AN ANALYSIS OF THE RECOUPING OPERATIONS AT XYZ COMPANY

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ABSTRACT

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The purpose of this study is to identify engineering and administrative based deficiencies that are associated with the cocoa recouping operations at XYZ company. The study focused on identifying at-risk ergonomic behaviors and modifying the activities to reduce the potential of future injuries. This process was completed by analyzing the operation to determine the most efficient use of human resources and equipment resources to ultimately expedite the process. In addition, the costs of injuries were determined to create a cost analysis for recommendations, which would be used to minimize the amount of future injuries. The study also reviews the physical demands associated with manual material handling activities that are connected to the grocery industry. Based on the results of this study, it is concluded that the recouping process has many ergonomic deficiencies that will put XYZ company at an elevated level of risk for future injuries.

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CHAPTER I

Statement of the Problem

Introduction

XYZ company is a manufacturing operation located in western Wisconsin and has around 400 employees. It is a large facility, which inhabits 20 acres of land. The function of the facility is creating grocery products for major retail stores, of which one of the retail products is cocoa.

As with many manufacturing processes, it is sometimes necessary to retain/recoup products that are flawed or mispackaged. The cocoa recouping process utilized at company XYZ recycles cocoa packets that are not at correct weight, have a flaw on the packet, are not centered, or are not sealed correctly. Flawed packets are combined in Rubbermaid barrels until there is enough to go through the cocoa recouping process. On average, a barrel that is full with cocoa packets weights between 200 and 300 pounds. The recouping process occurs every day but not on the same shift, only when there are enough packets to efficiently do the process. A job rotation has been utilized to increase employee efficiency and reduce the amount of physical stress on individual employees. Employees who do the process rotate every hour between pulling the containers from the pallets and packing the empty packets into the garbage barrels.

XYZ company is currently updating many of its manufacturing operations within their facility, although the cocoa recouping process has not been analyzed from a hazard identification/risk management standpoint yet because it does not function as a direct profit making operation. To date, many losses are currently occurring with in the

recouping process. Company recordable injuries have accounted for 11 injuries in 2001, and from these injuries, four were also OSHA recordables (i.e. required medical treatment off-site). XYZ company has incurred direct costs of over $71,000 from the four OSHA recordables, and the organization estimated indirect costs for these injures were well over $100,000. The injuries have resulted in 256 days of lost or restricted duty, which has accounted for $50,000 in lost wages. The injuries are making a significant impact in the profitability of the company because of these losses changes are needed to ensure the profitability of the company. Thus, the lack of performing a thorough analysis of the recouping operations at company XYZ is placing the organization at significant risk of incurring future employee based losses.

Purpose of this Study

The purpose of this study is to identify engineering and administrative based deficiencies that are associated with the cocoa recouping operations.

There are Three Goals of this Study

1. Identify at-risk ergonomic behaviors and modify activities to reduce the potential of future injuries.

2. Determine the cost of injuries and what the cost would be to minimize the amount of future injuries.

3. Analyze the process to determine the most efficient use of human resources and equipment resources to ultimately expedite the process.

Background and Significance of this Study

The Bureau of Labor Statistics (BLS) found work-related musculoskeletal disorders that were reported in 1995, accounted for 62% or (308,000) of illness that were

associated with repetitive trauma. What makes these figures even more significant is they do not include back injuries (NIOSH, 1997). NIOSH (1997) reported in back belt pamphlet that back injuries in the workplace accounted for 20% of all injuries and illnesses in the workplace and cost between 20 and 50 billion dollars each year (NIOSH, 1997). Currently at XYZ company there have been 11 recordable injuries, of these injuries six have been shoulder injuries while working on the recouping machine in the last year. Remaining recordable injuries accounted for five hand and finger injuries of which too were OSHA recordables.

Recouping injuries in 2001 have accounted for a significant portion of the company's total incidents and losses. In 2001, 33% of the plants total recordable incidents were in the recouping process. Recordable incidents accounted for 40% of the company's total lost time injuries and 40% of company's workers' compensation costs.

Past year's injuries are also having a significant impact on the company. In 2000, OSHA recordable injuries accounted for $55,000 dollars in lost wages and workers compensation expenses. In 2000, there were an additional four OSHA recordables. When looking at both 2000 and 2001, there were eight OSHA recordables which accounted for a total of $136,000 dollars in direct losses for the company. The amount of losses incurred in just the past to years indicates the company should analyze the recouping processes to see if it would be more cost efficient to throw the flawed material away and forget about it instead of trying to recoup the losses. The real question to be determined is, has the company lost more in workers compensation and lost time them the actual value of the flawed material.

Assumption of this Study

1. All financial, injury and illness information provided by XYZ Company is accurate and correct.

Limitation of this Study

1. Because of security purposes, it will be difficult to tour the facility as many times as needed to fully ascertain the extent of the problem as well as determine appropriate engineering and administrative controls.

Definitions of the Study

Administrative Controls: Controlling a hazardous situation by the use of training or personal protective equipment rather than changing the hazardous situation (Goetsch, 1993).

Anthropometrics: Is the study of differences within the human body as compared to sex and size (Laing, 1997).

Ergonomics: Is the study of human abilities and limitations in their working environment (Asfahl, 1995).

Hazard Analysis: The process of evaluating hazard within the work place and making recommendations to change the hazards (Goetsch, 1993).

Job Safety Analysis (JSA's): An evaluation to associated required tasks to complete a job and the identifiable hazards associated with the tasks (Vincoli, 1994).

Manual Material Handling (MMH): The element of a human in order to move a material or object (Laing, 1997).

Risk Event: The potential of an unwanted occurrence, which may potentially result in a loss by an accident (Vincoli, 1994).

Unsafe Condition: The condition within the environment that contributed to an accident or a loss (Laing, 1997).

CHAPTER II

Review of Literature

Introduction

This chapter will discuss the general areas of ergonomic risk factors that workers encounter while working in the grocery industry, the costs associated with ergonomic issues in other industries and strategies that companies have implemented to reduce ergonomic injuries. In addition, this chapter will review design and assessment issues that may be associated with XYZ company. Studies will be reviewed to identify the effectiveness of engineering changes accompanied by administrative changes to create a more ergonomically correct work site that will ensure reductions of future injures.

