- Identification of outliers
- Skewness of data
- Graphical representation of data (i.e., histogram)
- Percentiles

Upon completion of data collection and analysis, the results are then ready to be used for making inferences about the subject population.

4.5 SUMMARY

Muscles skeletal and nervous systems are the integrated systems that permit movement of the human body. They convert chemical energy, obtained from food and drinks, into mechanical energy, which creates force and allows movement of the body limbs and activities that result in task performance. Designing occupational environments, equipment, and processes to be compatible with the musculoskeletal system is a goal of ergonomics. Understanding muscle work and how stimuli are processed by the body is imperative for the ergonomist. How multiple bodily functions interact to allow task performance requires knowledge of not only the musculoskeletal system but the nervous system as well. The nervous system controls the musculoskeletal system via motor and sensory nerves, which, in turn, communicate with the central nervous system. Additionally, understanding the science behind the transformation of energy into muscle movement and also the factors contributing to fatigue will aid in efficient and safe task design.

Case Study

Ergonomic Analysis of a Telemarketing Operation
By Robert O. Andres, David D. Wood, and Nancy E. Laurie

Introduction

This report presents the results of our ergonomic analysis a telemarketing operation in the call center of a large mail order firm. Dr. Andres first observed the telemarketing floor during his visit on November 5, 1993. A subsequent site visit took place May 4, 1994; ergonomists Nancy Laurie, M.S. and David Wood, M.S.I.E. accompanied Dr. Andres and performed the analyses summarized in this report. It has been brought to our attention that since our last visit a possible change is being considered—the supervisors would be distributed about the floor so that the lead station and supervisors' offices would no longer be centralized. The implications of this change will be discussed in the Conclusions and Recommendations section.

Methods

The site visit on 5/4/94 yielded several types of data. Video records of task performance were acquired, both to document worker technique and worker interaction with their workstation as well as to provide examples that can be used

during training (if training is pursued as an intervention). We measured the dimensions of the existing workstations across the entire floor area to determine what is available. We were also supplied with OSHA 200 logs so that we could understand the nature of the injuries and illnesses experienced by workers overall and in the telemarketing area.

Clerical worker exposure to ergonomic risk factors was estimated from both the on-site visit and a video tape analysis in our lab. Observational data and video data were summarized using ANSI's Z-365 checklist. The OSHA 200 Logs were reviewed; only ergonomic injuries were summarized (cumulative trauma disorders [CTDs]).

Results

There were three lost time ergonomic injuries in 1993 in the clerical operation. We estimated the severity rate using the following formulas (Bureau of Labor Statistics [BLS]):

$$\text{Total hours per year} = 415(\text{workers}) \times 30(\text{h/week}) \times 50(\text{weeks/year}) 622{,}500 \text{ h/year}$$

$$\text{Severity rate for lost days} = \text{number of lostdays}/200{,}000 \text{ h/year} (57[\text{lost days}] \times 200{,}000)/622{,}500 = 18.31 \text{ lost days per 100 person years}$$

$$\text{Incidence rate for lost time injuries} = \text{number of lost time injuries}/200{,}000 \text{ h/year} (3 \times 200{,}000) / 622{,}500 = 0.96 \text{ incidents per 100 person years}$$

There were nine other lifting injuries; each had no associated lost time. There were 268 lost days due to three slip/fall incidents. Seventeen other falls had no associated lost time. We gave a quick glance at the warehouse OSHA 200 Log ergonomic injuries. In absolute terms the number of lost days was some 10–12 times higher than those in telemarketing. However, without knowing the number of hours spent working last year in the warehouse, the incidence and severity rates could not be calculated.

After the site visit and viewing the video shot during our visit an ANSI Z-365 general ergonomic risk assessment checklist was filled out. Two aspects of the telemarketing operator's work (mechanical pressure at wrist and neck flexion) were above the trigger point (meaning that engineering or administrative controls should be implemented to reduce the physical stress on the workers). The workers rest their wrists on whatever surface is available as they type. This mechanical pressure is a risk factor for CTDs of the hand/wrist. The neck is also a potential site for CTDs. Workers must continuously look down at forms and papers on their desks and then look up at their computer monitor.

Table 4.2 contains a summary of the workstation heights. Only workstations with a computer and chair were included; the actual number of workstations used varies over time with the volume of sales.

TABLE 4.2
Workstation Height Summary

Workstation Height (in.)	Number
26.50	11
26.75	154
27.00	71
28.00	90
28.25	18
30.25	3
30.50	59
30.75	1
31.00	4
Total	411

Conclusions and Recommendations

The number of CTDs found on the OSHA 200 logs was small (3). Comparing the incidence and number of lost workdays with nationally published values for the finance, real estate, and insurance sectors (which are the most clerical of the classifications published by the Bureau of Labor Statistics in Accident Facts, 1993 Edition, referring to the 1991 statistics), the national average incidence of lost workday rate was 1.1 (versus 0.96 at here) while the average lost workdays were 24.1 (versus 18.3 at here). The clerical operation is better than the national average for the number of lost workday cases and for the number of lost workdays. That does not mean that improvements cannot be made.

Suggested improvements will be proposed on both a short term and a long term basis. The short term suggestions are generally administrative controls, whereas the long term suggestions involve engineering controls as well.

Short term improvements

Assign workers to proper work surfaces based on height:

We understand that you are considering dividing the floor into teams; this may make assignment more complicated but we will provide worker heights matched to work surface heights if you elect to pursue this approach.

Make sure that footrests are placed where needed:

We noticed that footrests were not present in all workstations, and we also noticed that they were pushed to the side and not used in several situations where the worker was too tall for their work surface.

