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AN EVALUATION OF MANUAL METERIAL HANDLING TASKS IN A MANUFACTURING COMPANY

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ABSTRACT

Manual material handling (MMH) is one of the most common causes of accidents and ill-health in the workplace. Material handling encompasses a wide range of work activities - from occasional movement of very large loads with cranes and powered industrial trucks to routine, repetitive lifting of relatively light objects and tasks that are incidental to a worker's regular, daily activities.

Manual material handling tasks in a Philippine manufacturer (the Company) of Baby Diapers and other personal products were evaluated and analyzed. Five months worth of data from the Company showed that 7% of workers suffer from work-related musculo-skeletal injuries. Of these, 58% are classified as low back pain. It should be noted that most Philippine companies are notorious for under-reporting workplace related injuries, particular those that only cause loss of man-hours (as opposed to losing man-days or months) due to relatively lax regulations though the Company encourages employees to report these types of injuries.

The manufacturing line for Product H (a baby diaper) was analyzed using ergonomic checklists for general posture, task evaluation, and workstation evaluation, as well as a Cumulative Trauma Disorder (CTD) Risk Index. It was seen that bulk packing, auto-bagging, manual sealing and box stacking are the most problematic among the tasks. Poorly designed workstations as well as heavy manual lifting and moving tasks contributed as likely main causes for low back pain.

Proposed solutions included an improved layout for the manual packing, auto-bagging and bulk packing workstations, job redesign of the on-line inspector, as well as job rotation among the different product lines.

INTRODUCTION

Manual material handling (MMH) is one of the most common causes of accidents and ill-health in the workplace. Material handling encompasses a wide range of work activities - from occasional movement of very large loads with cranes and powered industrial trucks to routine, repetitive lifting of relatively light objects and tasks that are incidental to a worker's regular, daily activities.

MMH activities are often of concern when assessing job tasks for risks that have the potential to lead to musculoskeletal disorders. MMH activities usually contain ergonomic risk factors that may include awkward posture, repetition, excessive force and mechanical or contact stress. Several evaluation methods and guidelines exist for evaluating manual material handling tasks.

Many of the work-related injuries associated with ergonomic problems include musculoskeletal disorders (MSD) such as back injuries and carpal tunnel syndrome and result from overexertion or repetitive motion. About one-third of these injuries are serious enough to require time off work. Workrelated MSDs account for one-third of all workers' compensation costs each year because these injuries can require a lengthy recovery time. Aside from the lost days of work, the corresponding amount of money lost because of it is significant that it can't be ignored.

It is then important to minimize, if not completely eliminate, the causes of these work-related MSDs to reduce the costs associated with these.

A. **Objectives**

The paper aims to

- [1] identify work-related injuries and illnesses;
- [2] evaluate and analyze specific tasks that can potentially cause manual material handling injuries;
- [3] determine possible causes of these injuries and illnesses;
- [4] identify other risks that may as well contribute to the injuries;
- [5] analyze the factors in the work environment and layout that triggers work-related injuries and illnesses;
- [6] utilizing appropriate tools in evaluating manual material handling practices

B. Scope and Limitation

This study covers one of the product lines of The Company, the infant care product line (disposable baby diapers). The Company manufactures different grades of infant care products. This study will focus on the production of Product H. It will be limited to the evaluation of the manual material handlers in the infant care division. The analysis will concentrate on the different tasks such as manual bulk packing, auto-bagging, manual box sealing, automatic box sealing, online inspector and box stacker. Only the workers in the first shift of this production line were observed. Other data that will be used such as the medical data on work-related illnesses and injuries are from recent records of The Company.

C. Methodology

In evaluating the manual material handling practices in The Company, the proponents first got medical records on incidences of work-related illnesses and injuries from the clinic. The records were analyzed, and then the analysis was concentrated in on musculoskeletal and soft tissues disorders since the number of incidences of work-related illnesses and injuries is the area of interest.

The injuries and illnesses were then related to the work done by identifying which factors are responsible for it. Several evaluation tools were used to aid in identifying these factors. The tools used were: Worksite/Job Analysis, CTD Risk Index and Workstation Evaluation Checklist.

