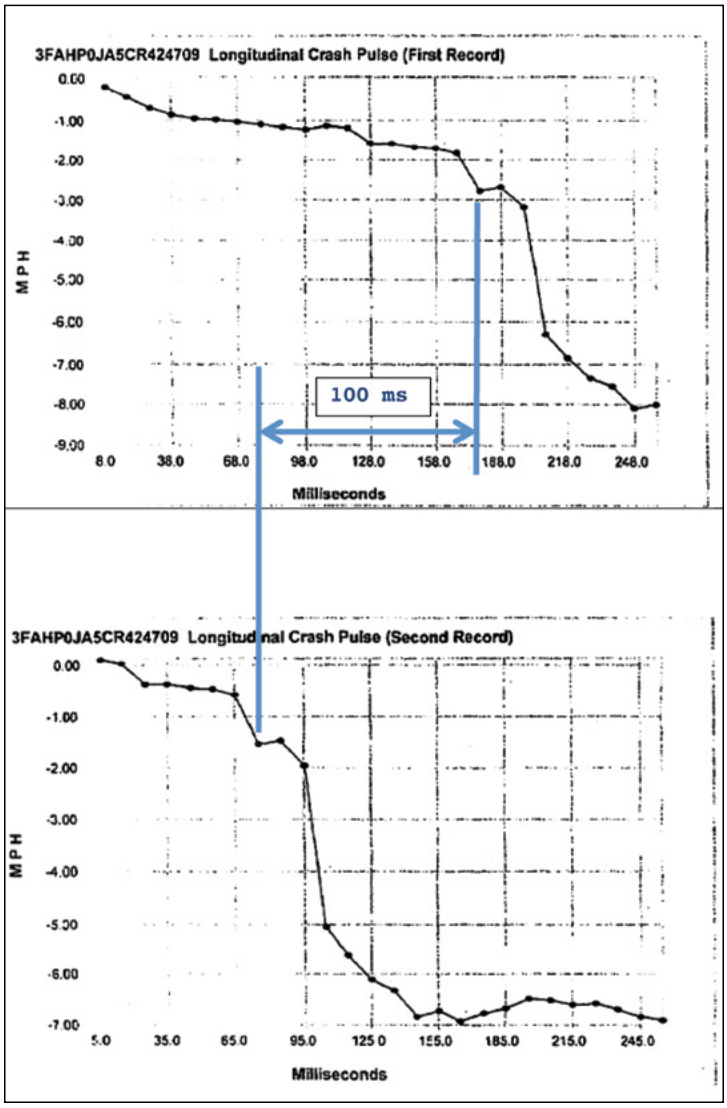

Figure 4 and 5
The above graphs show the longitudinal crash pulse for the first and second records. The horizontal arrow shows the overlap of 100 milliseconds of the two records.

The airbag control module, which was downloaded 10 days after the accident, showed there were two events[1]. The first was a non-deployment (ND) event because there was no airbag deployment, and the data was not locked. The second was a locked airbag deployment event of the side airbags. The two events were separated by approximately 100 milliseconds and were confirmed using the graphs in the Crash Data Retrieval[2] (CDR) report as shown in **Figures 4** and **5**. The graphs depict the change in velocity in miles per hour and time in milliseconds at the start of airbag deployment. This indicated that the first event was probably the sideswipe with the fence when the vehicle made contact with the corner and along the fence. The second event deployed the side airbags, which coincides with the rear driver side impact when the vehicle rotated into the tree.

The stability control telltale would have been flashing at 2 Hz, indicating that the vehicle was losing traction 2 seconds prior to AE. The accelerator pedal was at 100% throttle, and the brake was not applied. The driver's steering inputs showed that he performed a hard steer to the left at approximately 2 seconds prior to AE. The steering also showed that the driver steered to the right between -5 seconds and -3 seconds and then to the left; however, stability was maintained. This could be attributed to the emergency spare tire on the rear right, which had a 15-inch radius while the standard tires had a 16-inch radius.

Pre-Crash Data -5 to 0 sec [2 samples/sec] (First Record)

Times (sec)	Speed vehicle indicated MPH [km/h]	Accelerator pedal, % full	Service brake, on/off	Engine RPM	ABS activity (engaged, non-engaged)	Stability control (engaged, non-engaged)	Traction Control via Brakes (engaged, non-engaged)	Traction Control via Engine (engaged, non-engaged)
-5.0	47.6 [77.0]	73	Off	5,600	non-engaged	non-engaged	non-engaged	non-engaged
-4.5	48.5 [78.0]	75	Off	4,100	non-engaged	non-engaged	non-engaged	non-engaged
-4.0	51.0 [82.0]	86	Off	4,200	non-engaged	non-engaged	non-engaged	non-engaged
-3.5	52.6 [85.0]	87	Off	4,400	non-engaged	non-engaged	non-engaged	non-engaged
-3.0	55.3 [89.0]	87	Off	4,400	non-engaged	non-engaged	non-engaged	non-engaged
-2.5	57.2 [92.0]	89	Off	4,600	non-engaged	non-engaged	non-engaged	non-engaged
-2.0	59.7 [96.0]	99	Off	4,700	non-engaged	engaged	non-engaged	non-engaged
-1.5	60.3 [97.0]	100	Off	4,800	non-engaged	engaged	non-engaged	non-engaged
-1.0	64.0 [103.0]	0	Off	5,100	non-engaged	engaged	non-engaged	non-engaged
-0.5	58.4 [94.0]	0	Off	4,600	non-engaged	engaged	non-engaged	non-engaged
0.0	57.8 [93.0]	0	Off	3,700	non-engaged	engaged	non-engaged	non-engaged

Figure 6
Five seconds of pre-crash data for the first event show that approximately 1 second prior to AE the defendant took his foot off of the accelerator. It also shows that his vehicle reached the speed of 64 mph 1 second prior to AE.

