BASICS conference 23-25 September 2005

First Impact – Paper 45 minutes

Len Watson

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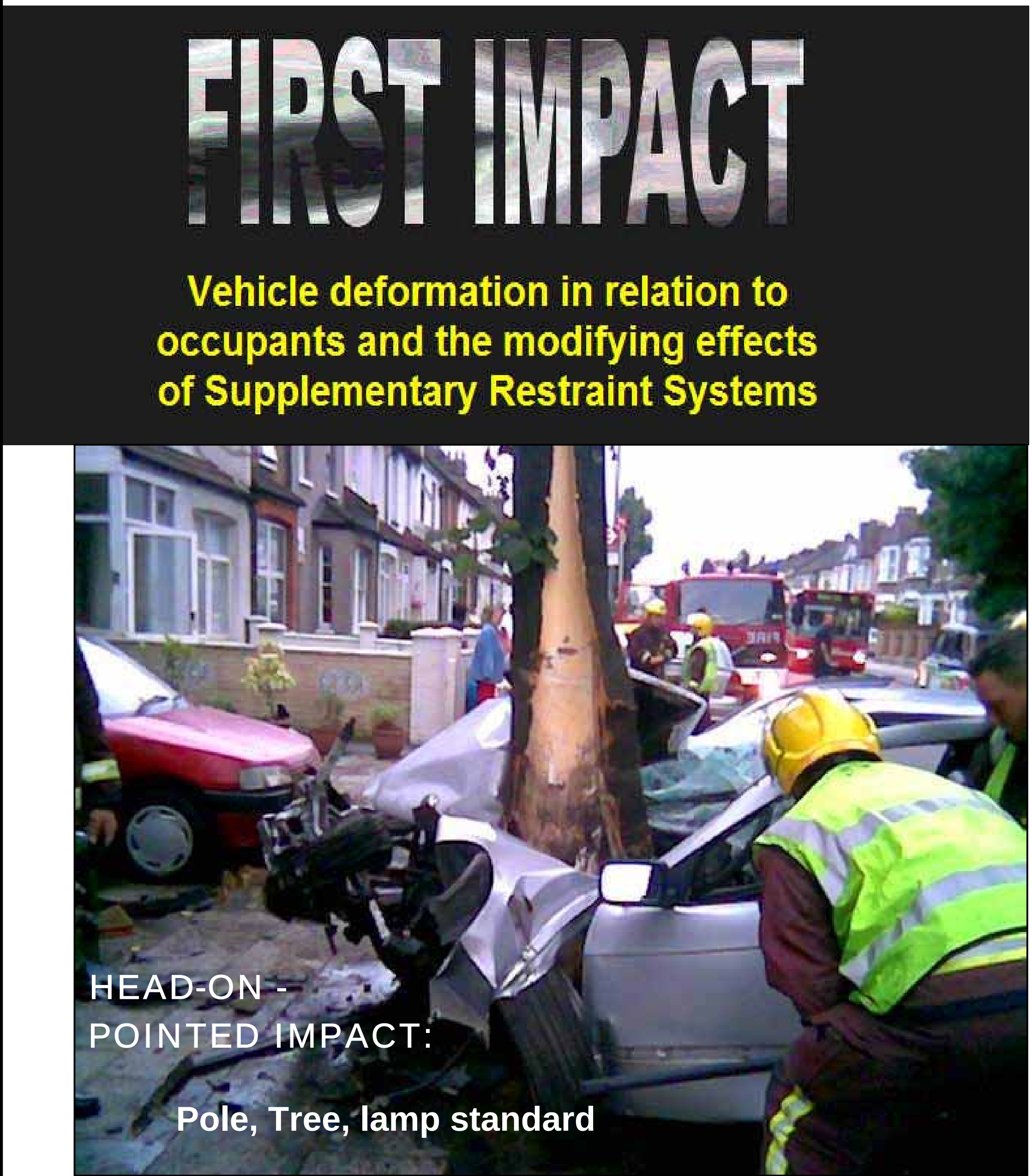

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ABSTRACT

An increased awareness of car design and construction will give a better understanding of front-end collision dynamics for head-on, pole impacts and front ¼ oblique collisions where ride-down, the spring-back effect, rotational forces, rebound and directional forces have a direct bearing on the mechanisms of injury. The first generation of supplementary restraint systems (SRS) were less than perfect and have left an undesirable legacy; one where the motor industry have found it necessary to issue warnings and to display decals within all new vehicles and in the owners handbook as a mitigating measure. New designs of SRS and smart systems offer improvements to overcome earlier problematic areas but end-outcomes will need to be analysed before we can say that these solutions have proved successful.

At a time before the inclusion of SRS in the UK, the car-user fatality rate dropped significantly by 34% between 1989 and 2003. With the introduction of SRS in 1993 the serious injury rate further reduced by some 26% between then and 2003. However the car-user fatality rate increased by some 6% of which the driver fatality rate rose 16% in the same period. That tends, to contradict the life saving claims for airbags bearing in mind the significant downturn between 1989 and 2003.

A strong argument can be made to support the notion that, at present, frontal airbag systems have had little bearing on who lives and dies in a vehicle crash, and in the absence of appropriate data collection, the outcomes for the more severe of the serious injury rate is hidden in the 16% reduction claimed for this all encompassing category.

The rescue profession needs to view SRS in a different perspective to come to an understanding why the car-user fatality rate has begun to rise again and what effects SRS have on critical casualties in higher speed impacts with greater delta V forces. Although the introduction of smart systems are designed to rectify some of the concerns raised by earlier systems, new areas of concern are already presenting themselves in terms of extrication rescue.

