RESET TO ZERO AND SPECIFY SAFETY SYSTEMS ACCORDING TO REAL–WORLD NEEDS

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ABSTRACT. Emergency Brake Assist (EBA), Adaptive Cruise Control (ACC) and alternative instantiations of intelligent vehicle control systems aspire to support the driver in controlling the vehicle and alleviate the incidents that would lead to collisions and injury. This paper resets to zero and based on data from the On-The-Spot (OTS) accident study challenges the capability of active safety systems to aim at the sources of longitudinal control failures. The road user interactions file from 3024 road accidents in Thames Valley and Nottinghamshire in UK was analysed. Interactions where "failure to stop" or "sudden braking" is the precipitating factor are analysed and the main contributory factors are identified. Some of those factors are addressed by current and coming technologies – like low road friction, excessive speed and close following, but significantly neglect to address other common ones – like distraction, failure to judge other person's path, failure to look, and "look but did not see" instances.

INTRODUCTION

Rear end collisions and are the most common type of road accidents and fortunately the ones with fewer fatalities (*Fatality analysis reporting system (FARS) web-based encyclopedia. data files and procedures to analyse them.*2005; Evans, 2004; Lee, 2006). However because of its prevalence, the cost of property damage (Blincoe et al., 2002) and the long term cost of injury (Barnes & Thomas, 2006; Barnes, 2006), the impact on society is comparable, if not greater, than loss of control/single car accidents – which are associated with more fatalities. The latter type of collision is associated with failure in lateral controllability while rear shunts relate with longitudinal control failures at the basic level of the driving task.

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There are many different descriptions and models about the driving task depending on the context in which the author develops it. From the early 40s till today driving has been described as a safe field of travel in which drivers adjust their speed and direction avoiding hazards and moving towards their destination (Gibson & Crooks, 1938), as an intermittent monitoring task (Senders, Kristofferson, Levison, Dietrich, & Ward, 1967) and other time-based descriptions (Godthelp, Milgram, & Blaauw, 1984; Van Winsum & Godthelp, 1996; Van Winsum & Heino, 1996; Van Winsum & Brouwer, 1997; van Winsum, Brookhuis, & de Waard, 2000/1), as a threat avoidance (Fuller, 1984), and finally as control actions used to adjust the state of the vehicle in response to *sic* perturbations (D. H. Weir & McRuer, 1970; D. H. Weir & Mcruer, 1973). All the above descriptions, no matter the differences among them, suggest a basic level of the driving task consisting of the longitudinal and the lateral control of the vehicle. This is instantiated through manipulation of brake/throttle pedals and steering wheel inputs respectively.

Bearing in mind the notion above, manufacturers and system developers suggest a series of vehicle systems supposed to help the driver in their task. Generally, there are four main types of systems already in production. These are the Adaptive Cruise Control (ACC) and the likes, Electronic Stability Program (ESP) and the likes, Lane Change Support (LCS) and the likes, and Emergency Brake Assist (EBA). Details about the functionality and the notion of the above is widely available (BOSCH, 2000; Society for Automotive Engineers, 1999; *Delphi active safety products for automotive manufacturers.*; *Honda safety - active safety.*). As active safety systems, their effect in accident mitigation has recently been supported by some statistical evidence (Breuer, Faulhaber, Frank, & Gleissner, 2007; Lie, Tingvall, Krafft, & Kullgren, 2006; Page, Foret-Bruno, & Cuny, ; Thomas, 2006). However, those macroscopic studies feature all the limitations of field correlation based analyses – loads of possible confounding variables and methodological inability to infer causation (Breakwell, Hammond, & Fife-Schaw, 2000).

Considering the above, an examination of the characteristics of “failure to stop” accidents from the On-the-Spot Accident (OTS) Investigation study (Hill, Thomas, Smith, & Byard, 2006) was carried out. OTS, as its name implies in a project run in cooperation with the police authorities in two main areas of UK; namely Thames Valley and Nottinghamshire. Accident investigators are able to arrive on the spot within minutes after an accident has happened and collect volatile data that would otherwise be lost.