Interviews were conducted as well as first hand observations in the production area to be able to accomplish these forms. After accomplishing the said forms, the tasks are analyzed in general to identify which has the highest probability of causing the injuries or increasing the risks.

Finally, recommendations on how to mitigate or eliminate the risks are provided at the end of the study.

E. Short Company Profile

The Company produces and markets a wide range of health and hygiene products. The Company is classified into three global business segments: Personal Care, Consumer Tissue and Business to Business.

Personal Care segment manufactures and markets feminine care products, disposable diapers and other related products. The Consumer Tissue segment produces and markets facial and bathroom tissue, paper towels, napkins and other products intended for household use. In contrast with the Consumer Tissue, the last segment which is the Business to Business manufactures the same products but is meant for away-from-home use. It also produces health care products such as surgical gowns, facemasks, exam gloves and respiratory products.

REVIEW OF RELATED LITERATURE

Manual material handling (MMH) is an activity requiring the use of force exerted by a person to lift, lower, push, pull, carry or otherwise move, hold, or restrain a person, animal or thing. It covers a wide range of activities including lifting, pushing, pulling, holding, throwing and carrying. It includes repetitive tasks such as packing, typing, assembling, cleaning and sorting, using hand-tools, and operating machinery and equipment.

In manual load handling, human effort intervenes in both a direct (raising, positioning) and indirect (pushing, hauling, shifting) manner. The carrying or holding of a load in a raised position is also considered to be manual handling. MH also includes holding the load with the hands or other parts of the body, such as the back, and throwing the load from one person to another.

Because most jobs involve some form of manual handling, most workers are at risk of manual handling injury. Of course, not all manual handling tasks are hazardous. But it is significant that around a one-third of all workplace injuries are caused by MMH.

Some of the work-related injuries and long-term health problems are known as repetitive strain injury (RSI), occupational overuse syndrome (OOS), cumulative trauma disorder (CTD) and work-related musculoskeletal disorder (WRMSD). All of these conditions are referred to as musculoskeletal disorders (MSD). MSD is defined as an injury, illness or disease that arises in whole or in part from manual handling in the workplace, whether occurring suddenly or over a prolonged period of time.

Other injuries that may also be caused include: upper limb injuries (shoulders, arms and hands), burns produced by loads at high temperatures; wounds and scratches caused by excessively sharp corners, splintering, very rough surfaces, nails, etc.; bruising caused by falling loads due to slippery surfaces (oils, greases or other substances); circulatory problems or inguinal hernias and other harm produced by hazardous substance spills.

Many of the work-related injuries associated with ergonomic problems include MSDs such as back injuries and carpal tunnel syndrome and result from overexertion or repetitive motion. About one-third of these injuries (600,000) are serious enough to require time off work. Work-related MSDs account for one-third of all workers' compensation costs each year because these injuries can require a lengthy recovery time.

The International Labor Organization (ILO) maintains that manual handling is one of the most frequent causes of accidents at work, accounting for 20-25% of all those produced. A study carried out by the U.S. National Safety Council in 1990 revealed that the greatest cause of occupational injuries (31%) was overexertion. The back is the part of the body that most frequently suffers injury (22% of 1.7 million injuries). This problem also exists in many EU Member States. In the United Kingdom a report prepared in 1991 indicated that the cause of 34% of accidents resulting in injury was manual load handling. Of these accidents, 45% affected the back. In France during 1992 manual load handling was the cause of 31% of all accidents at work involving time off. In Spain, the greatest cause of accidents at work in the period 1994-95 was overexertion. In particular, statistics for 1996 relating to accidents at work and occupational diseases include 22.2% of accidents at work with time off caused by overexertion, many of them probably due to manual load handling. As regards the nature of the injury, 8.9% of accidents were due to lumbago and 0.1% a slipped disc.

PROBLEM IDENTIFICATION AND DOCUMENTATION

Data on work-related injuries and illnesses

Before evaluating the manual material handling practices in The Company, it is essential to identify the problems associated with improper manual material handling. To see this, date were gathered on the number of work-related musculoskeletal and soft tissues disorder (MSD) incidents. The tabulated summary of the data (five months) is shown in Appendix A. About 7% of workers suffer from workrelated musculo-skeletal and soft tissues disorder.