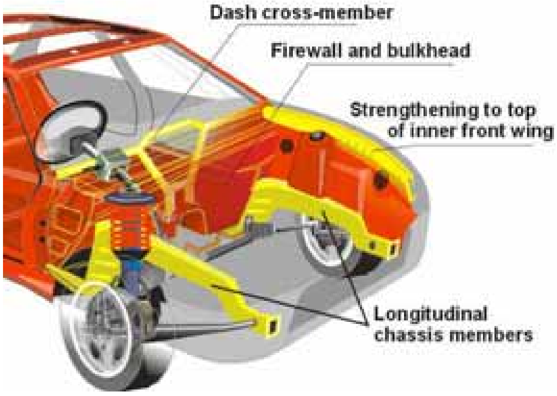
It is too early to say whether smart systems offer an improvement or not, even so we must be fully aware that we are left with a vast legacy of vehicles with first generation systems. Additionally, we must also consider that the design of smart SRS has not taken extrication rescue into account.

The real testing of new structural and safety innovations in the motorcar will be on our streets. The motorist will be the end-test dummy and, as the ‘dummy’, have no real understanding with which to address the issues that arise in serious crashes. Information, pertinent to extrication rescue, is not forthcoming from the motor industry. There are many questions and certain areas that need to be addressed and, to date; there is no avenue of approach available for structured extrication-rescue analysis and research.

Data collection from the crash site needs to be far-reaching. The emergency services have the capacity but lack the drive, the academic qualifications and resource to mount such a study. The motor industry could gain enormously from in-depth data collection and analysis. However it may be felt that this is too sensitive an area to pursue and one, which could open the door to further litigation and an expert witness program.

Understanding front-end collision dynamics

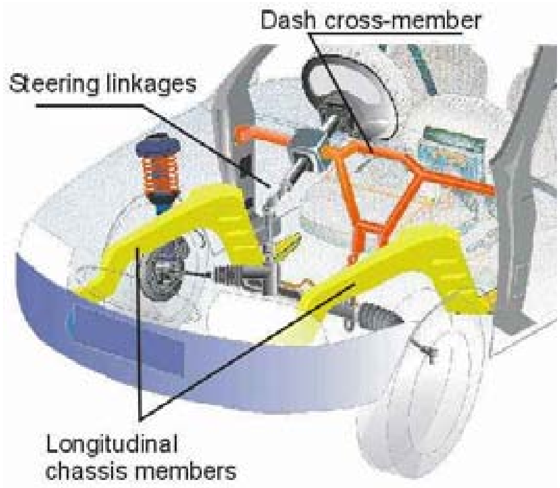
Vehicle design: Front end



The Longitudinal - The front chassis longitudinals support the vehicle's engine and suspension geometry. They have been designed to offer optimum crumple zone performance for the front of the vehicle.

Suspension and steering linkages

The floating suspension arm is bolted to the longitudinal. Where the impact misses the longitudinal (20% off-front centre) the crumple zone, that is the front wing, will be completely overwhelmed and the front road wheel and steering geometry forced back into the wheelarch/footwell, trapping the front seat occupant's feet and lower limbs. This can happen in relatively low speed impacts (30mph [42kph]) particularly where older vehicles are involved or collisions between vehicles of different weights and mass.



Head-on and Pole impacts
Ride down – Delta V

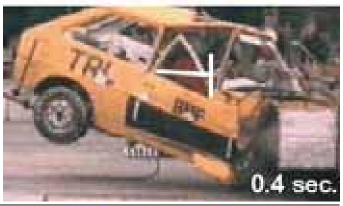
Where vehicles are subjected to a head on collision, the load is normally spread across the front of both cars. Crumple zones will give way allowing a significant 'ride-down' and reduction in the Delta V force involved. In a single vehicle accident with a tree, post or lamp standard, the force involved will be unyielding and concentrated in a pointed impact where most of the in-built crumple zones will not be affected. Apart from the higher Delta V force experienced, depth of bodywork intrusion and subsequent invasion of the passenger cell will be greater, and occupant entrapments generally more complicated.

The engine will be driven back over the steering linkage. This often forces the steering wheel upwards and in higher speed impacts the airbag will deploy in line with the steering wheel. Bear in mind that in collisions between vehicles of difference masses velocity change will have the effect of increasing the Delta V force experienced by the smaller vehicle and differential in ground clearance resulting in an under-ride, will exacerbate the incidence of steering wheel upturn,

Font ¼ oblique impacts (40% and 20% front off centre)

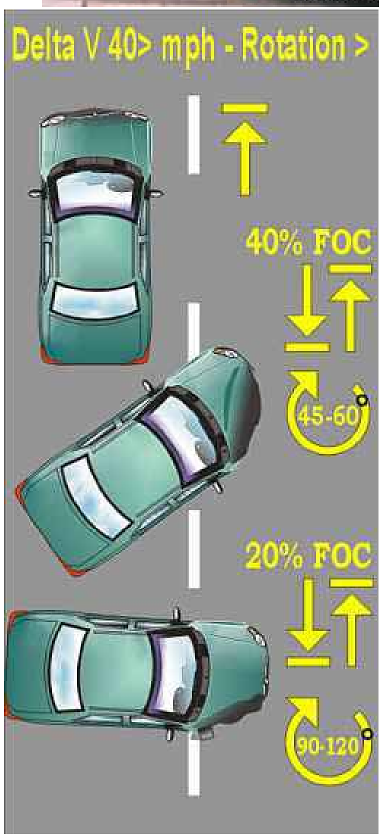
Crash testing offers rescuers a visual insight as to the behaviour of cars in front ¼ oblique impacts. Tests for crash worthiness are set-up at 40 mph (64kph) impact speed for a 40% front off centre collision, which includes the support of the longitudinal chassis member affording optimal ride-down for crash performance.

In the 20% FOC impact the longitudinal will be avoided and in comparison the wing offers much less resistance. The road-wheel, suspension and steering geometry will be more vulnerable to collapse. At impact speeds of 40 mph (64kph) and above, structural deformity will be extreme and entrapment pinning very likely as the road-wheel and suspension are driven into the footwell. Greater vehicle deformity and front cabin intrusion and a significant increase in rotational force make this crash type hold the highest morbidity rate of all accident categories.