The history behind OTS

Data on road accidents has been collected since at least 1909 (Hillard, Logan, & Fildes, 2005). However, it was not until 1949 that a nationwide system for accident data collection was introduced, namely STATS19. The original system collected both objective factors (speed limit, time, weather etc.) as well as contributory factors, i.e. the factors which the reporting officer on the accident scene believed that had contributed to accident occurrence. The system has been reviewed and improvised every five years since its introduction. After some arguments about the reliability of the subjective nature of contributory factors, such data ceased to be a national requirement in 1959 review. Collection and central collation of objective data continued as before. However, in 1994 half the country’s police forces still used some kind of contributory factors in accident data collection (Broughton, 1997).

That year’s report (Maycock, 1995) classifies in three broad groups the contributory data collected by the police forces at the time. Some police forces opted to record a simple list of causes, while other preferred to use a list of contributory factors, tailored to the level of flexibility considered necessary for individual local users. That report persuaded the Department for Transport to commission the Transport Research Laboratory (TRL) to develop and test a prototype system for the collection of contributory factors data. TRL elaborated on the previous hierarchical system and presented a "new system for recording contributory factors in road accidents" (Broughton, 1997). The suggested system was an amalgam of the theoretical model suggested by Leeds University during the late 80's (Carsten, Tight, Southwell, & Plows, 1989), plus the aggregated experience and practical needs indicated by the police forces. Therefore, a two-level hierarchy with the following terminology was developed:

- Precipitating factors are the failures and manoeuvres that immediately led to the accident.
- Contributory factors are the causes for these failures and manoeuvres. A recorded contributory factor always relates to a precipitating factor that has already been recorded.

In its early version, the system was flexible enough to allow up to three precipitating factors to be chosen and up to three contributory factors per precipitating factor. Factors had also to be entered in decreasing order of importance. The authors suggested that the hierarchical model has the advantage that it allows for the same factors to be recorded as in the case of a single tier approach, however in application it imposes a discipline upon the investigator and thus leads to a more reliable coding.

Police involvement was substantial in the development as well as in the support of the project. During the first stage of its development police accident files were examined to decide whether such system was applicable in real world incidents. This was followed up by interviewing and consultation with police officers

The finally tested version allowed for only one precipitating factor to be selected as only a few of the accident files revisited in the previous step included more than one and additionally the form design becomes simpler this way. The option "other" was introduced to allow flexibility and also check the completeness of the coverage in the current form. This allowed for new factors to be incorporated within the rapidly changing transport environment. The final innovation introduced was the "definite, probable, possible" option for the investigator to rate each contributory factor he/she so chooses.

After consecutive reviews in the year 2000 (Neilson & Condon, 2000) and 2002 (Wilding, 2002) suggested itemised amendments and especially the latter acknowledged the internal "blame machine" of the system, as it tended to lay blame on an individual and was totally inappropriate for accidents were there was contribution from multiple road users. The issues identified in the review in conjunction with the previous paper by Neilson and Condon lead the Department for Transport to commission the Transportation Research Group at Southampton University to go one step further and make suggestions to the Standing Committee on Road Accident Statistics (SCRAS) for the improvement of the contributory system. The subsequent report (Hickford & Hall, 2004), among other recommendations, suggested a revised form for collecting contributory data. However for ease of use, after consultation with the local authorities and the police, a different layout was adopted by SCRAS. The outcome was the STATS19 (2005) contributory factors form now in use, including seventy-six contributory factors and also an option to report "other factor" by text description. The factors are grouped in five main categories: road environment contributed (nine factors); vehicle defects (six factors); driver/rider only (forty-seven factors); pedestrian only (ten factors); and four factors for special codes (stolen vehicle, vehicle in course of crime, emergency vehicle on call, vehicle door open/closed negligently). The driver/rider category is further subdivided into five subcategories: injudicious action, error or reaction, impairment or distraction, behaviour or inexperience and vision affected (by). The reporting officer can select up to six factors from the grid, relevant to the accident. Previously suggested three and four-point scales of confidence are now substituted by a simple two-point scale: the officer indicates for each factor whether he/she considers it “very likely” or just “possible”. The system allows for more than one factor to be related to same road user and for the same factor to be related to more than one road user, if appropriate. This allows the police officer sufficient flexibility to include the necessary details in a concise manner.