Ergonomic Issues in the Grocery Industry

Baron, Putz-Anderson, and Waters (1998) assessed manual material handling tasks of employees in two grocery warehouses. It was established that there is a high potential of risk with low back injuries while working in this industry because of the disparity of tasks associated with a variety of jobs. The study also found that it was difficult to measure the exact risk for each job because there was variation in the weight of items, the sizes of items and the amount of repetitions a person had to use to move an item (Baron, Putz-Anderson, & Walters, 1998). This closely corresponds with past work experiences for the researcher where manual material handling in grocery warehousing facilities significant amounts of lifting, pushing, pulling, carrying items and, usually all of these tasks were required to move a single item. Manual material handling activities in a grocery warehouse environment typically require employees to have the endurance to lift and move possibly up to 50 one-pound items and then immediately go and lift and move

10 fifty-pound items and continuously do a rotation like this for eight to twelve hours while working for incentives. Many grocery warehouses have a variety of environmental conditions from freezer conditions that are –10º F, to working in coolers around 40º F, and even dry sections that may reach upwards of 90º F in the summer months. In addition, an employee could be rotating in each of these conditions while picking orders in a single shift. When looking at all of the risk factors associated with the grocery industry, it is evident that there are many challenges available for safety professionals.

A great challenge for all safety professionals is to sell the concept of ergonomics to management because it is difficult to show the exact benefit as commensurate with the cost (Stewart, 2002). Ergonomics can also be difficult to sell because there are no government laws which mandate policies or procedures to be in place. It can be difficult to give an exact cost analysis for ergonomic changes, but it must be accomplished in order to sell the change to upper management. Usually when ergonomic changes are created, they not only have direct impacts through cost, but also through improved employee morale. In addition, ergonomic changes provide greater efficiency within the operation and allows management greater flexibility in their hiring practices (Stewart, 2002).

Ergonomic Issues in other Industries

Besides the grocery industry, many other industries have ergonomic problems which cost companies extraordinary amounts of money each year. Punnett (1999) performed a study on musculoskeletal disorders in an automotive manufacturing industry to determine the cost associated with reported and unreported ergonomic injuries. The researchers knew that current losses in workers compensation and lost workdays were

having a significant impact on the company. Through this study, back and shoulder injuries combined costs totaled $786,807 for one year or the equivalent of $589 per active employee on the payroll. When looking at workers compensation cases over a three-year period, the costs were approximately $1.5 million or an average of $1,069 per workers compensation case (Punnett, 1999). Companies that are having significant controllable losses put themselves at a disadvantage with competitors. Therefore, it is advantageous to provide resources to eliminate or reduce controllable losses.

It was beneficial for the automotive industry to find that injuries were occurring but more importantly, to determine if they were going unreported. To better understand where the losses were occurring, Punnett (1999) reviewed 259 control subjects from the automotive company who had never reported an injury, to find if they had any symptoms of back or shoulder injuries. From the 259 control subjects, back pains were associated with 79 workers and 84 workers had shoulder pain which was never reported. Interestingly enough, 63% of the control group had either back or shoulder pain which had not been reported, and another 10 workers denied pain but had positive examination results. The statistics gained from the study of injured employees were used to compare the cost of reported versus unreported injuries. Findings indicated some interesting results; the average cost per case for a reported back injury was $2,290 compared to $3,365 for an unreported injury. Shoulder injuries indicated opposite results $1,851 for reported injuries and $936 for unreported injuries (Punnett, 1999). Unreported injuries can have a negative effect on a company's bottom line and this may be a potential area of loss for XYZ company.

To reduce manual material handing injuries, Ridyard and Hathaway (2000) implemented a multidimensional ergonomics-training program in a Northeast beverage-packaging warehouse. The program first identified obstacles which had to be overcome for the program to be successful. The obstacles were management and union differences with regard to implementing restricted duty work program for injured employees and how to achieve a complete buy-in from management and employees. After the management and union came to an agreement on a restricted duty work program, an ergonomic training program was initiated which focused on quantifying musculoskeletal disorders and risk factors associated with jobs, training employees to identify physical signs of injuries, and how to eliminate highly repetitive tasks. The last dimension of the program was medical management, which focused on reducing the cost and time associated with injured employees getting medical attention and returning employees to work quickly and safely. Eventually, four steps were used to implement the medical management program. The first step involved analyzing the current program by interviewing and gathering data from employees, supervisors, medical providers, and insurance companies. Identifying the interest of labor and unions was the second step and it was found that the union was not interested in a restricted duty program. Through negotiations with the union, conflicts were eventually resolved. The third step included developing a management system, which could make goals for the program that would ultimately drive the ergonomic program internally. One procedure in implementing this process was in developing job descriptions for restricted duty tasks which both union and management representatives could agree on. In addition, the process had to be individualized for specific injuries an employee may receive. The last step focused on

training the supervisor and employees to better understand the signs of an injury. This was completed through educating employees and supervisors about the restricted duty program and training the supervisor on how to better manage the injured employee (Hathaway & Ridyard, 2000).

The multidimensional ergonomics-training program completed by Hathaway and Ridyard (2000) indicated excellent results. One year before the training was initiated, there had been 2,407 lost workdays from injured employees. One year after the program was initiated, lost workdays had decreased to 1,317 and by the third year of the program, lost workdays had decreased to 272. The estimated savings in workers' compensation medical costs alone were approximately $515,320. This program had significant financial savings and only administrative changes were made (Hathaway & Ridyard, 2000). Administrative programs that are implemented correctly and gain upper management support can be effective, not only in building bonds between management and employees, but also in reducing company losses.