Spring back effect – Generally the spring-back effect is a little recognised phenomenon in high-speed Delta V crashes and can only be witnessed in high-speed film when run back in slow motion. In this way we can clearly see severe initial bodywork intrusion spring back to a lesser degree. What we actually see when we arrive at the crash site is therefore not a true facsimile of the deformity the vehicle suffered in the impact. As this effect is little known it is rarely taken into account when considering the mechanisms of injury.

As new vehicle designs have become more substantial we see less of this, but consider, crash testing is conducted at only 40 mph (64 kph).



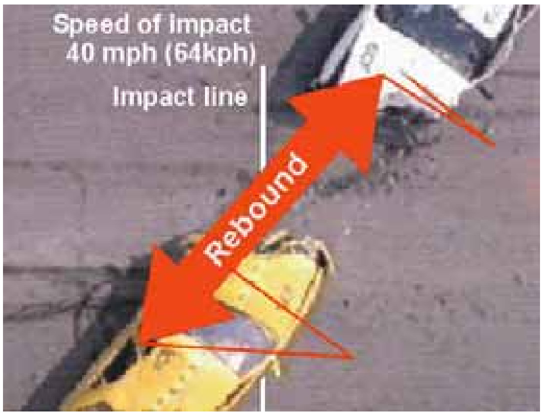
Rotational force – Where a vehicle is subjected to a front ¼ oblique impact at speeds 40 mph (64kph) and above, as it crashes, the rear of the vehicle will rise up and the whole vehicle will rotate. The degree and speed of rotation will depend on the Delta V force encountered but generally will take somewhere between 0.3 to 0.4 of a second. Occupants within the vehicle will be subjected to the directional force as normal but will also experience the rotational force.

In the 40% front off centre collision, rotational force can be clearly identified in crash test high-speed film footage. So much so that in the many tests performed we can see that rotation is very similar, irrespective of tyre foothold. Due to the way the car lifts and contorts we can clearly see that tyre adhesion is much reduced and rationally, rotation force would differ little on a wet road surface. Therefore, as a loose rule of thumb, at a Delta V at 40 mph (64kph), rotation will be in the region of 45-60º.

There is no crash test information for 20% FOC so we are left with observation at the roadside. Measurements are available from police stat.19 and photographic evidence from other sources. At a Delta V of 40 mph (64kph) rotation, as a loose rule of thumb, will be in the region of 90-120º.

Rebound – The greater the speed of head-on and front1/4 oblique impact the greater the amount of rebound can be expected. The reactionary force of metal memory retention and bounce back must be added to the Delta V force. This also adds to airbag deployment force. Therefore, rescuers should be aware of the three mechanical anomalies that can be involved –

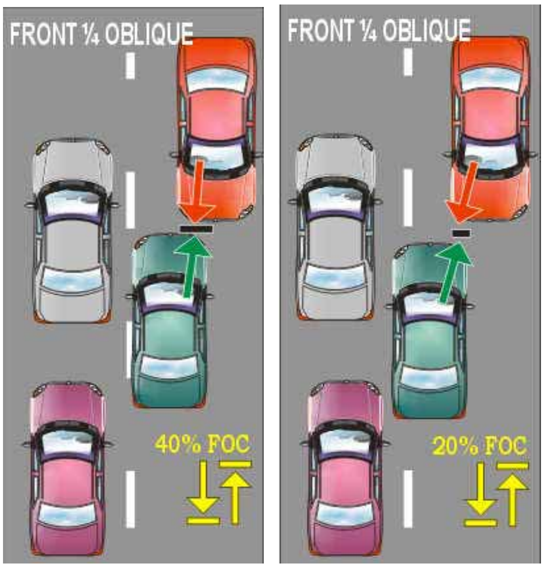
- The nature of front-end deformity. Delta V force in relation to ride-down
- Head-on as opposed front ¼ oblique
- Rebound



Directional Forces – In a collision, which is subject to high Delta V force, occupants will continue to travel in the same direction as before the impact. In the head-on impact the driver will be thrown onto the steering wheel and then projected rearward by the rebound force.

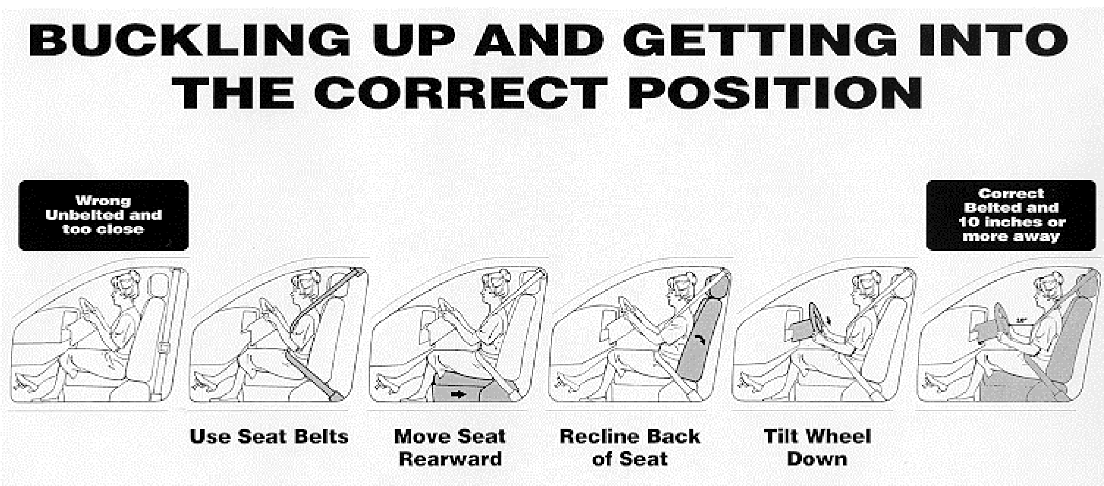
In the front ¼ oblique impact we must also appreciate that rotational force will alter the position of the car as the occupant travels forward and as they are projected rearward by the rebound force.