However since the year 2000, in parallel and based on the experience of accident data coding from STATS19 and microscopic on-the-spot studies in Germany (Otte, 1999) and France (Girard, 1993), OTS project commenced in the UK (Hill et al., 2006). Against the traditional retrospective studies, where accident data is collected long after an accident occurred the OTS offers the ability to collect invaluable data which would otherwise be lost such as vehicle rest position, debris locations, weather conditions, road surface conditions, tyre pressures, temporary changes in the road environment at the time of impact, immediate driver and witness descriptions. In addition to this, it includes data which is collected retrospectively in days or months after the accident (road signs, impact damage on vehicles, road dimensions etc.).

The procedure on the scene starts with the arrival of the investigation team at the scene of an accident. The serving police officer on the OTS team makes contact with the police officer in charge of the accident scene and briefs him about the intended activities of the investigators. After fulfilment of protocols and safety issues, the team makes contact with the people and the various elements involved in the crash. Data is coded in a database of 200 forms with over 3000 variables. Within those, as with any accident in the UK, a contributory factors form similar to the STATS19 one described earlier is included. Thus accident causation is coded in two levels: a precipitating factor and up to six contributory ones.

OTS cases are further analysed to determine more complex descriptions of accident causation in terms of possible interactions between the active road users. A system called “interactions” has been developed to allow analysis and recording of one or more interactions between each road user and his environment to provide description of events leading to impact at any degree of necessary complexity. This allows acquisition of information at a microscopic level, where each person can be involved, affect and be affected by multiple agents of the road traffic environment. All information is completely anonymous and does not include personal details or other documents. The project has been operational since the year 2000 and is now in its third phase.

ANALYSIS OF CASES WHERE “FAILURE TO STOP” OR “SUDDEN BRAKING” INITIATED THE ACCIDENT

With regard to vehicle control, there are two types of failures coded as precipitating factors in the database directly pertinent to longitudinal controllability. The first is a basic failure to stop the vehicle when necessary, and the second is stopping the vehicle at an inappropriate time or stopping in an abrupt manner. Therefore, the current study examined as a first step only the accident cases where “failure to stop” or “sudden braking” were the identified precipitating factor of the accident. However the data presented below takes advantage of the microscopic detail the multiple interactions/road user/case available. Thus, the following analysis is based on 1099 interactions in “failure to stop” accidents and 152 interactions in “sudden braking” accidents. The database has been compared against STATS19 data and validated as representative of accidents in the UK (Hill et al., 2006). All results presented hereafter has been tested for asymptotic significance (chi-square test) and found below the criterion a=0.01.

“Failure to stop”

Failure of a driver/vehicle to stop in time to avoid collision with another road user or object is identified as the precipitating factor in 301 cases investigated by the OTS team. “Failure to stop” therefore defines a unique set of accidents where that is the single, precipitating factor causing the accident. Clearly all accidents are in some way the result of a failure to stop before the collision occurs, but the sub-set under study here represent drivers who were considered to be the predominate, precipitating cause of their accident by failing to stop their vehicle in time. Each “failure to stop” will have been assigned as the precipitating factor following an accident investigation to eliminate other possible precipitating factors, such as for example, the driver travelling too fast, or a pedestrian stepping into the road. This is therefore a set of drivers who were not able to stop for a variety of personal psychological or other reasons. There will of course be other drivers who did not stop before collision (all the other drivers in the database). This study focuses, however, on the unique group for which “failure to stop” was the precipitating factor, together with an additional “sudden braking” group, as explained below. This study does not therefore attempt to consider all possible reasons for drivers failing to stop in time to avoid their accident.

Experience of accident investigation in high-hazard industry, aerospace, space and road traffic applications (Kirwan, 1994; Reason, 1990; Columbia Accident Investigation Board, 2003; Whittingham, 2004) indicates that we must first define a precipitating factor, but that it is equally important to then understand the additional contributory factors.
Therefore it is necessary to look further into the factors that contributed in the occurrence of an accident and not only focus the predominant factor that triggered the accident. Table 1 presents the predominant contributory factors in cases where “failure to stop” is acknowledged as the single precipitating factor. In a previous study based on the (coded by the police officer) Contributory Factors 2005 data (Gkikas, Hill, & Richardson, 2007), driver’s “too close” car following strategy is identified as the most common contributory factor in accidents followed by failures to obey traffic signals and overspeeding for the conditions present. Cognitive failures - to look and to judge other paths - and inappropriate reactions - sudden braking - are also commonly found in such accidents.