Both age and gender differences have can have a significant impact on occupational injuries. This is an important consideration for XYZ company because the average age of the line worker is between 40 and 50 and females represent 60% of the work force. Bauer, Fuortes, Saleh, & Vaughn (2001) performed an epidemiological study of occupational injuries, which focused on age and gender differences. Interestingly, characteristics of gender and age of company XYZ coincide with the study from Bauer et al. (2001) study. The Bauer et al. (2001) study reviewed a total of 2,631 workers compensation claims that were made in one year at a university setting. When looking at gender-related results of all worker compensation claims, 63% of the injuries

occurred with female workers. The largest percent of claims were submitted through the 36-45 age group which represented 34.9% of the workers compensation claims. The 26-35 and 46-55 age groups represented 22.7% percent for each of the submitted claims. When combining age groups, the 16-35 group represented 32.1% of the claims compared to 57.6% for the 36-55 age group. The last age group 55+ accounted for an additional 10% of submitted claims. When reviewing the nature and causes of these injuries, it was found that the majority of the claims were from either sprains, twists, or strain related injuries. The majority of the causes of the claims were found to be from lifting/material handling (Bauer et al., 2001). This study indicates that age and gender have a direct impact on occupational injuries. Injuries occur most frequently while lifting and handling material, which usually causes employees to sprain, twist, and strain body parts. Even though this study took place in a university setting, material handling is still present and therefore such activities can have a significant impact on the occurrence of workers compensation claims.

Industry Solutions to Ergonomic Problems

When looking for possible solutions with ergonomic problems, companies have found it is possible to re-evaluate the process and design a solution. Smith (2001) reviewed the actions that Aurora Packing, Ace Hardware and International Truck and Engine Corporation performed to reduce ergonomic issues in the work place. Aurora Packing has reduced the lost workdays to one third of the industry average through the development of workstations, engineering controls as well as various administrative functions. They found engineering controls can be expensive but if done correctly, the controls can have a significant impact in reducing losses. Aurora Packing redesigned

many of its work areas by adding conveyor belts to move products more efficiently and also by installing hydraulic lifts as well as mechanical pulleys to move products, instead of having employees bend and lift. They then brought in an occupational health physician to analyze the different job tasks and create a stretching program specialized for each department (Smith, 2001).

Ace Hardware's ergonomic deficiencies were causing their lost day incident rate to be 2.1 days higher then the national average. They reduced their lost day incidents by reviewing their procedures and improving the processes within the operation. Many of the injuries were occurring in the receiving department where employees were unloading freight from trucks, so Ace Hardware began to ask vendors to palletize products they were shipping to the facility. The results of these efforts provided the company with a reduction in injuries, as well as saving time in the unloading process. Another area of concern was handling the material during the shipping process, because employees were being injured while reaching across the pallet to get the products. They eventually redesigned the workplace so pallets would rotate 180 degrees to allow the employees to select the a product which is close to their body and in turn not have to reach. Ace Hardware also implemented a stretching program before each shift as an administrative change to reduce injuries. In addition, a new proper lifting program was implemented, where managers work one-on-one with new employees to teach proper lifting techniques (Smith, 2001). The use of engineering and administrative programs combined allows a company to engineer a problem out and administer training to further reduce the potential for injuries.

Another way ergonomic deficiencies were reduced was through the use of job safety analyses (JSA's) at International Truck and Engine. Safety supervisors worked together with employees and supervisors to complete JSA's. They wanted to be able to pinpoint problem areas and design changes to improve the deficiencies. When performed, job safety analyses found hazard areas where employees had to bend down and lift material off pallets at floor level. The area was redesigned so a lift table would move the material to a height that employee would no longer have to bend. Another hazard area JSA's found for improvement was the axle-housing department where employees were lifting 35 to 40 pound parts from floor level to pallets. The area was redesigned by adding cantilevered racks so employees could use a forklift to move the material. Since 1998, the company found that as a result of the JSA's, they have reduced the injury frequency rate by 70 percent as well as the lost workdays by 60 percent. In addition to JSA's, the company implemented a pre-employment physical for new employees to ensure that they could handle the physical job requirements and to screen out employees with back problems (Smith, 2001). XYZ company has never completed a job safety analysis on their cocoa recouping operations and doing so could shed some light on the hazards and deficiencies in the process.

As indicated in the previous analysis, Aurora Packing, Ace Hardware and International Truck and Engine have done a variety of engineering and administrative changes to reduce the number of losses that were occurring. Each of these changes could be an area of possible focus for XYZ company. Engineering changes can have a direct impact in employee productivity as well as minimize the amount of material handling involved in a process, thus reducing the potential for human injury. Administrative

changes allow a company to be proactive when engineering changes are not feasible (Smith, 2001). Both administrative and engineering changes will be reviewed in the redesigning of company XYZ recouping process.

Ergonomic Assessment Solutions

JSA's, RULA, and BRIEF™ are assessment tools which allow an organization to identify deficiencies within a process. BRIEF™, which is found in Humantech (1995) Applied Ergonomics Manual, allows an individual to identify at-risk behaviors in the hand, wrist, elbow, shoulder, back and legs. Each body area is categorized to determine what the potential areas of focus should be, which will allow the process to be redesigned appropriately. One strength of BRIEF™ is that it enables the entire process to be evaluated for deficiencies while looking at major body movement as well as detailed movements. The weaknesses of BRIEF™ are found in the grading system, where a score of 2 or higher indicates that the body area has a high potential for injury. If a body part has a score of 3, 4 or 5 BRIEF™ does not indicate that the body area is even more at risk for injuries. In addition, BRIEF™ does not factor in body size of the individual which can alter the results.

A Rapid Upper Limb Assessment (RULA) reviews the entire body while focusing on individualized frames or movements. This allows the assessor to ascertain if the process is acceptable, should be reviewed further, and or if immediate action should be taken to adjust the process. Another benefit of RULA is that it identifies weight limits and repetition requirements when assessing a process, which allows the assessor to identify additional deficiencies. The weaknesses of RULA are that it only reviews still-

shots of the individual instead of looking at the whole process and that it does not indicate what body parts are most at risk for injury.

A Job Safety Analysis (JSA) individually defines each of the processes of a job into steps and identifies the hazards associated with each step. JSA's not only allow a company to realize the hazards which exist for each job, but also what training may be appropriate and also provide a description of how to do the job safely. Additional benefits of JSA's are they can be reevaluated over time or when there is a change in the process, so a company can determine what additional changes need to be created (Laing, 1997).