Provide palm rests for the workers with wrist/hand complaints:

This may involve getting more palm rests because you do not want to take them away from people that already have them (we understand that this did happen at some locations on the floor as a result of the December 1, 1993 incident, and many workers expressed their dismay that they had been taken away).

We do not believe that all worke
discomfort or have developed
be provided on a case by case

Train the workers to properly

The chairs that the majority
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during prolonged sitting. Trai
chairs, and why. For example,
back may be too high, or if the
set too high. Proper sitting pos

Train the workers how to stret

We have worked with client
ranging from voluntary when
every hour. The stretches need
properly trained leaders or the
have developed a stretch guide
Implement a medical manage
workers and supervisors so th
problems, and make sure that
so that CTDs are prevented:

This type of program would
experience indicates that an eff
minor aches and pains from be
the biomechanical modificatio
days if early reporting and agg
part of corporate policy.

Long term improvements

Provide better work surfaces w

The sharp front edges on th
concentrations on the tendons o

Investigate adjustable work sur

These adjustable surfaces a
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Provide a small number of stan

These standing stations cou
workers can maintain their ide
could be used for up to 20 min
from continuous sitting.

Provide monitor stands:

Although the monitor heig
as workers are trained to bet

We do not believe that all workers need these, but for those that experience some discomfort or have developed some early symptoms (see #6 below) they could be provided on a case by case basis.

Train the workers to properly adjust their chairs and to sit properly:

The chairs that the majority of workers sit in seem to be adequate ergonomically. However, a good chair set in the wrong position can still cause problems during prolonged sitting. Training should be provided on how to adjust the chairs, and why. For example, if discomfort develops in the low back, the seat back may be too high, or if the back of the legs get sore then the seat pan may be set too high. Proper sitting posture should also be taught.

Train the workers how to stretch properly, and provide them with stretch breaks:

We have worked with clients who have implemented stretch break programs ranging from voluntary when the worker feels the need to mandatory 5 min every hour. The stretches need to be appropriate and they need to be either led by properly trained leaders or the individual workers need to receive training. We have developed a stretch guide for workers that was designed to fulfill this need. Implement a medical management program that would include training for the workers and supervisors so that they can recognize early symptoms of CTD problems, and make sure that management promotes a policy of early reporting so that CTDs are prevented:

This type of program would need to be corporate-wide to be effective. Our experience indicates that an effective medical management program can prevent minor aches and pains from becoming lost workday incidents. You can make all the biomechanical modifications possible and still have a large number of lost days if early reporting and aggressive pursuit of conservative treatment are not part of corporate policy.

Long term improvements

Provide better work surfaces with rounded front edges:

The sharp front edges on the existing stations can cause mechanical stress concentrations on the tendons of the forearms if workers rest their arms on them.

Investigate adjustable work surfaces:

These adjustable surfaces are rapidly coming down in price. In future facilities, it may be cost effective to buy a percentage of adjustable work surfaces to adapt to anthropometric extremes. This will become more cost effective if the company moves to more multiple shifts sharing the same stations.

Provide a small number of standing work stations:

These standing stations could be placed along a side wall, and as long as the workers can maintain their identity by logging on to one of these stations, they could be used for up to 20 min at a time on a voluntary basis for workers that tire from continuous sitting.

Provide monitor stands:

Although the monitor heights in the current workstations appear adequate, as workers are trained to better adjust their chair to their worksurface height

to promote the best body postures for keyboard work and writing, the need for adjustment of monitor height will increase. These devices will be needed most by the taller workers. These devices will also help if multiple shifts will be using the same workstation. However, the nature of the work performed should be taken into account—you do not want to raise all of the monitors if it will force people to look up and down more.

Before concluding this report, the lifting and slip and fall incidents need to be addressed. Even though lifting is not a primary component of the jobs performed by those answering the phones (and perhaps because it occurs so infrequently), there were nine incidents due to lifting in clerical employees. These employees need to be trained in proper lifting mechanics. The prevention of slips and falls for these workers is more a safety issue than an ergonomic issue, but slips and falls often lead to back injuries. Three lost day incidents were caused by falls experienced by clerical workers. Seventeen other falls or trips were experienced by office workers, but these did not lead to lost days. Although the injury log did not indicate where the falls took place, most of them may have taken place in another location besides the Telemarketing floor. Disparate surfaces (like tile and carpet or concrete and ice) can cause slips or trips when people move from one surface to the other. Obvious trip hazards in the telemarketing area should be removed if found.

The implementation of any of these short or long term interventions could best be handled by an active Ergonomics Committee as part of a structured Ergonomics Program. Such a program would include the training for the managers, supervisors, and employees that is referred to above, as well as generally raising the level of awareness of ergonomic issues across the entire telemarketing operation. With the approaching Ergonomics Standard being developed by OSHA, it would be better to start this process sooner instead of later.

In summary, even though the telemarketing operation currently has incidence and severity rates below the national average, several suggestions for improvements have been presented. Based on the OSHA logs we reviewed, however, it appears that the maximum opportunity for cost justifying ergonomic interventions is found in the Fulfillment Center distribution operation.

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EXERCISES

4.1 Define muscular work.
4.2 Explain how energy (work) can be exerted without actually performing work as defined by laws of physics.
4.3 Explain the muscle contraction process.
4.4 Explain the chemical processes that take place in aerobic an anaerobic contraction.
4.5 Define braches of the peripheral nervous system that innervate the muscles.
4.6 What is the difference in a reflex and a muscular movement such as kicking a ball?

4.7 Explain why muscles fati
pational task where static
4.8 Discuss the different type
4.9 Describe a process for dy
4.10 Develop a process for col

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