Table 1. The predominant contributory factors in accidents of “failure to stop” (Gkikas et al., 2007)

Factor	*Percent*	*Cumulative percent*
Following too close	26.5	26.5
Disobeyed traffic signal	15	41.5
Travelling too fast	12.8	54.3
Careless, reckless or in a hurry	11.3	65.6

Failed to look	8.2	73.8
Exceed speed limit	5	78.8
Failed to judge other person's path	3.9	82.7
Sudden braking	2.1	84.8
Slippery road	2	86.8
Stolen vehicle	1.6	88.4
Aggressive driving	1.5	89.9
Learner driver	1	90.9
Total	90.9[4]	

Further examination of the data coded by OTS investigators in the accident causation files reveals a more detailed picture. Additional contribution is founded in psychological factors such as distraction, panic behaviour, nervousness and inattention (tables 2, 3).

Table 2. Contribution of cognitive failures in "failure to stop" accidents

	% Definitely causative	*% Probably causative*	*% Possibly causative*	*Total*
Inattention	19.5	30.6	23.2	73.3
Failure to judge other person's path or speed	15.8	8.8	7	31.6
Failure to look	5.6	8.7	14.4	28.7
Lack of judgement of own path	7.8	7.4	11.5	26.7
Look but did not see	2.2	7.4	14.5	24.1

Table 3. Contribution of emotional factors in "failure to stop" accidents

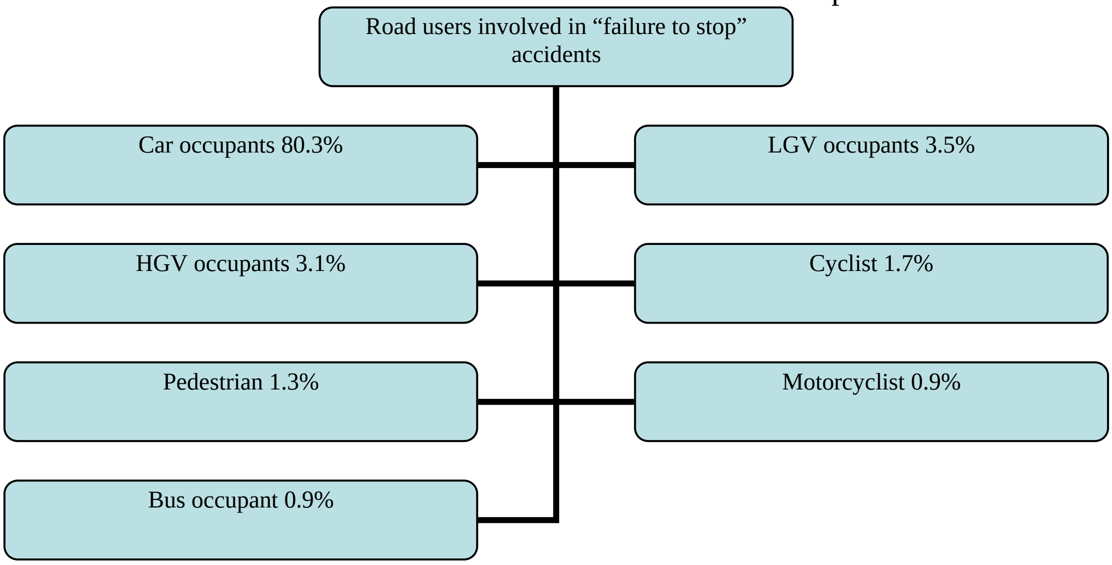
	% Definitely causative	***% Probably causative***	***% Possibly causative***	***Total***
Aggressive driving	0.6	3.6	4.2	8.4
In a hurry	1.7	8.8	8.8	19.3
Carelessness, reckless or thoughtless	18.6	17.7	14.1	50.4

In terms of who is involved in such accidents, most are male drivers – 52% against 36.6% female and 11% unspecified – and most are car occupants (table 4).

One of the common misconceptions is that accidents triggered by a failure to stop a vehicle in time are only rear end collisions happening during car – following settings. Common collision types associated with such accidents include crossing, merging, right turns, pedestrian crossings and more (Gkikas et al., 2007).

[4] The rest 9.1% consists of factors with contribution below 1%.