Design and Assessment Solutions

When designing an operation, ergonomic issues should be addressed at the first stage of the process. Nelson and Wickes (1998) found different perspectives to look at when designing a process. The first and most important method was to eliminate hazards before the process is constructed. Areas of focus would include reducing the amount of weight handled by the operator and finding balance points on the material being moved. The second method would be to add safeguards to the process to minimize the amount of risk or injury. Some examples of this would be providing handles on containers to make them easier to move and the use of mechanical lifts will minimize the amount of human lifting. The last resort would be labeling the material. This would allow the employees to easily identify that the material is heavy or that proper lifting procedures should be used to lift the material (Nelson & Wickes, 1998). Reviewing these elements in the initial stages of a project may ensure the project runs smoothly and also is completed correctly.

Additional design issues should be looked at for the older worker to ensure that they will not have any difficulties with a redesigned process. Green (2002) identified design deficiency issues associated with older workers that will help reduce the number of injuries they receive. Areas for improvement were found to be vision, hearing, compensation for decreased motor skills and slips and falls (Green, 2002).

It has been found that vision is a major area of concern when identifying older worker injuries. Vision is a factor because a 60-year-old person sees only about one third the light that a younger person does (Green, 2002). The author suggested completing a task analysis of the operation to see where the most light is needed and determine how much is needed. This will ensure adequate lighting is provided throughout the facility. The article suggested that a way to reduce glare would be to use many smaller light sources instead of a few larger sources and reduce the amount of tile surfaces (Green, 2002). Another recommendation of Green (2002) was to create similar levels of illumination because older peoples eyes adjust more slowly to light changes. If reading is required, make printed material large enough to be easily read (Green, 2002).

Hearing is another potential design problem when working with older people because over time people slowly lose their hearing. Recommendations for making more hearing-friendly work environments are to minimize the amount of machine noise and background noise especially when communication is essential. In addition, building designers should avoid making rooms into square shapes because it increases the amount of echoes and noise (Green, 2002).

Decreased motor skills with older employees is also an issue to be addressed in that aging causes loss of strength, flexibility and slower reaction times. Because of a loss

of strength, moving large or heavy material should be minimized (Green, 2002). The potential for slips and falls are injury areas that should also be examined during the redesign processes because older employees are less likely to recover when they lose their balance. Ways to reduce slips and falls are by making non-slip surfaces and provide good illumination to see potential hazarders (Green, 2002).

Questions from XYZ Company

When the study was initially started, XYZ company posed a few questions to be addressed during the study. The first was whether or not the risk could be reduced by having the employees work together to lift the barrel on to the static rollers. Secondly, determine how the process could be engineered to be completed safely with only one employee. Lee and Lee (2001) analyzed the efficiency of two-man lifting teams in which individual stature and lifting capacity were evaluated. Individual lifting capacity was determined to be 39.1 $\pm$ 6.48 Kg while team capacity increased to 65.8 $\pm$ 7.6 Kg. This is equal to 86.l lbs for an individual and 145.06 lbs for a team and equates to a 26.7 Kg or 58.96 lbs increase in weight when comparing team lifting to individual lifting. The study also found stature has an effect on team lifting. There was a 5% increase in the amount of weight a team could lift when the shorter member was raised to the equal height of the taller member (Lee & Lee, 2001). This indicates that if a team-lifting activity is to be as efficient as possible, lifters should be of equal height. The study then researched what the maximum acceptable weight would be for an eight-hour work shift. Individual and team maximum weight limits for lifting during an eight hour shift were 20.6 $\pm$ 3.3 Kg and 35.1 $\pm$ 5.0 Kg. This is equal to 45.4 lbs for an individual and 77.3 lbs for a team (Lee & Lee, 2001). These weights are significantly less then the 200 or 300 lbs the barrels

weigh, which indicates team lifting would not be an acceptable solution for the problem. The barrels could be filled with less cocoa packets but this would increase the amount of barrels needed and the length of time the recouping process would take.

The second question posed by company XYZ was to determine how the process could be engineered and completed safely with only one employee. Integrated pallet system (1998) indicated the integration of a new pallet system was found to increase efficiency and safety at Ace Hardware. The new pallets were called The Returnable Integrated Pallet System (TRIPS), and are made of plastic bottoms that have folding cardboard/plastic sides. The new pallet system increased efficiency at Ace Hardware because they could be folded to reduce the amount of space each pallet occupies. In addition, the new pallets are made of plastic which reduces their weight and eliminates wood splinters as well as the potential for cuts that are caused by wood pallets. Ace Hardware's engineers helped redesign the pallets so they could store up to 1500 lb loads (Integrated pallet system, 1998). This new pallet design could be used by XYZ company for the removal of the scrap cocoa packets instead of packing them into a garbage barrel. By using this method, one employee would not be needed in the process because the cardboard pallet would not have to be packed like the barrels and the forklift driver could move the pallets to the disposal area. The pallets also have the ability to be folded, which would minimize the amount of space they take up and thus reduce the amount of barrels needed.

Summary

Based on the literature review, ergonomic problems are having a significant impact on not only the grocery industry, but also many other industries. Even though

ergonomic issues are a problem, they are controllable through a variety of administrative and engineering changes. The method by which to minimize/prevent ergonomic-related injuries is to determine what the exact problems are and then institute design changes to fix the problem. The review of assessment processes indicated the recouping process could be evaluated on three different levels; the entire process, individual frames of the process, and individual body parts. Level one the whole process will be evaluated by JSA. The second level will be completed through RULA, in which individual fames of the process will be evaluated, then level three individual body parts will be evaluated by BRIEF™. It is believed that using all three assessment processes will provide a complete assessment of the recouping process also the design assessments indicated are another important focus when redesigning a process. It is important to look reducing hazards in the process but also look at the employees who are doing the work and designing the processes to fit their needs.

CHAPTER III

Methodology

Introduction

The purpose of this study is to identify, evaluate, and analyze engineering and administrative based deficiencies that are associated with the cocoa recouping operations at XYZ company. This chapter will review the assessment and evaluation tools used to evaluate the deficiencies within recouping operations. To accomplish this, the process will be evaluated using JSA's, RULA, BRIEF™, and a cost analysis.

