INVESTIGATION OF ERGONOMIC IMPROVEMENTS FOR MANUAL MATERIAL HANDLING OF HEAVY AWKWARD LOADS ON A LOADING DOCK

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ABSTRACT

The loading dock of a local manufacturer and distributor of high quality, custom garage door panels, hardware, and door openers was studied to determine if manual material handling could be improved. Many of their products are heavy (200 or more pounds) and inherently awkward (relatively long) making them difficult to safely transport, load, and unload from trucks and trailers. Careful handling to minimize the possibility of damage to the product itself also contributes to handling difficulty since the doors cannot be "thrown" or "dropped" but must be carefully stacked and moved to prevent damage.

The current truck loading process utilizes several handling and re-handling steps that could potentially be minimized or eliminated by changes in handling technique or workflow. Many lifts require floor to waist, floor to shoulder, or even floor to overhead movements which, coupled with the heavy and awkward loads, can present relatively high risk for musculoskeletal injuries. Much of this lifting and handling is further constrained by the space limitations of the trucks and trailers.

This analysis quantified the musculoskeletal disorder (MSD) risk based on ergonomic models. In addition, the team considered inefficiencies associated with the current system. Interventions were then proposed to reduce these risks and efficiencies. The company is currently considering the team's proposals and implementing some suggestions on a trial basis. The final goals of this project were improvements to worker safety, product safety (reduction in damaged product from handling), and employee retention (increased employee longevity and decreased absenteeism). It is expected that interaction between the University of Utah and this company will continue after this project and possibly result in further collaborations in other areas.

INTRODUCTION

This project was done in accordance with the Occupational Safety and Health Solutions course offered at the University of Utah. This course allows for interdisciplinary teamwork along with collaborating with local facilities to assist in solving workplace health and safety related problems. This team was approached by a local manufacturer and distributor of high quality custom garage doors. The company was concerned with the heavy awkward loads and unique material handling constraints involved with loading their products into their trucks and trailers in the loading dock area of the facility. Their interest was to reduce stress and risk of injury on their loading dock workforce.

Their garage doors are divided into panels. These panels are between 16 feet to 22 feet long, 18 to 36 inches wide, and 3 inches thick. Two to three panels are packaged together into a bundle to be loaded. This allows for reduction in packaging materials and fewer packages to be shipped. These bundles weigh 75 to 125 pounds. This creates a unique lifting situation within the constraints of a freight trailer. The number of doors loaded daily varies from 80 to 250. Approximately 80 to 100 doors are loaded in each trailer.

The loading dock division of the company's workforce has seen a relatively high turnover rate. This division also has the highest frequency of absenteeism in the facility. In addition, there is a high risk of severe injury and a high frequency of lifting in the loading dock.

METHODOLOGY

Current Package Handling and Loading Process

The current loading process utilizes several handling and re-handling steps. The following is a picture of the floor layout in the facility, the manufacturing area to the loading bays. The red "x" represents the minimal number of lifts in that particular area.

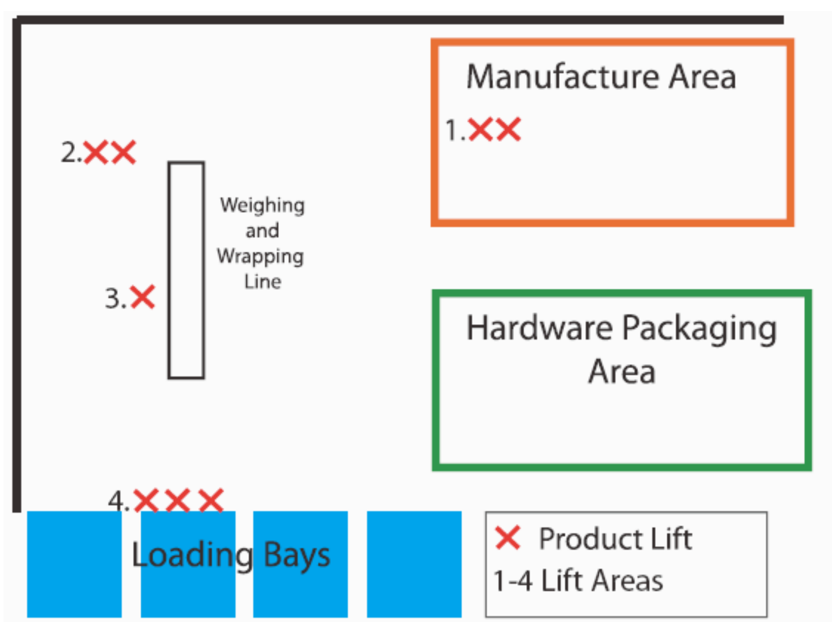

Figure 1 - Facility Floor Layout

Area 1 is the manufacturing division. Here, the door panels are put together and stacked on a cart. Then they are moved to areas 2 and 3. Areas 2 and 3 represent the weighing and wrapping line. The door panels are removed from the carts and placed on a scale. After being weighed, the door panels are then sent through the wrapping machine where they are covered tightly in plastic. Then, the panels are reloaded onto the carts to be moved to the loading bays. The loading bays, area 4, are where the door panels are sorted and arranged for shipping. After the panels are sorted, they are moved to the lift areas where they can be loaded onto the trucks and trailers. A team of loaders lift the bundles using a rotation to ease the loading on each individual.

