



Roadside Office Ergonomics: Laptop Use in Vehicles

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Brief Description: The use of mobile computers in vehicles is becoming increasingly widespread as more and more professionals use their vehicles as a mobile office. While a car is a great way to get from A to B, it's not designed to be an office space; as such it is not especially conducive to proper ergonomic practices. Yet, by implementing wise strategies, office ergonomics principles can be adapted to this new environment.

This paper discusses key points for choosing and properly mounting a mobile computer (laptop) in a vehicle to reduce the risk of injury to a user's back and shoulders.

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Using Mobile Technology in a Vehicle: Are You at Risk of Injury?

The widespread availability of wireless technology has allowed many types of workers to become mobile. As work demands increase, professionals need to maximize their productivity, both in the office and on the road. The productivity tools at their disposal are myriad, and many workers now leverage several mobile technologies, including, but not limited to, cell phones, GPS, tablets, and laptops. These devices have obvious benefits, especially relating to increased productivity. Productivity aside, does the use of wireless devices in your vehicle place you at risk of injury?

There are multiple sources of risk ranging from distracted driving to poor body postures. This paper will briefly address the risks associated with distracted driving and then focus on incorporating ergonomics into your mobile office.

Distracted Driving

A current debate for many local, state, and federal law makers is regulating the use of cell phones while driving. When you drive while using a cell phone or other mobile technology, you are mentally and physically multi-tasking. It is generally accepted that there is an upper limit to the amount of information the mind can process at a given instant. While multi-tasking the upper limit is divided across all of the tasks that you are trying to perform.

In everyday and common driving conditions, the task of driving does not require full mental capacity for most people (if it did there would be a lot more accidents). However, what happens when you devote your attention to an act that requires greater mental faculties while driving? And then, what happens when the typical, everyday driving situations suddenly change? There are many studies that have measured the effect of mobile devices on driving performance; and the vast majority of studies reach the same conclusion: distracted driving increases the risk of accidents, property damage, injury and death. Many types of devices and interaction methods (touchscreens, voice recognition, in-dash displays, etc.) have been studied, and all have been shown to have a negative impact on the ability to properly drive a vehicle and use the mobile device [1].

Using Your Vehicle as a Mobile Office

Mobile devices, such as laptops, are not used as frequently as mobile phones by typical drivers, but they are commonly used in police cars, ambulances, and fire trucks. In addition to emergency response vehicles, mobile computers are frequently found in fleet operations vehicles such as construction or utility (electric, gas, etc.) trucks, or by professionals that drive frequently, such as parcel delivery specialists, in-home nurses and traveling sales professionals. Mobile computers should never be used while driving a vehicle; the cognitive demands are even greater than those required by cell phone usage. That said, there are risks involved with using a mobile computer even while not driving the vehicle.

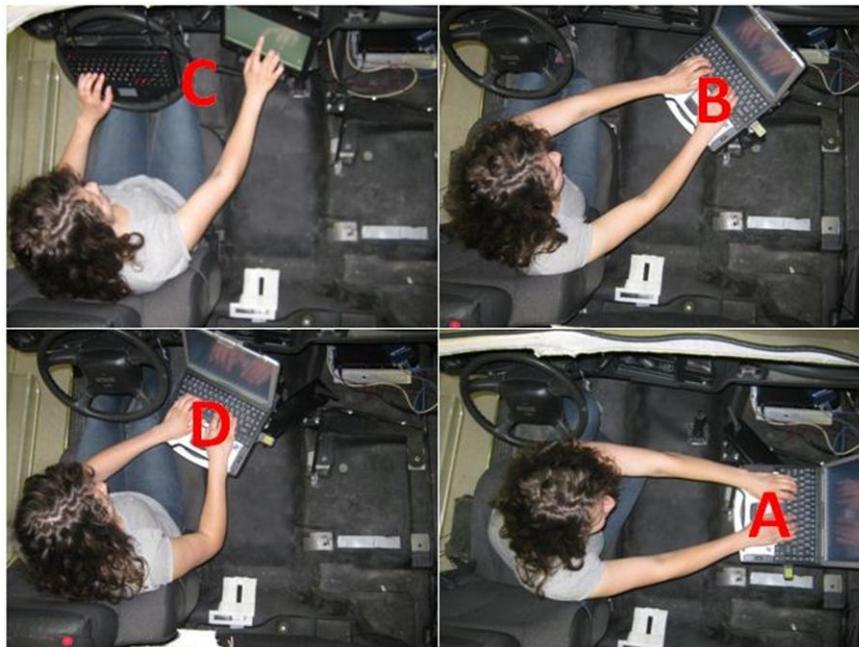
When the Front Seat Becomes an Office

Use of a laptop or other mobile computer in a vehicle essentially transforms your vehicle into a mobile office. Can the principles of office ergonomics apply to vehicles? The answer is yes, but a vehicle adds some extra variables – and challenges – to the equation.

In October of 2011, Marquette University ergonomics researchers published an experiment sponsored by the Electric Power Research Institute (EPRI) to determine the best location for mounting a mobile computer in a pick-up truck that would help reduce the risk of musculoskeletal disorders (MSDs) [2]. Researchers measured the impact of the computer's location and data input method (touchscreen or keyboard), on the users' body. The study's subjects were electric utility workers in an electric utility vehicle, but the results apply to most vehicle types and users.

In the study, four computer locations were used by each participant. The locations used in the study were selected based on current commercially available mounting systems. Three of the four locations used a removable laptop (A, B, and D in the figure below).