JSA's Evaluation

The evaluation process for JSA's will be accomplished by reviewing company procedures that document all the required steps to effectively do the recouping process. Each step will then be itemized to determine the elements of movement within the process and the hazard associated with each movement. After JSA evaluations are completed, RULA and BRIEF™ analysis will be utilized to determine where the deficiencies are within the process.

RULA Evaluation

RULA will be used as an additional resource to determine if the process is acceptable. After the JSA's are completed, an evaluation will be made from the JSA's to determine the most at-risk positions an employee would use. RULA will then be used to evaluate that specific position. This will be completed by the researcher taking sketches of what could be the most at-risk positions an employee would be in. The sketches will be analyzed to determine upper arm location, lower arm position, wrist position, if the wrist is twisted, the load and force which is used to move the object. Also, the position

of the neck and trunk are evaluated to determine what angle they are at. In addition, the legs are evaluated to determine if they are balanced and supported. The results of the analysis are determined numerically and will determine if the process is acceptable (a rating of 1-2), if it should be investigated further (a rating of 3-4), if it should be investigated further and changed soon (a rating of 5-6) or if it should be investigated and changed immediately (a rating of 7).

BRIEF™ Evaluation

BRIEF™ will be used to determine the body areas that are at risk for future injuries. This evaluation will be completed from the results of the JSA's, which will indicate the processes and areas of focus. BRIEF™ evaluates smaller body movements, which will focus on individual body parts such as the hand, wrist, elbow, neck, shoulder, back, or legs. Each of these body parts are evaluated by the position it is in, the amount of force used by the body part, the duration of time it is used and the frequency the body part is used. BRIEF™ is also evaluated numerically, position, force, duration, and frequency all count for one or more points if the processes is being completed incorrectly. Any body part that has a total score of 2 or more is at high risk and should be evaluated further.

Cost Analysis

A cost analysis will determine the amount of years it will take to pay for any changes associated with the process. It will be computed by taking the total cost of the improvement divided by the decreased cost of injuries. This will equate to the amount of years it will take to pay for the cost of the improvement. An example of this would be, if the improvement costs $10,000 and injuries were currently totaling $100,000, a 10%

decrease in injuries would be $10,000. Taking the improvement costs of $10,000 divided by a 10%, decrease in injuries at $10,000 would equal the amount of years it would take to pay for the improvement, which is one year.

Example

Total Cost of Injuries and Damages for the Past Year $100,000
Divided by Estimated Percent Reduction of Past injuries 10%

10% ÷ $100,000 = $10,000

Cost of Recommendation $20,000
Divided by total for top figure $10,000

$10,000 ÷ $20,000 = 2.0

2.0 equals the amount of years it will take to pay for the cost of the recommendation.

Summary

The use of a variety of different tools will allow the study to focus on many different ways to look for improvements. Completing the JSA's will identify the hazards associated with the process, which will help determine the exact positions the employees are at risk. After identifying the exact positions the employees are at risk, RULA will be an effective tool to identify if the task is acceptable or if changes should be made to the process. BRIEF™ will then identify the large movements and individual body parts which are at risk while completing the process. If the process is determined to have deficiencies cost analysis will be an effective tool to help promote improvements. This will be completed by showing how the cost associated with any recommended changes will be recouped by a reduced amount of losses in only a few years.

CHAPTER IV

Results

Introduction

This chapter will include the results of the study, which have been compiled from JSA's evaluations, RULA evaluations, BRIEF™ evaluations and cost analysis evaluations. The results of the evaluations will provide information for recommendations which will be looked at in the next chapter.

JSA Evaluation

First, the steps of the process had to be determined to accurately identify how the operation is completed. The operation works as follows: Rubbermaid™ barrels containing cocoa powder packets are placed four per pallet; the barrels weigh between 200 and 300 pounds and a full pallet weighs between 800 and 1200 pounds. Pallets of cocoa packets are then brought by forklift to the cocoa recouping machine. The pallets are dropped off by static rollers where the employee has to pull the barrels off the pallet onto the static rollers. Containers of cocoa packets are then pushed down the static rollers to a yellow dumper machine which lifts the cocoa containers and dumps them into the recouping machine. Cocoa packets then go through a leakier machine, which rips apart the packets and removes the cocoa from the packets by air suction. All of the cocoa powder is then sucked into a vat for storage and reuse. Empty packets are then removed at a very quick pace by conveyor, which empty into a garbage bucket. The second employee packs the empty cocoa packets down inside the garbage bucket using a tamp to conserve space. In the last process the bag is tied, the garbage bucket is turned over, and the plastic bag is removed.

Operational Steps and Hazards found by JSA

Step 1. Pallets of cocoa packets are brought by forklift to the cocoa recouping machine and dropped off next to the static rollers.

Potential Hazard: The static rollers are not bolted to the ground and could slide into the employee.

Step 2. The employee has to pull the barrels off the pallet onto the static rollers.

Potential Hazards: Each barrel each has excessive weight (200-300 lbs) and requires the employee to use large amounts of force to move the barrel. This has caused back and shoulder injuries in the past. Employees step on and across the static rollers to move barrels. Static rollers cause employees to stretch and lean to the move barrels, which put them in awkward positions while pulling the heavy barrels. In addition, the static rollers cause a potential slip hazard.

Step 3. Containers of cocoa packets are then pushed down the static rollers, to a dumper machine.

Potential Hazards: Barrels have fallen from the static rollers, which resulted in additional time to pick up cocoa packets. Additional shoulder and back injuries have occurred during this step.

Step 4. The barrels are then pushed onto the dumper machine.

Potential Hazard: Hand injuries have occurred during this step, from being pinched between the dumper machine and barrel.

Step 5. Barrels are raised and emptied into leakier machine. During this step, the employee pushes a button on the dumper machine while walking up three stairs. In

addition, the employee must hold the barrel to ensure it does not fall into the machine while emptying.