Pre-Crash Data -5 to 0 sec [2 samples/sec] (Second Record)

Times (sec)	Speed vehicle indicated MPH [km/h]	Accelerator pedal, % full	Service brake, on/off	Engine RPM	ABS activity (engaged, non-engaged)	Stability control (engaged, non-engaged)	Traction Control via Brakes (engaged, non-engaged)	Traction Control via Engine (engaged, non-engaged)
- 5.0	47.8 [77.0]	73	Off	5,600	non-engaged	non-engaged	non-engaged	non-engaged
- 4.5	48.5 [78.0]	75	Off	4,100	non-engaged	non-engaged	non-engaged	non-engaged
- 4.0	51.0 [82.0]	86	Off	4,200	non-engaged	non-engaged	non-engaged	non-engaged
- 3.5	52.8 [85.0]	87	Off	4,400	non-engaged	non-engaged	non-engaged	non-engaged
- 3.0	55.3 [89.0]	87	Off	4,400	non-engaged	non-engaged	non-engaged	non-engaged
- 2.5	57.2 [92.0]	89	Off	4,600	non-engaged	non-engaged	non-engaged	non-engaged
- 2.0	59.7 [96.0]	99	Off	4,700	non-engaged	engaged	non-engaged	non-engaged
- 1.5	60.3 [97.0]	100	Off	4,800	non-engaged	engaged	non-engaged	non-engaged
- 1.0	64.0 [103.0]	0	Off	5,100	non-engaged	engaged	non-engaged	non-engaged
- 0.5	58.4 [94.0]	0	Off	4,600	non-engaged	engaged	non-engaged	non-engaged

Figure 7
Five seconds of pre-crash data for the second event show that approximately 1 second prior to AE the defendant took his foot off of the accelerator, which is identical to the first event.

Prosecutor's Argument

Referencing the CDR download (as shown in **Figures 6 & 7**), which put the defendant's vehicle speed as high as 64 mph (103 kmh) in a 30-mph zone — and given the fact that the defendant had a blood alcohol level of 0.17 — he was charged with DWI. The defendant was arrested, removed from the scene, and taken to the hospital (where he was in a coma for the first three days and then stayed for several weeks). He was unable to recall events leading up to the crash.

Based on the opinion of the prosecutor's expert witness and the evidence presented by him to the grand jury, the prosecutor charged the driver with vehicular homicide and DWI with the maximum prison time of 25 years.

Case Material Reviewed

The author reviewed 84 photographs taken by the police of the vehicle at the scene as well as photographs taken when the vehicle was in the police impound. Also reviewed were the CDR report, pages from the grand jury testimony of the prosecutor's expert witness, and portions of the medical examiner's report. The author also visited the location and took measurements and photographs.

Defendant's Argument

The author was engaged by the defendant's attorney, and used the data from the CDR download to analyze the case. The 5 seconds of pre-crash data, prior to AE, was input into the accident reconstruction software Virtual Crash (V-Crash)[3] and PC-Crash[4]. The computer software calculations for PC-Crash and Virtual Crash are based on Newtonian physics, linear and rotational energy, and momentum principles. The results are plotted, and the vehicle is shown in motion and rest position. The data used included the speed, steering angle, and longitudinal acceleration. This data was recorded every 100 milliseconds, beginning with the velocity of the defendant's vehicle of 48 mph (77 kmh).

Using Internet satellite maps to gather an aerial view of the location, the path of the vehicle was plotted along the parkway service road. Note that there was a discrepancy between the CDR data recorded regarding speed and the speed calculated using the input values of longitudinal acceleration. The maximum speed calculated using Virtual Crash and PC-Crash software was approximately 60 mph versus the CDR-recorded speed of 64 mph. This could be attributed to the asynchronous writing of the data in the airbag control module and/or the frequency of data recording: the airbag control

Figure 8
This shows the path of the vehicle as it moves from the roadway onto the sidewalk and into the fence and tree. The motion depicted was created by inputting the CDR longitudinal accelerations, steering angles, and speeds into PC-Crash sequences.

CLICK ON PHOTO TO ACTIVATE VIDEO.

FLASH PLAYER MUST BE INSTALLED TO RUN THE VIDEOS.
IT CAN BE DOWNLOADED AT: HTTPS://GET.ADOBE.COM/FLASHPLAYER/

module catching the maximum speed but not at the appropriate data writing time. Some studies have also shown that the accuracy of pre-crash data in EDRs vary from 1% to 4%. This could also account for the difference. The EDR is using engine RPM and tire size ratios to calculate the reported speeds, but it cannot account for worn tires.

