

# Diagnosing Seatbelt Use or Non-Use

When "Traditional" Witness Marks Are Absent

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**Untangling a Web of Questions**

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**Attorneys at Law**



**A Nationwide Law Practice Dedicated to Vehicle Safety Issues**

**214-324-9000**



## INTRODUCTION

The seatbelt industry has known since the 1960's, that seatbelts that were buckled could unlatch in a motor vehicle accident. Dan Davee, a former Allied Signal engineer, who always testifies on behalf of the automobile and seatbelt industry, has testified that there are only four mechanisms that will unlatch a seatbelt buckle in an accident.

### The Only Ways To Unlatch a Buckle In An Accident

- A. OVERLOAD**
- B. INADVERTENT CONTACT**
- C. FALSE LATCH /  
PARTIAL ENGAGEMENT**
- D. INERTIAL RELEASE**

Knowing that seatbelt buckles can unlatch in an accident, it is incumbent on any type of investigator to conduct a thorough seatbelt investigation before concluding a person was belted or unbelted when an accident began. However, this isn't always done. In fact, oftentimes, people jump to a conclusion that a person was unbelted when they see or learn that a person was ejected from the vehicle during a motor vehicle accident.



**If you don't think that people tend to jump to a conclusion, take this little test. Is this a picture of a haggard, old woman? Yes or no? (the answer is on page 15.)**

No matter if you represent plaintiffs or defendants, or handle soft tissue injuries or product liability cases, you will run across the following issue:

***Was the decedent or injured person wearing his seatbelt when the accident began?***

This brochure was prepared to provide lawyers, seatbelt investigators, medical investigators and police officers proven tools to help scientifically diagnose seatbelt use or non-use when "traditional" seatbelt witness marks are not present.

## ACCIDENT REPORT CONCLUSIONS AS TO SEATBELT USE OR NON-USE ARE OFTEN WRONG

Simply using the accident report to prove seatbelt use or non-use is improper. Reliance on the accident report to accurately conclude seatbelt use or nonuse is misguided for a number of reasons:

- ➔ **Police officers lack the necessary engineering, medical and forensic training to accurately determine seatbelt use.**
- ➔ **Police officers do not have the time to properly analyze the physical, medical and forensic evidence to accurately determine belt use or nonuse.**
- ➔ **Police officers routinely rely solely on the word of people in the vehicle as to whether they were belted rather than conduct a detailed seatbelt investigation.**

Furthermore, police officers often conclude that people are unbelted when they are ejected or displaced from their reported seating position inside the vehicle. It is the worst kind of science to conclude that solely because a person was ejected from a vehicle, that they were not using their seatbelt. However, police officers routinely assume (based on their training at the academy) that a person was unbelted due solely to their ejection. Jumping to a conclusion without evaluating any of the physical, medical or forensic evidence is a rather close-minded and shallow methodology. In fact, it is no methodology at all.

## “UNBUCKLED” STATUS IS OFTEN WRONG

If someone relies exclusively on the sensing diagnostic module (SDM) data retrieved from the vehicle's onboard computer, they may be relying on flawed data. The NHTSA has uncovered hundreds of accidents where the SDM indicated the ejected person was in fact "buckled."

**Vetronix CDR**

Vehicle Identification Number	3GNFK16R8XG134932
Investigator	John
Case Number	550R krist
Investigation Date	02-08-02
Crash Date	
Filename	3GNFK16R8XG134932 #1.CDR # 3
Saved on	2/8/02 1:07:10 PM
Data check information	A480DB71
CDR version	Crash Data Retrieval Tool 1.200
Program verification number	948D3C51

**System Status At Near Deployment**

SIR Warning Lamp Status		OFF
Driver's Belt Switch Circuit Status		BUCKLED
Passenger Front Air Bag Suppression Switch Circuit Status		Air Bag Not Suppressed
Ignition Cycles At Near Deployment		6517
Ignition Cycles At Investigation		6520
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)		83.75
Maximum SDM Recorded Velocity Change (MPH)		-8.3372

**DMV 001**

DATE OF COLLISION (MO, DAY, YEAR): 04/04/2001

TIME (HHMM): 0410

OFFICER ID: 12646

NUMBER: 01-04-0002

WITNESS ONLY	DRIVER	PASSENGER ONLY	AGE	SEX	EXTENT OF INJURY (X ONE)	INJURED WAS (X ONE)	PARTY NUMBER	EDC FOR	SAFETY EQUIP.	EJECTED
			50	F	<input checked="" type="checkbox"/> FATAL INJURY	<input checked="" type="checkbox"/> DRIVER	1	1	H	1

INJURED ONLY TRANSPORTED BY: SAN BERNARDINO COUNTY CORONER'S OFFICE

DESCRIBE INJURIES: INTERNAL TRAUMA INJURIES. PRONOUNCED DEAD AT SCENE BY PARAMEDIC

OCCUPANTS	SAFETY EQUIPMENT	MC BICYCLE - HELMET	EJECTED FROM VEHICLE
A - NONE IN VEHICLE B - UNKNOWN C - LAP BELT NOT USED D - SHOULDER HARNESS USED E - SHOULDER HARNESS NOT USED F - SHOULDER HARNESS USED G - LAP-SHOULDER HARNESS NOT USED H - PASSIVE RESTRAINT USED I - PASSIVE RESTRAINT NOT USED J - NONE IN VEHICLE	L - AIR BAG DEPLOYED M - AIR BAG NOT DEPLOYED N - OTHER P - NOT REQUIRED Q - CHILD RESTRAINT R - CHILD RESTRAINT S - CHILD RESTRAINT T - NONE IN VEHICLE U - IN VEHICLE NOT USED V - IN VEHICLE USE UNKNOWN W - IN VEHICLE IMPROPER USE X - NONE IN VEHICLE	Y - YES Z - YES	0 - NOT EJECTED 1 - SAFELY EJECTED 2 - PARTIALLY EJECTED 3 - LONELYDOWN

