Ergonomics study in Honeywell UOP India private Limited

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Abstract: The main aim of ergonomics is to help reduce injuries and occupational hazards while concentrating on how to make people enjoy their work. Improper workplace ergonomics can lead to musculoskeletal disorders, also known as repetitive stress injuries. Musculoskeletal disorders are the most common work-related health problems in the industrialized world. Proper ergonomic design is necessary to prevent repetitive strain injuries, which can develop over time and can lead to long-term disability.If the employees feel comfortable at their workplace, absenteeism and frequent breaks go down. Reduced hazards bring down the medical expenses while a healthy environment reduces chances of managers and employees turning in sick. All these contribute to enhanced throughput of the business.

***Index Terms* - Ergonomics community, Motion economy, Repetition, Mental Demands, static loading**.

I. INTRODUCTION

The term ergonomics is derived from the Greek words “ergon (work) and nomos (natural laws)”. Ergonomics is a science concerned with the "fit" between people and their work. It takes account of the worker's capabilities and limitations in seeking to ensure that tasks, equipment, information and the environment suit each worker. Ergonomics is the science of work. Ergonomics removes barriers to quality, productivity and human performance by fitting products, tasks, and environments to people. Ergonomics is the scientific discipline concerned with designing according to the human needs, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance. The field is also called human engineering, and human factors engineering. Ergonomic research is primarily performed by ergonomists, who study human capabilities in relationship to their work demands. Information derived from ergonomists contributes to the design and evaluation of tasks, jobs, products, environments and systems in order to make them compatible with the needs, abilities and limitations of people.

1.1. The Components of Ergonomics

Ergonomics deals with the interaction of technological and work situations with the human being. The basic human sciences involved are anatomy, physiology, and psychology. These sciences are applied by the ergonomist towards two objectives: the most productive use of human capabilities, and the maintenance of human health and well-being. In a phrase, ‘the job must fit the person’ in all respects, and the work situation should not compromise human capabilities and limitations.

a) Application of ergonomics to anatomical problems

The contribution of basic anatomy lies in improving the physical ‘fit’ between people and the things they use, ranging from hand tools to aircraft cockpit design. Achieving good physical fit is no mean feat when one considers the range in human body sizes across the population. The science of anthropometrics provides data on dimensions of the human body, in various postures. Biomechanics considers the operation of the muscles and limbs, and ensures that working postures are beneficial, and that excessive forces are avoided.

Many jobs are better done by workers of a particular shape and size. The motor car is an obvious example; the seating and controls are designed to suit the majority of the driving population. The same approach should be used in the design of most controls. Whilst many design engineers use their general knowledge and experience for positioning controls etc., there are statistical data used by ergonomists that give the dimensions of most parts of the body relating to percentages of the population. Using these data, the carmakers know fairly accurately the number of people who will not fit comfortably in their cars and can assess the cost of meeting their needs against the amount of lost sales.

b) Application of ergonomics to physiological problems

Our knowledge of human physiology supports two main technical areas. Work physiology addresses the energy requirements of the body, and sets standards for acceptable physical work-rate and workload, and for nutritional requirements. Environmental physiology analyses the impact of physical working conditions — thermal, noise and vibration, and lighting — and sets the optimum requirements for these.

The physiological effects of environmental factors have been traditionally catered for by increased rest allowances. Ergonomists have shown this practice to be erroneous; it now contravenes health and safety legislation. Actually by giving workers an increased rest allowance, indirectly translatable into cash, vulgarly but accurately called 'dirty money', management formally acknowledges the health hazard by bribing the worker not to make a fuss about it. Thus, there is cause for saying that both management and workforce become liable to prosecution where poor environments are compensated for in increased wages, however sophisticated the payment system may appear.

c) Application of ergonomics to psychological problems-Psychology is about the theory of the human mind.

Psychology is concerned with human information processing and decision-making capabilities. In simple terms, this can be seen as aiding the cognitive ‘fit’ between people and the things they use. Relevant topics are sensory processes, perception, long- and short-term memory, decision making, and action. There is also a strong thread of organizational psychology.

The difficulty with the application of psychology in management services departments is in its vagueness. Psychology is concerned with the analysis and classification of various states of the human mind. Because human beings vary so much between each other and in such complex ways, all attempts at classifying people into groups merely results in the statement of broad principles that may or may not be relevant to the individual worker on the shop floor or in the office.

II. LITERATURE SURVEY

J.L. Seminara.,[1]The writer conducted a survey of ergonomics in Yugoslavia during the month of December 1982. This survey was made possible by the scientific exchange program between the National Academy of Sciences of the USA and the Council of Academies of Yugoslavia. The writer met with engineers and scientists in academic, research and public health institutions to develop an overview of historical developments, the composition of the ergonomics community, current research interests and methodologies, academic training programmes and future trends.