Table 4. The distribution of road users in "failure to stop" accidents



Sudden braking

Starting from where we left with the previous type of accidents, a similar variety of collisions applies here as well (Gkikas et al., 2007). Rear end collisions are the most common case, but not the only. Loss off control in cornering (left), missing intersections, loss of control on curves and going off road are common collisions initiated by the sudden braking of a leading vehicle. In total 18% of the cases initiated by sudden brake application lead to collisions of these types. Another 7.9% of those cases involved side- and head-on collisions during overtaking, while an interesting 5.3 % includes collision with miscellaneous objects fell from moving vehicle.

In terms of injury outcomes, as was the case in “failure to stop”, sudden braking initiates accidents with small amount of fatalities and serious injuries. The biggest part of road users remains uninjured or leave the crash scene with minor injuries. However this does not include any long-term effects of the accident occurrence. Most road users were car occupants as previously, however there is a greater proportion of LGV, HGV, and bus occupants as well as motorcyclists and cyclists (table 5). Among those most are male (71.7%), 18.4% are female and the rest remained unspecified in the file.

Table 5. Distribution of driver/riders involved in “sudden braking” accidents

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Car occupant	111	73.0	73.0	73.0
	LGV occupant	14	9.2	9.2	82.2
	HGV occupant	10	6.6	6.6	88.8
	Bus occupant	4	2.6	2.6	91.4
	Cyclist	4	2.6	2.6	94.1
	Motorcyclist	9	5.9	5.9	100.0
	Total	152	100.0	100.0	

The primary contributory factors that nested the accidents according to Contributory Factors (STATS19) 2005 form are presented in table 6. Sudden brake application of another vehicle is the most common contributory factor leading to the sudden brake application of the vehicle that leads to the immediate collision, suggesting a transition effect of the phenomenon that leads to the accident. Too close car-following behaviour is associated too and is the second most common contributory factor, followed by failures to judge others path and inadequate or masked signs. Other factors include overspeeding and distractions are common too as in the "failure to stop" cases, while a case by case examination of each case file, revealed an element of loss of control in some cases. That is the tendency of sudden braking to be followed by loss of vehicle control and most of those cases were fatal.

Table 6. The main contributory factors in "sudden braking" accidents (Gkikas et al., 2007)

	Frequency	*Percent*
sudden braking	54	35.5
following too close	37	24.3
failed to judge other person's path or speed	12	7.9
inadequate or masked signs or road markings	7	4.6
careless, reckless or in a hurry	7	4.6
exceeded speed limit	5	3.3
distraction outside vehicle	4	2.6
aggressive driving	4	2.6
road layout (e.g. bend, hill, narrow carriageway)	4	2.6
travelling too fast for conditions	4	2.6
Animal or object in carriageway	3	2.0
slippery road (due to weather)	3	2.0
Vision affected by road layout (e.g. bend, winding road, hill crest)	3	2.0
junction overshoot	3	2.0
Cyclist entering road from footway	1	.7
failed to look properly	1	.7
Total	152	100.0

In parallel, further examination of the cases by OTS investigators reveals increased contribution of emotional (table 7) and cognitive factors (table 8) , while contribution of car following and speed behaviour (table 9) is about the same level as in the National Causation data. Carelessness/recklessness/thoughtlessness was found contributing between 15.8% – 32.2 % of interactions, panic behaviour between 7.2% and 23.6%, aggressive driving between 13.2% - 15.8%, while nervousness/uncertainty contributed from 2% to 11.9%. Inattention was a major factor not immediately identified in the Contributory Factors (STATS19) 2005 form. Its contribution was found between 9.2% - 42%. Failure to judge other road users' path or speed had a contribution between 15.1% and 29.6%, higher than the STATS19 form suggests, while lack of judgement for own path ranged between 2.6 and 11.2 percent, and "look but did not see" failures had a 0-8.5% contribution. The important contribution of too close car following found previously (table 6) was confirmed (16.4%-34.8%) as well as the contribution of speeding (5.9%-14.4%).