Virtual Crash was selected over PC-Crash for the reconstruction because the Virtual Crash pedestrian model remained in the standing position until vehicle contact, whereas the PC-Crash multibody began to sag due to gravity immediately upon starting the software. The time between the start of the software and the subsequent pedestrian impact was approximately 3 seconds — hence the sagging of the PC-Crash multibody.

At the corner, the software allowed the placement of a model tree and model fencing into which the defendant's vehicle crashed (see **Figure 8**). Somewhere along the vehicle's path the pedestrian was struck. Through iteration, the pedestrian's rest position was determined and agreed with the location of the body rest position as represented by police photographs. The software showed the pedestrian's head impacted the windshield as indicated by the scene photographs. After impact with the vehicle, the pedestrian was projected into the chain-link fence of the adjacent ball field and fell onto the sidewalk in the rest position. Using Virtual Crash software, iterations were performed of the vehicle-pedestrian impact.

When placing the pedestrian on the northwest corner of the street, the pedestrian was projected along the service road and came to rest in this road. The author also determined that the pedestrian could not have been struck while on the sidewalk because the carry distance of the pedestrian was greater than the width of the sidewalk. The vehicle would have thrown the pedestrian along the service road and not into the chain-link fence. Therefore, the pedestrian must have been struck east of the northwest corner of the service road somewhere within the path of the vehicle.

Various placements of the pedestrian — from the crosswalk east along the vehicle path to approximately in front of the bus stop — would have thrown her into the chain-link fence, striking her head on the passenger-side windshield as the evidence showed (see **Figures 9** through **12**). The closer the pedestrian strike was to the northwest corner of the street, the greater the probability

Figure 9
Pedestrian rest position. Notice the indentation of the chain-link fence where pedestrian struck as a result of her trajectory from the vehicle into the fence. The arrow shows the indentation into the chain-link fence.

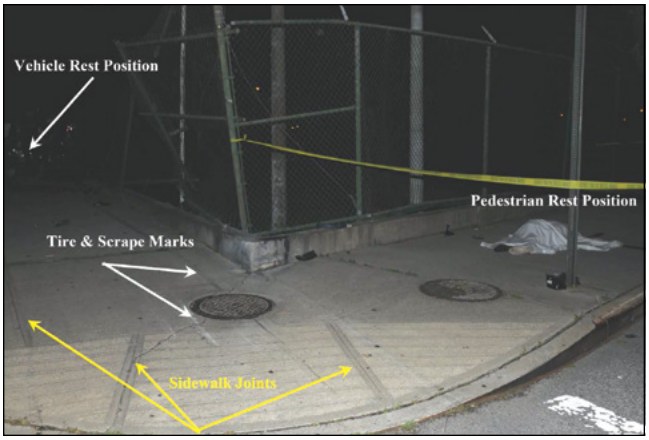

Figure 10
The photograph shows tire marks and scrapes (white arrows) where the vehicle mounted the sidewalk and sideswiped the fence. The yellow arrows depict the sidewalk joints. At this point in time, the vehicle was yawing; the fence sideswipe caused AE but no airbag deployment (ND).

Figure 11
The spider pattern of the passenger side of the windshield shows where the pedestrian's head struck the glass. Also shown are the deployed side airbags.

Figure 12
The interior of the vehicle shows that the front airbags were not deployed.

of the pedestrian being thrown over the chain-link fence. Therefore, the most probable strike of the pedestrian was in the street adjacent to the corner bus stop.

Analysis Methods

The author reviewed the CDR report, took the 5 seconds of pre-crash data (which included the longitudinal acceleration, steering angle, and speed before the crash), and input the data into Virtual Crash and PC-Crash software to get the time/distance path of the vehicle (see **Figures 13** through **15**). The purpose was to place a model pedestrian in the path of the vehicle to determine the throw distance and location of where she was struck and landed in the final rest position (see **Figures 16** through **20**).

The author used the speed of the vehicle at the time of AE as 57.8 mph (93.0 kmh) to arrive at the distance the vehicle traveled between the first and second record enable events. The time lapse of 100 milliseconds and speed of the vehicle in "record one" AE yields that the distance the vehicle traveled between the two records was approximately 8 feet. This distance approximately coincides with the distance between when the first and second records were enabled,

Pre-Crash Data -5 to 0 sec [2 samples/sec] (First Record)

Times (sec)	Speed vehicle indicated MPH [km/h]	Accelerator pedal, % full	Service brake, on/off	Engine RPM	ABS activity (engaged, non-engaged)	Stability control (engaged, non-engaged)	Traction Control via Brakes (engaged, non-engaged)	Traction Control via Engine (engaged, non-engaged)
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-0.5	58.4 [94.0]	0	Off	4,600	non-engaged	engaged	non-engaged	non-engaged
0.0	57.8 [93.0]	0	Off	3,700	non-engaged	engaged	non-engaged	non-engaged

Figure 13
First record of pre-crash data from the non-deployment event.

Pre-Crash Data -5 to 0 sec [2 samples/sec] (Second Record)

Times (sec)	Speed vehicle indicated MPH [km/h]	Accelerator pedal, % full	Service brake, on/off	Engine RPM	ABS activity (engaged, non-engaged)	Stability control (engaged, non-engaged)	Traction Control via Brakes (engaged, non-engaged)	Traction Control via Engine (engaged, non-engaged)
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-0.5	58.4 [94.0]	0	Off	4,600	non-engaged	engaged	non-engaged	non-engaged

Figure 14
Stability control telltale flashing light at 2 Hz signaled at 2 seconds prior to AE, which coincided with a hard steer to the left, as shown in Figure 15.

