

A CASE STUDY ON THE IMPACT OF AN ERGONOMIC CHANGE TO THE MALL DELIVERY TRAILER AND REDESIGN OF A MALL CART USED FOR DELIVERY IN THE TRANSPORTATION SECTOR

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Members of an Ergonomic Change Team of a transport sector company utilised a participatory ergonomic approach to address several problems associated with courier mall delivery. The interventions developed were an addition of a tail lift to a delivery transport trailer and an addition of a locking brake on the mall-cart. The impacts of these changes included decreased cumulative L4-L5 output measures and shoulder moment during material handling seen through the elimination of double handling of boxes as well as elimination of the safety hazard of entering and exiting the trailer. A proposed mall cart redesign is also discussed demonstrating further potential improvements. Overall, the ECT introduced an ergonomic change that eliminated root causes of the problems, reduced the risk factors for injury.

Keywords: Ergonomic Change Team; Participatory Ergonomics; Material Handling

UNE ÉTUDE DE CAS SUR L'IMPACT D'UN CHANGEMENT ERGONOMIQUE AU BAS DE PAGE DE LA LIVRAISON DE MAIL ET À LA NOUVELLE CONCEPTION D'UN CHARIOT DE MAIL UTILSÉ POUR LA LIVRAISON DANS LE SECTEUR DE TRANSPORT

Les membres d'une équipe ergonomique de changement d'une compagnie de secteur de transport ont utilisé une approche ergonomique participatoire pour adresser plusieurs problèmes liés à la livraison de mail de courier que les interventions développés étaient une addition d'un ascenseur de queue à un bas de page de transport de la livraison et une addition d'un frein de fermeture sur le mail-chariot. Les impacts de ces changements ont inclus des mesures du rendement L4-L5 et le moment cumulatifs diminués d'épaule pendant la manipulation matérielle vue par l'élimination de la double manipulation des boîtes aussi bien que l'élimination du risque en matière de sécurité d'entrer dans et de sortir le bas de page. Une nouvelle conception proposée de chariot de mail est également discutée démontrant encore d'autres améliorations potentielles. De façon générale, l'ECT a présenté un changement ergonomique qui a éliminé des causes de racine des problèmes, réduit les facteurs de risque pour des dommages.

Keywords: équipe ergonomique de changement, ergonomique participatoire, manipulation matérielle

INTRODUCTION

Participatory Ergonomics has been reported to be an effective method for implementing ergonomic interventions [7]. Part of this effectiveness can be contributed to its potential worker “buy-in” and exchange of information created through worker participation [7, 9]. Utilization of participatory ergonomics programs can also produce changes that result in significant reduction of physical loading and improvement in productivity if the program provides an avenue to identify root causes of the problems and opportunities to build solutions. The Ergonomics Change Program utilized in our research has a 6 step reactive process that identifies opportunities for improvement, assesses the risk factors and prioritizes each opportunity based on their *root causes*. By building a solution designed to address the root causes of problems, and by utilizing a structural implementation and evaluation process for prototypes the reactive process allows effective solutions to be adopted. The Ergonomic Change Team (ECT) discussed in this paper from a courier company, utilized the University of Waterloo’s Participative Ergonomics Implementation Blueprint [8] to identify root causes that contributed to high injury rates and the risk factors contributing to the difficulty of entering and exiting the freight trailer utilized for mall deliveries, the abundance of double handling that occurred during unloading as a result of unloading the trailer without the use of a loading dock, and delivery of freight throughout the mall. In addition the ECT identified that the current cart design did not allow for proper pushing technique due to visual constraints of the load and the inherent obstacles of the mall setting. These same constraints also led to unsafe stopping techniques to reduce the likelihood of the cart striking someone accidentally. The purpose of this paper is to demonstrate the effectiveness of these ergonomic changes in reducing or eliminating the root causes identified during the Ergonomic Change Process.

METHODS

An ECT consisting of management, workers and union from a courier company were assembled and trained by researchers on the University of Waterloo’s Ergonomic Change Blueprint, basic ergonomic principles, and various ergonomic assessment tools. This group then followed the ergonomic change blueprint and made interventions as they determined appropriate. One of the researchers acted as a facilitator for the group for 18 months to ensure understanding of the process and that appropriate tools were being utilized.