**STATE FARM MUTUAL**

UNIT: MOTOR VEHICLE

YEAR: 1999

MODEL: GOLD/CHEVY

VEHICLE NO: 3GNFK16R8XG134932

DRIVER: JOHN

DATE OF COLLISION: 3-PP-4

OCCUPANT'S POSITION	NAME (LAST NAME FIRST)	AGE	SEX	INJURY	RESTRAINT USED	RESULT
DRIVER	JOHN					
FRONT PASSENGER						
REAR PASSENGER						
REAR SEAT						

**EJECTED**

CODE FOR TYPE RESTRAINT USED	VEHICLE
A - NOT APPLICABLE	
Y - YES	
N - NO	
P - PARTIALLY	
U - UNKNOWN	

**Vetronix CDR**

Vehicle Identification Number	3GNFK16R8XG134932
Investigator	Thomas Braun
Case Number	
Investigation Date	16 July 2001
Crash Date	
Filename	3GNFK16R8XG134932.CDR
Saved on	7/18/01 2:53:24 PM
Data check information	SD22ECC8
Collected with CDR version	Crash Data Retrieval Tool 1.233

**System Status At Near Deployment**

SIR Warning Lamp Status		OFF
Driver's Belt Switch Circuit Status		BUCKLED
Passenger Front Air Bag Suppression Switch Circuit Status		Air Bag Not Suppressed
Ignition Cycles At Near Deployment		6533

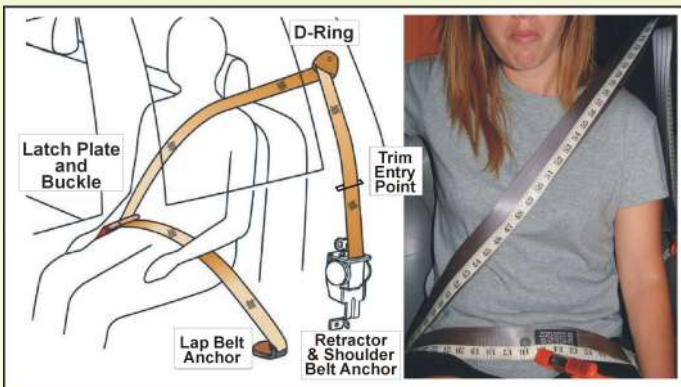


Other incidents have been reported where the decedent was still found belted inside his vehicle and the SDM download indicated "unbuckled."

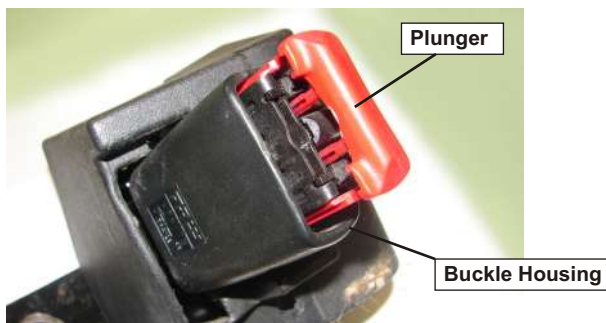
Still other reported accidents had the decedent ejected from his vehicle when the seat collapsed rearward, and yet the buckle was still latched but the SDM download indicated "unbuckled."

### **SOMETIMES SEATBELT USAGE EVIDENCE IS VERY OBVIOUS SUCH THAT THERE ARE "TRADITIONAL" WITNESS MARKS**

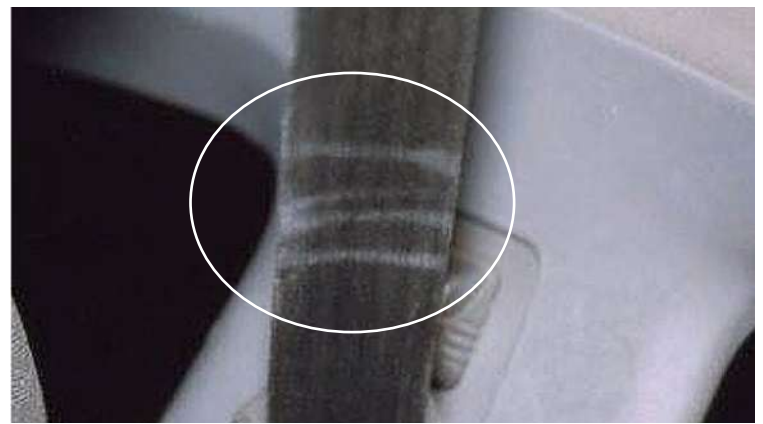
There are several treatises that assist the investigator in assessing whether or not safety belts are being worn in a crash. A seminal paper by Edward Moffatt in 1984 provided an outline of a number of locations where the seatbelt hardware and seatbelt webbing may contain witness marks, as well as suggesting the types of seatbelt usage evidence that might be expected in severe collisions. Moffatt's paper focused on the more "traditional" types of seatbelt evidence that are found in high speed frontal impacts.



Moffatt's paper illustrated "traditional" load marks on seatbelt webbing and hardware that he had found when investigating vehicles following a frontal accident.



1. Buckle loaded and pulled upward. The plunger should be flush or below the buckle housing.



2. Web grabber mark.

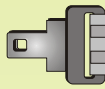


3. Retractor jammed with webbing extended.



4. Retractor frame damaged when seatbelt load is applied.





D-Ring / Latchplate Striations



5. Imprint of the webbing in plastic coated parts of the restraint, such as the latchplate or D-ring. There is often a corresponding transfer of plastic to the webbing.



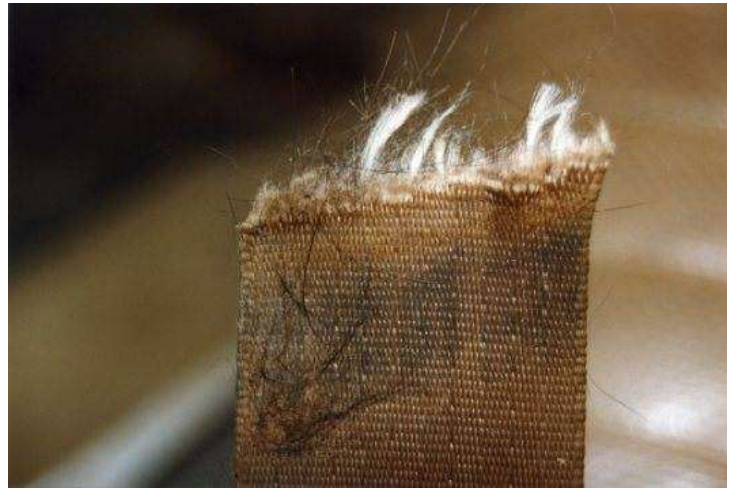
6. Plastic transfer from D-ring / latchplate on webbing.