The data on work-related musculoskeletal and soft tissues disorder shows that low back pain contributes the most to the illnesses/injuries that workers suffer from. It constitutes 58% of workrelated musculoskeletal and soft tissues disorder in the company.

Tasks to be analyzed

The following jobs under the production of Product H are to be analyzed in the succeeding section of the paper. The proponents thought of analyzing the jobs individually and not to analyze the workers per se because the workers switch over in their work and it would be more difficult to make an analysis this way.

All the following tasks are dependent on the speed imposed by the process. The Product H machine produces 500 diapers per minute, so it is important that the workers are efficient in what they do, or else, the production of Product H would suffer.

[1] Bulk pack Packer – the worker packs Product H diapers directly into a box; a manual bulk pack packer averages 500 boxes per 8-hour shift

[2] Auto-bagger Packer– the worker packs the Product H diapers that are bagged in packs of 8 by the machine into a box; an auto-bagger averages about 657 boxes per 8-hour shift

[3] On-line Inspector – the on-line inspector inspects Product H randomly during the production; he/she sees to it that the Product H being produced and bagged are not defective; he/she also signals the line leaders if defectives come out of the process so they can either check the machine while in production or temporarily stop production and resolve the cause of defects

[4] Box Sealer (manual and automatic) – manual sealers seal the box by hand while a machine is used for automatic sealing

[5] Box Stacker – the stacker places the boxed items in the pallets to be placed in the stock area, ready to be transported; for the bulk pack, the stacker lifts a box that weighs about 2.5 kgs; for the auto-bagging, he/she lifts a box that weighs about 2.6 kgs.

Job/Worksite Analysis Guide

The job/worksite analysis guide identifies problem areas within a particular area or worksite. Before collecting data, the analyst has to observe the worker, the task, the workplace and the surrounding guide the analyst in using other, more quantitative tools for collecting and analyzing data.

To initiate the ergonomic evaluation of the jobs enumerated above, the proponents then performed a job/worksite analysis guide to determine which factors, and their corresponding tools, and problem areas to focus on. The job/worksite analysis guide can be found in the appendix.

From the results of the analysis, it can be seen that the analysts have to concentrate on the problem areas namely repetitive lifting and grasping, awkward posture, awkward wrist and shoulder motions and unacceptable noise level.

The analysts then performed the following to evaluate the jobs: CTD Risk Index, General Posture and Task Evaluation Checklist and Workstation Evaluation Checklist.

The CTD Risk Index is then computed to identify which among the jobs is the most risky, injurious and prone to Cumulative Trauma Disorder (CTD). It will also help in identifying poor postures and serves as a design tool for selecting key conditions to redesigning. The Workstation Evaluation Checklist will aid in analyzing the workstations of the workers while the General Posture and Task Evaluation Checklist will aid in the analysis of the performance of the tasks.

RESULTS AND DISCUSSION

General Posture and Task Evaluation

The first evaluation tool used is the General Posture and Task Evaluation Checklist. This checklist has been modified as the proponents see fit for the assessment of the said tasks. Table 1 shows the results for each task.
Table 1 shows which among the tasks is problematic with regards to posture and task. It can be seen that bulk packing, auto-bagging, manual sealing and box stacking are the most problematic among the tasks. Automatic sealing is the least problematic because the worker is only feeding the box to the sealing machine. Inspection, meanwhile, is not as problematic as the other tasks since the worker is not subjected to excessive bending and twisting as the other four.

Table 1. General Posture and Task Evaluation Checklist Results

POSTURE EVALUATION	TASKS					
	Bulk packing	Auto-bagging	Manual Sealing	Automatic Sealing	Inspection	Box Stacking
forward bending	✓	✓	✓	✓	✓	✓
twisting of the trunk	✓	✓	×	✓	✓	✓
sudden movements or jerks	✓	✓	✓	✓	×	×
changes in posture	✓	✓	✓	×	×	✓
excessive reaches	×	✓	✓	✓	✓	✓
TASK EVALUATION	**Bulk packing**	**Auto-bagging**	**Manual Sealing**	**Automatic Sealing**	**Inspection**	**Box Stacking**
static muscle exertions	×	×	×	×	×	×
long duration of static exertions	×	×	×	×	×	×
materials and tools not w/in normal working area	×	×	×	×	×	×
tasks carried out above shoulder level	×	×	×	×	✓	✓
tasks carried out below knuckle height	✓	×	✓	×	✓	✓
lifts performed quickly without knees bent	✓	✓	✓	×	×	×
no breaks allowed during shift	×	×	×	×	×	×
Total Score (# of checks)	6	6	6	4	5	6