Table 7: Contribution of emotional factors in "failure to stop" accidents

	%definitely causative	*%probably causative*	*%possibly causative*	*total*
careless/reckless/thoughtless	15.8	3.3	13.2	32.3
Panic behaviour	7.2	7.2	9.2	23.6
aggressive driving	13.2	0	2.6	15.8
nervous or uncertain	2	5.3	4.6	11.9

Table 8: Contribution of cognitive failures in "failure to stop" accidents

	%definitely causative	*%probably causative*	*%possibly causative*	*total*
inattention	9.2	16.4	16.4	42
failure to judge others path or speed	15.1	7.9	6.6	29.6
lack of judgement of own path	2.6	0	8.6	11.2
look, but did not see	0	2.6	5.9	8.5

Table 9: Contribution of tactical/strategic-level behaviour in “failure to stop” accidents

	%definitely causative	*%probably causative*	*%possibly causative*	*total*
following too close	16.4	12.5	5.9	34.8
excessive speed	5.9	4.6	3.9	14.4

Road user reaction

Taking into account how critical the human input is in the driver-vehicle-road environment system, road user reaction is a necessary bit of information, very hard to extract accurately though. In “failure to stop” cases, almost half the road users have no significant reaction as the accident phase commences (table 10).

Table 10. Percentage distribution of road users' reaction in "failure to stop" cases

	Frequency	*Percent*	*Valid Percent*
No sig brkng, strng or acc	518	47.1	48.2
Accelerated (also steering somewhat to the Right)	9	.8	.8
Steered Right (also Accelerating somewhat)	3	.3	.3
Steered Right without significant braking or acceleration	10	.9	.9
Steered Right (also Braking somewhat)	13	1.2	1.2
Braked (also steering somewhat to the Right)	29	2.6	2.7
Braked without significant change in steering	399	36.3	37.1
Braked (also steering somewhat to the Left)	34	3.1	3.2
Steered Left (also Braking somewhat)	13	1.2	1.2

Steered Left without significant braking or acceleration	2	.2	.2
Steered Left (also Accelerating somewhat)	3	.3	.3
Accelerated (also steering somewhat to the Left)	12	1.1	1.1
Accelerated without significant change in steering	5	.5	.5
Unknown	25	2.3	2.3
Total	1075	97.8	100.0
Missing System	24	2.2	
Total	1099	100.0	

In "sudden braking" cases the proportion of road users that applied brakes is much greater than in the previous cases. Combined steering and braking inputs consist about 15% of reactions while steering only reactions are minimal (table 11).

Table 11. Percentage distribution of road users' reaction in "sudden braking" cases

	Frequency	*Percent*	*Valid Percent*
No sig brkng, strng or acc: stayd clse to orig line or curve	37	24.3	24.7
Steered Right (also Braking somewhat)	2	1.3	1.3
Braked (also steering somewhat to the Right)	11	7.2	7.3
Braked without significant change in steering	92	60.5	61.3
Braked (also steering somewhat to the Left)	3	2.0	2.0
Steered Left (also Braking somewhat)	1	.7	.7
Steered Left without significant braking or acceleration	2	1.3	1.3
Unknown/missing data	4	2.6	2.6
Total	152	100.0	100.0

DISCUSSION OF RESULTS

Starting from the very first table of the results, one thing is transparent: road accidents are not transparent events in their causation. There are so many different variables affecting each one of those events, changing from place to place, time to time, culture to culture, vehicle to vehicle, person to person. Close car-following behaviour, non-adherence to traffic rules and speeding contribute to about 50 % of "failures to stop" and is logical to focus on; however there is another 50% which does not includes the above factors. Cognitive failures and errors of road user judgement have also been identified to play a significant part. This comes in accordance with ethological studies suggesting compromised decision-making ability particularly common in intersection crashes (Preusser, Williams, Ferguson, Ulmer, & Weinstein, 1998).

Inattention is identified as a very important factor in failures to stop the vehicle in time (table 3). As this is not the first study to identify such phenomenon (Knipling et al., 1993), the introduction of more and more in-vehicle devices ranging from simple music players to internet and e-mail facilities can easily be approached with scepticism. It is hard not to acknowledge that the additional workload imposed by a vehicle interior full of “bleeps” and “buzzes” magnifies the risk for such accidents. There is a great deal of work necessary to incorporate all those components in the vehicle environment without side-effects.