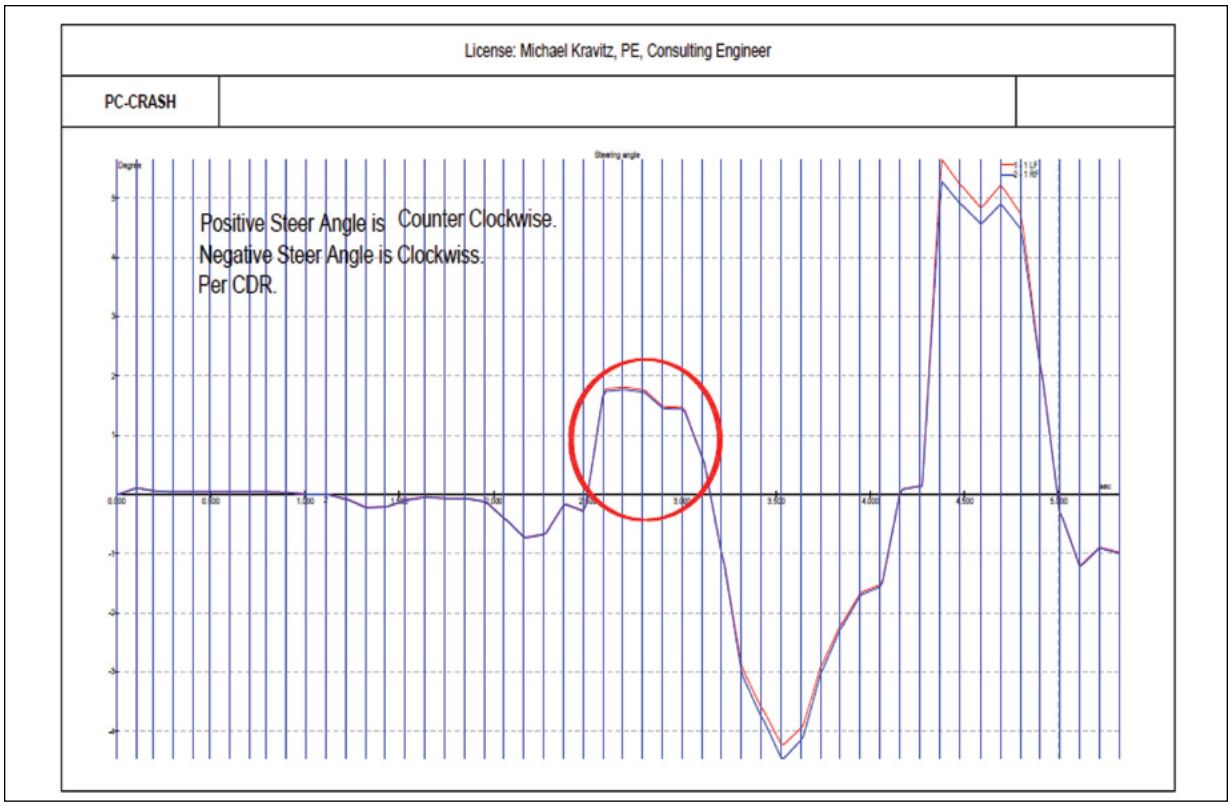


Figure 15
Steering diagram shows a hard steer to the left (counter-clockwise) at approximately 2.3 seconds prior to AE. The hard steer to the left is what the author opines is an evasive action by the driver to avoid the pedestrian or a reflex action after striking the pedestrian. Vehicle travels left to right.

