SIT FIT - ERGONOMICS FOR DRIVERS

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ABSTRACT

Professional drivers sit for prolonged periods of time, often in awkward postures. They may not know how to use the adjustability features of their vehicles, or what the optimal driving posture looks like. Through research and practice, we developed a process to standardize the evaluation of driver postures and tasks, and a checklist to optimize posture. The "Sit-Fit" process involves educating the driver, and making recommendations to address the risk factors found. An attempt to objectively analyse driving demands was made using University of Michigan 3D Static Strength (version 6.0.6, 2012), which proved useful in evaluating shoulder demands, but not neck or leg issues. This paper explores the challenges with conducting a "Sit-Fit", and provides recommendations for hazard assessment and control.

KEYWORDS: Ergonomics, driving, sit-fit assessment

SIT-FIT – L'ERGONOMIE CHEZ LES CONDUCTEURS

RÉSUMÉ

Les conducteurs professionnels sont assis pendant de longues périodes, souvent dans des postures inconfortables. Ils ignorent comment utiliser les différents réglages de leur véhicule et à quoi doit ressembler une bonne position au volant. Grâce à la recherche et à la pratique, nous avons développé un processus de normalisation en matière d'évaluation des postures et des tâches chez les conducteurs ainsi qu'une liste de contrôle pour optimiser leur posture. Le processus « Sit-Fit » consiste à informer le conducteur et à lui recommander des moyens de contrer les facteurs de risques trouvés. À l'aide du logiciel *3D Static Strength* (version 6.0.6, 2012) de l'Université du Michigan, nous avons tenté d'analyser objectivement les besoins relatifs à la conduite. Cette démarche s'est avérée utile dans l'évaluation des sollicitations faites aux épaules, mais ne nous a pas permis d'aborder les sollicitations faites au cou ni aux jambes. Le présent article explore les défis que pose le processus « Sit-Fit » et fournit des recommandations pour bien évaluer et analyser les risques.

MOTS CLÉS : ergonomie, conduite, évaluation « sit-fit »

1. INTRODUCTION

Drivers, much like office workers, often sit for prolonged periods of time in their vehicles, in awkward postures. Just like in an office environment, many interventions are available to reduce awkward postures, and improve comfort while driving. In our experience, we've found workers often do not know how to use the adjustability features of their vehicles to optimize their driving/working posture, and may not know what the optimal driving posture looks like. However, few ergonomics assessment tools are available to objectively evaluate the working postures of drivers, or to determine the suitability of a particular vehicle for a driver. Unlike office assessments, where a chair can be replaced, and the workstation adjusted or redesigned fairly easily, very limited controls can be applied in vehicles.

Through research and practice, we have developed a process to standardize the evaluation of driving postures, and a checklist to help workers optimize their fit in their vehicle. The "Sit-Fit" process aims to educate the driver, and make recommendations to address the musculoskeletal disorder (MSD) hazards found during the evaluation.

A second but related driver ergo issue involves variability between vehicles, which can also affect the comfort of a driver, and the suitability of a vehicle for a driver with specific needs. Different vehicles offer different features. For example, reclined seating, found in passenger cars, creates different challenges than upright seating, as found in vans and buses. A seat with a wider or deeper seat pan may accommodate a larger driver but create awkward postures for a smaller driver. An attempt to objectively analyse driving postural demands was made using University of Michigan 3D Static Strength (version 6.0.6, 2012), which proved useful in evaluating shoulder demands, but not helpful in evaluating neck or leg issues.

This paper explores the challenges with developing a "Sit-Fit" protocol that adequately assesses risk, and provides recommendations for hazard assessment and control.

2. SIT-FIT PROCESS

A "Sit-Fit" assessment is a process used by an ergonomist and a worker to optimize driving postures and habits. The ergonomist also evaluates the fit of that driver in his/her vehicle, and provides recommendations to optimize fit.

The Sit-Fit process begins with a pre-assessment survey completed by the driver to identify areas of perceived discomfort, an interview with the employee, an analysis of the 'as found' driving posture, an adjustment process (where a checklist is followed), a second evaluation of the fit in the car following adjustments, a short drive with the employee, and a report writing phase where the findings are summarized, and recommendations are described.