Proposed Process - Compartmental Cart Loading System

In an attempt to minimize the number of lifts as well as reduce the difficulty of the lifts throughout this process, the compartment cart loading system (CCLS) was proposed, which can be seen in Figure 2.

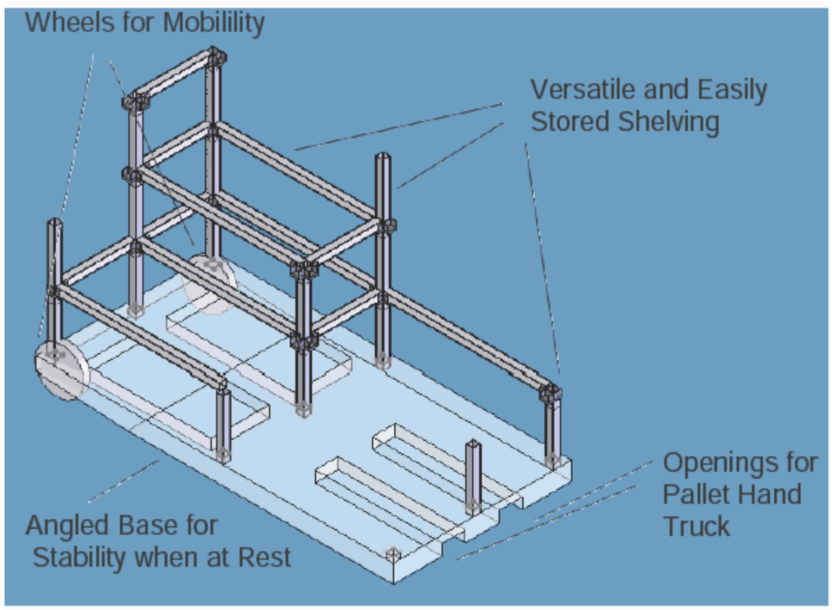

Figure 2 – Compartmental Cart Loading System (CCLS)

The compartmental cart loading system is comprised of a rack that can be made mobile utilizing a pallet hand truck. This feature creates options for loading bundles external to the trailer. The loader no longer is constricted by the walls of the trailer while loading the rack. Additionally, assisted lifting devices are more easily implemented outside of the confined trailer space. By utilizing a sloped lower surface, lowering the hand truck stabilizes the cart with the wheels no longer interfacing with the ground.

A key feature of this cart is its ability to be broken down allowing easy storage for backhaul capabilities. Additionally, the break down design also facilitates easy loading and unloading. One can load the bottom row without lifting above or through the support structure. If the bundle is loaded on its side, all bundles remain accessible within the cart, and through the mobile design, every bundle within the truck can be accessed with far less effort than the current system.

DISCUSSION/RESULTS

Current Package Handling and Loading Process

As mentioned earlier, many lifts are required throughout this process. The types of lifts include floor to waist, floor to shoulder, and floor to overhead positions. The frequency and awkwardness of the loading presented a relatively high risk for musculoskeletal injuries. Because of this, we decided to look at the back compressive forces for each type of lift: floor to waist, floor to shoulder, and floor to overhead. The 3D Michigan Model was used to analyze these lifts.

NIOSH indicates that compressive forces in excess of 770 lbs will put some portion of the work force at risk. Also, compressive forces in excess of 1430 lbs will put most members of the work force at risk. For the analyses of the lifts, we used the average size of the doors which came to be 45 pounds in both the left and right hands. Based on this information, we first looked at the floor to waist lift.

Figure 3 – 3D Michigan Model: Floor to waist lift

For the floor to waist lift, a back compressive force of 1683 pounds was found. This number is well above the NIOSH indicated value of 770 pounds. It also shows that this type of lift will put most members of the loading dock workforce at risk for a musculoskeletal injury. Next, we looked at the floor to shoulder lift.