During the solution building phase of this process, the ECT proposed interventions to the delivery trailer and the mall-cart that would overcome the root causes of high injury rates and reduce the physical exposures that were determined in step 2 of the ergonomic process. The team determined that the addition of a tail lift to the delivery trailer would eliminate the risk of falling out of the trailer when entering and exiting. In addition, the tail lift would provide an easier method of unloading the freight by allowing the cart to be brought directly into the trailer, which would eliminate double handling of boxes and above the shoulder postures required to remove the freight from the back of the trailer.

The addition of the tail lift required that a locking system be installed on the existing cart so that it could be taken into the trailer. The ECT saw this as an opportunity to produce a cart that facilitated the activities of the courier, instead of the current design that encouraged poor operating postures. The ECT concluded that a redesigned mall-cart would also reduce the risk factors for injury and facilitate easier freight delivery throughout the mall. Therefore, the ECT set out to design the “ideal” cart that would facilitate this position through the elimination of the identified risk factors. The redesigned cart began as a basic idea from the ECT; however, it grew into a more sophisticated model with the assistance of corporate engineering and the cart manufacturer. A schematic drawing of the cart is illustrated in Figure 1. The new mall-cart will be equipped with a braking system, which when locked will allow usage of the cart on the tail lift and assist in stopping the cart during delivery and a modified handle that enable the courier to push the mall-cart from in front of the load and more easily observe mall pedestrians. This growth in

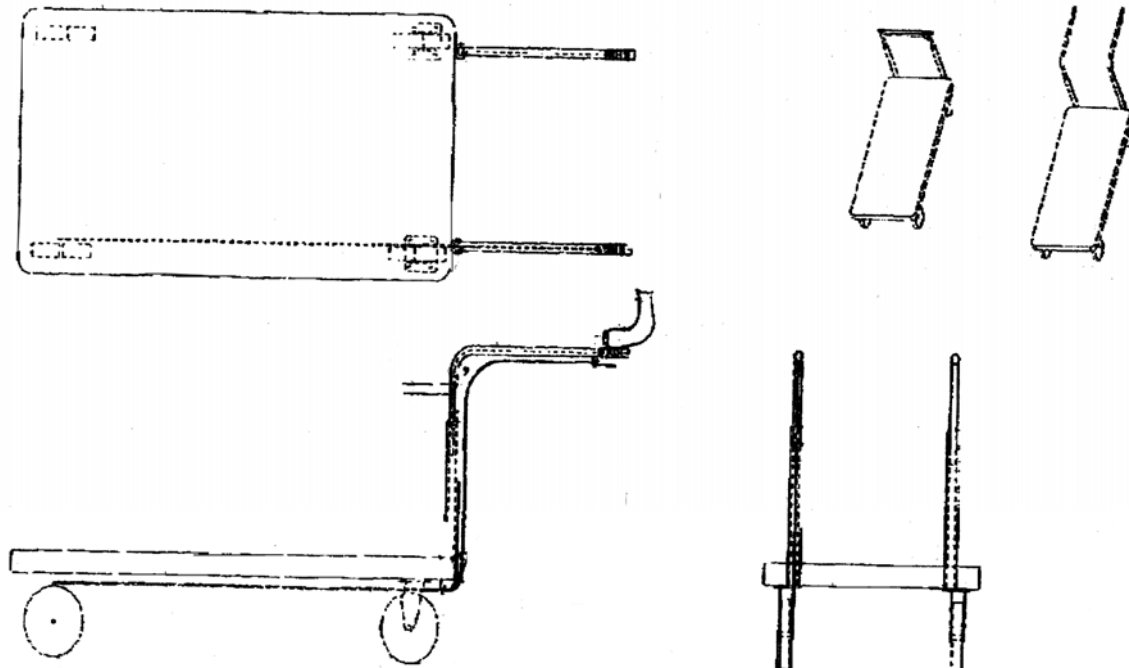


Figure 1: Schematic drawing of proposed redesign of the mall-cart.

the development stage has since delayed the implementation of this prototype and therefore will not appear in the results of this evaluation; however its potential benefits will be discussed later.