S. Bao, H. Shahnavaz.,[2] Ergonomics or human factors, as an applied science concerning the design of interfaces between man, machine and the working environment, has shown its great capacities and potentials for improving working conditions and efficiency during its applications in most industrially developed countries (IC). As a means of improving the economy, industrialization has been initiated in many industrially developing countries (DC).

Markku Mattila.,[3] The aim of this paper is to give an overview concerning the fields of ergonomics for which computer-aided methods have been developed and to present experiences and possibilities how computer-aided ergonomics may benefit the implementation of ergonomic and safety expertise.

John R Wilson .,[4] In this paper ergonomics is defined as a discipline in its own right, as the theoretical and fundamental understanding of human behavior and performance in purposeful interacting socio-technical systems, and the application of that understanding to design of interactions in the context of real settings. This definition is justified in the financial, technical, legal, organizational, social, political and professional contexts in which ergonomics works.

Neville A. Stanton ',[5] A re-occurring theme in applied ergonomics is the idea of "giving the methods away" to those with little formal education in the subject. Little is known, however, about the reliability and validity of these methods when applied to the design process, for novices or experts. It is important to establish just how well the methods will perform in the hands of the analyst. The study reported in this paper presents data on novice intra-analyst and inter-analyst reliability together with criterion-referenced validity across a range of methods.

Gary A. Mirka .,[6] Industry-specific ergonomics guidelines are an important component in the four-pronged approach to workplace ergonomics currently pursued by the United States Occupational Safety and Health Administration. The American Furniture Manufacturers Association has taken the initiative of developing such a guideline for its members. The result of this effort is the "AFMA Voluntary Ergonomics Guideline for the Furniture Manufacturing Industry", a document that includes basic information about ergonomics program components as well as a compilation of work-proven, ergonomics best practices as submitted by members of the furniture manufacturing community. This guideline was developed through an industry-research-government partnership and made strategic use of the unique attributes that each sector brought to this effort.

Hal W. Hendrick.,[7] Based on evidence accumulated during the author's 45 years of professional experience, the author presents 23 important "lessons learned" regarding applying ergonomics to systems. Documented results from reporting cases or other evidence is presented to validate each of these practical learning points.

Janet Torma-Krajewski', [8] Since 1990 and the publication of the Ergonomics Program Management Guidelines for Meatpacking Plants by the US Occupational Safety and Health Administration, numerous reports of companies implementing ergonomics program have been published. However, despite these numerous reports, no examples of implementing an ergonomics program in the mining industry have been reported. In 2000, NIOSH initiated a long-term project to demonstrate the implementation of an ergonomics process designed to identify and reduce exposures to ergonomic risk factors found in mining.

Ole Broberg.,[9] A cross-sectional case study was performed in a large company producing electro-mechanical products for industrial application. The purpose was to elucidate conditions and strategies for integrating ergonomics into the product development process, thereby preventing ergonomic problems at the time of manufacture of new products. In reality the product development process is not a rational problem solving process and does not proceed in a sequential manner as described in engineering models. Instead, it is a complex organizational process involving uncertainties, iterative elements and negotiation between key actors. Design and production engineers have a great influence on ergonomics in manufacturing departments. Ergonomic considerations are partly taken into account by production engineers, but not as a part of standard operating procedures.

III. FACTORS OF CONSIDERATION

To produce a workplace that will minimum amount of strain to the worker, ergonomics takes into account the following three factors

3.1.Anthropometric data

Anthropometry is the study of measurement of physical features of human beings. It studies the strength of various muscles and ranges of body movement.

The data on human body dimensions are of two types

a)Structural dimensions:

These are body dimensions of a person in a static condition. There are two static positions, namely sitting and standing.

b) Functional dimensions:

These are the body dimensions of a person in motion. This is more important than the structural dimensions as most of the working conditions are dynamic in nature.

3.2.Human activity analysis

- Movements
- Human strength and endurance
- Speed and accuracy

3.3. Motion economy

Motion economy helps achieve productivity and reduce Cumulative Trauma at the workstation or sub-micro level. The Principles of Motion Economy eliminate wasted motion, ease operator tasks, reduce fatigue and minimize cumulative trauma such as Carpal Tunnel and tendonitis.