7. Webbing curled. (Also often called "cupping") This is caused from occupant loading.



8. Webbing "folds" or "creases" due to loading.



9. Torn or broken seatbelt webbing due to overload or a sharp surface.

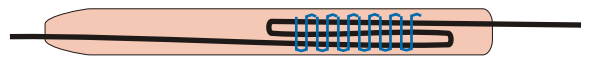


10. Webbing is discolored due to clothing transfer.

There are other "traditional" seatbelt witness marks that are routinely seen during a vehicle seatbelt inspection that Moffatt never addressed in his paper.



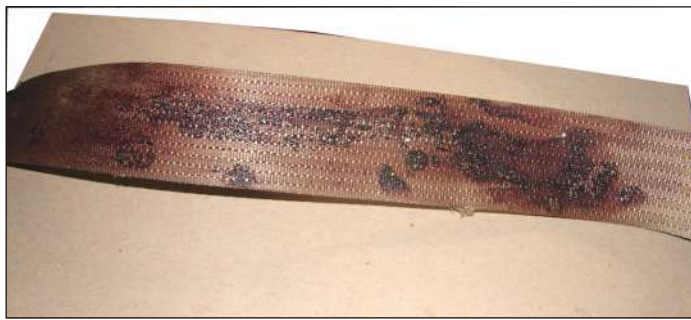
Energy Management Loop Stitches Deployed (Pulled)



Original "Stitching" of Energy Management Loop

1. Deployment (pulling) of the energy management loops indicate seatbelt loading.





2. Belt stiff and inflexible due to blood.



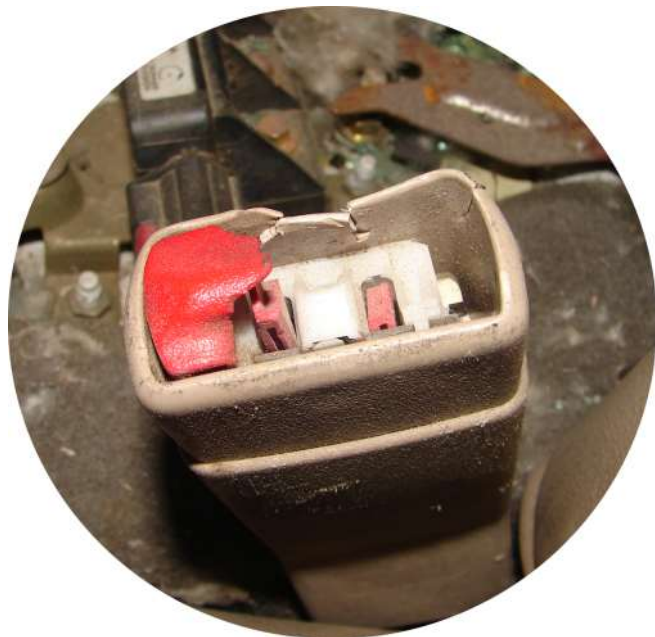
3. Seatbelt buckle stalk is deformed due to loading.



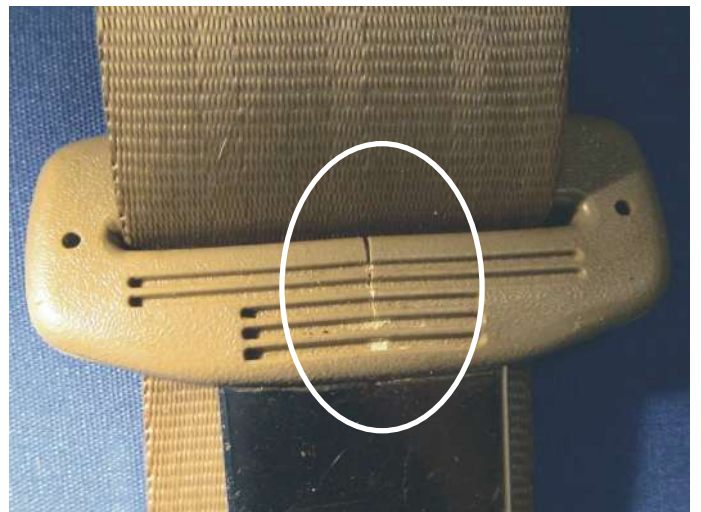
5. D-ring fractured due to loading.



6. Webbing trapped in ABTS outlet / D-ring.



4. Plunger is fractured because latchplate is forced out during accident.

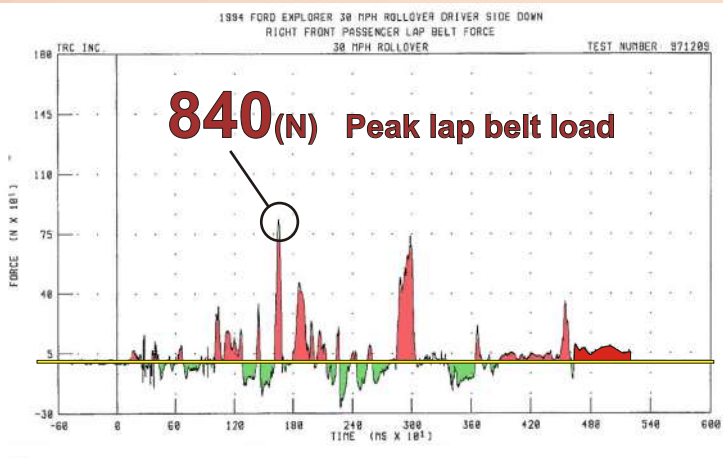


7. Latchplate fractured due to loading.

The Moffatt paper correctly points out, "The signs of loading will be more pronounced in severe crashes and with heavier occupants: the absence of a particular finding, therefore, may not mean that the restraint system was not worn." There are other factors that affect the presence of "traditional" seatbelt load marks.



The assessment of loading on seatbelts is confounded in rollovers due to the low seatbelt loading, which rarely exceeds 5 DaN. (10-12 lb.)