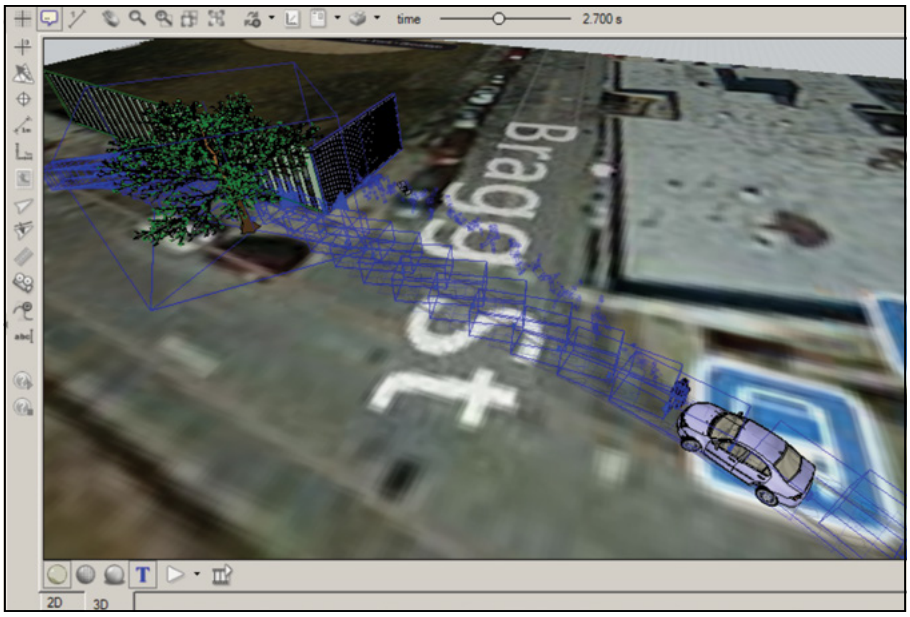


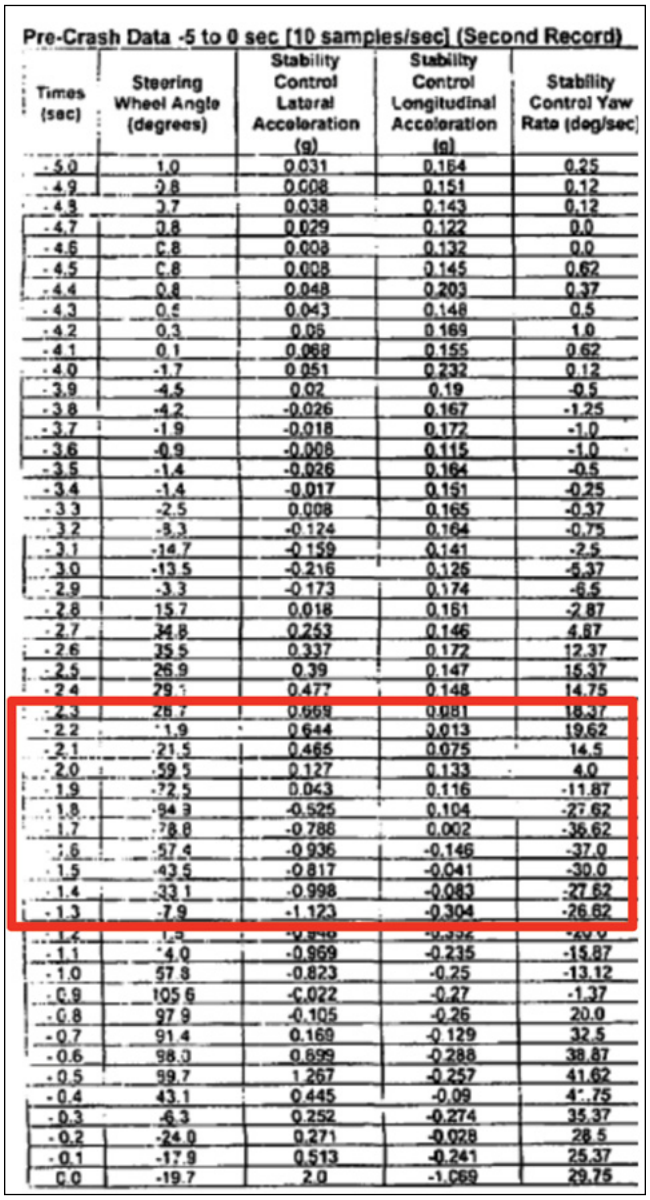
Figure 16
2.7 seconds into simulation corresponds to -2.3 seconds CDR. Pedestrian is in the roadway in front of bus stop. The image is taken from Virtual Crash simulation.

CDR Timing	Virtual Crash Timing
-5	0
-4	1
-3	2
-2	3
-1	4
0	5

Figure 17
Timings comparing the CDR with Virtual Crash data.

which is the estimated distance between the vehicle striking the fence and the tree. This was important because it validated the opinion of the author that the pedestrian was not struck on the sidewalk. Therefore, record one AE was caused by the vehicle striking or side-swiping the fence — not the pedestrian.

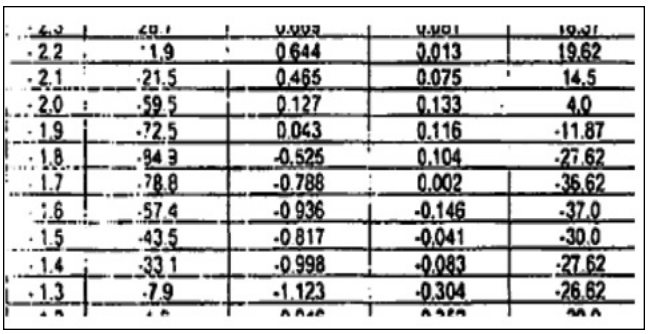
Additionally, the pedestrian was not standing on the sidewalk when struck by the vehicle because there was not enough distance for her to be carried by the vehicle and strike the fence, as shown in **Figure 9**. The carry time of the pedestrian is approximately 200 milliseconds, which was estimated from the video. In order for the pedestrian to strike the fence, she would have to be projected from the windshield within approximately 110 milliseconds to 175 milliseconds over a distance of between 10 feet and 15 feet at a speed of 58.7 mph and still strike the fence at the angle to create the depression in the chain-link fence, as evidenced in **Figure 9**. The opinion of the prosecution expert that the pedestrian was struck while standing on the sidewalk could not have happened based on the speed of the vehicle, the distance to the fence, and the carry distance of the pedestrian on the hood of the vehicle.