Potential Hazards: Employees can trip while walking up the stairs. Also, there is the potential to pinch their hand between the dumper machine and the stair railing. Employees must have the strength to hold the barrel with one hand while it empties into leakier machine. If the employee lets go of the barrel it could fall into the leakier machine and stop the process. There is minimal guarding in place to stop the employee from falling into the recouping machine.

Step 6. The barrel is lowered using the dumper machine and removed and the next barrel is pushed on to the dumper machine.

Potential Hazards: The employee can trip while walking down the stairs. In addition, there is the potential to pinch their hand between the dumper machine and the stair railing. Also, the employee steps on and over static rollers while pulling the barrel from the dumper machine, thus creating a trip hazard. In addition, there is the potential for airborne cocoa powder to become an irritant through inhalation.

Step 7. Empty packets are then removed at a very quick pace by conveyor, which empties into a garbage bucket. The second employee packs the empty cocoa packets down inside the garbage bucket using a tamp to conserve space.

Potential Hazards: The employee is bent over pushing and pulling a seven-pound tamp which has resulted in back and shoulder injuries. In addition, the conveyor is only minimally guarded and the employees' head is in close proximity, which could result in the employee's head being hit by the conveyor or their head being pulled into the conveyor.

Step 8. When the bag is full, it is tied and the barrel is pushed over to remove the bag. The bag is then pulled from the barrel.

Potential Hazards: Employees must hold onto the barrel while pushing it over to ensure the barrel does not roll into the bottom of the conveyor. This requires the employee to bend over while lowering the barrel and also while removing the bag. The employee must use force to remove the bag from the barrel because it is tightly packed and because of the suction that is created between the barrel and the plastic bag (during packing). Back and shoulder injuries have occurred during this step.

Step 9. The bag is pulled over to and placed on a pallet, which is transported by forklift to a waste removal vehicle.

Potential Hazards: Pulling the bag across the floor requires the employee to bend over. In addition, there is the potential to trip on the pallet and or get cut or splinters. There is also the potential to rip the bag on the pallet, which could slow the process.

RULA Evaluation

The RULA evaluations were completed by determining which steps in the JSA had the most potential for employee injury. The steps that were determined to have the most potential to future injury for employees were steps 2 and 7. Step 2 involved the employee pulling the barrels off the pallet onto the static rollers. Step 7 involved emptying packets that are then removed at a very quick pace by conveyor, which empties into a garbage bucket. The second employee packs the empty cocoa packets down inside the garbage bucket using a tamp to conserve space. Both of these steps not only put the employee at risk by being in an awkward position, but also have the potential for slips as well as falls and being pulled into or hit by the conveyor.

Figure 1 Step 2 RULA Analysis

Arm and Wrist Analysis	**Score**	**Neck, Truck and Leg Analysis**	**Score**
Upper Arm Position	2	Neck Position	2
Lower Arm Position	1	Trunk Position	3
Wrist Position	2	Legs	2
Wrist Twist	1	Posture Score	5
Posture Score	3	Muscle Use Score	1
Muscle Use Score	1	Force/ Load Score	3
Force/ Load Score	3		
Total	**7**	**Total**	**9**

Combined Total Score 7

Figure 2 Step 7 RULA Analysis

Arm and Wrist Analysis	**Score**	**Neck, Truck and Leg Analysis**	**Score**
Upper Arm Position	2	Neck Position	3
Lower Arm Position	2	Trunk Position	2
Wrist Position	1	Legs	2
Wrist Twist	1	Posture Score	4
Posture Score	3	Muscle Use Score	1
Muscle Use Score	1	Force/ Load Score	3
Force/ Load Score	3		
Total	**7**	**Total**	**8**

Combined Total Score 7

Results of RULA Evaluation

The highest potential combined score for RULA is 7. Both RULA evaluations resulted in a combined total score of 7, which indicates the process should be investigated and changed immediately. This indicates that there is increased potential for injuries with each of these processes. Past injuries have been associated with each of the processes, which would also indicate problems with the process.

BRIEF™ Evaluation

Steps 2 and 7 from the JSA were evaluated with BRIEF™. This was performed to determine the individual body areas of concern.

Figure 3 Step 2 BRIEF™ Evaluation

	Left			Right					
	Hand and Wrist	Elbow	Shoulder	Hand and Wrist	Elbow	Shoulder	Neck	Back	Legs
Posture				1	1	1	1	1	1
Force				1	1	1		1	
Duration					N/A				
Frequency									
Total	*	*	*	2	2	2	1	2	1

* Only Right or Left hand, wrist, elbow and shoulder were used for this evaluation.

Figure 4 Step 7 BRIEF™ Evaluation

	Left			Right					
	Hand and Wrist	Elbow	Shoulder	Hand and Wrist	Elbow	Shoulder	Neck	Back	Legs
Posture	1	1	1	1	1	1	1	1	
Force	1		1	1		1		1	
Duration	1	N/A	1	1	N/A	1	1	1	
Frequency		1	1		1	1	1	1	
Total	3	2	4	3	2	4	3	4	

* Right and Left hand were used during this process.

Results of BRIEF™ Evaluation

A score of 2 or greater for any body area indicates an elevated risk of injury for that particular body area. Step 2 evaluations indicated hand, wrist, elbow and back were all at a high risk for future injuries. Step 7 evaluations indicated both left and right; hand, wrist, elbow and shoulder were at an elevated risk for injury. In addition, the neck and back were identified to be at risk for future injuries. In Step 7, scores for the shoulder

and back reached rankings of 4, which would indicate all measurement areas were at risk for future injuries.

Cost Analysis

Cost analysis will determine estimations of cost to minimize the future risk of injuries within the cocoa recouping process. The estimations will be determined at a $20,000, $30,000, $40,000, and $50,000 range. Each estimation will be evaluated on a 30% reduction of future injuries.

Estimate 1

$20,000 recommendation, which will result in a 30% decrease in last years $100,000 of direct and indirect losses.

A 30% decrease in last years $100,000 of direct and indirect losses would equal $30,000. A $20,000 recommendation divided by $30,000 savings in losses equals .66, or the amount of time in years it would take to recoup the cost of recommendations. Thus, it would take 240.9 days or 2/3 of a year to recoup a $20,000 recommendation, which would result in a 30% decrease in losses.