3.4. Principles of Motion Economy

a). Use of Human Body

- The **two hands** should begin end their motions at the same time.
- The two hands should not be **idle at the same time** except during rest periods.
- Motions of the **arms** should be made in opposite and symmetrical directions and should be made simultaneously
- Hand motions should be confined to the **lowest classification** with which it is possible to perform the work satisfactorily
- **Momentum** should be employed to assist the worker whenever possible, and it should be reduced to a minimum if it must be overcome by muscular effort.
- **Smooth continuous motions** of the hands are preferable to zigzag motions or straight-line motions involving sudden and sharp changes in direction.
- **Ballistic movements** are faster, easier, and more accurate than restricted (fixation) or "controlled" movements.
- **Rhythm** assists smooth and automatic performance. Arrange the work to permit an easy and natural rhythm.

b).Arrangement of The Work Place

- There should be a **definite and fixed place** for all tools and materials.
- Tools, materials, and controls should be **located close in** and directly in front of the operator.
- **Gravity feed bins** and containers should be used whenever possible.
- **Drop delivers** should be used whenever possible.
- Materials and tools should be **located** to permit the best sequence of motions.
- Provide for adequate **visual perception**. Good illumination is the first requirement.
- Arrange the **height** of the workplace and chair for alternate sitting and standing, when possible.
- Provide a **chair** of the type and height to permit good posture.

c).Design of Tools and Equipment

- Relieve hands of work that can be done more advantageously by a **jig, fixture, or a foot-operated device.**
- **Combine tools** whenever possible.
- **Pre-position tools** and materials.
- Where each finger performs some specific movement, such as in typewriting, the load should be distributed in accordance with the **inherent capacities of the fingers.**
- **Handles** (i.e. cranks and large screwdrivers) should permit as much of the surface of the hand to come in contact with the handle as possible, especially when considerable force is necessary.
- For **light assembly,** a screwdriver handle should be smaller at the bottom.
- **Levers, crossbars, and hand wheels** should be located in such positions that the operator can manipulate them with the least change in body position and with the greatest mechanical advantage.

IV. RESPONSIBILITIES OF MANAGEMENT AND EMPLOYEES

4.1 Management Responsibility

a) Management will support an employee suggestion procedure which will allow employees to bring their concerns to management and get feedback without fear of reprisal.
b) Management will support a procedure which will encourage the early reporting of signs and symptoms of Cumulative Trauma Disorders.
c) Management will support an ergonomics team, which has the required skills to identify and analyze jobs for ergonomic stress and which is capable of making recommendations for solutions.
d) Management commitment to provide adequate authority and resources to all responsible parties, so that assigned responsibilities are met.
e) Management commitment to assign and communicate the responsibility for the various aspects of the ergonomics program so that all managers, supervisors, and employees involved know what is expected of them.
f) Management will support a policy that places safety and health on the same level of importance as production. The responsible implementation of this policy requires management to integrate production processes and safety and health protection to assure that this protection is part of the daily production activity within the facility.

4.2 Employee Responsibilities

a) Employees will provide feedback to the ergonomic committee when the first signs of Cumulative Trauma Disorders are experienced.
b) Employees will work with the Ergonomics Team during the work analysis period. Once change has been recommended, the employee will implement the recommendations made. If the change does not resolve the problem, the employee will notify the committee and work with them until the problem has been resolved. The employees are encouraged to report any ergonomic hazard identified.

V. OCCUPATIONAL RISK FACTORS FOR ERGONOMIC DISORDERS

Occupational risk factors for ergonomic injuries include high force, high repetition, awkward postures, direct trauma or contact stress from hard or sharp surfaces, prolonged exposure to cold ambient temperatures, and exposure to whole body or segmental vibration. For cumulative trauma disorders, these risk factors may be present during hand-tool use, in manufacturing assembly or packaging jobs, or while working at computer workstations. High rates of CTDs are found in manufacturing, construction, and office trades. Back injuries are most prevalent among workers involved in manual materials handling, including truck drivers, nurses and nurses aides, forklift operators, and construction workers. High rates of back injuries are also found among workers in sedentary jobs, typically associated with postural stress.

5.1. Workplace risk factors are presented below:

a) Repetition

Repeated motions or tasks increase fatigue and muscle-tendon strain. Highly repetitive tasks often prevent adequate tissue recovery from the effects of awkward postures and force. A task is considered repetitive when the cycle time is less than 30 seconds or when one fundamental cycle constitutes more than 50 percent of the total cycle. The level of risk from repetition varies by body part.

b) Force

Forceful exertions increase the physiologic stress to muscles, tendons, and joints.The Muscles fatigue faster as the force exerted increases. The Force increases as the result of the following factors: object weight, load distribution characteristics (shifting or bulky loads require more force exertion), object friction (slippery objects or surfaces require more force), awkward postures, vibration (localized hand tool vibration increases grip forces), and the type of grip (a grip that involves one or more fingers and the thumb places three to four times more forces on tendons than a power grip).

c) Posture

Awkward postures require increased muscle force; contribute to muscle fatigue, tendon fatigue, and joint soreness; and increase forces on the spine.

d) Mechanical Compression or Contact Stress

Mechanical compression, such as grasping a tool or using a pinch grip, creates pressure over a small area. Hard or sharp objects, the sharp edge of the desk, and small diameter handles can cause mechanical compression that interferes with blood flow and nerve function.

e)Vibration

Force and acceleration play an important role in ergonomics. Occupational vibration sources include motor vehicles (e.g., heavy equipment, buses), and various handheld power tools that may contribute to worker discomfort and ultimately lead to injury. For practical purposes, the mere presence of vibration in the workplace is a potential risk factor.