Workstation Evaluation Checklist

The next evaluation tool used is the Workstation Evaluation Checklist. The result of the evaluation is shown in the appendix. Two workstations are evaluated: Standing and Sitting. For the standing workstation, only the inspector has one cross mark since the inspector is originally to be seated but most of the time the inspector is standing.

The most poorly designed workstations among the tasks are that of manual sealing and case stacking since they got three cross marks and no check marks (check=positive). The manual sealing task has a problematic workstation since the worker has no permanent workstation. By this, we mean that the manual sealing of boxes is done on the floor and the worker is bent the whole time he/she is performing the task. The back angle of the worker -- between 45º and 90º -- is terrible for the back, more so that this is sustained for eight hours of work.

The workstations of the automatic sealing, auto-bagging and bulk packing are relatively acceptable. But there are some problem areas that need to be addressed in these workstations too. The analysts observed that the workstation layouts for the auto-bagger and automatic sealing are not properly designed which causes much of the awkward bending and twisting motions of the workers in this area. The depth and height of the bin where the bagged diapers accumulate while the packers stuff them into a box is low with respect to the height and reach of the worker. The bin looks like Figure 1.

Figure 1. Bin at a working height where the worker has to bend to reach a far object
Source: Kroemer et al, Ergonomics: How to Design for Ease and Efficiency (Fig. 11-17, p 540)

The top view of the workstation for auto-bagging and automatic sealing can be seen on the figure below. The two circles on both sides of bin represent the auto-baggers. The boxes are placed on their sides.

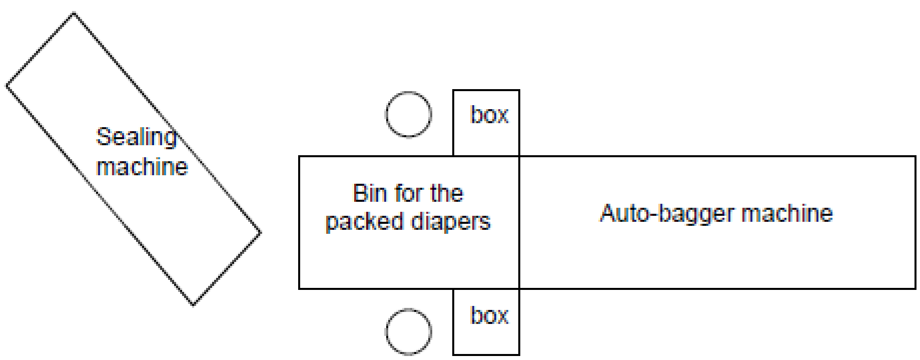

Figure 2. Top View of the current workstation for auto-bagging and sealing

The machine-packed diapers falls on the deposit from the machine and the packer grabs them and stuffs them into a box. And since the speed of the worker in packing is imposed by the process, bending and twisting motions becomes more unavoidable as the worker tries to hasten his/her packing to avoid bottleneck or excessive accumulation of packed diapers in the deposit area.

The single sealing machine placed to the sides of the workers working on the auto-bagger is also not properly situated which causes a lot of awkward twisting motions for the worker. The sealing process looks like this:

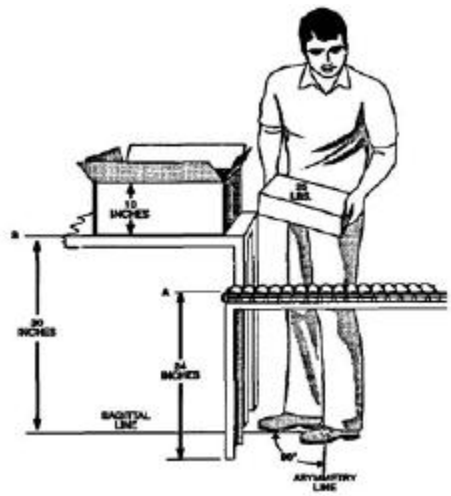

Figure 3. Layout of Work Area for Packaging
Source: Waters et al, Applications Manual for the Revised NIOSH Lifting Equation (p 80)

