## References


1. Schramm, A., K. McKenzie, and A. Williamson, *Rear-end collisions: Review of Literature*. CARRS-Q, 2012.
2. Michael, P.G., F.C. Leeming, and W.O. Dwyer, *Headway on urban streets: observational data and an intervention to decrease tailgating*. Transportation research part F: traffic psychology and behaviour, 2000. 3(2): p. 55-64.
3. Yan, X. and E. Radwan, *Analyses of rear-end crashes based on classification tree models*. Traffic injury prevention, 2006. 7(3): p. 276-282.
4. Davis, G.A. and T. Swenson, *Collective responsibility for freeway rear-ending accidents?: An application of probabilistic causal models*. Accident Analysis & Prevention, 2006. 38(4): p. 728-736.
5. Hutchinson, P., *Tailgating*. 2008: Centre for Automotive Safety Research.
6. Demmel, S., D. Gruyer, and A. Rakotonirainy. *Comparing cooperative and non-cooperative crash risk-assessment. in Intelligent Vehicles Symposium (IV), 2013 IEEE*. 2013. IEEE.
7. Sommer, C. and F. Dressler, *Progressing toward realistic mobility models in VANET simulations*. Communications Magazine, IEEE, 2008. 46(11): p. 132-137.
8. Glaser, S., et al., *Maneuver-based trajectory planning for highly autonomous vehicles on real road with traffic and driver interaction*. Intelligent Transportation Systems, IEEE Transactions on, 2010. 11(3): p. 589-606.
9. Mourllion, B., *Extension d'un système de perception embarqué par communication: application à la diminution du risque routier*. 2006, Paris 11.
10. Mills, P. and C. Hobbs, *Probability of injury to car occupants in frontal and side impacts*. Proceedings: Stapp Car Crash Conference, 1984. 28: p. 223-235.
11. Fitzgerald, E. and B. Landfeldt. *A system for coupled road traffic utility maximisation and risk management using VANET. in Intelligent Transportation Systems (ITSC), 2012 15th International IEEE Conference on*. 2012. IEEE.
12. Lambert, A., et al., *Usefulness of collision warning inter-vehicular system*. International Journal of Vehicle Safety, 2010. 5(1): p. 60-74.
13. Demmel, S., et al. *Empirical IEEE 802.11 p performance evaluation on test tracks. in Intelligent Vehicles Symposium (IV), 2012 IEEE*. 2012. IEEE.


# Autonomous emergency braking – the next seat belt?

*by Matthew Avery*

*Crash and Safety Manager, Thatcham Research, Colthrop Way, Berkshire, RG19 4NR, United Kingdom*
*matthew.avery@thatcham.org*

## Introduction

Autonomous Emergency Braking or AEB is a safety technology which monitors the traffic conditions ahead and automatically brakes the car if the driver fails to respond to an emergency situation. It is one of the most significant developments in vehicle safety since the advent of the seat belt or the airbag. As technology improves, the numbers of fatal and serious injuries on UK roads are reducing. With improved vehicle structures, improvements to the road infrastructure and consumer test programmes such as Euro NAP, the number of fatalities has continued to fall, from over 7,000 in the 1970s to just 1,754 in 2012 in the UK alone [1].

However, some types of injury have been proportionally increasing in recent years - in particular injuries to vulnerable road users and pedestrians. We have also seen a significant rise in whiplash and associated personal injury claims. Auto braking technologies, such as AEB, can help to reduce the kind of incidents that result in these significant injuries by preventing the crash from happening at all.

Some of the reduction in casualties we have seen on UK roads is due to improvements in commonly recognised safety systems, such as seat belts and airbags; defined as passive safety systems that aim to prevent or reduce injury in a crash. However, AEB can be defined as an active safety system, operating before the crash happens and aiming to prevent the crash from occurring in the first place, or to reduce its severity. With the increasing technological complexity and computing power accessible from a modern vehicle's control systems, the availability and performance of these active safety systems are improving rapidly. Human error accounts for 90% of crashes, so it is easy to understand how driver intervention systems can help to substantially reduce the likelihood of a crash.