Estimate 2

$30,000 recommendation, which will result in a 30% decrease in last years $100,000 of direct and indirect losses.

A 30% decrease in last years $100,000 of direct and indirect losses would equal $30,000. A $30,000 recommendation divided by $30,000 savings in losses equals 1.0 and or the amount of time it would take to recoup the cost of recommendations. Thus, it would take 365 days or 1 year to recoup a $30,000 recommendation, which would result in a 30% decrease in losses.

Estimate 3

$40,000 recommendation, which will result in a 30% decrease in last years $100,000 of direct and indirect losses.

A 30% decrease in last years $100,000 of direct and indirect losses would equal $30,000. A $40,000 recommendation divided by $30,000 savings in losses equals 1.33 and or the amount of time it would take to recoup the cost of recommendations. Thus, it would take 485 days or 1 1/3 year to recoup a $40,000 recommendation, which would result in a 30% decrease in losses.

Estimate 4

$50,000 recommendation, which will result in a 30% decrease in last years $100,000 of direct and indirect losses.

A 30% decrease in last years $100,000 of direct and indirect losses would equal $30,000. A $50,000 recommendation divided by $30,000 savings in losses equals 1.66 and or the amount of time it would take to recoup the cost of recommendations. Thus, it would take 605 days or 1 2/3 year to recoup a $50,000 recommendation, which would result in a 30% decrease in losses.

Summary

The use of JSA determined that there are hazards associated with the recouping process at XYZ company. RULA determined immediate action should be taken to minimize the potential risks associated with steps 2 and 7. In addition, BRIEF™ backed up the claims of RULA and identified the exact body areas that were at elevated risk for injury. When comparing the BRIEF™ and RULA evaluation results to past employee injuries, the information coincided. Thus, the results indicated cost analysis estimates

should be completed to determine an approximate amount of money to be used for future recommendations and the time it would take to recoup the cost of the recommendations.

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CHAPTER V

Conclusions and Recommendations

Introduction

The purpose of this study was to identify engineering and administrative based deficiencies that are associated with the cocoa recouping operations. The goals of this study were to:

1. Identify at-risk ergonomic behaviors and modify activities to reduce the potential of future injuries.

2. Determine the cost of injuries and what the cost would be to minimize the amount of future injuries.

3. Analyze the process to determine the most efficient use of human resources and equipment resources to ultimately expedite the process.

This chapter will provide the option/recommendations for the recouping process at XYZ company. The results of the study indicated that the recouping process at XYZ company has a high potential for future injuries if changes are not completed. In addition, the results of Chapter 2 indicated past ergonomic changes at other companies have resulted in facilities that operate more efficiently and have a reduced amount of injuries and accidents. Because of past process changes at XYZ company, they understand that investing in engineering modifications result in benefits for everyone.

Conclusion

After reviewing the automotive article in Chapter 2 that indicated unreported injuries were have a significant impact on the company's bottom line, XYZ company may want to look into the possibility of workers becoming injured and not reporting

injuries. Unreported injuries for XYZ company may not only affect the total cost of injuries, but also may not accurately represent the losses that are accruing at the recouping process. XYZ company may want to look at a training program to help employees better identify injuries that may be work-related as well as prompt the expedient reporting of such.

XYZ company posed a couple of questions in Chapter 2; one being if two-man lifting teams would be effective and the second was to determine if the process could be engineered to only need one employee. The first answer was that it would be safer to have two individuals lift the barrel instead of one, but the increase in safety would only be minimal. Using two-man lifting teams would still put employees at risk for future injuries. In addition, two-man lifting teams would not increase the productivity of the operation and in reality would potentially slow the operation. Because of the minimal impact two man-lifting teams would create, it would not be in the best interest of the company to use this lifting method.

When examining the possibility of redesigning the operation so only one individual would be needed, the Integrated Pallet System (1998) article provided some excellent ideas. In a review of various literature, the Returnable Integrated Pallet System (TRIPS) pallets, appeared to be very durable and could hold the shredded paper that XYZ company creates in their recouping process. It was also found that the sleeves of the pallets fold, and as a result of this, they take up very little room in the warehouse and are not as heavy as wooden pallets or create the slivers and cuts like wooden pallets do. The cost of the pallets are around $150 per pallet, which would be significantly less than purchasing a moveable garbage bin at $460 each. Purchasing the TRIPS pallets would

also eliminate the need for a second person in the operation because the forklift driver could remove the full pallets while bringing in the pallets with cocoa powder bins. This would save the company an estimated $49,920 per year, a figure that was provided by the safety manager of XYZ company. The estimated savings are calculated by using the average employees' hourly rate (including benefits) at $24 per hour.

Recommendations

Options/recommendations will be presented on a good, better and best approach. For each option, an estimated cost will be provided plus the positive and negative aspects that are associated with each option. In addition, each option will include the JSA process steps that are eliminated/reduced with the option.

Two areas that will be a constant for all options include the use of TRIPS pallets and the use of a conveyor belt. It is recommended the company purchase 10 TRIPS pallets in order to ensure they will not run short at peak production times. Also, it will provide the company some flexibility so that when pallets leave the facility to the disposal site, there will still be extra pallets available. The estimated cost of each TRIPS pallets is $1,500; this is computed by taking the 10 pallets times $150 per pallet. The positive aspects of the TRIPS pallets are they eliminate the need of a second person in the operation, which will bring an estimated cost savings of $49,920 per year. The pallets are also easily stored and will require minimal human handling. Negative aspects of the pallets are that they have never been used at this facility before and additional guards will have to be placed on the lower portion of the conveyor. Also, there is the potential for the company to run short on pallets at peak production times which may require them to convert back to old methods. JSA process steps that will be eliminated/reduced are the

employee packing the cocoa packets in the barrel with a tamp and the process of removing the full bag from the barrel (JSA process steps 7, 8 and 9).