Meanwhile, for the on-line inspection workstation, there is also a problem with the posture and chair provided for the inspector while working. The chair doesn't have a backrest and a footrest that is large, stable, and adjustable in height and slope. And most of the time, the inspector is standing while he/she randomly inspects Product H and then she bends every time she selects a diaper to inspect because the opening where she gets the diaper is placed on slightly above the knee level.

It can be concluded that poorly designed workstations are one of the main causes of low back pain complaints of the workers.

CTD Risk Index

The Cumulative Trauma Disorder (CTD) Risk Index is then computed for all the tasks to determine which of the tasks is/are the most prone to CTD. CTD risk analysis sums risk values for all three major causative factors into one risk score. A frequency factor is determined by the number of damaging wrist motions, and then scaled by a threshold value of 10,000. A posture factor is determined from the degree of deviation from the neutral posture for major upper extremity motions. A force factor is determined form the relative percentage of maximum muscle exertion required for the task, and then scaled by 15 percent, the maximum allowed for extended static contractions. A final miscellaneous factor incorporates a variety of conditions that may have a role in CTD causation. For relatively safe conditions, the index should be less than one.

The values of the force determined for each tasked were rough estimates since the analysts don't have the proper tool to measure the forces required for each task. The analysis was based on the observations made by the proponents during their visits in The Company. The table below summarizes the calculations performed for each job. The individual calculations are found in the Appendix.

Table 2. Computed CTD Risk Index for each task

Type of Job	Frequency Factor	Posture Factor	Force Factor	Miscellaneous Factor	CTD Risk Index
Bulk Packing	0.40	0.80	2.33	0.33	1.092
Auto-bagging	0.54	0.90	1.67	0.33	0.965
Manual Sealing	0.45	0.80	1.67	0.33	0.9080
Automatic Sealing	0.3375	0.40	1.67	0.33	0.7543
Inspection	0.55	0.80	1.67	0.33	0.9380
Box Stacking	0.27	0.70	2.13	0.33	0.963

The results show that the most prone to CTD and the most risky task is manual bulk packing. The next most risky job is manual sealing of boxes. It can be seen that most of the manual jobs are riskier than the ones where a machine assists in doing the job. The least risky of them all to CTD is inspection. This is of course expected since the inspector's job is not as physically demanding as the other jobs.

All the jobs, except manual bulk packing, have indices of less than one which means that they are *relatively* safe from CTD. This must be verified by The Company since the values of the force factor which contribute a relatively large value to the computed indices are only rough estimates.

Noise Levels

The production area for Product H has a very high noise level. The source of the noise is the machine itself and there is no way to eliminate this because this means shutting down the machine entirely. All the workers are subjected to noise levels of 90-91dB the entire eight hours of their work. The workers, though, are provided with earplugs for hearing protection. But some of the workers, the analysts observed, do not use this earplugs to protect themselves from this ear-damaging noise level. They are sometimes unmindful of the noise surrounding them.

The earplugs effectiveness is measured quantitatively by a noise reduction rating (NRR). To compute for the reduction in noise level, we use the formula:

New Noise Level = Original Noise Level – (NRR-7)/2

The earplug that The Company provides for its workers has an NRR of 33. The computation for the new noise level given that The Company has a noise level of 90dB in the Product H production area is 77 dB, which is lower by thirteen decibels. But typically, in a real-world setting, with hair, improper fit, etc, the NRR value is going to be considerably lower.

The possible outcome for the workers who don't use their earplugs while at work is hearing loss. As the exposure time increases, especially where higher intensities are involved, there will eventually be impairment in hearing. Nerve deafness is due most commonly to excess exposure to occupational noise. Individuals vary widely in their susceptibility to noise-induced deafness.