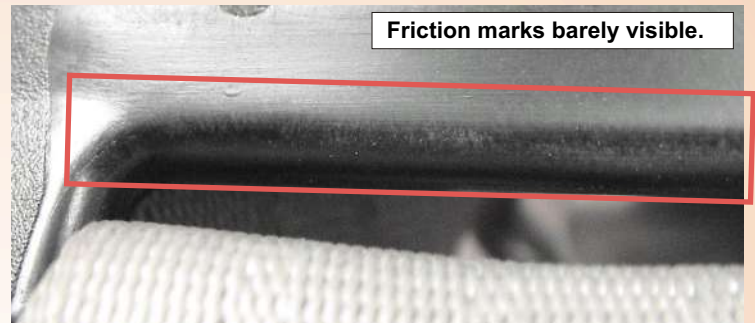


As shown above, even the peak lap belt load is less than 840 N. (190 lb.) in a rollover. Whereas, in a typical frontal crash test at 56.5 KPH (35 MPH), seatbelt loads have frequently exceeded 9000 N. (2000 lb.) Therefore, it is unlikely that significant seatbelt loading marks will be found on the hardware or on the seatbelt webbing in a rollover crash, even if the safety belt has worked properly. Accordingly, it is improper to conclude that a person is unbelted if “traditional” witness marks are lacking, since crash dynamics play a principle role in leaving “traditional” seatbelt load marks.

**THE LACK OF “TRADITIONAL” SEATBELT HARDWARE LOADING EVIDENCE DOESN'T MEAN THE PERSON IS UNBELTED**

One area where loading marks (striations) are “traditionally” found is on the latch plate plastic coating. The striations are created when the webbing creates heat which melts the plastic.

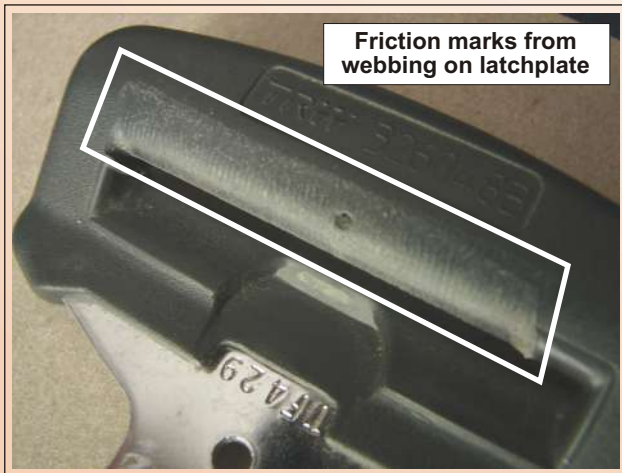
The absence of striation marks on the latchplate is not conclusive of non-belt use however. Unpublished data shows that latchplate signs of loading may be very faint, despite hundreds of Newtons of dynamic load on the seatbelt webbing, imposed by a 50<sup>th</sup> percentile male test dummy. The illustration below shows the damage to the latchplate plastic found in a test where the seatbelt load on both the lap and torso belts exceeded 5000 Newtons (N). The scuffing from the seatbelt webbing on the latch plate plastic coating is barely visible.



Striations of the shoulder belt D-ring are another “traditional” indicator of belt use.

However, D-ring marks can be extremely faint

in many collisions, especially in those collisions where air bags take loading off the webbing, or in rollover collisions, where belt loads on a properly functioning safety belt are generally trivial. Hence, the absence of D-ring marks is not conclusive of an unbelted individual.



It is not uncommon for either the D-ring or the latchplate to have little or no load marks and the other piece of hardware is loaded heavily. The latchplate and D-ring shown below came out of the same vehicle. Yet, the latchplate has hardly any "traditional" witness marks when compared to the D-ring which is heavily striated with "traditional" load marks.



### **MULTI-DISCIPLINARY APPROACH TO SAFETY BELT EVALUATION WHEN "TRADITIONAL" SEATBELT EVIDENCE IS NOT PRESENT OR POORLY DEFINED**

Moffatt recognized the fact that loading marks on the webbing and seatbelt hardware may not be present in lower severity crashes or when the occupant lacks sufficient weight. As a result, he suggested various other "non-traditional" witness marks that should be evaluated on the seatbelt webbing that would be indicative of seatbelt use and would be less dependent on seatbelt loading. These include:

- 1. Dust on the webbing;**
- 2. Glass particles on the webbing; and**
- 3. Blood on the webbing.**

Other investigators mention paint transfers, glass abrasions, glass "picks" and torn fibers as potential "non-traditional" seatbelt evidence indicators that should be considered when determining whether the seatbelt was being worn.

However, no one has ever provided a methodology for making a clear forensic determination of the value of these non-load-related markings. Therefore, a systematic effort is necessary to accurately determine seatbelt use when "traditional" seatbelt load marks are absent.

One approach to evaluate "non-traditional" seatbelt witness marks that has been used

successfully by the author is the use of a multi-disciplinary "tag team" to assess evidence. Once an investigator determines that seatbelt use in a collision is likely to be controversial because "traditional" seatbelt physical evidence is not obvious or is poorly defined, all available physical, medical and forensic evidence should be evaluated in a systematic fashion. Evidence from various sources should not be analyzed separately. A better approach to evaluating "non-traditional" seatbelt evidence involves an assessment of all physical, medical and forensic evidence in concert with one another to accurately diagnose seatbelt use. This multi-disciplinary approach is outlined below.

## **MEDICAL EVIDENCE**

### **PRESENCE OF INJURIES**

Forensic pathologists often note that the lack of injuries is oftentimes as significant as the presence of injuries. A systematic approach to seatbelt use requires a complete analysis of each injury, no matter how trivial. Each injury should be placed on a diagram. If a 3-point belt was worn, there is likely to be patterned injury and/or injuries that are aligned on the body. Likewise, there will likely be corresponding damage to the webbing. In fact, the seatbelt webbing may have pulled fibers, elongated panels or belt folds whose importance is not detected until a medical diagram and surrogate study are conducted. The critical aspect of evaluating "non-traditional" seatbelt loading evidence is the importance of evaluating all available evidence, not just a myopic analysis of one or two points that have been "traditionally" used to determine seatbelt usage.

