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# Increasing seat belt use: Two field experiments to test engineering-based behavioral interventions

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ABSTRACT

This paper presents separate field experiments. The studies assessed engineering-based behavioral interventions to increase the frequency of drivers' seat belt use. In Experiment 1, we instrumented a large portion of a commercial fleet with a seat belt gearshift interlock system. This system prevented drivers from engaging their transmissions unless they were buckled. The goals of Experiment 1 were to measure the change in belt use from a baseline period averaging about three months to an intervention period ranging one to three months and to assess the drivers' acceptance of the system at the beginning, middle, and end of the intervention. The results indicated a significant increase in seat belt use from 81% to 96%, but ratings of driver acceptance were low, indicating poor acceptance. In Experiment 2, we evaluated a system that applied a counterforce that pushed against the accelerator pedal of unbelted drivers when vehicle speed exceeded 20 mile per hour (mph). Unbelted drivers could continue to drive and exceed 20mph by pressing harder than the counterforce but doing so required focused attention and physical effort. The results of Experiment 2 indicated that belt use increased from 56.2% during baseline to 99.74% during the intervention. Driver acceptance ratings were favorable. Taken together, the experiments indicate that such engineering-based behavioral interventions have considerable promise in terms of increasing seat belt use, but each faces challenges to becoming viable countermeasures. The challenges associated with the interlock appear to be attitudinal in nature on the part of the drivers, whereas those associated with the counterforce system are technical matters involving fitment of the hardware across different makes and models.



## 1. Introduction: Increasing seatbelt use

Research indicates that wearing a seat belt is one of the most effective countermeasures to reduce injury resulting from a motor vehicle crash. The National Highway Traffic Safety Administration (NHTSA, 2014) estimates that fatalities for front seat passengers would be reduced by 45% if seat belt use was 100%. Although the current seat belt use rate of 86% has been increasing steadily over the last 3 decades, millions of drivers within the US (i.e., 14% of 200+ million estimated drivers) are still driving without their belts.

The majority of efforts to increase seat belt use have focused on legislation requiring seat belt use, public education about the laws and benefits to buckling, and police enforcement of such laws. Strong legislation alone is associated with increased

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seat belt use. For example, data indicate that states with primary seat belt enforcement laws that allow officers to make traffic stops for seat belt infractions have seat belt use levels 9% higher than states with secondary seat belt laws, or laws that require a traffic stop due to another violation (e.g., speeding) (Houston & Richardson, 2005). Behavioral programs aimed at increasing awareness of the enforcement of the legislation have produced large sustained increases in seat belt use. Evaluations indicate that annual highly publicized enforcement campaigns such as *Click It or Ticket* are associated with increased levels of seat belt use (NHTSA, 2009a, 2009b). Other studies have shown that providing posted feedback in a jurisdiction with a history of seat belt enforcement can further increase seat belt use (Grant, Jonah, & Wide, 1983; Malenfant, Wells, Van Houten, & Williams, 1996). As a result of these efforts, seat belt use in the United States reached 87% in 2013 (NHTSA, 2014).

Some automobile manufacturers offer enhanced seat belt reminder systems in an engineering-based approach to increase seat belt use. Enhanced seat belt reminders present auditory or visual alerts that last longer than the required 4–8 s required by Federal Motor Vehicle Safety Standard 208. Whereas public education and police enforcement focus on changing the attitudes and subsequently the behavior of the general public, enhanced seat belt reminder systems are designed to directly influence vehicle occupant buckling behavior. Freedman, Zador, and Bergeron (2009) completed an observational study of seat belt use of drivers of several thousand vehicles and reported that vehicles equipped with enhanced seat belt reminder systems were associated with a statistically significant 3–4% increase in seat belt use of front seat passengers compared to vehicles without enhanced reminder systems. Seat belt use rates in these vehicles were approximately 85%. These results indicate this engineering countermeasure has promise, although belt use was significantly less than 100%.