The adjustment procedure for the driver's seat is similar to the steps followed when adjusting an office

chair, with several additional considerations. The seat needs to be adjusted high enough for the thighs to be parallel to the floor, and also high enough to provide a line of sight to the road in front. However, a tall driver may, in an effort to optimise leg comfort following these instructions, sit so high that his/her visibility is obstructed by the roof of the vehicle, or head clearance is compromised.

To adjust the seat, the driver is first asked to adjust the seat pan height and suspension, to slide the seat back or forward, and to adjust the seat pan tilt. The driver should keep the right foot on the accelerator and the left foot on the foot rest while checking these adjustments, as this is the posture that these drivers will be in for the majority of the time. Next, the lumbar support height and depth, back rest inclination, armrests, and steering wheel position are adjusted to achieve the most neutral posture possible. The adjustment is iterative; the driver may need to re-adjust the fore-aft position of the seat, and the height, after the rest of the adjustments have been made. The mirrors should always be adjusted last.

For the fit evaluation we take measurements and make observations such as:

- Hand location (forward reach, hand height, lateral distance to each hand)
- Body joint angles (usually can be estimated from a photograph)
- Leg well width (including clearance between the leg and car door or console)
- Contact stress against any body part (e.g. at the knees from the console)
- Visibility - Does the hood of the car or rooftop interfere with the driver's view of the road and street lights? Does the driver have a direct line of sight through the windows that is in the blind spots of the mirrors?
- Head space (distance from top of the driver's head to the roof top)
- Reach to controls - Can the driver reach all controls while keeping his/her back against the backrest?
- Steering force
- Pedal forces

If the driver performs any other duty in the vehicle (e.g. uses a laptop computer), we assess these tasks as well, and provide suitable recommendations when needed.

3. CHALLENGES WITH CONDUCTING A SIT-FIT

We have encountered several challenges during our Sit-Fit procedure. Most of these result from a lack of research, or the insensitivity of our assessment tools for lower limb and neck concerns.

Different manufacturers report their adjustability ranges differently, which makes a comparison between vehicles difficult. For example, we might observe that a tall driver experiences contact pressure against the shin while driving a certain vehicle, and the ability to slide the seat pan back a few centimeters would be of great benefit. We have attempted to standardize the measurements that we take, so that we are always making a fair comparison. For example, the seat pan height in some vehicles can be adjusted without affecting seat pan tilt. However, in other vehicles, as seat pan height is adjusted, the seat pan tilt and fore-aft position of the seat change as well.

A decision needs to be made whether to photograph and assess the driver with his/her hands at a "typical" position on the wheel, or in a standardised (e.g. "8 and 4 o'clock")

position on the wheel. For risk assessment, a "typical" position best represents the hazard, although many drivers will automatically choose to model a "10 and 2 o'clock" position, in the belief that this is the "safest" hand position. However, in a vehicle comparison study, the driver will not be as familiar with the vehicle and its adjustment options, and so may not be able to predict where s/he would position the hands.

Further challenges are experienced while photographing driving postures. Photos are often obtained from outside the vehicle, with the door open when the driver is posing (instead of driving) because a photograph from the passenger seat, where the ergonomist sits during the assessment, is too close, and is obstructed by the console. Because the driver's door must be open when the picture is taken, the left armrest is not in use, even if the driver would normally use it. Additional leg clearance may be offered by the open door; if the driver rolls his/her left knee out to the side, the angle at hips and knee will be different in the photo from what it really is once the door is closed and pushing against the driver's leg. Moreover, photos from either side rarely show the right leg position, where pedal position and contact pressure often occur. Photos from behind the worker can be obtained, but are often difficult to interpret and usually cannot be taken from an appropriate perspective for measuring angles.

Further measurement challenges are experienced while attempting to measure pedal and steering forces, because they need to be measured while the vehicle is in motion.