### **External Injuries**

#### **Chest Injuries**

Patchy abrasions and purple contusions involve inner upper and lower quadrants of left breast

Confluent to punctate hemorrhages with linearity.

Purple contusions and red abrasions extend at an angle from left neck base across left supraclavicular fossa and left clavicle, across left breast, across mid chest and across lower right anterior chest

#### **Right Wrist**

Palpable dislocation

#### **Abdomen**

Distended with horizontal abrasion of left upper quadrant and vertical abrasions of lateral right upper quadrant.

#### **Facial Injuries**

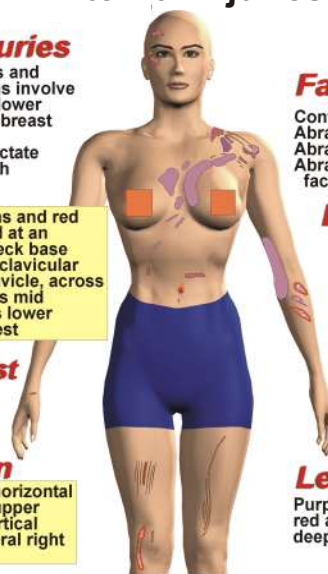
Contusion of left intraorbital ridge  
Abrasion of right forehead  
Abrasion of right eyelid  
Abrasions to right side of face

#### **Left Shoulder**

deep brownish-black abrasions overlying the anterior and lateral aspects of left shoulder and base of the neck

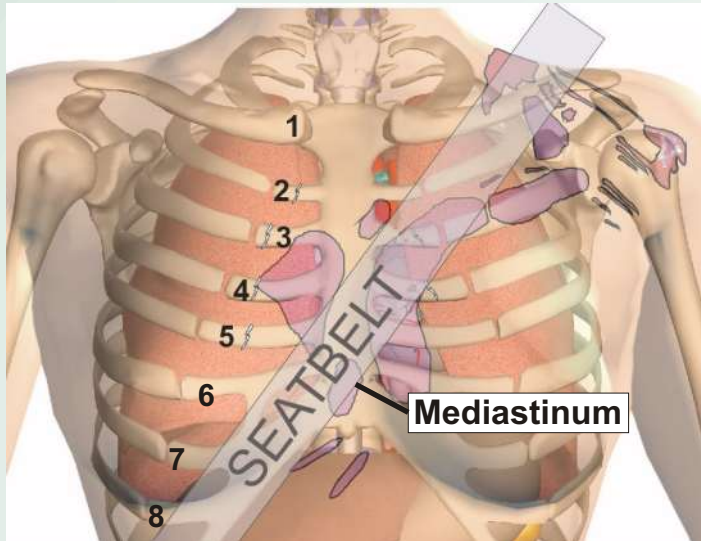
#### **Left Forearm**

Purple contusions, red abrasions and deep lacerations

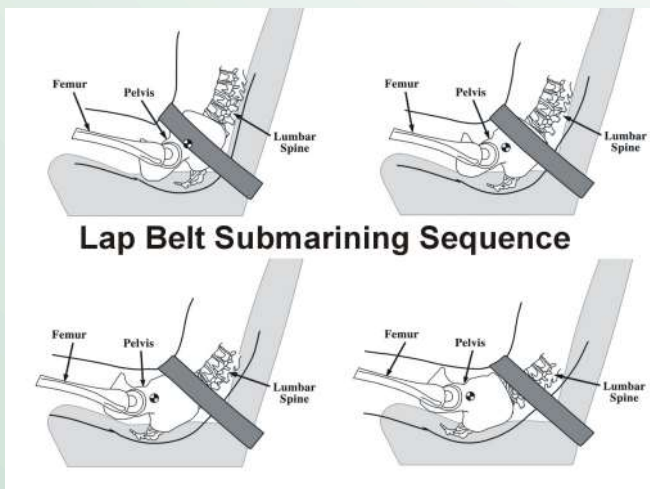




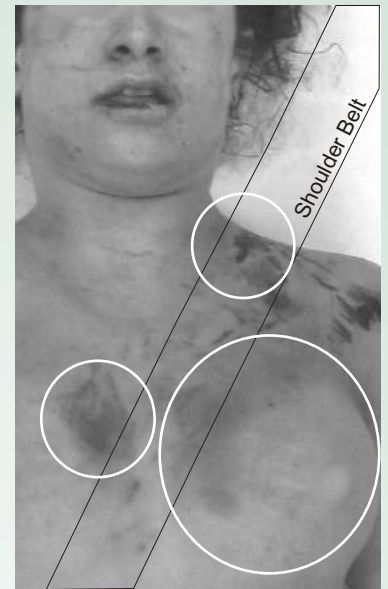
An often-misunderstood injury pattern is rib fractures on the left and right side of the anterior chest. There are biomechanical engineers that claim that a 3-point belt cannot cause left and right side rib fractures. This shows a total lack of anatomical knowledge. Specifically, a shoulder belt can load the mediastinum bone and impart forces sufficient to fracture ribs to the right and left, and above and below the mediastinum.



Bruising patterns are another type of injury often misunderstood or misinterpreted by biomechanical engineers. Many biomechanical engineers claim that bruising should always be below the umbilicus. Such is not the case as the human body is a flexible and pliable living organism that is capable of virtually infinite variation in movement relative to the belt. In fact, there is an entire classification of injuries, known as "submarining," which relate to the pelvis slipping under the lap belt. Injuries from lap belt submarining include blood in the abdomen, internal organ lacerations and tearing and bruising to the internal organs.



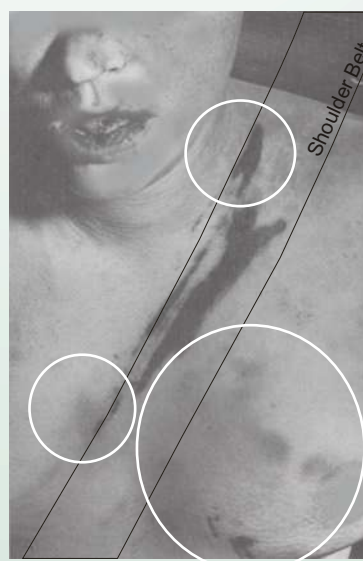
Neck and mid-torso injury patterns that relate to motion relative to the upper torso belt can also be identified if submarining occurs. As such, the shoulder belt bruise pattern may be shifted upward or downward from its nominal position on the supraclavicular fossa. Further, the shoulder belt bruising may be centered to the left or right of the midline of the mediastinum if submarining occurs.