This article presents two experiments that used two different engineering approaches that influence seat belt use more directly than enhanced belt reminders. The first study tested a seat belt gear shift interlock, and the second study tested a system that applied counter force to the accelerator pedal when drivers exceeded a preset speed and were not wearing seatbelts. We expected both systems would lead to belt use at or near 100%, as the interventions are more compelling than enhanced belt reminder systems installed by vehicle manufacturers. However, the drivers' acceptance of the two interventions was of equal interest because of the importance of this construct in determining the extent to which such systems could become commercially available.

*Seat belt interlocks*. There are at least three types of seat belt interlock systems that could be implemented, including seat belt ignition interlocks, seat belt gearshift interlocks, and entertainment or accessory interlocks. Each system has drawbacks that might lead to automation disuse, which Parasuraman and Riley (1997) describe as intentional avoidance of automation through circumventing, deactivating, or disabling the system. In the 1970s, the National Highway Traffic Safety Administration (NHTSA) mandated that vehicle manufacturers install seat belt ignition interlocks in all MY 1974 vehicles. The experience with this countermeasure indicated that interlocks were unacceptable to drivers – many buckled the belts behind their backs and left them buckled or took other actions to avoid the system (Cohen & Brown, 1973). In principle, an ignition interlock requires drivers to buckle their seat belts to start, heat, and defrost the vehicle in the winter, or to cool it in the summer. Drivers must then unbuckle if they choose to leave the vehicle while it warms or cools, and, if this is the case, the driver must re-buckle when reentering the vehicles because the motor is already running. Such a behavioral progression would result in avoidance of the interlock device and introduces the possibility that the driver might forget or choose not to re-buckle. Remote starting of vehicles would present a similar obstacle for seat belt ignition interlocks.

In contrast to ignition interlock, an entertainment interlock would not force the driver to engage the seat belt at some point. Rather, the driver is deprived of radio or other entertainment systems until the seat belt is buckled. Although this form of interlock may be more acceptable than an ignition interlock, it might be prone to disuse because drivers do not always use their sound system on all trips. A more problematic, unintended consequence would be a driver's installation of an aftermarket system or use of portable systems (e.g., MP-3 players) to bypass the entertainment lockout.

Intuitively, a seat belt gearshift interlock system would be more resistant to disuse than an entertainment interlock and more acceptable to a larger proportion of drivers than the ignition interlock. The gear shift interlock system allows drivers to warm or cool vehicles or use remote start features. Malenfant and Van Houten (2008) completed an observational study to assess when drivers buckled their seat belts relative to other tasks that occur during the starts of trips. The authors reported that, of drivers who buckled, 31.1% did so before starting the vehicle, whereas 42.2% buckled after starting their cars but before engaging the transmission. To the extent that Malenfant and Van Houten's sample of approximately 1200 individual generalizes to the driving population, the gearshift interlock would be transparent for a significantly larger portion of drivers than the ignition interlock. This system is also a direct use system that does not depend on the motivation to listen to music on a particular trip as is the case with an entertainment system interlock.

In two previous studies, Van Houten and colleagues tested variations of a gearshift interlock and reported large, significant increases in seatbelt use compared to baseline periods (see Van Houten, Malenfant, Austin, & Lebbon, 2005; Van Houten, Malenfant, Reagan, Sifrit, & Compton, 2010). Rather than a complete gearshift interlock, the researchers designed the various gearshift delays that prevented unbelted participants from engaging their transmissions for periods that ranged from 5 to 20 s.

Although a gearshift interlock should be more robust than an ignition or entertainment interlock, there are potential drawbacks for a gearshift-based interlock system. For example, a gearshift interlock does not allow drivers to start a trip until their seat belt is buckled, and Malenfant and Van Houten's (2008) observational data suggests that a significant segment of drivers belt after engaging their transmissions. Drivers who on certain trips buckle their seat belts in such a progression would need to acquire a new buckling habit, which could lead to annoyance and low acceptance of the technology. Van Houten et al. (2005) indicated that some participants who experienced 20 s delays became annoyed and attempted to