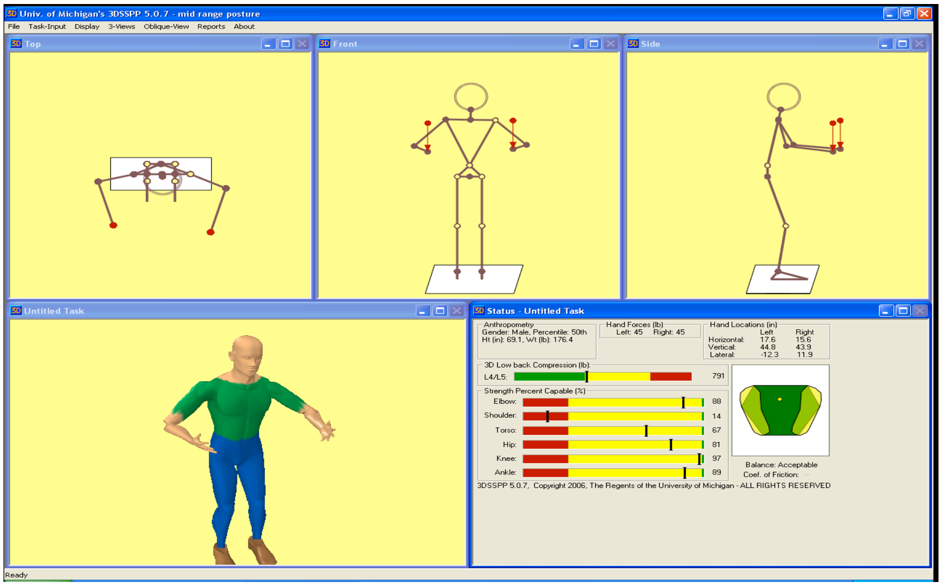

Figure 4 – 3D Michigan Model: Floor to shoulder lift

For the floor to shoulder lift, a back compressive force of 791 pounds was found. This number is significantly lower than the floor to waist lift. However, this force is still above the NIOSH indicated value of 770 pounds. So, there is still a chance that some of the loading dock workforce will be subjected to some type of risk of obtaining a musculoskeletal injury. Finally, we looked at the floor to overhead lift.

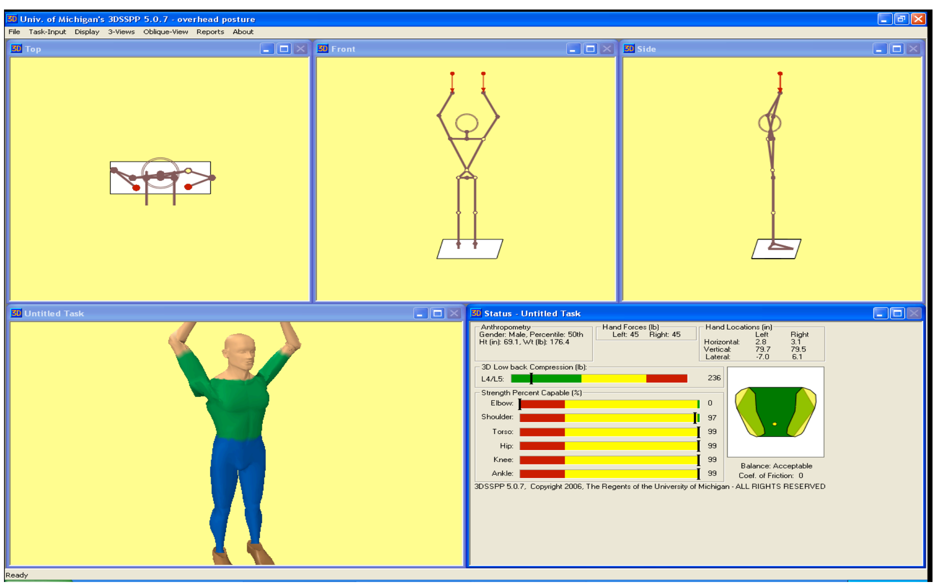

Figure 5 – 3D Michigan Model: Floor to shoulder lift

For the floor to overhead lift, the back compressive force was found to be 236 pounds. According to NIOSH, this compressive force is acceptable because it is well below the indicated value of 770 pounds. However, it was observed from the model that this lift produces a lot of stress on the arms and elbows. Also, in the event of a slip and/or fall, it could be catastrophic for the worker, with a heavy load such as these doors, to be held above their heads.

Proposed Process - Compartmental Cart Loading System

After observing the current process, we decided to brainstorm some ideas to see where we wanted to focus our project. The following is a list of some of the initial brainstorming ideas considered:

- Loading outside the trailer
    - Using some type of forklift for loading
- Assisted lifting/conveyor device
- Different lifting techniques
    - Bending positions
    - Load carrying positions
- Addition of tooling
    - Straps
    - Load Sling

Since the company's interest was to reduce stress and risk of injury on their loading dock workforce, we decided to focus on minimizing the amount of lifts required throughout the entire process. Therefore, we came up with a cart design known as the Compartmental Cart Loading System (Figure 2) to try and limit the lifting frequency.

With the new loading system it is predicted that the frequency of the lifts as well as the severity of the lifts will be reduced. In addition to these benefits there should be a decrease in damages and loading time. The changes to the current system are expected to increase worker retention due to the decrease in difficulty of the job tasks. Due to the increased product accessibility as well as ease of cart use, implementation of the new design throughout the facility is desirable.

CONCLUSION

Due to concerns with the heavy awkward loads and unique material handling constraints involved with loading products into trucks and trailers in the loading dock area of this facility, the CCLS was designed to minimize lifting frequency and the risk of obtaining a musculoskeletal injury. Also, this system is expected to decrease loading time, increase employee retention, and increase employee comfort. We are in the process of further implementing this design by ordering parts needed to construct the design and testing it in the facility. We look forward to working with this company in the continuation of this project and others that may come about in the future.

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