A frequent mistake made during seatbelt diagnosis is suggesting that the shoulder belt must create identical bruising as the lap belt. This shows a basic lack of knowledge of crash dynamics, crash forces and anatomy. In seatbelts with separate lap and shoulder segments, the shoulder belt loads are sometimes four to five times as high as lap belt loads. When occupant kinematics involve rolling out of the shoulder belt, the shoulder belt loads are likely to be half of the lap belt loads, or even less.



**Rollout sequence. Rollout reduces shoulder belt loads and increase lap belt loads.**



Lastly, persons unfamiliar with human anatomy and the results of numerous autopsies often suggest that the webbing will always leave a perfect imprint 1 3/4 inches wide. This is not the case. In fact, in accidents where there are multiple components such as a frontal, then a side slap followed by a rollover, it is not uncommon for the bruises to be much wider than the seatbelt due to



occupant movement. If the seatbelt folds, as it often does at the neck, or across the lap, the bruise or belt abrasions may be much narrower than the webbing. Notice also that the bruising caused by the shoulder belt often migrates into the surrounding tissues.

A thorough understanding of the human body is necessary to distinguish seatbelt bruising from other blunt force traumatic events. This requires testimony from a medical doctor such as a forensic pathologist rather than a biomechanical engineer. Biomechanical engineers tend to spend too much time focusing on evaluating anthropomorphic test devices rather than actual humans. It is uncontroverted that ATD's lack the necessary biofidelity to accurately evaluate what seatbelt loads it takes to cause bruising on a human.

## LACK OF INJURIES

Any determination of seatbelt use should also evaluate the absence of injuries to the individual whose belt use is being evaluated. An unrestrained occupant in a frontal impact will act like a flying projectile. Most importantly, the unrestrained occupant will experience at least the same amount of g's as those experienced by the vehicle. For example, a 200 lb occupant that experiences 20 g's, will have the impact force of a 4,000 lb object experiencing one g.

When unrestrained occupants that generate forces of at least 4,000 lbs strike the instrument panel, steering rim, a-pillar, b-pillar or back of the front seats, there are a constellation of injuries that are routinely seen including:

Facial abrasions, contusions or lacerations  
Fractured facial bones  
Fractured nasal bones  
Cervical fractures  
Cervical ligamentous injuries  
External skull fractures  
Abrasions and contusions to shoulders  
Abrasions, contusions to lower torso  
Fractures to patellas, tibias, fibulas and ankles

It is also recognized in the literature that unrestrained rear seat passengers pose a significant risk to the occupants seated in front of

them in a frontal collision. There are also front seat occupant injuries that are associated with these unrestrained rear seat occupants:

Rib fractures  
Thoracic spinal injuries  
Skull fractures  
Brain injury  
Seatbelt injuries (if restrained)

A diagram outlining the lack of injuries should be prepared by the medical technician. This diagram will be used later when the vehicle interior is studied to look for the presence or lack of vehicle damage. A restrained occupant will have an absence of injuries because his seatbelt prevented injurious contacts with the vehicle interior.



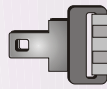
## "NON-TRADITIONAL" EVIDENCE USED TO DETERMINE SEATBELT USE

While the medical professional is evaluating the presence and lack of injuries, the restraint engineer must evaluate the restraint system and the vehicle to help diagnose seatbelt use.

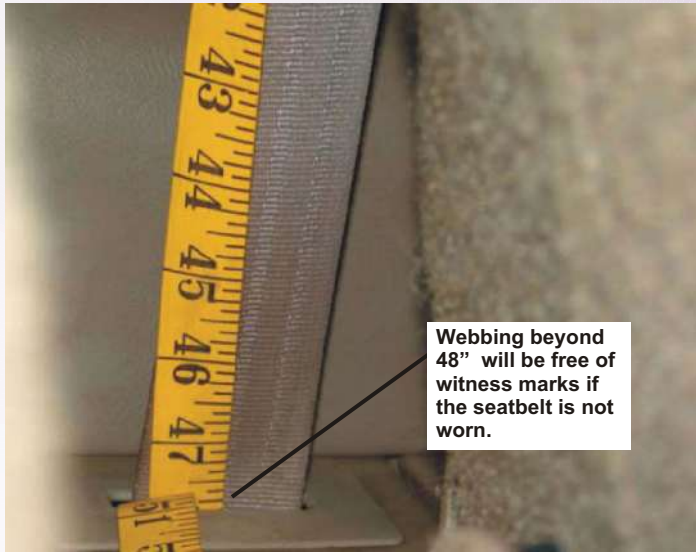
## SEATBELT

Unfortunately, there is no readily available checklist that a technician can use. General Motors established a checklist as part of a research program, but it is proprietary. However, there are some telltale seatbelt usage evidence indicators that must be considered when "traditional" witness marks are absent.





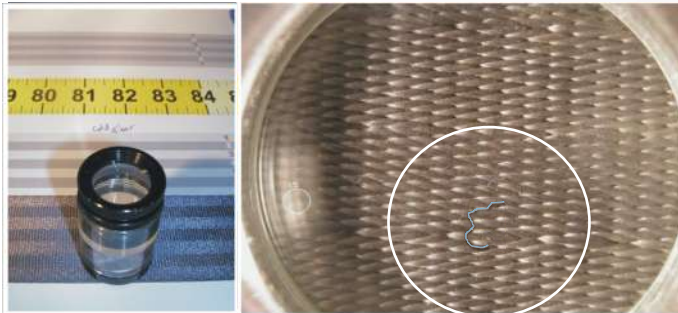
First, determine where the webbing goes into the trim such that the webbing is not exposed to the accident environment when not worn.



Webbing beyond 48" will be free of witness marks if the seatbelt is not worn.