5.2. Noise can be a Stressor

- If you work near a constant noise source, such as generators or fans, close your door, or wear earplugs.
- Besides causing ear damage, constant noise can create extra muscle tension in the body, causing fatigue and making it easier for ergonomic injuries to occur.
- If you use equipment which makes loud noise, wear ear plugs. EH&S can help you find some which are comfortable and appropriate

5.3. Temperature can be a Stressor

- People are more prone to ergonomic injuries in cold environments because circulation is slowed down and muscles and other tissues are more tense.
- Dress appropriately
- Do warm up exercises such as stretching before you begin work.

5.4. Psychosocial Stress

Any interactions, job tasks or personal problems which cause psychological or social stress cause increased muscle tension, which can make injury more likely. Be aware of these additional stresses and compensate for them by taking extra breaks and being especially careful when under extra pressure.

5.5. Individual Stressors

- People face different stresses and have different abilities to cope.
- Employees vary in physical condition.
- Some individuals are also dealing with chronic illnesses or disabilities

VI. ERGONOMIC DISORDERS

The different types of Musculoskeletal Disorders are as follows:

a) Repetitive Stain Injury
b) Carpal Tunnel Syndrome
c) Low Back Pain (LBP)
d) Herniated Disc
e) Tendinitis
f) Tenosynovitis
g) Epicondylitis
h) Thoracic Outlet Syndrome
i) DeQuervain's Syndrome
j) Ganglionic Cysts
k) Eye Fatigue

- **Repetitive Strain Injury** (RSI) is the general word that is used to describe the prolonged pain experienced in shoulders or hands or neck or arms. Repetitive Strain Injury occurs when the movable parts of the limbs are injured. Repetitive Strain Injury usually caused due to repetitive tasks, incorrect posture, stress and bad ergonomics. Repetitive Strain Injury generally causes numbness, tingling, weakness, stiffing, and swelling and even nerve damage. The chief complaint is the constant pain in the upper limbs, neck, shoulder and back. The Repetitive Stress Injury generally effects the group of workers who generally use excessive and repetitive motion of the neck and head are at high risk.
- **Carpal Tunnel Syndrome** is a pinched nerve (called the Median nerve) in the wrist. Carpal Tunnel Syndrome (CTS) is the inflammatory disorder that is caused due to repetitive stress, physical injury or any other condition that causes the tissues around the median nerve to inflate. Carpal tunnel is a small canal or tunnel runs from the forearm through the wrist. Bones form three walls of the tunnel, which are bridged by strong, broad ligament. The median nerve passes through this tunnel, which actually supplies feeling to the thumb, index, and ring fingers, the nine tendons that flex the

fingers and also provides function for the thinner muscles, which are actually the muscles at the base of the thumb as shown in figure1.

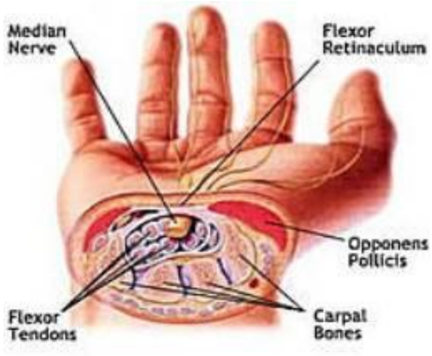

Fig.1 Carpal Tunnel Syndrome

The key risk factors in the workplace that causes the Carpal Tunnel Syndrome.

- Repetition
- High force
- Awkward joint posture
- Direct pressure
- Vibration, and
- Prolonged constrained posture.

VII. IDENTIFICATION OF POSSIBLE WAYS IN WHICH MSD'S OCCUR

7.1 Problem Area Identification

Two methods will be used to identify problem areas. Cumulative Trauma Disorder injury and illness trends will be monitored. Once an upward trend has been identified in an area or department, I will target the area for review in order to eliminate the root cause of the increase.

A. Analysis of Occupational Injury and Illness Records

1) I will use the internal injury/illness record for data collection.
2) I will track the Illness Type, Location of the Injury, Supervisor, and Job Classification on a monthly basis.
3) I will track the Incidence Rate for the factory and the individual work centers. When an upward trend occurs the individual records will be analyzed to identify the root cause of the increase. The results will be provided to management on a quarterly basis.
4) Once the location of the increase has been identified, I will perform a work analysis of the area in question.