## AEB: on the roads

Electronic Stability Control (ESC) was one of the first highly effective crash avoidance technologies. This system, which became widespread in new vehicles from 2000, helps to prevent loss of control or skidding during high speed manoeuvres or on slippery surfaces and is therefore very effective at preventing or mitigating single vehicle crashes. A subsequent report from the Department for Transport showed that ESC reduces the risk of your involvement in a life threatening crash by up to 25% [2].

ESC was an important enabling technology for AEB, since it automatically controls the vehicle's brakes. AEB builds on this by using forward looking sensors to anticipate potential hazards ahead. The first AEB systems used RADAR technology and were often associated with Adaptive Cruise Control (ACC) and Forward Collision Warning (FCW) systems. These were most often optional systems, sometimes fitted at high cost, but were shown to have a significant benefit, reducing damage and injuries by at least 10% and 14% respectively [3].

Mainstream AEB entered the market in 2008 when Volvo launched standard fit City Safety, using a low cost laser based LIDAR sensor. As it was fitted as standard the effect could be easily statistically measured and subsequent international insurance claims data rapidly highlighted the benefits. This showed a reduction in third party damage crashes and injuries by at least 15% and 18% respectively [4]. Thatcham's study of UK insurance claims data showed an 18% reduction in third party personal injury claims and a 9% reduction in third party damage claims over the period from 2009 to 2013.

The evidence that AEB is working on our roads is extremely encouraging, not least because it is already contributing to reducing the whiplash problem for the UK. There are over 550,000 whiplash claims annually in the UK, costing society £2 billion and adding an extra £90 a year to the average motor insurance premium [5, 6].

Such is the benefit from AEB systems that through the vehicle Group Rating process, UK insurers have already adjusted the insurance rating on cars fitted with the system. The aim is to encourage wider awareness and demand for AEB and since 2012 vehicles with standard fit AEB systems and which have passed a few basic operational criteria, have seen a reduction in their vehicle grouping, translating into potential savings of around 10% on consumers' insurance premiums. The performance of the system is assessed by Thatcham using a dynamic test against a stationary realistic car target, at speeds from 10-50km/h; the performance is used to derive the size of the group rating reduction applied.

This pioneering system to encourage broader AEB fitment has subsequently been adopted in Germany too, giving more incentives for manufacturers to fit AEB systems and protect even more road users.

## AEB: system types

Different AEB systems are effective at different speed ranges, depending on the sensor technology used. Three quarters of all collisions occur at speeds of less than 20mph [7]. The majority of these low speed crashes are seen in city environments such as queuing traffic, at junctions or roundabouts; where most whiplash injuries also occur. This is where AEB systems using the cost effective LIDAR sensor are very effective, typically avoiding crashes completely at speeds of up to 12-15mph and mitigating those up to 25mph.

Higher speed crashes can be addressed by RADAR based systems, which are typically more expensive and often only available currently as optional extras depending on the vehicle manufacturer. These 'Urban' type crashes are not as common, but as you might expect are normally more serious. RADAR based systems are effective at preventing or mitigating these higher speed crashes up to motorway speeds.

As environmental, economic and congestion pressures encourage more cyclists and pedestrians, we have seen the proportions of injured road users changing. Whilst overall numbers of all casualties are decreasing each year, pedestrians and particularly cyclists now represent an increasing share of the injuries. In 2012 in the UK there were 420 pedestrian and 118 cyclist fatalities [8]. AEB can now address these vulnerable road user collisions too, since systems are now combining cameras with radars in sensor fusion.

## AEB: assessments

Thatcham is a member of Euro NCAP and has been leading the implementation of testing procedures into their consumer vehicle safety ratings programme. Tests are carried out to exacting standards with the vehicles precisely controlled by test engineers and robots, using high precision measuring equipment. This work involved the use of real world crash scenarios to define the tests, bringing about the development of a realistic car target that could be repeatedly impacted, and the subsequent definition of the assessment and scoring procedures.