**Measured position of a "Stowed Belt" where the belt enters the protected area inside the trim.**

Second, inspect the seatbelt webbing at all areas below this measurement point. The photograph below shows that no piece of evidence is too small that is placed on the evidence board.

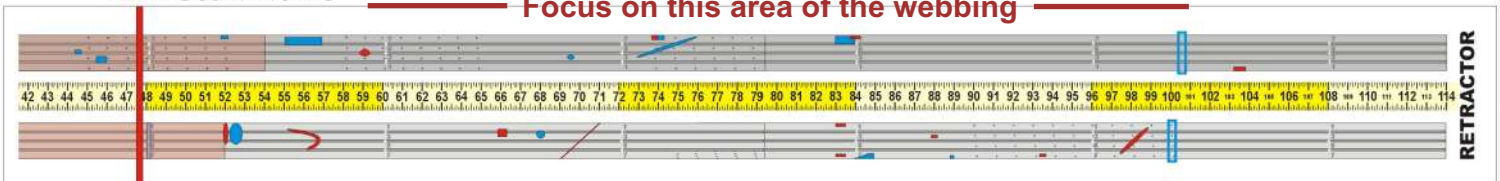


**Example webbing inspection. Clothing fiber that is matched to Decedent's clothing found below "stowed belt" line.**

One way to document the location of belt evidence found beyond the trim panel stow point is to focus solely on the areas of the seatbelt webbing that would have been below the point where the webbing goes into the trim. If the seatbelt was not being worn when the accident began, there is little chance that damage to the seatbelt webbing beyond the trim panel stow point could happen.

**Trim Stow Point**

**Focus on this area of the webbing**



Third, document every mark, cut, dirt/stain, pulled fiber, cupped fiber and damage to the webbing on the label side and non-label side of the belt from 1 inch to the end of the belt. The technician should then transfer each cut, dirt/stain, pulled fiber, cupped fiber and observation of webbing damage onto an evidence board. The best way to accurately and thoroughly document the webbing evidence is to remove the belt and lay it out on a prepared board that has a measuring tape and illustrates the same number of webbing panels as the actual webbing.

**Label and non-label side of seatbelt is laid out on a seatbelt evidence board that includes a measuring tape.**



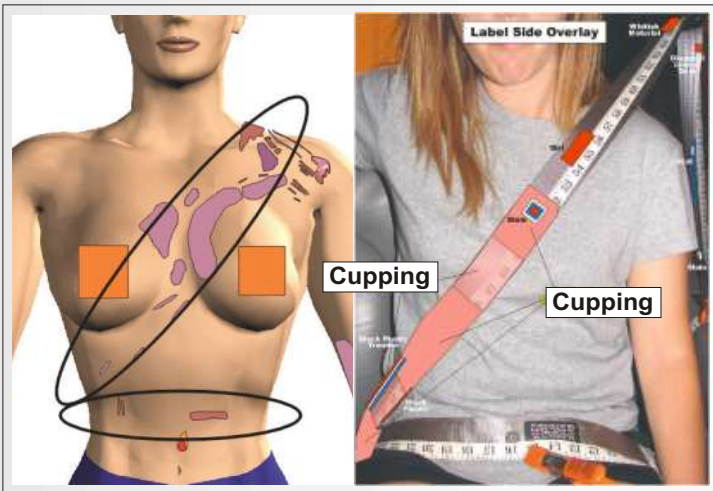
**SURROGATE STUDY- CORRELATING PHYSICAL EVIDENCE TO MEDICAL EVIDENCE**

Using a surrogate the same height, weight and waist size as the individual being evaluated, determine where all physical belt evidence that has been transferred onto the seatbelt evidence board matches up on the surrogate's body.

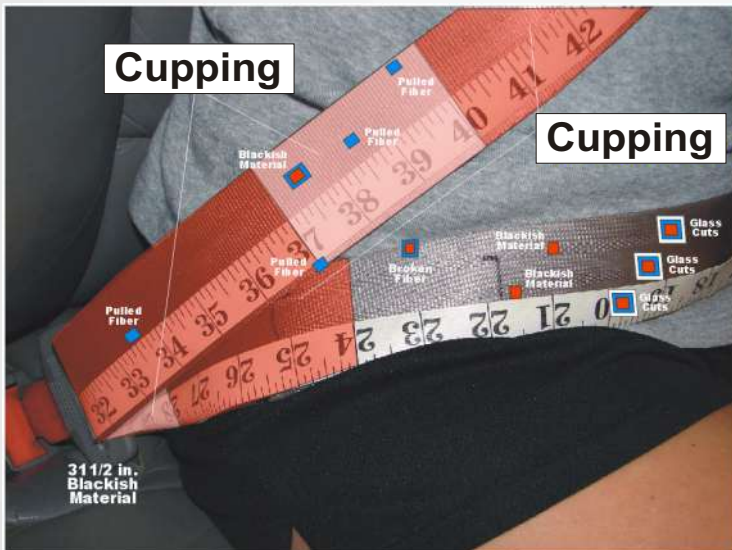




Now, the medical technician in conjunction with the restraint technician should evaluate if the physical evidence on the belt matches up with the medical injuries that were diagrammed earlier. Even the slightest pulled fiber, broken fiber or belt cut on the seatbelt webbing can correspond to a bruise or abrasion. More pronounced belt loading like cupping can correspond to deeper bruises or fractures on the occupant.



The surrogate study “matches up” physical evidence with medical evidence.



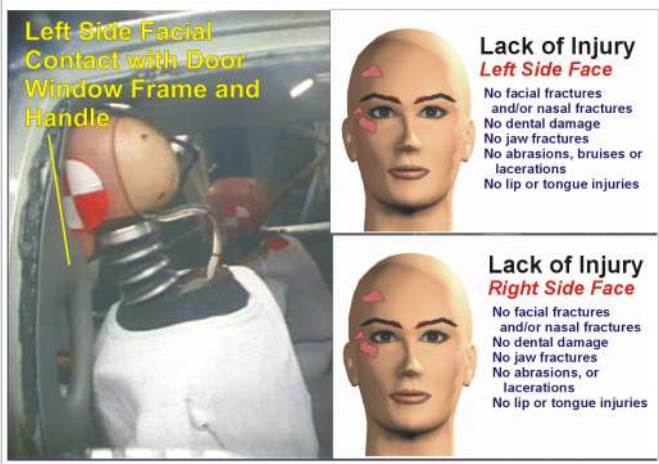
## THE VEHICLE INTERIOR MUST BE EVALUATED AND COMPARED TO MEDICAL EVIDENCE

The restraint technician must continue his analysis of diagnosing seatbelt usage by evaluating the presence of damage and lack of damage that are found inside the vehicle. Just like the absence of injury is important to the forensic pathologist, the absence or presence of damage to vehicle components like the steering wheel, instrument panel, lower dash, a-pillar, b-pillar and back of the front seats should also be evaluated. When a driver is unrestrained, the steering wheel and knee bolsters are typically deformed and there is hair in the windshield.