B. Employee and Supervisor Suggestions

Employee and supervisor suggestions and complaints will also be solicited and analyzed. When an issue has been identified, a work analysis will be performed.

7.2 Work Analysis

The first step in the work analysis is to inform the employee of what to expect. The goal of the work analysis is to identify the following problems:

1. Work tasks which involve awkward movements
2. Tasks which involve excessive movements
3. Wasted motion or energy
4. Poor operation flow
5. Work tasks that present the potential for psychological stress
6. Cumulative Trauma Disorder factors
7. Need for automation
8. Need for tooling changes
9. Need for work method changes
10. Employee-generated changes in the work place

7.3. ERGONOMICS CHECKLIST

Ergonmic checklists - Work Method

a) Physical Demands

- Does the task involve a heavy muscular load; if so, does this limit selection of worker?
- Does the work involve overloading small muscle groups?
- Can the workload be transferred by method change to larger muscle groups thus reducing fatigue?
- To what extent can muscular effort be reduced by using suitable equipment?
- To what extent are heavy loads snatched or carried awkwardly?
- Are small or large muscle groups involved in static exertion by holding tools or material; can jigs be used?
- Is alternation of work and rest, and of static and dynamic work built into the work method?
- Is the pattern of movement in agreement with the principles of motion economy?
- Does the task require great accuracy of movement; is there an absence of feedback?

b) Mental Demands

- Is there the recommended compatible relation between direction of movement of control and the resultant effect?
- Can the controls be recognized easily by shape, size, labeling, color, for both normal use and in emergency?
- Are the controls as near as possible to the corresponding sources of information?
- Are the positions of controls in the right sequence for the performance of the task?
- Do workers receive sufficient information regarding the process flow and output?

- Have data to be processed before required action can be taken?
- Have different data to be compared before action can be taken?
- Are any data to be estimated?
- Are standards of comparison available and used?
- Are parts to be assembled, supplied correctly pre-orientated?
- Can signals be confused?
- Do signals always have the same level of significance?
- Is the task adapted to the capacities of older workers; considering thought, sight, hearing, touch and movement as separate processes?
- Are there adequate rest pauses during the monitoring work; to what extent can rest be taken during the task?

c) Flow of Information

- Are the data required to carry out the task obvious, unequivocal, and relevant?
- Is every part of these data necessary for performance; are differing and appropriate amounts of data available during the learning process?
- Is the rate of information likely to exceed the mental capacity of the operator and to overload him or her before the end of the task?
- Can the relative advantages of seeing, hearing, touching, smelling, etc. be used to advantage in spreading the information load more evenly?
- Is the rate of information likely to under load the operator?
- How are signals to be detected when the worker's mind is occupied by monitoring actions?
- Do the various displays of different information vary in more than one aspect? To what extent can they be distinguished from each other simply and in emergency?
- How much information has to be retained for longer than three seconds; to what extent is it reinforced by retrieval?
- Is the attention span longer than about 20 minutes if a signal can occur at any time; but does it occur less than about four times per half-hour?
- Can signals from different sources occur simultaneously or almost simultaneously; is this more likely to happen in an emergency when the consequences of misinterpretation could be catastrophic?
- Can preferred signals be easily distinguished?
- Do identical or very similar signals occur for a long time and are they frequently repeated?
- To what extent does the worker have to make one or more choices in response to a signal, and how soon does he or she know if the choice is wrong?
- Are all the factors relevant to a decision presented at the right time and sequence?
- Is adequate time allowed for decisions and resulting actions, not only in the normal circumstance but more importantly in the emergency?
- To what extent does rapid feedback give the results of system adjustment; to what extent is there a knock-on effect?

d) Ergonomic Checklists - The Workplace

Physical Demands

- Is the workspace adequate?
- Does the position of equipment, controls and workbench allow a satisfactory posture and correct control by hand and foot?
- Does the worker have to stand for all or most of the time; alternatively, must he or she remain seated for all the time?
- Is the provision for the worker to sit adequate in relation to the task?
- Is the height of the worktable satisfactory in relation to posture and viewing distance; if posture is unsatisfactory is it due to the construction of the machine, workbench, controls, or portable instruments?
- Is the surface of the workbench satisfactory in regard to hardness, smoothness, color, and slope?
- To what extent are any foot controls required?
- Are pedals satisfactory in respect of position and size, and is special allowance made if there are more than two for sitting postures or any used for a significant time for standing postures?
- Are foot rests and/or supports for arms, hand, back, available if required; do any of these restrict the safe and effective operation of the task?
- Are the characteristics of the hand controls compatible with the forces required to operate them (shape, size, surface) and are the forces acceptable?
- If hand tools are used, are they the correct ones for the task; are they adequately maintained, and are they accessible to the operator in the most effective way?
- Are containers used; is their position, size and weight satisfactory?
- To what extent can the speed of the machine be adjusted according to the skill and/or preference of the operator and how does this affect output?
- Is design and layout of the equipment satisfactory for repair and maintenance?
- Are any of the considerations unsatisfactory so as to bring liability under health and safety regulations; are recommendations as to operator comfort and stress clearly distinguished?