Pre-Crash Data -5 to 0 sec [10 samples/sec] (Second Record)

Times (sec)	Steering Wheel Angle (degrees)	Stability Control Lateral Acceleration (g)	Stability Control Longitudinal Acceleration (g)	Stability Control Yaw Rate (deg/sec)
-5.0	1.0	0.031	0.164	0.25
-4.9	0.8	0.008	0.151	0.12
-4.8	0.7	0.038	0.143	0.12
-4.7	0.8	0.029	0.122	0.0
-4.6	0.8	0.008	0.132	0.0
-4.5	0.8	0.008	0.145	0.62
-4.4	0.8	0.048	0.203	0.37
-4.3	0.5	0.043	0.148	0.5
-4.2	0.3	0.05	0.169	1.0
-4.1	0.1	0.068	0.155	0.62
-4.0	-1.7	0.051	0.232	0.12
-3.9	-4.5	0.02	0.19	-0.5
-3.8	-4.2	-0.026	0.167	-1.25
-3.7	-1.9	-0.018	0.172	-1.0
-3.6	-0.9	-0.008	0.115	-1.0
-3.5	-1.4	-0.026	0.164	-0.5
-3.4	-1.4	-0.017	0.151	-0.25
-3.3	-2.5	0.008	0.165	-0.37
-3.2	-5.3	-0.124	0.164	-0.75
-3.1	-14.7	-0.159	0.141	-2.5
-3.0	-13.5	-0.216	0.126	-5.37
-2.9	-3.3	-0.173	0.174	-6.5
-2.8	15.7	0.018	0.161	-2.87
-2.7	34.8	0.253	0.146	4.87
-2.6	35.5	0.337	0.172	12.37
-2.5	26.9	0.39	0.147	15.37
-2.4	29.1	0.477	0.148	14.75
-2.3	28.7	0.669	0.081	18.37
-2.2	1.9	0.644	0.013	19.62
-2.1	21.5	0.465	0.075	14.5
-2.0	59.5	0.127	0.133	4.0
-1.9	72.5	0.043	0.116	-11.87
-1.8	94.3	-0.525	0.104	-27.62
-1.7	78.8	-0.788	0.002	-36.62
-1.6	57.4	-0.936	-0.146	-37.0
-1.5	43.5	-0.817	-0.041	-30.0
-1.4	33.1	-0.998	-0.083	-27.62
-1.3	7.9	-1.123	-0.304	-26.62
-1.2	1.9	-0.849	-0.592	-29.0
-1.1	4.0	-0.969	-0.235	-15.87
-1.0	57.8	-0.823	-0.25	-13.12
-0.9	105.6	-0.022	-0.27	-1.37
-0.8	97.9	-0.105	-0.26	20.0
-0.7	91.4	0.169	-0.129	32.5
-0.6	98.0	0.699	-0.288	38.87
-0.5	99.7	1.267	-0.257	41.62
-0.4	43.1	0.445	-0.09	41.75
-0.3	-6.3	0.252	-0.274	35.37
-0.2	-24.0	0.271	-0.028	28.5
-0.1	-17.9	0.513	-0.241	25.37
0.0	-19.7	2.0	-1.069	29.75

Figure 18
CDR report shows that the hard steering to the left begins at approximately -2 seconds prior to AE. This can be attributed to either an evasive steer or reaction steer after striking the pedestrian.



-2.2	1.9	0.644	0.013	19.62
-2.1	21.5	0.465	0.075	14.5
-2.0	59.5	0.127	0.133	4.0
-1.9	72.5	0.043	0.116	-11.87
-1.8	94.3	-0.525	0.104	-27.62
-1.7	78.8	-0.788	0.002	-36.62
-1.6	57.4	-0.936	-0.146	-37.0
-1.5	43.5	-0.817	-0.041	-30.0
-1.4	33.1	-0.998	-0.083	-27.62
-1.3	7.9	-1.123	-0.304	-26.62

Figure 19
Close-up of the timing from approximately 2 seconds prior to AE.

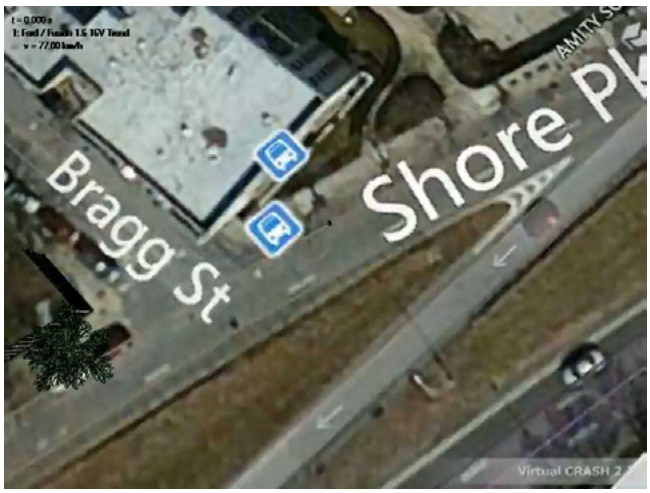


Figure 20
Above is the overview of the path of the vehicle along the service road. The vehicle strikes the pedestrian in the roadway near the bus stop. The pedestrian is projected into the chain-link fence and falls to the sidewalk. The vehicle continues into the tree and comes to rest at approximately its rest position as depicted in the photographs.

CLICK ON PHOTO TO ACTIVATE VIDEO.

Figure 21
Closer view of the pedestrian being struck by the vehicle.

CLICK ON PHOTO TO ACTIVATE VIDEO.