In terms of road user involvement in those cases, it is clear that there is more than just car drivers to be considered for a safe road environment. Although the respected proportions of non-car drivers in the cases examined are lower than European averages of road user casualties (European Commission), still there is about 20% of non-car occupants and vehicles to be considered. Similar proportions apply in the case of “sudden braking” with an extra involvement of LGVs.

In “sudden braking” cases although a reasonable amount of contribution is identified in too close car-following behaviour (table 7), speeding related factors have very low numbers compared to the previous tables about cases of “failure to stop”. The cognitive factors are at stake here in significant numbers as well, as the contribution percentages of road user failures to judge other’s path, sudden braking as contributory factor itself and factors related to visual perception suggest. The multiple numbers of road users per case combined with the great proportion of contribution of sudden braking to others’ sudden braking suggests a strong systematic domino effect in those cases. The reaction of one driver comes in accordance with the reaction of another.

This systematic phenomenon is supported by the distribution of driver reactions in respective cases. In the case of “sudden braking” accidents, braking is the most common reaction of road users. Only a quarter of the drivers have no significant reaction in the accident sequence. In the case of “failure to stop” initiated accidents, almost half the road users did not even apply brakes (at least not significantly). When some reaction took place, it was only brake application most of the time. This result comes somewhat in contrast with a field study that suggests brake application in tandem with steering wheel inputs as a common evasive action of drivers (Muttart, 2005), although in that case the methodology was constrained in the monitoring of an urban junction only. Overall, the high proportion of non-evasive reactions raises considerations about the value of investments in systems based on driver braking (such as EBA).

CONCLUSIONS: WHAT ACTIVE SAFETY SYSTEMS DO WE NEED?

Facing the variety of factors and the complexity of the interactions that contribute to an accident it is hard to avoid scepticism about the degree in which the current automotive systems address accident causation. Although most of them are based on basic notions about the main factors that trigger an accident, in each of the tables presented in the results section an array of factors which are not addressed or are addressed insufficiently can be found. While it could be supported that factors like failures to stop should be ameliorated by EBA, car following distances/times could be controlled by ACC and Intelligent Speed Adaptation could minimise speeding, similar development cannot be observed to address “failures to look”, failures of judgement, driver motivation and emotional conditions, inappropriate reactions (sudden braking) or driver distraction and inattention. Specifically for the last two problems there should be two things accounted: first, the need to specify systems that improvise the deceleration-properties of the single vehicle but at the same time are harmonised with driver intentions and allow some slack for the communication of vehicle imminent status to other road users. Second, as the in-vehicle environment becomes more and more demanding visually, manually, acoustically, cognitively and/or tacitly, there is a need to integrate those elements in future systems specification. This is a major problem in modern vehicle systems design, as distraction affects lateral controllability as well (Gkikas & Richardson, 2007), which is associated with the most deadly type of accident – loss of control/road departure (Lee, 2006). Safety systems integration with HMI controllers of in-vehicle devices looks promising in this area (Amditis, Kussmann, Polychronopoulos, Engstrom, & Andreone, 2006), however such systems are still in conceptual stages/early development.

It would be unfair not to acknowledge that conceptually ACC and EBA seem ideal against longitudinal control failures. The problem is that they currently only touch on the surface of the problem (longitudinal control failure) and fail to address the core factors behind it. Failing to go below the surface (precipitating factors) only makes the problem appear in a slightly different form (Hollnagel, 2004; Wagenaar & Reason, 1990). Unfortunately, experience in high-hazard industries has widely indicated this through horrific disasters accompanying safety design that follows this approach (Hollnagel, 2004; Whittingham, 2004). A concurrent work in Chalmers University in Sweden adopts this approach in accident investigation with the aim at active safety systems specifically (Ljung, Fagerlind, Lövsund, & Sandin, 2007). Hopefully, this system will fill in the gaps of traditional accident investigation – such as the one this study is based on.

Overall, there is a need for more interdisciplinary work in order to constantly harmonise the three elements of road transport: human, vehicle and road environment. Furthermore, there is a need to lean towards the first element, the driver and design for them, according to them. This is a generally accepted principle. However this is rarely sufficiently applied, as “averages” are far from accommodating most drivers and customisation in active safety is in a primitive phase. It comes naturally to wonder how an x specification (stability, cruise control, brakes assist etc.) system can accommodate for the capabilities and limitations of the real driving population, with variety in skills and limitations similar to the general population.

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