e)Ergonmic Checklists - Workplace Sensory Demands

Vision:

- Does the task impose high visual demands?
- Is the illumination level adequate for the visual demands required?
- Is lighting met by general and/or local lighting?
- Is the visual contrast between workplace and surroundings as it should be?

- Is there any discomfort glare; is there any disability glare?
- Is color discrimination needed; are operators screened for visual acuity, and what allowances are made for ageing?
- Are controls, instruments, equipment etc. in comfortable visual range and adequately lit?
- Are warning lights correctly designed and located?

Hearing:

- To what extent are auditory signals used; are their characteristics appropriate to the message conveyed?
- Does noise level permit adequate verbal communication if required in the task?
- Is confusion possible because of auditory signals required for other tasks?

Other senses:

- Does the task require accurate tactical discrimination?
- Are all controls and tools recognized by touch, and are they positioned correctly?
- Does the task require a good sense of balance (with ladders), and are these workers regularly screened, especially older workers?
- Does the task require accurate position movements or exact application of muscular force?
- Does the task require a good sense of smell or taste; if so, has any attempt been made to check the abilities of the operators?
- Have the effects of vibration, infrasound or ultrasound been thought of seriously, both in the health and safety context and in terms of performance decrement?

f)Ergonmic Checklists - Visual Displays and Dials

Legibility:

- Can the required data be obtained from display quickly with the required accuracy?
- Are the scales correctly graduated and are as simple as possible; not giving needless or spurious accuracy?
- Do the letters, numbers, graphics and markings conform to the relevant standards in relation to the required reading distance; is the required reading distance different from the normal reading distance?
- Are pointers and other indicators simple and clear, and do they allow numbers to be read without obstruction?
- Are pointers mounted so that the visual parallax is minimized?
- Have great differences in brightness between displays, dials and surroundings been avoided?
- Is the legibility of the display impaired by reflection of light sources?
- Is the legibility of dials impaired by bright lights visible within the same area of vision?
- Has shadowing by pointers, edges, or controls been avoided?
- Does the chosen numerical progression minimize reading errors?

Grouping:

- Is it possible to group the different categories of dials and displays in different planes or surrounds of mounting?
- Can groups of displays of a specific category be divided by area or color patterning; are the layouts of displays so contrived as to highlight when the normal changes to abnormal?
- Are displays located near to their corresponding controls?
- Have the most important and/or the most frequently used instruments the best position in the normal visual field?
- Are the most frequently used instruments grouped together in one and in the same area of the visual field?

Positioning:

- Is the positioning of controls on similar machines or displays correctly standardized?
- Does reading of instruments require undue movement of head and/or body?
- Is the location and size of the display correct in regard to sitting posture, arm reach and viewing direction?

Accuracy and speed:

- Is the accuracy of the instrument compatible with the required reading accuracy?
- Are reading errors minimized by the design of the instrument?
- Is the time lag between changes in the system and indication of it in the display minimized as far as possible?
- Are digital displays used for accurate reading and for adjusting to a predetermined value?
- Is a moving pointer display used for estimation of the degree of deviation and for adjusting deviation?
- Is the dial as simple as possible in regard to the desired information; can colored zones (e.g. red, amber, green) be used instead of numbers and markings when only check information is required?
- Is a satisfactory signal used to indicate the breakdown of a measuring instrument; and is the knock-on effect whereby several alarms may occur simultaneously avoided in favor of the most important?

Conformity:

- Does the grouping and arrangements of displays conform to the required reading sequence?
- Do pointers and other graphics point in the same direction when equipment is working correctly?
- Does the direction of the movement display have a similar meaning in different displays? Is the positioning of displays in different colors the same where these panels serve a similar purpose?

Controls:

- Is it possible to see immediately which situation is indicated by the position of the control?
- Does the controlling hand impede the reading of the dial?
- Is it possible to indicate the zero position by a stop?
- Is it possible to recognize controls or visual graphics by means of differences in shape, color or size?

7.2. PREVENTION AND CONTROL

The focus of this section will be to ensure ergonomic hazards are prevented. This will be accomplished through effective design of the work station, tools and task. The goal will be to focus the activity on making the job fit the person .