Below is a series of consecutive images taken from the prepared video depiction of the position of the pedestrian head strike on the windshield. **Figure 22** through **Figure 25** are images taken from Virtual Crash simulation software that show where the pedestrian was struck relative to the vehicle. Similarly, **Figure 26** through **Figure 29** show where the pedestrian would have been struck relative to the vehicle if she was struck on the sidewalk, if she were standing on the northwest corner sidewalk. **Figures 22** through **29** are identical with the head striking the windshield at the same location. This shows that had the pedestrian been struck while standing on the sidewalk, the windshield pattern would have been the same, but the pedestrian would have come to rest along the service road instead of where she came to rest on the sidewalk (as indicated in **Figures 20, 21, 30,** and **31**).

Figure 22
Stop motion of pedestrian struck by vehicle.

Figure 23
Stop motion of pedestrian struck by vehicle.

Figure 24
Stop motion of pedestrian struck by vehicle.

Figure 25
Stop motion of pedestrian struck by vehicle.

Figure 26
Stop motion of pedestrian struck by vehicle.

Figure 27
Stop motion of pedestrian struck by vehicle.

Figure 28
Stop motion of pedestrian struck by vehicle.

Figure 29
Stop motion of pedestrian struck by vehicle.

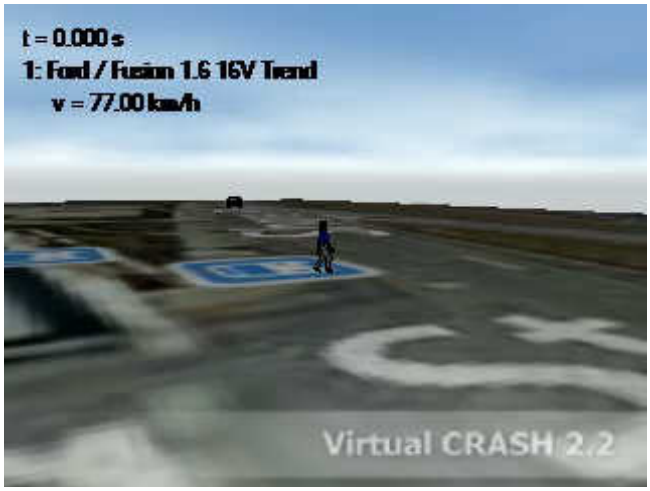


Figure 30
Video of pedestrian being struck in street near bus stop and projected into the fence.

CLICK ON PHOTO TO ACTIVATE VIDEO.

Figure 31
Video of pedestrian being struck on the northwest corner sidewalk as opined by the prosecution expert.

CLICK ON PHOTO TO ACTIVATE VIDEO.

Other Considerations and Discrepancies

The problem with the author's analysis is that the graph below, which is taken directly from the CDR data, shows a small change in velocity at 2.3 seconds — the estimated point of pedestrian impact (see **Figure 32**). The graph below, which is from the Virtual Crash pedestrian impact data, shows a distinct change in velocity at the same time.

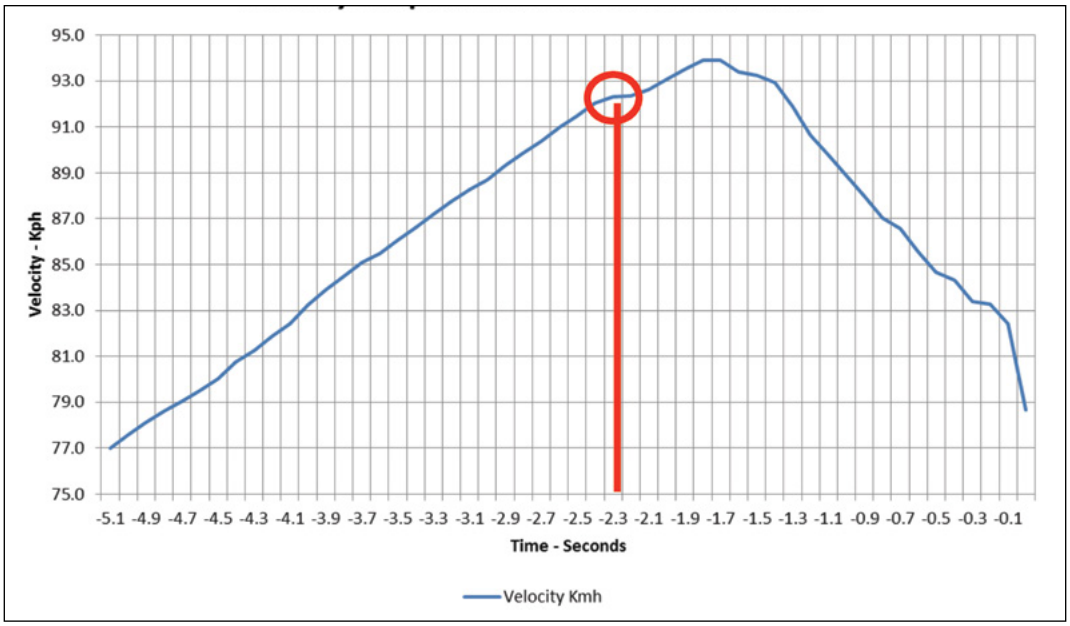


Figure 32
The velocity of the vehicle (in kph) from the CDR download where the probable pedestrian hit coincides with the simulation by Virtual Crash as shown. Vehicle travels from left to right.

