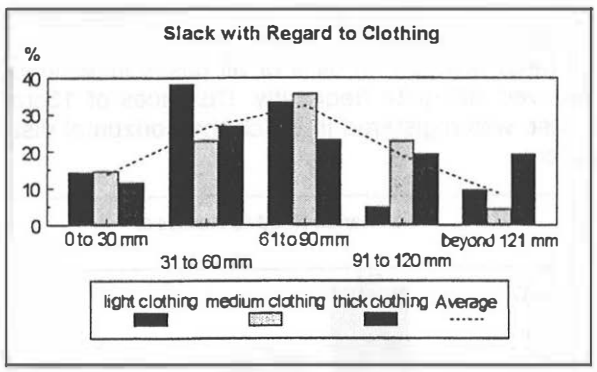
Seat Belts and Head Restraints: The Daily Use

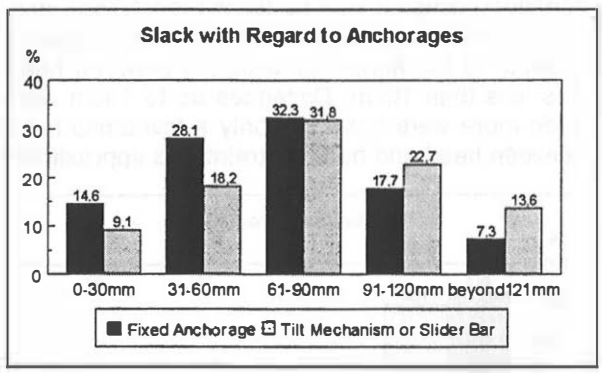
Dipl.-Ing. Klaus Pilatus, Dipl.-Ing. (FH) Detlev Oertel,
Dipl. Ing.-Jürgen Fischer, Autoliv GmbH

The effectiveness of occupant restraint systems mainly depends on their correct use. In a field study it was investigated whether or not features of the protection system such as B-pillar height adjusters for the seat belts and adjustable head restraints are operated by car occupants. Further the amount of slack in the seat belt system in its normal use was established. Slack is defined as the additional amount of pulled out webbing versus the amount which is required if the webbing is tightly fitted around the occupant. The way slack was measured for this study is such that a flexible ruler was firmly fixed to the diagonal belt, the starting point of the ruler matching with the D-ring. By pulling by hand at the vertical strap of the webbing the seat belt was pulled tight and the amount of webbing taken of the system could be read from the fixible ruler running through the D-ring.

For this study 118 vehicles and their drivers were examined when arriving on the car park of DEKRA AG's Munich test area. Dealers who took cars on behalf of the owners to periodical vehicle examination are not included in this study.

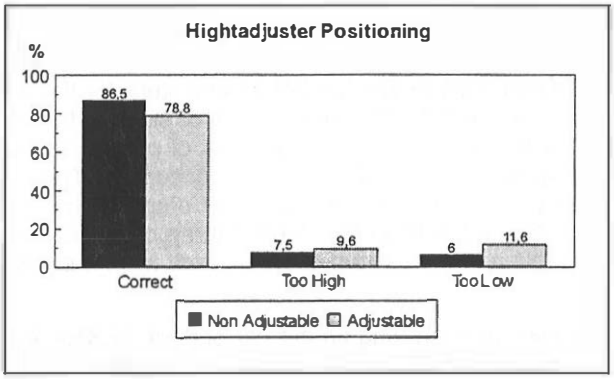
With respect to belt slack it was found that clothing of the occupant did have less influence on the amount of slack than expected. More important is the care which the occupant takes to fasten the seat belt correctly.
Apart from slack caused by poorly designed interior features, the maximum slack established in this investigation was 190mm. Belt slack above 70mm was found on 50% of all drivers examined.
When looking at the different parts of the belt system it was found that with 90% of all drivers examined the shoulder belt did not have slack. Even in cases where the shoulder belt did not fit very tight the amount of slack was negligible compared to the slack found in the lap belt. Not only the amount of slack found in the lap belt was remarkable but also the fact that in 75% of all vehicles examined the lap belt was very loose. A possible reason for this can been seen in the friction of the webbing in the buckle tongue and also the webbing to cloth friction in the diagonal part of the belt system. Further, looking to the final attachment of the seat belt at the lower B-pillar, it becomes obvious that the way it is fixed to the body shell influences the amount of slack found in the belt system. Cars with a fixed lower anchorage, normally 4 and 5 door models, had least slack. In cases with slider bars or tilt mechanisms (2 and 3 door cars) the situation was worse.