This will be further accentuated the more off centre the impact. At 20% FOC the driver's head is likely to meet with the intruding windscreen pillar and as they are projected rearward by the rebound force the back of their head will meet the car's centre post.



Supplementary Restraint Systems

Frontal airbags were incorporated into the steering wheel and the dash area in the front passenger position to help mitigate the mechanisms just outlined. Pre-introductory tests looked very promising but after they were introduced it was soon realised that airbag deployment, apart from protecting front occupants, could be dangerous and in the coming years some deaths where squarely placed at their doorstep. In low speed crashes, airbag induced-injuries were recognised, especially in young children, small people and those that are sitting too close to the steering wheel.



Vehicles soon displayed warnings and recommendations in user handbooks and on sun visors on how to sit correctly in vehicles. Even with a high compliance rate these recommendation failed to address the problems. To explain fully we need to view the history of airbags and take an in-depth look at airbag deployment and the introduction of second-generation and smart systems.

Although supplementary restraint systems are seen as the way forward in crash mitigation, airbags can injure, maim and kill vehicle occupants. At face value it is easy to accept the manufacturers' interpretation for this and their advisory solutions, but when we begin to take a more in-depth look we see shortcomings in airbag system design where new measures to improve design and performance are now been introduced.

It does not stop there for in analysing crash performance in the higher speed crash or between vehicles of different masses occasioning greater Delta V forces and bodywork deformity, we start to see the entire picture. For those of us involved in crash rescue where the 'mechanisms of injury' are an essential diagnostic tool, the fundamental understanding of the first impact and the moderating effects of SRS offers an insight for study and debate that can ultimately improve the quality of post crash rescue.

SRS - REAL ISSUES

A Different Perspective:

A document for discussion - by Len Watson

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Introduction of SRS:

The Federal Government in the USA required that all new design mass production vehicles should incorporate a steering wheel airbag from 1989 onwards. This initiative overflowed into Japan in 1991 and Europe and the rest of the world soon after. The first English car to incorporate SRS was GM's Vauxhall Astra in October 1993, where the purchaser could have a steering wheel airbag fitted as an optional extra. The Astra was the first UK vehicle to incorporate seatbelt pre-tensioners as standard.

After that, the introduction of SRS was rapid and many models offered frontal airbags and pre-tensioners as a standard fitting from 1994 onwards. It is interesting to note that the introduction of seatbelt pre-tensioners did not happen in the US until the mid 90's. Although the side effect of sliding under the deploying airbag was first recognised in the US, Europe and Japan were the first to introduce the pre-tensioner and the in-built seat ramp into the mass market.

Pre-tensioners are designed to activate before the airbag and instantly draw in the slack in the seatbelt webbing restraining the seat occupant, keeping them away from the deploying airbag. This would intimate that even in the early 90's the deploying airbag had been recognised as an injury source. On the other hand, the in-built seat ramp on front seat cushions was already a feature in some models prior to the installation of airbags. However, its incorporation would become widespread, as it would counteract occupants sliding forward on the seat cushion, underneath the lap harness closer to the deploying airbag.

Even with the very best interests of the motorist in mind, frontal-airbags have been pinpointed as yet another cause of traumatic death in the USA. It is stated that they prevent many more deaths than they have actually caused and as such, they are heralded as a desirable commodity to have in your car. Although vast resources and data collection surrounds SRS and agencies such as NHTSA are bending over backwards to explore the effects of their inclusion in motor vehicles and the further possibilities to improve these systems, many questions are left unanswered. To be convinced by their statements we only have to ask ourselves one question, since the introduction of SRS, has the fatality rate in car-users in the US fallen, remained the same or raised? But does all this really provide us with the answers?

An unusual phenomenon happened in the UK in the period 1989-1993. The car user fatality rate in the UK reached an all-time peak in 1989 and fell sharply by some 32% in the following years through to 1993. SRS had not been introduced in the UK until the latter part of 1993 and only then on one model type. It has taken several years for the population of vehicles incorporating SRS to become prevalent in the UK. Even so there has been no further reduction in the car-user fatality rate to date. Figures have fluctuated but the 1993 figure remains the lowest in this time period - *see table 1*

Table 1

All car-user fatality rate by year 1989-2003 - RAGB/RCGB The Casualty report														
1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
2,426	2,371	2,053	1,978	1670	1,764	1,749	1,806	1,795	1,696	1,687	1,665	1,749	1,747	1,769

Although the 1993 figure compares favourable with 2003 (+ 6%) we can still ask 'where is the saving'. Some may argue that this is a misrepresentation of the facts as it includes all the car-user fatality rate. However, when we become more specific and only view the driver fatality rate, we are left with a more pronounced increase of some 16%.

Table 2

Car-user Driver fatality rate by year 1989-2003 - RAGB/RCGB The Casualty report													
1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003			
1,009	1,102	1,086	1,146	1,171	1,134	1,082	1,087	1,164	1,146	1,169			

I believe a strong argument can be made to support the notion that, at present, frontal airbag systems do not have much bearing on who lives and dies in a severe vehicle crash. If anything, in terms of UK figures, we can see a slight increase in the fatality rate. However, the status quo may have altered, as they are responsible for some deaths in low speed crashes that otherwise would not have happened. Of course, in making this statement we must also appreciate that they may have saved some lives that would otherwise have been lost. As the difference is so minimal we cannot state, by any stretch of the imagination that here is the proof that they actually safe lives.