CONCLUSIONS AND RECONNENDATIONS

After evaluating the manual handling practices in The Company using the three tools and observations, the most problematic tasks are manual sealing and both packing tasks (automatic and bulk packing). These tasks have bad workstation designs and they entail excessive bending and twisting motions. Manual sealing is particularly awkward because the worker is bent most of time, the back angle being 45º to 90º.

The workstations of the on-line inspector and the auto-bagging process (both packing and sealing) are found to be in need of redesigning to fit the worker to the workstation. Another thing that can be identified with the workplace design is the distances of the equipment or machines or tools from the worker. It should be within the reach of the worker and should be designed or laid out such that awkward movements and postures will be minimized, if not eliminated entirely.

We said earlier that workers switch over jobs during the 8-hour shift. This is a good thing because it will minimize worker fatigue from doing a single, sustained task. And it is also very flexible in that once bottlenecks occur in the packing of diapers, the others can help to remedy it.

For the auto-bagging task, The Company should reconsider redesigning the depth and height of the bin. They could also provide a chair for the auto-baggers so as not to tire the workers easily fromstanding for long periods of time. They can also opt to add another worker to assist in the sealing of the boxes so that the auto-baggers will not do the dual task of packing and sealing concurrently.

We propose a redesigned workstation for the auto-bagging process (packing and sealing) which can be seen at the figure below. This alternative requires that The Company buys another sealing machine (which is costly). In this workstation, the auto-baggers still do the sealing of the boxes.

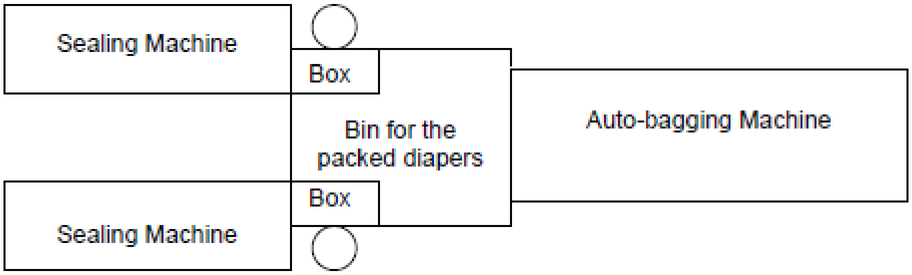

Figure 4. Proposed layout of workstation for auto-bagging process (option 1)

A cheaper alternative is for The Company to hire another worker that is tasked solely to do the automatic sealing of the boxes. He will get the boxes from both auto-baggers. This will avoid excessive bending and twisting motions for the auto-baggers and this could also prevent bottlenecks in packing since they will only concentrate on their task. The workstation design for this can be seen on the figure below. The baggers should be provided with comfortable chairs (with a back rest and an adjustable foot rest).

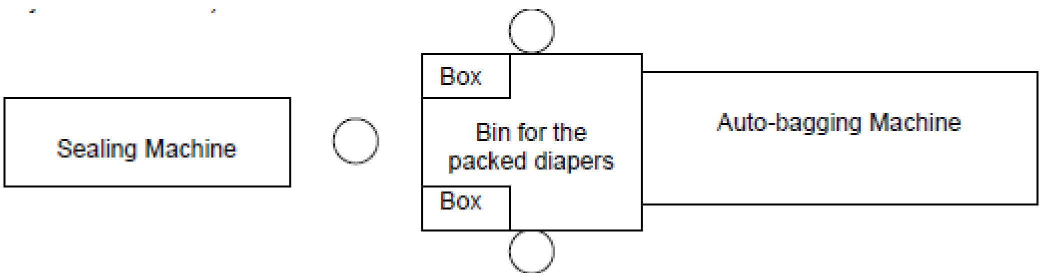

Figure 5. Proposed layout or workstation for auto-bagging process (option 2)

For the on-line inspector, he/she should also be provided with a comfortable chair (with a back rest and an adjustable foot rest) that is placed near the opening where he/she gets the diaper for testing. It is not advisable to redesign the height of the opening because it is dependent on the positioning of the huge machine. To place the opening higher means redesigning a big part of the machine. For the manual sealing task, The Company should provide a table where the sealer can prepare and seal the boxes. This will eliminate the excessive bending brought about by the current manual sealing practice.

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APPENDIX

Appendix A.