The evaluation of the new unloading method made possible by the addition of the tail lift on the trailer and locking pin attached to the current mall-cart was done utilizing pre-intervention and post-intervention videos that were taken as part of the investigation and evaluation process that the team used. The video segments utilized for these evaluations followed the mall courier as they unloaded the freight for distribution from the trailer. The video segments were then analyzed using 4D WATBAK (ERGOWATCH, University of Waterloo, Waterloo, Canada). The analysis outcomes utilized in this analysis were Cumulative L4/L5 Moment, Cumulative L4/L5 Compression, Cumulative L4/L5 Reaction Shear, and the Cumulative Shoulder Moment. These outcomes were then compared pre/post intervention to determine whether the intervention had an effect on worker physical loading. In addition, one-minute surveys (brief questionnaires) that the ECT utilized as an evaluation process were also examined.

RESULTS and DISCUSSION

The participatory approach that was utilized for these changes proved to be a very constructive approach as the development of these changes came about through the communication that a participatory approach facilitates. These interventions were anticipated to be effective in addressing the root causes of the identified problems. A trailer with tail lift was purchased and a locking system was installed on the current mall cart and both interventions were implemented without an offline trial. There are small modifications to the lift pending based upon user feedback. The proposed redesigned mall cart, is currently being constructed, and was not available for evaluation; however, the potential benefits during mall tasks will be discussed here.

Unloading Freight from the Delivery Trailer

The implementation of the tail lift by itself has eliminated the risky actions of climbing in and out of the trailer. Falls have been shown to be the 3rd largest cause of lost time claims in Ontario [11].

Given that the transportation sector has the 4th largest percentage of lost time claims, the impact of this change is likely substantial.

The combination of this new tail lift and the locking system to the current mall-cart provides benefits to the mall courier as it allows the mall cart to be brought directly into the delivery trailer. This eliminated approximately one-third of the lifting required to deliver the freight since the courier no longer had to transport the packages from inside the trailer to the rear of the trailer and then from the rear of the trailer to the cart. As a result of the reduction in handling, a number of positive effects were produced for both the back and the shoulders. The absolute cumulative L4-L5 reaction shear, compression and moment decreased by 46.5%, 57.9%, and 55.1% respectively. In addition, this intervention decreased the cumulative shoulder moment by 66% (Figure 2).