In all fairness, there is an area where the benefits of SRS can begin to be appreciated. Not all car-users who receive life-threatening injuries die. The serious injury rate is compiled of those victims who receive injury/ies and are detained in hospital as an in-patient, or any of the following injuries, whether or not they are detained in hospital: *fractures, concussion, internal injuries, crushing, burns, severe cuts and lacerations, severe shock requiring medical attention, and injuries causing death 30 or more days after the accident.*

Table 3

All car-user serious injury rate by year 1989-2003 - RAGB/RCGB The Casualty report														
1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
27258	26749	23340	23146	21161	22127	21710	22239	21394	19980	18681	18054	17675	16981	15522

Table 4

Car-user Driver serious injury rate by year 1989-2003 - RAGB/RCGB The Casualty report													
1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003			
13269	13774	13471	13866	13708	12707	11913	11608	11391	10884	9871			

The reduction in the serious injury rate, which now stands at -26%, is quite prevalent as it reduces injuries, suffering and disability. It also considerably reduces hospital stay, aftercare and improves future quality of life. If figures for the year 2004 and onwards also show a decrease, there would appear to be good reason to support the introduction of airbags and pre-tensioners without adequate testing as far back as 1989.

Before we fully accept this argument, we should realise that life-threatening injuries sustained in the more severe crash is hidden as a small percentage of the serious injury rate and, as such, may not necessarily be representative of this –26% reduction. Also we still require a reason for the reduction in the car-user fatality rate between 1989-1993 and the subsequent 6% increase between 1993 and 2003. Perhaps the reduction in the serious injury rate has another reason, one of which has not yet been identified. Certainly something quite substantial did influence outcomes in the 1989 - 1993 period that could have a real bearing on the reduction in the serious injury rate through to the current period. Pinpointing the cause or causes surely makes sound sense and could possibly be built-on to further reduce the carnage.

Indeed, what could be responsible for such a reduction? Better vehicle design, road engineering, policing, driver awareness or, could it possibly be a greater emphasis on rescue? Well yes, in the annals of rescue development we can pinpoint a growing awareness and a giant step forward in both capability and rescue resource in this same time period. Why not! Just because data collection, analysis and structured study, not forgetting world governments, the motor industry and motoring organisations dismiss the value of rescue in their correlations, does not mean to say that its influence has not made its mark.

What exactly do I mean by rescue? Well, when someone is trapped in vehicle wreckage, it is pointless talking about accident reduction and hospital definitive care, when in real terms, at that exact moment in time they are dead or dying. Intervention is all-important and in general terms, a massive developing trend in rescue in the late 80’s and early 90’s had given the rescue team a leading edge in retrieval and injury severity reduction. As far as data collection and structured analysis exists, it is as if rescue has no effect on casualty outcomes: has no bearing on this subject whatsoever.

However, getting back to the subject matter, it is pretty much accepted that the first generation of SRS leaves a lot to be desired. Especially from the rescuers' point of view where these systems were introduced without any regard for the rescue scene. Frontal airbags and all position pre-tensioners, side airbags (seat or door mounted) and roof mounted systems have added a complexity to extrication in dismantling the car body away from the victim. Moreover second-generation systems have further complicated extrication and have added to the time frame associated with these evolutions.

Notwithstanding this, there is another more sinister side. Some adverse effects of these systems have not gone unnoticed. In the background, hospital studies and rescuers are talking of horrific injuries as a result of these systems. De-gloving of the skin of the forearm and hand, avulsed thumbs, corneal eye damage and blindness are amongst many of the recorded injuries. Dislocation of the knee and tearing of the popliteal artery are associated with the seat ramp, and myocardial contusion and sternum fractures have been associated with airbag deployment and seatbelt pre-tensioner activation. Although it is true to say that such injuries would still happen if these systems were not in place, the question must be asked - 'Do these injuries now happen more frequently’?

The current situation:

It is well documented that the small, tall, large or frail front-seat occupant is more at risk from airbag deployment than someone of average height and weight. Although less well publicised, it is also recognised, albeit to a lesser extent, that other areas also contribute to the dangers of airbag deployment.

Manufacturers place notices on sun visors and publish information in the owner’s handbook on the correct seating posture, the fitting of child seats and keeping the space in front of air bag deployment paths free of objects. These points are obvious risk areas and are generally accepted. Manufacturers also offer simple advice to rescuers in the form of 'hand-outs' with open copyright to allow departments to distribute this information freely. Unfortunately, this raises more questions than answers and is seen as a derisory attempt to show due diligence and duty of care. Very real issues do exist and this paper attempts to raise awareness as to some of the more important ones left un-addressed by the motor industry.

Let us begin by highlighting the natural reaction of any driver, which is to steer clear of trouble, away from the impact. In crossing the arm in front of the steering wheel, the deploying airbag has less room to deploy and has been known to tear away the skin on the forearm. In sounding the centrally mounted horn, the deploying airbag can de-glove the hand or avulse the thumb. Again, where the front seat passenger outstretches their arms to brace themselves against the dash, the deploying airbag can also fracture wrists, radius and ulna, and dislocate shoulders.

In 40% off-front crash testing the dummy's face is painted so as to measure contact with the airbag. As can be seen here the head sometimes missed the airbag and is channelled towards the intruding windscreen pillar

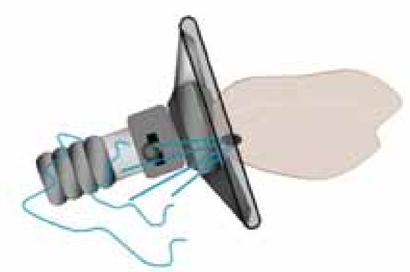
The Front ¼ oblique crash (front off-centre impact), particularly where it is 40% or more front off-centre, will be subject to rotational forces and the forward trajectory of the seat occupant towards the direction of impact.

In the structured study 'Vehicle entrapment rescue and pre-hospital trauma care', the invading windscreen pillar, as a result of the front off centre crash, was identified as the major cause of life threatening head injury. This study, although arguably small, was conducted before the introduction of SRS in the UK and runs in line with the fact that the larger proportion of fatal and serious injury crashes are a result of front ¼ oblique impacts. I would suggest that most rescue veterans analysing this situation would support this understanding.