Work-related Muskuloskeletal and Soft Tissues Disorder (MSD's) in the company

Musculoskeletal and Soft Tissue Disorder	April	May	June	July	August
Infection					
a. lower extremity	1		1		
b. upper extremity	2	2			2
c. others					1
Trauma					
a. lower extremity		1		1	
b. upper extremity		1	3	2	
Low Back Pain	5		1	22	
Muscoskeletal Pain					
a. lower extremity			1		1
b. upper extremity					1
c. lower back					
d. upper back					1
Total	8	4	6	25	6
Total Illnesses Treated/Encountered	101	75	192	220	194

Appendix B.

Job/Worksite Analysis Guide (Biebel and Freivalds, 2004)

Job/Worksite Analysis Guide

Job/Worksite:	Analyst:	Date:
Description:		
Worker Factors		
Name:	Gender: M F	Height: Weight:
Motivation: High Medium Low	Job Satisfaction: High Medium Low	
Education Level: Some HS HS College	Fitness Level: High Medium Low	
Personal Protective Equipment: Safety Glasses Hard Hat Safety Shoes Ear Plugs Other:		
Task Factors		***Refer to:***
What happens? How do parts flow in/out?		*Flow Process Charts*
What kinds of motions are involved?		*Video Analysis, Principles of Motion Economy*
Are there any jigs/fixtures? Automation?		
Are any tools being used?		*Tool Evaluation Checklist*
Is the workplace laid out well? Any long reaches?		*Workstation Evaluation Checklist*
Are there awkward finger/wrist motions? How frequent?		*CTD Risk Index*
Is there any lifting?		*NIOSH Lifting Analysis, UM2D Model*
Is the worker fatigued? Physical workload?		*Heart Rate Analysis, Work-rest Allowances*
How long is each cycle? What is the standard time?		*Time Study, MTM-2 Checklist*
Work Environment Factors		***Work Environment Checklist***
Is the illumination acceptable? Is there glare?		*IESNA Recommended Values*
Is the noise level acceptable?		*OSHA Levels*
Is there heat stress?		*WBGT*
Is there vibration?		*ISO Standards*
Administrative Factors		Remarks:
Are there wage incentives?		
Is there job rotation? Job enlargement?		
Is training or work hardening provided?		
What are the overall management policies?		

Appendix C.
Workstation Evaluation Checklist (Niebel and Freivalds, 2004)

WORKSTATION EVALUATION CHECKLIST

-	TASKS					
Sitting Workstation	**Bulk packing**	**Auto-bagging**	**Manual Sealing**	**Automatic Sealing**	**Inspection**	**Case Stacking**
1. Is the chair easily adjustable according to the following features:	NA	NA	NA	NA	×	NA
a. Is the seat height adjustable from 15 to 22 inches?	NA	NA	NA	NA	×	NA
b. Is the seat width a minimum of 18 inches?	NA	NA	NA	NA	×	NA
c. Is the seat depth 15 to 16 inches?	NA	NA	NA	NA	×	NA
d. Can the seat be sloped ±10° from horizontal?	NA	NA	NA	NA	×	NA
e. Is a back rest with lumbar support provided?	NA	NA	NA	NA	×	NA
f. Is the back rest a minimum of 8 x 12 inches in size?	NA	NA	NA	NA	NA	NA
g Can the back rest be moved 7 to 10 inches above the seat?	NA	NA	NA	NA	NA	NA
h. Can the back rest be moved 12 to 17 inches from the front of the seat?	NA	NA	NA	NA	NA	NA
i. Does the chair have five legs for support?	NA	NA	NA	NA	×	NA
j. Are casters and swivel capability provided for mobile tasks?	NA	NA	NA	NA	×	NA
k. Is the chair covering breathable?	NA	NA	NA	NA	NA	NA
l. Is a footrest (large, stable, and adjustable in height and slope) provided?	NA	NA	NA	NA	✓	NA
2. Has the chair been adjusted properly?	NA	NA	NA	NA	×	NA
a. Is the seat height adjusted to the popliteal height with the feet flat on the floor?	NA	NA	NA	NA	×	NA
b. Is there approximately a 90° angle between the trunk and thigh?	NA	NA	NA	NA	✓	NA
c. Is the lumbar area of the back support in the small of the back (~ belt line)?	NA	NA	NA	NA	NA	NA
d. Is there sufficient legroom (i.e., to the back of the workstation)?	NA	NA	NA	NA	✓	NA