The use of a conveyor belt instead of the currently used static rollers will be recommended in order to streamline the operation. XYZ company currently has the material from past processes that have been changed to make the recommended conveyor system and because of this, the material cost will be minimal. The majority of the cost for this conveyor will be employee hours. It is estimated that this project will require 3 maintenance personnel 5 days (40 hours each) to complete the project. The estimated cost will be $2,880, this figure is computed by taking 3 employees times a pay rate of $24 per hour times 40 hours which equals $2,880. The combined total cost of the pallets and conveyor system is $4,380, a figure which will be calculated into all options. Positive aspects of this option are that it will make the operation more efficiently because employees will no longer have to push the barrels down the static rollers. Other benefits would be that the slip trip fall hazard from the static rollers will be eliminated, the conveyor will be more stable which will reduce the number of barrels that fall off, and the conveyor will be bolted to the ground reducing the chance it will hit the employee. Negative aspects of the conveyor system are that it will require routine maintenance inspections. In addition, it may require employee training, and it is a considerably larger cost compared to the static rollers. JSA process steps that will be eliminated/reduced are pulling cocoa barrels from a pallet to the static rollers, and requiring an employee to push the barrels to the dumper machine (JSA process steps1 and 3).

Option 1

The first option presented will be one that may be considered the least beneficial, although it is the lowest in cost. The use of an overhead hoist, which has barrel attachments, will allow employees to move the barrels onto the conveyor belt with minimal force. Estimated cost of the overhead hoist with barrel attachments is $1,500 plus installation costs. Positive aspects of this option are that employees will no longer struggle when dragging the barrels across pallets and employees will be able to move barrels without stepping on or over static rollers. Negative aspects of this option are that the use of the hoist may slow the operation, there may be additional bulky parts on the hoist that can injure employees by hitting them and use of the hoist will require some form of employee training. Dependent upon the size and type of hoist, it may limit the area where pallets can be placed in the operation. In addition, the dumper machine will still be in the process, which will not eliminate all JSA process steps such as the employee operating the dumper machine (JSA process steps 4, 5, and 6). The additional JSA process step that will be eliminated/reduced through this option is the employee pulling the barrels onto the static rollers.

Total Estimated Cost

$2,880 Conveyor
$1,500 TRIPS Pallets
+$1,500 Overhead Hoist
$5,880 Total estimated cost

Option 2

It is believed by the researcher that this option is a slightly better choice than the first option because it does not require the employee to physically move the barrels as often. The second option involves using forklift mounted barrel-moving equipment to

move the full barrels of cocoa powder. This process works whereby, the equipment attaches to the forks on the forklift allowing the operator to mechanically grip barrels and move the barrels around the facility. The estimated cost of the forklift mounted barrel-moving equipment is $2,400 per machine. Positive aspects of the equipment are that the employee will not have to touch the barrel while putting it on the conveyor and the employee will not have the potential to trip on a pallet. Negative aspects of the forklift-mounted equipment are that the device must be removed in order to move pallets, it will require the forklift driver to spend a lot more time in the process, and additional employee training will be required. In addition, this option will not minimize or eliminate all JSA process steps such as the employee operating the dumper machine (JSA process steps 4,5 and 6). The additional JSA process step that will be eliminated/reduced through this option is the process of the employees pulling the barrels onto the static rollers.

Total Estimated Cost

$2,880 Conveyor
$1,500 TRIPS Pallets
+$2,400 Forklift mounted barrel-moving equipment
$6,780 Total estimated cost

Option 3

This option is the most beneficial for the company because it will eliminate/reduce all JSA process steps. The option will require the current dumper machine to be removed so an industrial barrel manipulator can be added. The industrial barrel manipulator will pick up a barrel, turn it, and dump the contents of the barrel into the recouping machine. The process will require the forklift driver to then place the pallet of barrels on the conveyor. Then the conveyor will move the pallet of barrels to the

employee running the industrial barrel manipulator, at which point the employee will remove the barrels from the pallet and empty them into the recouping machine. The empty barrels will then be placed inside one another to conserve space and empty pallets will be removed through the use of a forklift. The estimated cost of the industrial barrel manipulator manufactured by Dalmec, is $25,000. Dalmec has been in business for over 35 years and provides manipulator equipment for many major manufacturing and chemical industries. A positive aspect of this option is that all JSA process steps will be eliminated/reduced. In addition, an entire step of the process will be eliminated by allowing a forklift driver to place a full pallet of barrels on the conveyor, thus making the operation more mechanized and subsequently less manual from a human interface standpoint. This new process should require less employee hours to complete the job, which will allow XYZ company more flexibility in scheduling the process. The new process will require employees to handle only empty barrels which should eliminate/reduce many of the back and shoulder injuries that have occurred. Negative aspects of the new process are that it will require additional employee training and the price of the industrial barrel manipulator. This option will eliminate/reduce all JSA process steps, this is the only option to eliminate/reduce all JSA process steps.

Total Estimated Cost

$2,880 Conveyor
$1,500 TRIPS Pallets
+$25,000 Industrial Barrel Manipulator
$29,380 Total estimated cost

Cost Analysis

When reviewing the changes presented in option 3 above, it is estimated that there should be a 40% reduction of injuries in the recouping process because no employee

manual material handling is required. The cost analysis indicated that a $30,000 option results in a 40% decrease in last year's $100,000 of direct and indirect losses and thus will take less then one year to pay for itself. A 40% decrease in last year's $100,000 of direct and indirect losses would equal $40,000. Taking a $30,000 option divided by $40,000 savings in losses equals .75 or the amount of time it would take to recoup the cost of options. Thus, it would take 273 days to recoup a $30,000 option, which would result in a 40% decrease in losses. When looking at the total cost of option 3, it should be noted that this process will require only one employee, which will add an additional cost savings of $49,920 per year.

Summary

Cost analysis for options 1 and 2 were not estimated because, the process of the employee operating the dumper machine was not eliminated (JSA process steps 4, 5 and 6). In addition, if option 1 and 2 reduced injuries by only 10% margin it would take under one year to pay for each of the options. The final option is considerably better than the first and second options because it eliminates/reduces all of the JSA process steps. It may be in the best interest of the company to consider option 3.

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