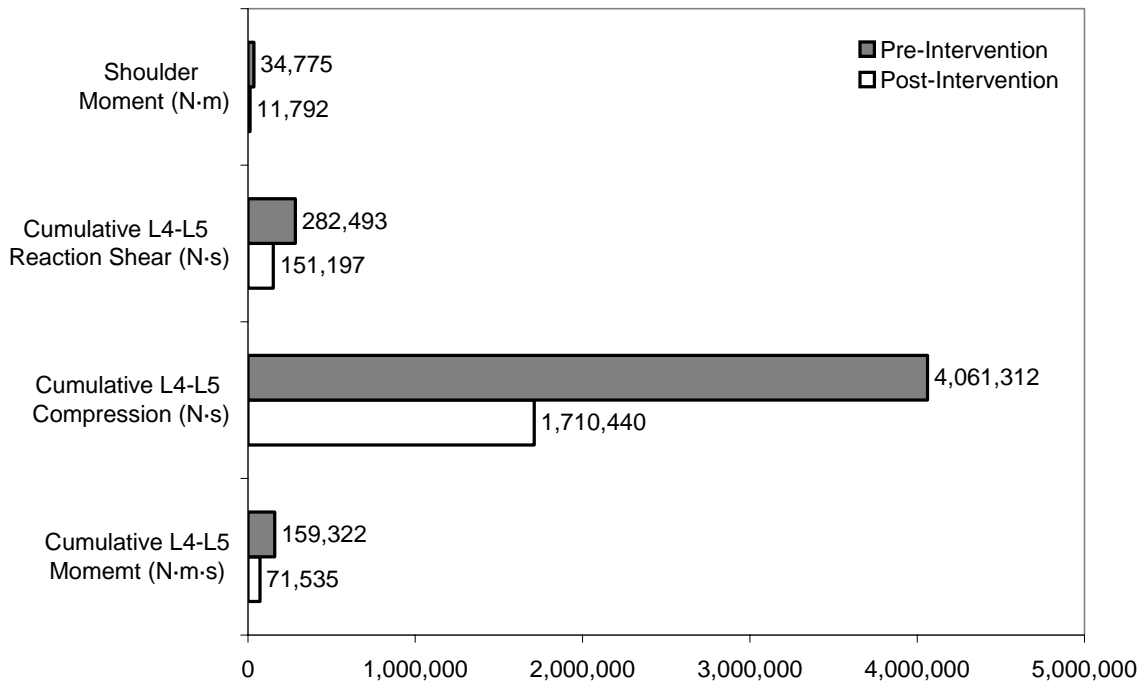


Figure 2: Cumulative L4-L5 and Shoulder Output Measures for Unloading the Trailer

The interventions were met with very positive reviews from the workers on the shift. Utilizing one-minute surveys in step 5 of the Ergonomic Change Blueprint, the ECT determined that the couriers felt this intervention improved their job. They deemed it was safer to enter and exit the vehicle, quicker to unload the trailer and it also reduced upper limb strain.

Unaccounted for Time

The unaccounted for time in the post-intervention condition increased by approximately 33 minutes due to the elimination of double handling of boxes and climbing up and down from the trailer. Due to this increase in unaccounted for time, the courier has the potential of being more productive / effective in performing other tasks during this time. However, this rationalization of additional workload may lead to additional loading and an 'ergonomic pitfall' [10]. For this analysis it was assumed that the courier did not performed manual material handling during this time, and thus a standing posture was modeled.

Pushing/Pulling the Mall Cart

The current cart does not allow for proper pushing technique to be utilized, because the large freight volumes require the freight to be stacked to a height that creates a visual block to see

around. In order to see the obstacles in the mall the work method couriers choose is to use a one handed pull to allow better sight lines. The new cart with a modified handle allows the courier to push the load from in front of the cart and is thus able to see mall pedestrians and avoid collisions, particularly with small children. Furthermore, it is speculated that the passive braking system on the new cart will decrease the required forces and risk factors of stopping the cart to avoid these collisions and prevents the cart from falling off the tail lift while being lifted into the trailer.

The proposed design for a new mall cart will also change the one-handed pulling of the cart to a more preferred method of two-handed pushing, which balanced the load and enabled a symmetrical posture to be used. Literature has shown that a transfer from one-handed asymmetric pulling to two-handed symmetric pushing is beneficial. Studies have reported higher compressive forces during one-handed pulling compared to pushing [2, 4, 5, and 6]. These increased compressive forces during one-handed pulling with the load at the side of the body are attributed to higher moments caused by greater moment arms [6]. Similarly, postural asymmetry and one-handed pushing/pulling have been shown to decrease force exertion capabilities [1, 3]. Thus, it is expected that the proposed redesign of the mall cart allows the forces to be exerted through the lower back which should minimize the moment and the spinal loading [6]. The proposed redesigned cart, although not quantified here, certainly can be seen as benefits in addition to those seen with the addition of the tail lift in the unloading task.

LIMITATIONS

Limitations of the case study include two dimensional analyses not adequately capturing the exposure, as some twisting occurs during the unloading of boxes. The unloading was modeled using average weights, sizes of packages, and frequency of lifting due to the complexity of combinations of load that were seen in the pre and post conditions.

CONCLUSION

The ECT utilized a participative ergonomics approach to successfully initiate and implement a ergonomic intervention that addressed the root cause of the problems identified in unloading trucks without a loading dock. The implementation of the tail lift has eliminated climbing in and out of the trailer, which has been shown to be a major contributor to injury rates, not only this company but for WSIB claims in general. Utilization of the cart and the tail lift eliminates double handling during trailer unload. The proposed redesign of the cart allows for a preferred method of two-handed pushing versus one-handed pulling, which has been shown in literature to be very positive as this changes the loading from asymmetrical to symmetrical. Work of the ECT may have applications in other parts of the company providing similar benefits to all mall couriers.

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