4. ERGONOMICS (RISK) ASSESSMENT

A company may present the question, "We understand that this vehicle is not comfortable for this driver. But, is it *unsafe*?" In order to objectively analyse risk for the Sit-Fit report, we attempted to use the University of Michigan 3D Static Strength software (version 6.0.6, 2012) with Potvin's duty cycle calculation (2012). We encountered several challenges with this approach.

Applying the duty cycle equation has proven a challenge for this type of assessment. We used the amount of time spent driving in a typical day of work as our "exertion time" in the analysis. However, drivers' estimates of their driving time may conflict dramatically from the employers' understanding of driving time. Further, upper and lower leg postures can vary greatly while driving; a driver whose left shoulder is fatigued will drive with the right arm for a while, providing rest for the tired left shoulder muscles. Assuming a static driving posture overestimates risk.

The 3DSSPP does not include a neck model, so we were unable to assess the risk of neck injury. The external moments in the ankle and knee were difficult represent in the program, and the software was not sensitive enough to show differences in muscles activity with changes in the leg posture, in particular, the common 'knee rollout' issue experienced by taller drivers. Furthermore, the lumbar support and seat incline angle do not provide enough sensitivity in the software to compare different positions. We were able to assess shoulder demands for various hand positions on the wheel, but, since shoulder concerns were rarely identified by drivers, none of our projects to date have warranted the time to collect accurate duty cycle (duration/frequency) data.

5. RECOMMENDATIONS FOR HAZARD ASSESSMENT AND CONTROL

Hazard assessment during a Sit-Fit is currently driven by the ergonomist's observations of the postures and techniques adopted by the driver while driving, and a comparison with literature that identifies known hazards (CSA guideline on Office Ergonomics, Diffrient et. al., 1981, Golsse, 1994, ISO 2631-1, 1997, Occupational Health, Safety and Environmental Services, 2008 & 2010, MIL-STD-1472F). Although this approach does not provide an objective "risk index", insufficient data and insensitive analysis tools are currently available to assess risk while driving. The Sit-Fit report also includes a description of the discomfort reported by the driver, which is accounted for when prioritising suggestions. An observed deficiency in lumbar adjustability, for example, would be a higher priority for change for a driver who experienced back pain, than for one who did not.

The most typical recommendations that are presented in a Sit-Fit assessment are postural adjustments that are implemented during the 'adjustment' phase of the Sit-Fit. To date, the most common challenge has been accommodating larger drivers, since the adjustability ranges in standard passenger vehicles often won't fit this population. Unlike an office environment, purchasing a different seat, or swapping out a seat pan in a vehicle is not a feasible solution.

Several products that are safety-approved for vehicles such as seat cushions, lumbar supports, mirrors to improve visibility, and laptop trays, can be provided to improve the posture and comfort of drivers.

Job coaching is also a useful tool for optimising driver comfort. For example, hand position on the steering wheel, and steering techniques can greatly affect muscular demands. The "8 and 4 o'clock" hand position helps to keep the elbows close to the body, minimizing shoulder strain. The "shuffle" steering technique allows the driver to remain upright, with the back against the steering wheel, in comparison to the hand over hand, where the driver typically reaches up and forward and leans away from the backrest. (This is most evident in city buses.) The technique that the driver applies to move the foot between the accelerator and the brake pedal can reduce demands and awkward postures in the right ankle, knee, and hip. Lifting the leg and moving the foot involves a more neutral leg position through the hip/knee/angle, in comparison to "planting" the heel and rotating at the ankle to switch between accelerator and brake.

To objectively identify when a new vehicle is required (when a vehicle is not suitable for a driver), we have used the following criteria:

- whether hazards exist 'after adjustments'
- whether the driver continues to experience substantial discomfort a few weeks following the sit fit and the implementation of the recommendations
- biomechanical assessment using the University of Michigan's 3D strength program (for the upper body)
- our professional judgement
- exposure to known hazards for MSD (e.g. complete lack of lumbar support).

6. CONCLUSION

Much research is needed in this area of ergonomics. However, the Sit-Fit process that we have developed has helped us to standardize the in-vehicle assessment of drivers, and provide recommendations to improve ergonomics for many drivers. Our clients seem happy

with this process, as it is more objective than making decisions based only on driver's preference.

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