This is the second stage of this project. In this step I am going to describe the possible preventive measures which are provided by means of engineering controls and the administrative controls for the identified risks which are not eliminated by means of engineering measures are described.

7.2.1 ENGINEERING CONTROLS

Ergonomic engineering controls redesign the equipment or worksite to fit the limitations and capabilities of workers. Where an ergonomic evaluation determines that engineering controls or accommodations are required, such controls or accommodations must be provided at no cost to the employee. Equipment or worksite redesign typically offers a permanent solution, e.g., a video display terminal workstation that can be adjusted to a wide range of anthropometrical dimensions.

The preferred method to resolve ergonomic issues is via internal controls and tool/work station design.

- ***Work Station Design***

Work stations will be designed to conform to the workstation guidelines ., The Ergonomic Guidelines for Industrial Engineers. Individual workstations will be tailored to meet their needs.

- ***Tool and Handle Design***

Tools shall be designed to meet the requirements outlined in the tool design guidelines The Ergonomic Guidelines for Industrial Engineers. The tool selection shall be based on eliminating or minimizing the following stresses:

1. Chronic muscle contraction or steady force
2. Extreme or awkward finger/hand/arm positions
3. Repetitive forceful motions
4. Tool vibration
5. Excessive gripping, pinching, pressing with the hand and fingers

- **Work Practice Controls**

Employees/Supervisors will be trained on proper work posture. Once an employee has been trained, the supervisor will monitor the area for improper work posture. The following areas will be examined.

1. Proper tool holding techniques
2. Proper work posture
3. Correct lifting techniques
4. Proper maintenance of pneumatic and power tools
5. Correct use of work stations and fixtures

7.3 ADMINISTRATIVE CONTROLS

Although engineering controls are preferred, administrative controls can be helpful as temporary measures until engineering controls can be implemented or when engineering controls are not technically feasible. Since administrative controls do not eliminate hazards, management must assure that the practices and policies are followed. Common examples of administrative control strategies for reducing the risk of WMSDs are as follows:

1. Employees Exposed to Ergonomic Stressors

In those cases where the operator will be exposed to ergonomic stressors, the following administrative controls will be enforced.

a. Decreasing production rates and limiting overtime work.
b. Providing rest periods to allow recovery time of muscle-tendon groups.
c. Increasing the number of employees assigned to a task to alleviate severe conditions, especially in lifting heavy objects or jobs requiring a lot of work above shoulder height.
d. Using job rotation as a preventative method. Care must be taken to alleviate physical stress of a particular set of muscles and tendons by rotating employees among other jobs that use different muscle-tendon groups.

2. In those cases where a job has been identified as an ergonomic stressor, the ergonomics committee and the industrial engineering department will work to eliminate the problem either by redesigning or automating the task.

7.4. PERSONAL PROTECTIVE EQUIPMENT (PPE). PPE is not necessarily recommended for controlling exposure to WMSD hazards, since little research has been conducted to support claims of its usefulness.

- Appliances such as wrist rests, back belts, back braces, etc., are not considered PPE. Before purchasing such devices, their potential effectiveness should be discussed with trained ergonomic personnel.
- Consider WMSD hazards when selecting PPE. The PPE should:
- Be properly worn or used according to manufacturer's specifications.
- Be available in a variety of sizes.
- Accommodate the physical requirements of personnel and the job.
- Not contribute to WMSD hazards.

Implementing Controls

Ideas for controls can be derived from a variety of sources:

- Trade associations may have information about good control practices for addressing different problem operations within an industry
- Insurance companies that offer loss control services to their policyholders
- Consultants and vendors who deal in ergonomic specialty services and products
- Visits to other worksites known to have dealt with similar problem operations

Ideas from these sources are in addition to those ideas gained from brainstorming with employees who perform the jobs or from work teams engaged in such problem solving.

Implementing controls normally consists of

- trials or tests of the selected solutions,
- making modifications or revisions,
- full-scale implementation, and

- follow up on evaluating control effectiveness.

Testing and evaluation verify that the proposed solution actually works and identifies any additional enhancements or modifications that may be needed. Employees who perform the job can provide valuable input into the testing and evaluation process. Worker acceptance of the changes put into place is important to the success of the intervention. After the initial testing period, the proposed solution may need to be modified. If so, further testing should be conducted to ensure that the correct changes have been made, followed by full-scale implementation. Designating the personnel responsible, creating a timetable, and considering the logistics necessary for implementation are elements of the planning needed to ensure the timely implementation of controls. A good idea in general is that ergonomic control efforts start small, targeting those problem conditions which are clearly identified through safety and health data and job analysis information. Moreover, the control actions can be directed to those conditions which appear easy to fix. Early successes can build the confidence and experience needed in later attempts to resolve more complex problems.

