

**Summary:**

# **Traffic safety of adapted cars for disabled drivers**

Adaptation of cars for disabled drivers spans a wide variety of technical solutions, from simple ones like extra power steering to very advanced systems, e.g. a four-way joystick combining steering, braking and accelerator in the same unit. The question of traffic safety naturally comes to the fore in connection with solutions that imply changing standard manoeuvring equipment, long proven safe and reliable. The project reported here consists of two parts. The first part is an assessment of possible effects of adapted cars on traffic safety, based on a theoretical analysis of driver information needs and information processing capabilities, and how adaptations of the manoeuvring units may change the difficulty of the driving task. The second part is an analysis of crash involvement for a sample of adapted cars. The sample was drawn from the registers of a group of vendors of adapted cars, and insurance companies provided data on crash involvement of these cars, as well as yearly driving distances and some other background information about the owners.

The number of cars in Norway where basic functions (steering, brakes, and/or accelerator) have been modified, is estimated at somewhere between 5 000 and 9 000 (exact figures are missing, because there is no central register for this information). Most of the adaptations are financed by the National Social Insurance Office, on the basis of applications from the disabled persons. The adaptations must be approved by a vehicle inspector from the Public Roads Administration. If the applicant already holds a licence, there is no formal requirement for a new driving test. Some vehicle inspectors, however, require a documentation that the applicant is able to use the equipment in an adequate way, as part of the technical approval. If the vehicle inspector suspects that the driver is not fit to drive, he may inform the health authorities, which in turn will require a medical examination to ascertain whether the applicant fulfils the health requirements for license holders.

## **Theoretical analysis of safety aspects of different adaptations**

Ordinarily, driving behaviour is to a very large extent automatic, and is carried out without much conscious effort and attention. The more difficult and complicated the task, the more effort is needed. This may imply that driving certain adapted cars may be more demanding to the driver, and this may increase the mental load and thereby reduce the capacity to attend to unexpected traffic events.

Combining several manoeuvring functions in one unit may possibly result in interference between the different functions. For example, with a four-way joystick the steering movements (right-left) may interfere with braking (forward) or accelerating (backward), or vice versa. For drivers with sufficient mobility in both arms, replacing the four-way joystick by two two-way joysticks is therefore a better solution.

Another kind of interference may be between a joystick-operated electrical wheelchair and an adapted car. Wheelchairs are normally operated by moving the stick forward for accelerating and backward for braking (and reversing). This is not considered safe for a joystick-operated car, due to the risk of inadvertent accelerator activation when e.g. falling forward in the car; therefore the braking is performed by forward movement of the stick. Thus, in a critical situation a driver may possibly use the well-learned habit of braking by backward movement, which would have been adequate with the wheelchair but result in a possibly hazardous acceleration of the car. For this reason wheelchairs are often modified as well for drivers who are going to drive a joystick-operated car. However, because well-learned habits tend to dominate in stressful situations, very much practice is needed to replace an old inadequate response by a new and correct one.

A different problem with joystick steering is the small area of movement of the joystick compared to a steering-wheel. This may result in low precision of steering, because a relatively small movement of the stick has a large effect on the wheels, which may be dangerous during high-speed driving. Special joystick systems have been developed to reduce such problems, e.g., a speed-dependent sensitivity of the joystick, and filters to dampen the effects of inadvertent jerky movements, e.g. by drivers with spasms.

Some solutions consist of button panels where several functions can be performed easily with one hand. Close proximity between functions may here be a source of interference, with the risk of pushing the wrong buttons. Such solutions are mostly used for secondary controls (e.g. lights, wipers, ventilation, etc.), which are less safety critical than steering and speed control, but in special situations wrong or missing activation of e.g. wipers may be critical.

Some drivers have reduced head and neck mobility, and therefore need special devices to aid their view to the rear and to the sides, e.g. special mirrors, or video monitors. It is important that such equipment does not interfere with the forward view.

These examples indicate several reasons to suspect that adapted cars would be over-represented in crashes.

### **A study of actual crash involvement**

To investigate the actual risk, data about crashes for a sample of 194 adapted cars were collected from the two largest insurance companies in Norway. The annual driving distances for the insurance premiums were taken as a measure of exposure. The results showed that the adapted cars were involved in 10.3 crashes per million vehicle kilometres, which is very close to the risk for cars in general (estimated at 10.1 crashes per million vehicle kilometres for the period 1998-2000).

In other words, there are no indications from our data that the crash risk of adapted cars taken as a whole differs from that of cars in general. This finding may possibly be explained by drivers compensating for a difficult driving task by driving more cautiously, slowing down, concentrating more on the traffic, and/or avoid difficult traffic conditions, where the crash risk may be higher, like slippery roads, darkness and rush hours.

This result does, however, not exclude the possibility that there may be considerable differences in risk between different kinds of adaptations. Unfortunately, the present sample was too small for estimating the risk of subgroups of adapted cars.

For future assessments it is recommended that information about adapted cars, including type of modification, is compiled in a central register.