For Euro NCAP the tests mirror those implemented by the aforementioned UK insurance group rating process and these low speed tests against a stationary car target are termed 'City' tests. Thatcham and Euro NCAP have also defined higher speed tests against both stationary and moving car targets, known as 'Inter-Urban' tests.

From 2014 these city and inter-urban tests have become a key element of Euro NCAP's new car assessment programme, see: www.euroncap.com/results/aeb.aspx

Similarly detailed test procedures for the assessment of pedestrian AEB systems are almost complete and are planned for implementation during 2016. This type of test procedure is now also being adopted further afield in the US, Japan and China.

## ADAS: the future

ESC and AEB are just the beginning of the revolution in crash avoidance. Advanced Driver Assistance Systems (ADAS), such as AEB, designed to prevent or mitigate different crash types, are entering the market every year. The future will bring autonomous steering to prevent head-on collisions and 'run off road' crashes which are often very serious, or even fatal. As technology develops, we'll also see opportunities to reduce other vulnerable road user deaths such as the junction scenario where a car pulls out in front of a motorcycle.

It is important for drivers to remember that most of the ADAS systems currently available are designed to support them only in emergencies and that the driver remains responsible for the vehicle at all times. In the longer term, we can expect to see systems that will automate normal driving functions in limited traffic circumstances, such as control of speed and steering on motorways, in order to relieve the driver of the driving burden. Eventually, driverless cars will transfer this burden from the driver to the vehicle – but that is a long way off for the mainstream market, with the first fully driverless cars not expected until the end of the next decade.

The new world of crash avoidance technologies is on our roads today in the form of AEB, and is already reducing crashes, preventing injuries and fatalities and saving associated societal costs.

## References

1. Department for Transport (2013) Reported road casualties Great Britain 2012. London, The Stationery Office.
2. Frampton, R. and Thomas, P. (2007) Effectiveness of Electronic Stability Control Systems In Great Britain. On behalf of the Department for Transport. Loughborough, Vehicle Safety Research Centre, Loughborough University.
3. Insurance Institute For Highway Safety (IIHS) (2012) They're Working. Status Report, 47.
4. Insurance Institute For Highway Safety (IIHS) (2013) Crash Avoidance. Status Report, 48.
5. Association of British Insurers (2013) Lifting the bonnet report uncovers the real cost of motor insurance. London, Association of British Insurers.
6. Association of British Insurers (2013) Fair, independent, objective – ABI publishes proposals to curb the UK's whiplash epidemic. London, Association of British Insurers.
7. Volvo Car Corporation (2007) Estimates from NASS and STO data. Gothenburg, Volvo Car Corporation.
8. Department For Transport (2013) Reported road casualties Great Britain 2012. London, The Stationery Office.

# Motorcycle safety through smart technology

*by Mark Jackman*
*Regional President Chassis Systems Control, Bosch Australia*
*Mark.Jackman@au.bosch.co*

Spend a Sunday meandering your way along the Great Ocean road or through many of the other winding roads, all over Australia and you are sure to encounter dozens of motorcyclists gliding around the smooth curves. The freedom of controlling a machine through the bends accelerating and braking, shifting their weight, picking the best line and leaning into the corners makes a scenic ride even more enjoyable. However with the highs of motorcycle riding come significant risks, many of which can be reduced through intelligent selection of the bike's safety features.

Per kilometre travelled, motorcycle riders are over 37 times more likely than car drivers to be seriously injured when on the road [1]. Motorcycles account for 4.5% of all Australian passenger vehicle registrations and 1.1% of vehicle kilometres travelled. However, motorcycle riders and pillions account for approximately 15% of all road crash deaths and an even higher proportion of serious injuries.

Of the 287 people killed on Victoria's roads in 2011, 49 were riders of motorcycles. This represents 17% of the road toll [2]. The Motorcycle Council of NSW states that almost half (48%) of crashes in their 2006-2010 study involved excessive speed [3]. Importantly this does not mean they were all exceeding the speed limit, just that their speed was inappropriate for the conditions. In fact many accidents occur due to poor road surface, other road users' errors or even animals and debris on the road.

A small change in balance or direction when rounding a corner, loose stones or the need to brake suddenly can all