The legacy:

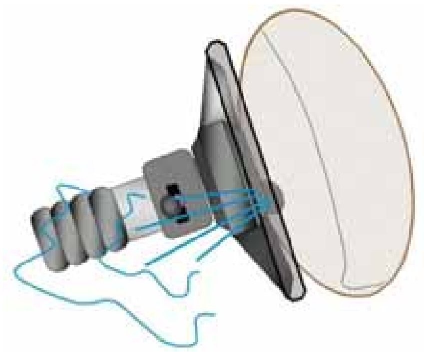
Frontal SRS deployment -
In the ideal situation, the seatbelt pre-tensioner will deploy and tighten on the seat occupant as the airbag deploys. The airbag is designed to cushion the occupant as he moves forward, their body contorting and their weight stretching the seatbelt. The neck will bend as deceleration increases the weight of the head. Where the shear impact speed (Delta V force) is above 30 mph (48 kph) the face is likely to make contact with the airbag where it will be cushioned as the airbag deflates

Steering wheel design was altered to house and support the airbag. The centre hub is larger and deeper and the spokes supporting the rim are shorter and more robust. The additional in-built strength coupled with airbag deployment has altered the mechanisms of injury, but before we can take this further we must appreciate how the bag deploys.



Up 2005 model year vehicles the actuating airbag will initially deploy in the shape of a tongue. The module can generate over 700 psi and deploy the bag at over 200 mph. The bag is designed to deploy as quickly as possible and in doing so it will vent excess pressure via the exhaust ports at the rear of the bag. If the bag could not vent itself it would simply self-destruct.

As the airbag fully inflates it will form a circular cushion in front of the steering wheel, which will deflate as the gas generator dissipates. Airbag deployment takes less than 0.2 sec., less than the blink of an eye. In the following split second, under ideal circumstances, it will both ride-down and cushion the torso and head of the seat occupant.



Deployment residue and smoke will be contained within the vehicle, especially where laminated all round glazing remains intact. Where two or more airbags deploy, conditions within the vehicle can become uncomfortable very quickly.

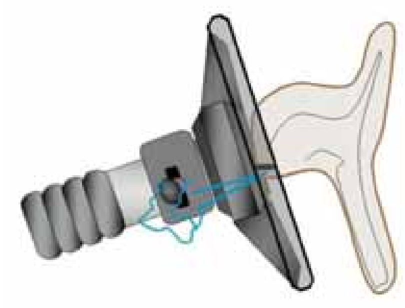
All well and good, but other considerations must be weighted in the equation. The deflated airbag rests in front of the steering wheel on the seat occupant.
To assist in casualty assessment and removal, the airbag can be moved to one side. Deployment residue, smoke and dust that are retained within the bag will vent out the exhaust ports and will add to the casualty's distress.

Where the impact is over 40 mph (64kph) Delta V force, the occupant is likely to be seriously injured by intrusion in the front footwell. Fractures to tibia, fibula, femur and posterior hip dislocation must be considered and victim entrapment is a possibility.

As impact speeds increase above 40 mph (64 kph) deceleration forces will be increased. There also comes a point where the driver either tries to steer clear, crossing his arm in front of the steering wheel, and/or moves forward in the impact before the airbag can deploy fully. Additionally, as the airbag deploys, the dash, steering wheel and column will be driven backwards as the vehicle suffers deformity, lessening further the space between the airbag and the seat occupant.

This will be further accentuated where the occupant sits too close to the steering wheel or where they are rotund and large. The airbag, as it deploys will strike the seat occupant prematurely.

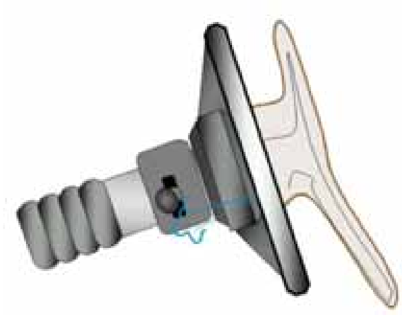
As the bag forms a tongue it can hit the occupant in the eye, causing corneal damage and blindness. Where there is insufficient room between the steering wheel and the airbag for the bag to fully inflate unimpeded, it will propel the occupant backwards with almost instant force.



Instead of acting as a cushion, which deflates on contact, the inflating airbag will act more as a catapult, ejecting the seat occupant backwards.

Compromised exhaust ports preventing normal venting is likely to increase the deployment force dynamically. The airbag must unfold sufficiently from the module to allow full exhaust emission. Any restriction in exhaust will cause an immediate build-up of pressure and, an increase in bag deployment speed will result in a much greater ejection force.

Of course this will depend on the amount of restriction and whether the bag had sufficient space to unfold, exposing the exhaust ports prior to coming in contact with the seat occupant.

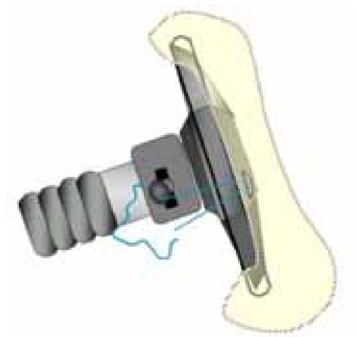


The nearer the front seat occupant at the moment of deployment, the greater the rejection forces. Vehicle rebound and ejection by the airbag will increase the deceleration force experienced by the front seat occupant, considerably adding to the risk of internal 'shear' injury at lower speeds than otherwise might be indicated. The cervical spine may be put at additional risk and although there is less likelihood of brain contusion from secondary impact, there may be greater risk of shear 'contre-coup' and brain stem injury.