Evaluating Control Effectiveness

A follow up evaluation is necessary to ensure that the controls reduced or eliminated the ergonomic risk factors and that new risk factors were not introduced. This follow up evaluation should use the same risk factor checklist or other method of job analysis that first documented the presence of ergonomic risk factors. If the hazards are not substantially reduced or eliminated, the problem-solving process is not finished.

The follow up may also include a symptom survey, which can be completed in conjunction with the risk-factor checklist or other job analysis method. The results of the follow up symptom survey can then be compared with the results of the initial symptom survey (if one was performed) to determine the effectiveness of the implemented solutions in reducing symptoms.

Because some changes in work methods (and the use of different muscle groups) may actually make employees feel sore or tired for a few days, follow up should occur no sooner than 1 to 2 weeks after implementation, and a month is preferable. Recognizing this fact may help avoid discarding an otherwise good solution.

In addition to the short-term evaluations using job analysis methods and symptom surveys, long-term indicators of the effectiveness of an ergonomics program can include

- reduction in the incidence rate of musculoskeletal disorders,
- reduction in the severity rate of musculoskeletal disorders,
- increase in productivity or the quality of products and services, or
- reduction in job turnover or absenteeism.

The above-mentioned indicators offer bottom-line results in evaluating interventions that have been put into place. Other indicators may also be used that represent in-process or interim accomplishments achieved on the path to building an ergonomic program for example, the extent of the ergonomic training given the workforce, the number of jobs analyzed for potential problems, and the number of workplace solutions being implemented. While bottom-line results are most telling in terms of defining a successful program, the interim measures allow the total development to be monitored.

VIII. TRAINING

The key to a successful ergonomic program is employee education. All levels of personnel must have an understanding of what a Cumulative Trauma Disorder is and how to prevent the illness from occurring. They must also have a clear understanding of who they need to contact in case a problem should develop. Most Cumulative Trauma Disorders are preventable or can be resolved if the cause is identified early.

a) General Training

Employees who are potentially exposed to ergonomic hazards will be given formal instruction on the potential hazards associated with their jobs and equipment. Information provided will cover the varieties of Cumulative Trauma Disorders, what risk factors contribute to them, how to recognize and report symptoms, and how to prevent these disorders. This training will occur on an annual basis.

b) Job Specific Training

New employees and re-assigned employees will receive an initial orientation and hands on training in ergonomics prior to assuming new job responsibilities. A break in period for new employees or employees transferring to new job assignments will be established. The training will include what are Cumulative Trauma Disorders, the associated contributing factors, prevention techniques, proper tool usage and proper work station set-up.

Employees will also be notified of who to contact should signs of Cumulative Trauma Disorder occur.

c) Training for Managers, Supervisors and Ergonomics Team Members

1. Managers, Supervisors and Ergonomics Team members will be given a training class comparable to that of the employees, but with additional training which will help reinforce the ergonomics program.

2. Managers, Supervisors and Ergonomics Team members will be able to identify and recognize early signs and symptoms of cumulative trauma disorders, and hazardous work practices.

3. Managers, Supervisors and Ergonomics Team members will also be provided information which will allow them to correct improper work practices and set-up.

IX. MONITORING

1. The Supervisor/Manager will enforce the stretching program and encourage employee participation. The purpose of the program is to help eliminate the static loading of the worker's body. The stretches should be performed every hour except when a break or lunch occurs. It should be noted that the stretching program shall be performed during overtime periods.

2. The Supervisor/Manager will monitor the area for the implementation of the work analysis recommendations.

3. The Supervisor/Manager/Ergonomics Team will perform regular monitoring of all levels of the operation to help ensure that employees are practicing proper work technique per their ergonomics training.

Ergonomic breaks

- Follow the "20/20/20" rule for computer use: Every 20 minutes, take 20 seconds and look 20 feet away. Always try to get away from your computer during lunch breaks.

- Avoid eye fatigue by resting and refocusing your eyes periodically. Look away from the monitor and focus on something in the distance. Rest your eyes by covering them with your palms for 10-15 seconds. Use correct posture when working. Keep moving as much as possible.

AbbreviationsandAcronyms

CTD	*Cumulative Trauma Disorder*
RSI	*Repetitive Strain Injury*
EPI	*Environmental Program Inventory*
MSD	*Musculo Skeletal Disorder*
CTS	*Carpel Tunnel Syndrome*
EH&S	*Environmental Health & Safety*
LBP	*Low Back Pain*
PC	*Personal Computer*
WMSD	*Work Related Musculo Skeletal Disorder*
VDT	*Visual Display Terminal*
PPE	*Personal Protective Equipment*

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