3. Is the workstation surface adjustable?	NA	NA	NA	NA	×	NA
a. Is the workstation surface roughly at elbow rest height?	NA	NA	NA	NA	✓	NA
b. Is the surface lowered 2 to 4 inches for heavy assembly?	NA	NA	NA	NA	×	NA
c. Is the surface raised 2 to 4 inches (or tilted) for detailed assembly or visually intensive tasks?	NA	NA	NA	NA	×	NA
d. Is there sufficient thigh room (i.e., from the bottom of the work surface)?	NA	NA	NA	NA	✓	NA
4. Is sitting alternated with standing or walking?	NA	NA	NA	NA	✓	NA
Standing Workstation						
1. Is the workstation surface adjustable?	×	×	×	×	×	×
a. Is the workstation surface roughly at elbow rest height?	✓	✓	NA	NA	NA	NA
b. Is the surface lowered 4 to 8 inches for heavy assembly?	NA	NA	NA	NA	NA	NA
c. Is the surface raised 4 to 8 inches (or tilted) for detailed assembly or visually intensive tasks?	NA	NA	NA	NA	NA	NA
2. Is there sufficient legroom?	✓	✓	NA	✓	✓	NA
3. Is a sit/stand stool (adjustable in height) provided?	×	×	×	×	✓	×
4. Is standing alternated with sitting?	×	×	×	×	✓	×
Number of checks (sitting workstation)	NA	NA	NA	NA	6	NA
Number of X's (sitting workstation)	NA	NA	NA	NA	13	NA
Number of checks (standing workstation)	2	2	0	1	3	0
Number of X's (standing workstation)	3	3	3	3	1	3

Appendix D.

CTD Risk Index (Niebel and Freivalds, 2004)

Job Title:	Machine:	Date:
Job Description:	Dept:	Analyst:

Cycle Time (in sec):		1
#Cycle/Day	2a	3
#Parts/Day (if known)	2b	
#Handmotions/Cycle		4
#Handmotions/Day		5
Frequency Factor (5 divided by 10, 000):		

(Circle appropriate condition)	Points			
	0	1	2	3
Working Posture	Sit	Stand		
Hand Posture 1: Pulp Pinch	No	Yes		
Hand Posture 2: Lateral Pinch	No	Yes		
Hand Posture 3: Palm Pinch	No	Yes		
Hand Posture 4: Fingers Press	No	Yes		
Hand Posture 5: Power Grip	Yes	No		
Type of Reach	Horizontal	Up/Down		
Hand Deviation 1: Flexion	No	Yes		
Hand Deviation 2: Extension	No	Yes		
Hand Deviation 3: Radial Dev.	No	Yes		
Hand Deviation 4: Ulnar Dev.	No	Yes		
Forearm Rotation	Neutral	In/Out		
Elbow Angle	= 90 °	≠ 90 °		
Shoulder Abduction	0	< 45 °	< 90 °	> 90 °
Shoulder Flexion	0	< 90 °	< 180 °	> 180 °
Back Angle	0	< 45 °	< 90 °	> 90 °
Balance	Yes	No		
Total Points For The Conditions:				6
Posture Factor (6 divided by10):				

Grip or Pinch Force Used on Task	7 lbs.	9 Divide 7 by 8
Max Grip Pinch Force	8 lbs.	
Force Factor (Divide 9 by .15) =		

(Circle appropriate condition)	Points			
	0	1	2	3
Sharpe Edge	No	Yes		
Glove	No	Yes		
Vibration	No	Yes		
Type of Action	Dynamic	Intermittent	Static	
Temperature	Warm	Cold		
Total Points for the Circled Conditions:				10
Miscellaneous Factor (divided 10 by 3):				

CTD Risk Index = 0.3 x (Frequency + Posture + Force Factors) + 0.1 x (Miscellaneous Factor)

CTD Risk Index = 0.3 x (+   +   ) + 0.1 x (   ) =