If the vehicle interior that is in front of an occupant is undamaged, then the technician must ask why since they know an unrestrained occupant would have impacted into the interior component. The absence of vehicle damage and lack of corresponding injuries to the occupant is the final way to combine physical evidence with medical evidence when diagnosing seatbelt use. The seatbelt is the primary safety system that helps prevent injurious contacts with the vehicle interior while also minimizing injuries during an accident.





The lack of injury and lack of vehicle damage correlation may unequivocally prove seatbelt use. However, under the multi-disciplinary approach, this conclusion must be confirmed with forensic science.

## FORENSIC CONFIRMATION OF EVIDENCE

The culmination of the multi-disciplinary approach to diagnosing seatbelt usage is the utilization of forensic science. Many laypersons are familiar with the various CSI television shows where crime scene investigators track the evidence. Forensic scientists can use Luminol®, Hemastix® and other chemical agents to evaluate if documented stains on the seat belt evidence board are consistent with blood. The elimination of stains as being consistent with blood is important in trying to determine the source of each stain. DNA testing can also be conducted if the fluid sample has not been exposed to direct sunlight or degraded due to time.

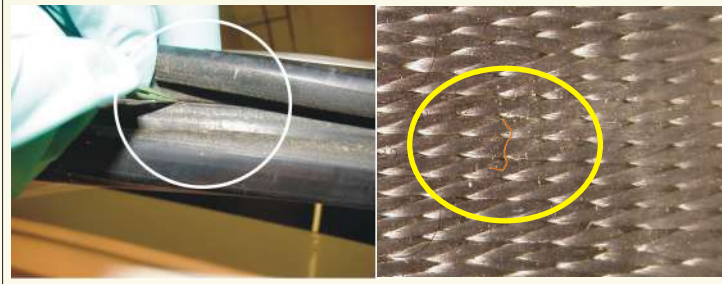


Hemastix® technology used in these photos to identify blood on the belt and interior of the vehicle even though the blood on these items were exposed to outdoor elements for a long time. The results are then placed on the evidence board.





Forensic scientists can also retrieve samples of various fibers and hairs that are entrapped in the webbing and vehicle interior and compare them with clothing and hair of the individual. When the entrapped fibers or hairs are found below the stow point that goes into the trim panel, the investigator has shown forensically the probability of seatbelt use.



**Forensic technicians collect fiber and hair and conduct chemical testing for blood on the webbing and vehicle interior.**



Forensic science eliminates as much as confirms the existence of blood, hair and fiber evidence on the seatbelt webbing and inside the vehicle. It is natural for some, following an accident, to jump to a conclusion that fluid material in front of a person who is believed to be unbelted is blood. However, chemical testing can disprove an erroneous assumption.

Likewise, forensic technicians can utilize chemical testing to actually assist in analyzing occupant kinematic movements by tracking blood evidence when no visible blood trace is evident inside the vehicle.

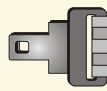


## **KINEMATIC EVIDENCE: BELTED VERSUS UNBELTED KINEMATICS**

Once medical, engineering and forensic technicians have concluded their work and determined that the evidence is consistent with seat belt use, there remains one last scientific analysis that can be used to verify belt use: kinematic analysis. There is one axiom that is not subject to change: The principles of Newtonian physics as applied to objects in motion are constant. Put another way: an unrestrained occupant will move differently than a restrained occupant in the identical impact. Hence, the restraint investigator must evaluate how a restrained and unrestrained occupant would move to finalize the belt diagnosis analysis. Of course, this ties back into an evaluation of the presence or lack of damage to the vehicle and to the presence or lack of injuries to the occupant. Ultimately, this kinematic analysis "closes the loop" by encompassing all aspects of the evidence.







In these two identical sled tests, the belted occupant's kinematics are noticeably different than the unbelted occupant's kinematics. First, forward excursion is retarded by the seatbelt which prevents injurious head, chest and lower leg contact into the vehicle structure. Second, the seatbelt prevents vehicle damage from occurring. Third, the seatbelt actually protects the driver from being injured by an unrestrained flying projectile into the back of his seat. The multi-disciplinary approach to diagnosing seatbelt usage insures that the user had "clicked" his seatbelt before the accident happened.

**CONCLUSION**

When "traditional" evidence of seatbelt use is not present, a multi-disciplinary approach to diagnosing seat belt usage should be utilized. Specifically, engineering, medicine, forensic science and crash dynamics vis-a-vis occupant kinematics should all be used to evaluate seat belt usage. Each discipline contributes its own unique evidence foundation.

When there are questions about seatbelt usage, investigators should not merely jump to a conclusion or rush to reach a conclusion. A multi-disciplinary approach to diagnosing seatbelt usage can be time-consuming and expensive. However, once complete, the result will have been checked, double checked, checked and double checked again for accuracy.

Under the multi-disciplinary approach, no one particular piece of evidence trumps another. The evidence, when considered as a whole, is utilized to help diagnose seatbelt usage or non-usage. When the "loop is closed," the investigator can accurately say that a person is belted or unbelted having considered all of the evidence.

**Answer to question on page 2: if you investigate further and analyze all the evidence, you will find that this picture is not a haggard, old woman.**



**Turn the page upside down to learn the answer**





**Do you want your seatbelt buckle to perform like this if you, your spouse or your child were involved in an accident?**



**Instead of solving this safety problem, how did the vehicle industry insure its seatbelt buckles wouldn't unlatch in their tests?**



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