The probable cause of error is because the vehicle is at 100% throttle, which has a small effect on the change in velocity of the vehicle but a large effect on impacting the pedestrian.

The CDR graph shows flattening of the velocity curve where the pedestrian probably struck.

The Virtual Crash graph with the pedestrian hit shows a vertical drop in velocity (see **Figure 33**).

Conclusion

The conclusion of the author was that the pedestrian was struck by the vehicle in the roadway of the service road opposite the bus stop where there is no crosswalk. The pedestrian was not struck while standing on the northwest sidewalk of the street and service road as the prosecution expert opined because there was not enough time or distance for the pedestrian to strike the chain-link fence at the angle evidenced in the photographs.

The defendant negotiated a plea to DWI/speeding and was sentenced to three years in prison.

The use of computer software enabled the author to examine this case based on the data captured in the airbag control module, which led to an analysis based on physics and Newton's laws of motion and not to *ipse dixit* opinion.

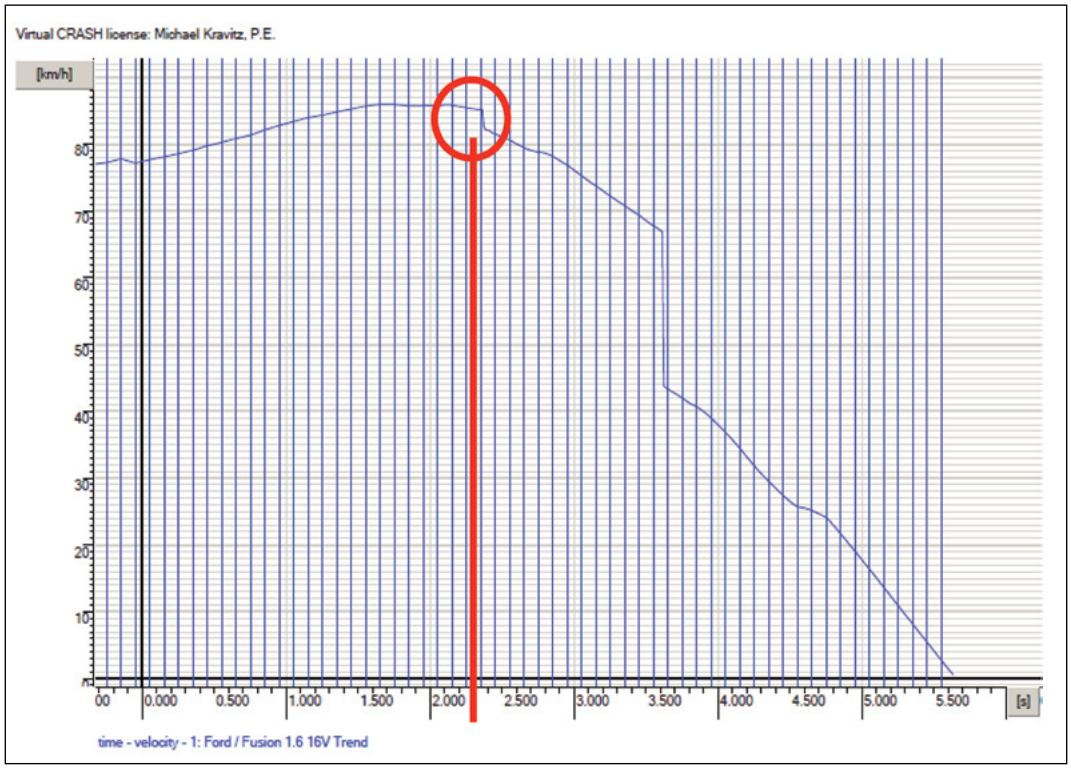


Figure 33
The graph above shows the pedestrian hit at about 2.3 seconds from the simulation of Virtual Crash. Notice the vertical drop indicated, which shows a change in velocity of the vehicle (traveling left to right).

Epilogue

After sentencing, the author was informed of the negotiation between the prosecutor and defendant's attorney that resulted in the DWI plea. The defendant's attorney discovered that the pedestrian had a psychological illness, and it was noted in her records by her doctor that she wished to commit suicide by walking in front of a vehicle. She gave this statement to her psychiatrist 10 days prior to the accident. It was surmised by the defendant's attorney that she wanted to walk onto the service road that night. The on-ramp entrance to the parkway was a short distance from where she was struck, as indicated by the arrow (see **Figure 34**).

Figure 34
Image of pedestrian being struck in street near bus stop.

References

1. 49 CFR 563.8 – data format. National Highway Traffic Safety Administration, Department of Transportation (event data recorders). Code of Federal Regulations, United States Government Printing Office. http://www.gpo.gov/fdsys/granule/CFR-2011-title49-vol6/CFR-2011-title49-vol6-sec563-8

2. Bosch Crash Data Retrieval software system, version 10.2 (Bosch Diagnostics, www.boschdiagnostics.com/cdr)

3. Virtual Crash (V-Crash) accident reconstruction software, 2.3 (www.vcrash3.com)

4. PC-Crash accident reconstruction software, version 10.0 (MEA Forensic, www.pc-crash.com)