- A – Passenger seat-mounted “desk” unit. This type of unit is a low-cost option for laptop vehicle use. It is easily tethered to the seat with a seatbelt, and the laptop is placed on top of the “desk”.
- B – Post mounted in front of the passenger seat with docking station. The laptop is mounted on a docking station directly above the post with limited adjustability.
- C – Screen mounted to the dashboard with keyboard placed on the steering wheel. This location is common in emergency vehicles.
- D – Mount with two articulating arms and docking station. Participants were allowed to place the computer where they felt most comfortable given the constraints of the vehicle. All participants chose to place the laptop near the right side of the steering wheel.



Researchers found that locations A and B – user seated in driver seat while operating passenger side-mounted laptop— required particularly poor body postures, and increased muscle strain compared to steering wheel laptop mounting (locations C and D). Researchers further concluded that use of a mobile computer with passenger side-mounting may:



- Lead to muscle fatigue in the lower back and shoulders within 10 minutes
- Increase the risk of low back pain
- Increase the risk of shoulder MSDs

To further corroborate the researchers findings, study participants preferred steering wheel (or near steering wheel) mounting. While it may be more costly (parts, more complex installation) to implement steering wheel location mounting, driver-side computer mounting may help reduce the risk of very costly low back or shoulder injuries.

Ideal Postures for Using a Computer in a Vehicle

When selecting and installing a mobile computer and mount in a vehicle, consider the following guidelines. While all of the postures might not be completely feasible due to the vehicle constraints or size of the individual, the highest priority postures are listed first.

- **Back:** Position the computer directly in front of the user (or as close as possible). The user should be sitting erect or against the back rest, requiring minimal torso twisting or forward/lateral bending.
- **Shoulder:** Position the computer at approximately forearm length away from the user. The user's elbows should be near his/her sides. Positioning the computer too close to the user should also be avoided (elbows behind body and wrists bent toward the little finger).
- **Wrists/Hands:** Position the keyboard at elbow height and forearm length away from the body. The user should have neutral or minimally bent wrists. (If the computer tasks are mostly visual with little keyboard input, focus on neck posture before wrist posture)
- **Neck:** Position the top of the computer screen at roughly eye level in front of the user. The user should be looking forward with minimal forward/lateral bending. (If the computer is a laptop – keyboard and screen connected – and the tasks require mostly keyboard input or a mix of keyboard input and visual tasks, focus on wrist posture first. The neck has larger muscle groups that can handle poor postures better.)
- **Legs:** Position the computer in front of the user. The user should support his/her body weight evenly on both legs.

Computer and Mounting Considerations

Your vehicle is not always the friendliest environment for your computer either. Other than the placement of the computer during use, you will need to select a computer and mount with the appropriate features to withstand other potential abuses caused by a vehicle. Many of the following points were adapted from a study by Eost and Galer Flyte [3].

When selecting a computer, make sure that it can handle:

- An occasional bump or drop. The computer will invariably be taken in and out of the vehicle frequently, increasing the risk of damage to the device.
- Extreme temperatures. Ensure that the computer can be used and stored in extreme temperatures (from 0° to 100°F) or areas where the temperature can fluctuate wildly over short periods. Humidity should also be considered.
- Poor lighting. Many computer screens are hard to read in daylight or cab lights due to screen glare. Also, consider a light for the keyboard if the mobile computer will be used after dark.



When selecting a mount:

- Be sure to carefully review the mount area so as to identify and vehicle controls/knobs/displays that could be blocked or impeded. Consider a mount that can easily be moved and locked into a storage position.
- Ensure the mount location does not conflict with or impede the airbag zone. If an airbag deploys, the safety benefits will be significantly decreased, and worse, the computer itself could become a projectile. Know your airbag zones and get a mount that can store the computer securely out of the zone.
- Be cognizant of the potential for theft. Install a mount that can securely lock the computer to the car, or facilitate quick-release should you wish to store it in the trunk or elsewhere. A quick release is preferred if the computer is used in and outside of the vehicle.
- Determine if there will be a passenger in the vehicle. Many commonly used mounting systems restrict passenger side floor space and could potentially injure a passenger in the event of a crash.
- Also consider other office materials that you might need and where you will store them. This will vary based on the type of work being done in the vehicle. To minimize physical storage, consider using digital versions of reference materials or other similar documents on your computer.
- Spending the extra money for a high-quality mount for your fleet will ensure:
 - Productivity is optimized
 - Less risk of musculoskeletal injury due to the postures required when using a mobile computer
 - The computer can be safely stored outside of the airbag zone while driving
 - The computer is used to properly complete all of the assigned tasks

Fleet Vehicle Considerations

Develop an implementation team to decide on the best options for your crew. The team should include:

- Crew members
- Supervisors
- Fleet managers
- Engineering
- Information Technology (IT)

The input of this team should be considered in the selection of the final system to ensure that it will be used properly by the crew, will function properly and safely, and will reduce the risk of injury to the user.

- Different computer and mount vendors should be contacted and their products should be demonstrated in your vehicles to select the best possible option for your fleet.

References

- (1) Multiple articles in the Special Section of Driver Distraction in Human Factors: The Journal of the Human Factors and Ergonomics Society Winter 2004 46



- (2) Saginus, K. A., Marklin, R. W., Seeley, P., Simoneau, G. G., and Freier, S. "Biomechanical Effects of Mobile Computer Location in a Vehicle Cab." *Human Factors: The Journal of the Human Factors and Ergonomics Society* 53.5 (2011): 474-88.
- (3) Eost, C and Galer Flyte, M. "An investigation into the use of the car as a mobile office." *Applied Ergonomics* 29.5 (1998): 383-388.



Contact Information

Contact Aon's Ergonomics Group for assistance with integrating mobile technology into your vehicle with ergonomic principles.

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