In the front off-centre collision, the rotational force will spin the vehicle. As the occupant is thrown backward by the airbag, the back of their head can come in contact with the centre post. This occurrence can be dramatically seen in slow motion video footage taken during front off-centre crash testing, particularly in 4 x 4 vehicles. Fracture at the occipital lobe of the skull may be present and brain stem injury cannot be ruled out.

In the higher speed impact (>40 mph [>64 kph]), dash and steering wheel intrusion will lessen deployment space, particularly where the collision force is over 40% off front centre and more likely to deploy late. A bag with impeded exhaust ports with insufficient space to deploy safely will crush the occupant's torso against the seat back.

Airbags may prevent external injuries to the head and torso but broken ribs, myocardial contusion and in severe cases; tamponade and tearing of major vessels can be the end result. The occupant may die even where there are no visual signs of injury



Where the steering wheel moves upwards in the collision, The occupant's head can even be driven into the roof structure.

The higher speed collision with severe accident deformity to the dash and steering wheel, where the airbag has insufficient room to deploy, will see uniform bending to the steering wheel rim. The airbag, as it fully deploys will wrap over the rim and force it back on its spokes.

In lower speed collisions it is most unusual to see any bending to the steering wheel rim, particularly where the airbag module is housed in a large centre hub with four spokes supporting the rim. However, in the higher speed impact, the severity of injury can be indicated by the number of supporting spokes and the degree of bending in the rim.

A noticeable trait to be looked for is the uniform bending of the rim behind the centre hub.

Where the steering wheel and column are forced upwards in the crash, bending will be more noticeable at the bottom of the rim.

These traits will be less pronounced on the four-spoke steering wheel or where two spokes immediately support the deformity.

Smart systems: The smart airbag -
As more and more blame for death and serious injury is laid at the door of frontal airbags, manufacturers have looked for ways to underline the causes which contribute to this situation and preventative measures to combat recognised causes. These range from how to sit correctly in a vehicle to the development of smart airbag systems that use the minimum of force to restrain front seat occupants.

A host of new and innovative SRS are coming our way. Offering the building blocks for tomorrow, they appeared in as early as model year 2002 vehicles. SRS force sensing (FS) technology has the ability to combine multiple functions within one sensor and a seamless interface with the multi gas generator electronic airbag. Passenger presence detection (PPD) and a weight classification system (WCS) make for a more complete safety system. They can both measure the weight of the occupant and trigger the appropriate number of gas generators to offer a more appropriate ride-down for the seat occupant in the event of a crash. Unlike a manually operated switch on the dash, FS technology will automatically switch off an airbag and will determine the force and velocity of airbag deployment.

It is too early to say whether these systems offer any improvement as this will be dependant on percentage of vehicle population before we can begin to witness their performance in teal time crashes in sufficient numbers. Whatever the improvement we must be fully aware that we are left with a vast legacy of vehicles with first generation airbags**. Additionally, we must also consider that the design of smart SRS has not taken the equation of extrication rescue into account.**

Future perspective: Extrication rescue and SRS -
Crashes that occasion death and serious injury will leave many of the victims trapped in the wreckage. Where a vehicle suffers severe bodywork deformity and interior intrusion, where a casualty is seriously injured, they will require extrication from their predicament by the fire department. In their efforts to cut free entrapped casualties, rescuers have to contend with accident jammed doors, entangled metal, tempered and laminated glazing, leaking fuel and undeployed safety systems, particularly where the vehicle’s battery cannot be disconnected.

Not all airbags and pre-tensioners deploy in a crash. There are certain crash types, which do not come within the pre-set deployment parameters of some or all of these systems. This situation will become more pronounced with the incorporation of smart systems. Part deployed smart systems may or may not put rescuers and entrapped occupants more at risk, but they certainly materialise danger and fear when in close proximity to these systems at the crash scene.

In the more severe off-centre frontal impact, the steering geometry and road wheel will be driven back into the footwell, trapping the feet and lower limbs against the transmission housing and front seatbase. The casualty's limbs can block access to the seat's reverse adjustment lever and, where the battery has remained intact and the floorpan has gone in twist, even electric seat adjustment will be prevented.

One of the saving graces of this type of accident is that on some occasions the battery will be destroyed in the impact. Where the battery is housed on the opposite side to the crash damage, it will take up valuable time and essential equipment to gain access to disconnect the battery. This can delay the release of the casualty and increase the timeframe for SRS capacitors to drain.

At some accident types the intact battery may be inaccessible and cannot be disconnected. A vehicle that comes to rest on its roof or in the event of a front or rear footwell entrapment, where the battery is located under the seat, will necessitate the extrication to be performed with power on and undeployed safety systems. This situation may be difficult to imagine for the layperson but is a well-known occurrence in rescue.

Dangerous and toxic chemicals are incorporated in these systems, which can possibly be activated or liberated when removing roof structures and cutting away the side of a vehicle when performing crash rescue. Other anomalies also exist but the motor industry has remained silent. In their silence they have made it blatantly obvious that they want no part in the rescue of motorist trapped within their products. Yet they are astute enough to successfully use safety as a vehicle for advertising and promoting their products. What sort of deal is it that promotes safety while an inbuilt invisible force can compromise your survival after a crash traps you in the wreckage? Consider this, it may not be the safety system or even the ineptitude of rescuers but an unknown quantity incorporated within the vehicle that threatens or slows the rescue process.

A tubular metal crossmember has been incorporated within the dash area to strengthen and support the dash structure for airbag deployment. This crossmember will be found on most new design vehicles, model year 1996 onwards.

Although, it can be argued that the dash crossmember will help reduce footwell entrapment from intrusion of the doorpost, this same dash crossmember will resist 'steering wheel relocation', removing a valuable and established technique for viewing and releasing the driver's feet trapped in the footwell. Remember that where lower limbs are trapped by the doorpost against the transmission housing, 'dash relocation' using power rams or to winch the front end of the car off the occupant, will compromise injuries, unless the legs are released first.