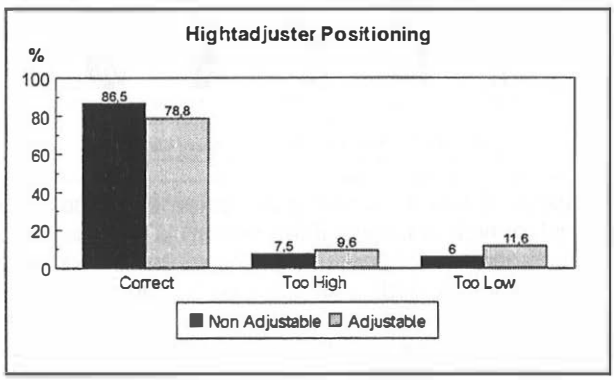
Also a few examples were discovered in which poor design of interior features did enlarge the possible amount slack of the belt system or at least increase the risk of high belt slack if the system is not used with awareness. If in case of a swivelling attachment this attachment is not carefully pulled to its correct position it may remain in a rearward direction and under accident loads, additional slack up to 200mm can be released or, poor matching of several components of a inner sill trim, in combination with a slider bar design of the lower outer anchorage in two and three door vehicles, may lead to a situation where the webbing is obstructed for sliding into the correct position. If the belt system is loaded due to an accident, depending on where the partition line of the cover pieces is located, a reasonable amount of additional slack will be released. Another concern observed was related to the seat design. An outward located adjuster wheel for the seat back angle may, if there is not sufficient room left, lead to a situation in which the webbing is caught by the wheel. This will occur when a new taller driver pushes the seat into a more rearward position. In this particular case an additional belt slack of 120mm was detected. These incidents can be looked at as stand alone examples and they are not included in the graphs above.

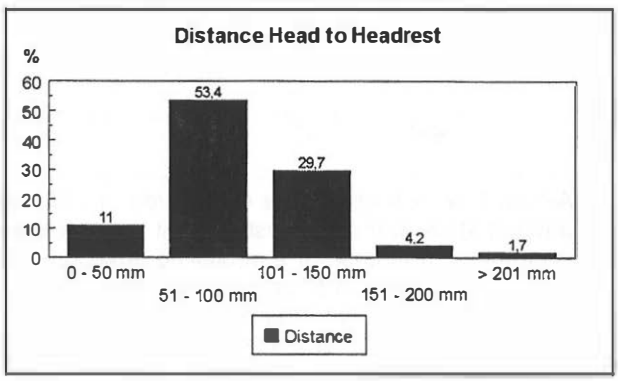
Adjustable head restraints and seat belt height adjuster at the B-pillar are rarely known features of a car's safety system. A huge majority of the drivers asked in this study either did not know that the safety system of their car did offer possibilities to adjust the system to their individual conditions or in case they new about these possibilities the knowledge about a correct adjustment was quite poor.



In case of height adjusters it was found that 44% of all cars examined had them at the B-pillar. With 78% of these vehicles the height adjuster was adjusted to the correct level, with 12% the height adjuster was adjusted too low, and in 10% of the vehicles the height adjuster was too high. A comparison to vehicles not having adjustable pillar loops shows that with 87% of those cars, the height of the fixed pillar loop was correct, with 6% it was too low and with 7% it was too high. Having asked the drivers about the use of the adjustable pillar loop all drivers declared that they either did not know that there was an adjustable device or they had never used it before. Also it was not know what the correct level in height for the pillar loop should be. That means without detailed information of the car users, an adjustable pillar loop does not offer the assumed benefits versus a fixed one.

The height adjustment of the head restraint is quoted to be at its best if upper comer of head and head restraint are on same level. It still can be tolerated if the upper corner of the head restraint is at the same level as the eyes. This adjustment is defined as correct for the purpose of this study. In our examination however it was found, and this has been stated in other studies also, that in many cases although adjustable head restraints can not be adjusted to a correct position especially for taller people. With more than 70% of all cars examined in this study the head restraints were adjusted too low i.e. upper head restraint corner was below eye level of the seat's occupant. In 70% of these cases it was possible to adjust the head restraint to the correct level. As seen with the adjustable pillar loop, there is a lack of customer knowledge of the purpose of a head restraint and its correct adjustment. In cases the interview driver claimed to have adjusted his/her head restraint it had happened for the convenience of the user. Even in cases where the head restraint was adjusted correctly, this happened mainly by accident or was related to the body shape of the respective person. In 67% of all cases in which the head restraint was set to a correct level the respective occupant was no taller than 1,75m, and in 62% of all cases in which a too low adjustment level for the head restraint was observed the occupant was taller than 1,75m.
Looking to the horizontal distance between head and head restraint, in 64% of all cases investigated, it was less than 10cm. Distances up to 13cm were observed still quite frequently. Distances of 13cm and even more were observed only a few times but one case was registered in which the horizontal distance between head and head restraint was approximately 40cm.





From the investigation above three items can be concluded:

a) Belt slack is part of the daily use of safety belts. Pretensioning devices therefor are needed to better protect car occupants. Looking to where the main part of the slack was found buckle pretensioning obviously is the best kind of pretensioning.
b) Features like pillar loop height adjusters and adjustable head restraints are poorly known to car users. Therefor the benefits offered through these devices come in useful only by accident. Education of the public is required.
c) It seems the seat belt still is widely seen as a single component rather than part of a complete system during design of a vehicle.