Although, the dash crossmember has withdrawn this most valuable avenue of approach, it has allowed new techniques to be developed. One technique, although it takes longer to perform, uses the crossmember itself to relocate the dash area and steering wheel and column. How this new technique may effect undeployed or partially deployed frontal airbags is as yet an unknown quantity. The answer to this question, without the help and resource of the motor industry, remains theoretical. Crisis risk management cannot be allowed to continue. Motor vehicle accident rescue is far too important an issue for the motor industry to sweep under the carpet. Surely they must hold some responsibility for the carnage that is created and hold reasonable duty of care for their unfortunate customers that are trapped and injured in vehicles made by them?

Vehicle accident rescue has been allowed to develop experientially and has been neglected by the motor industry, to the point of being totally ostracised from crash testing and design development. Crash tested vehicles and monies are not available to those who could study and analyse them for the purpose of developing further techniques and evolutions for extrication rescue. Only in recent years have some new model vehicles been released to a few fire departments and organisations. Unfortunately, these resources are not wholly suitable and have been squandered and not professionally analysed in terms of entrapment and extrication science. Moreover, there has been no sharing or dissemination of this information.

Any worthwhile information, pertinent to extrication rescue is not forthcoming from the motor industry. There are many questions and trials that need to be addressed and undertaken. To date there is no avenue of approach available for structured crash-rescue research. My greatest fear is that when recognition and monies are made available for such research, it will be placed in the wrong quarters in an attempt to cloak the real issues that prevail.

Data collection and audit:

Car users are dying needlessly. This controversial statement is difficult to back up; particularly as data collection and analysis from the roadside in terms of entrapment and actual vehicle crash performance are not available. Even crash rescue is unaccountable and is allowed to runs free. With the best intentions in the world, rescuers are selling their customers short. Victims of accidents and families need more than our good will and support. What they really need is a measured assurance of best value.

Without data collection, analysis and audit, how can we possibly say that the emergency services are giving best value. Where different approaches and commitment towards rescue vary enormously interdepartmentally and also between the emergency services worldwide, we cannot even begin to justify our good name and the high esteem we are held in. The questions raised in this paper for discussion, are by no means exhaustive, yet how many departments/services view the effects of SRS on rescue, let alone the casualty. In fact, who indeed is realistically viewing victim and casualty outcomes in respect of SRS?

Even the Crash Injury Research and Engineering Network project (CIREN) neglects the effect that rescue has on victim and casualty outcomes. The CIREN project encapsulates a multi-centre research program with the exclusion of all fatal crashes, involving clinicians, engineers, industry and government in the in-depth study of crashes. Altered outcomes are not measured and yet their mission statement is to improve the prevention, treatment and rehabilitation of motor vehicle crash injury, to reduce deaths, disability and human and economic burden. Don't get me wrong, as this is the most advanced research program in the world to date; one that has gleaned some very useful information in regards to the mechanisms of injury for many of the crash types that have never been investigated before.

The project is interstate with nine research centres, including seven trauma centres, involved in the study. The network collects crash and injury data, and geographic and demographic information. This information is analysed and used to examine trauma care systems, vehicle design, paramedical intervention, law enforcement and rehabilitation care. The hypothesis that SRS may have a significant impact on morbidity and mortality rates is also being researched but as the CIREN project is part funded by the motor industry and fatal crashes are outside its parameters, the study appears to be transparantly restrained.

Manufacturers and the motor industry are making exciting and wonderful claims for SRS and have literally invested billions in the inclusion and promotion of these systems in their products. I am not in anyway saying that the overall concept is bad, but I strongly submit that real-time structured investigation be fully explored and for audit from the street to be part of their development. At present manufacturers' claims, for the most part, fail to stand up to scrutiny. Intelligent systems have been slow in coming, and even now are limited as to what they could be and only initially appear in top of the range models.

As with all new structural and safety innovations in the motorcar, the real trial of the product will be on the streets. SRS are no different. The motorist will be the end-test dummy, except he has no voice at all with which to address the real issues that arise in serious crashes. Moreover, solicitors and briefs are unaware and uneducated as to the entrapment situation and the so-called expert advice that exists, which all comes from the academic quarter of crash testing, have only a very limited knowledge of extrication rescue and in-vehicle pre-hospital trauma care.

Crash testing is much too limited and confines itself to the structural performance of the vehicle in just a very small proportion of accident types. Incidentally, the dummies used rarely get trapped in the vehicle or suffer life-threatening injuries that deteriorate progressively in the minutes that follow the crash. The question begs - 'Why are such issues, that are prevalent on our streets, never suitably analysed and measured against crash testing and real casualty outcomes'? In the real world, how many victims are accounted dead on arrival at scene that could possibly be saved and how many die, become irretrievable or their fate and future quality of life sealed as efforts are made to release them?

How can the general public accept this anomaly? How can we buy a car and not question its real safety record? Why are vehicles allowed on our roads even though they have been proven sub-standard in a crash test? **Why is the motor industry not forced to address and compensate for this situation?** If the introduction of SRS was meant to combat and reduce the carnage that exists on our streets, why did SRS pre-release testing fail so miserably and leave us with such a disturbing legacy? These are just a few of the questions that spring to mind that indict and strongly suggest that the motor industry have much to answer for.

Data collection from the crash site needs to be far-reaching. The emergency services have the capacity but lack both the academic qualifications and resource to mount such a study. However, if suitable data collection was undertaken, the motor industry could gain enormously from such an exercise. No doubts there are those in position of authority who feel it far too sensitive an area to pursue and could open the door to litigation and an expert witness program.

If your department/service collects data, let's hear about it. Join the debate on SRS. Help others to drive the development of rescue forward. Your opinion matters! Become part of this on-going discussion and reply by e-mail at www.resqmed.com/Study.htm

Debate, Questions and Answers

Awaiting your input ....

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