"ROLE OF ERGONOMICS IN INDUSTRY: A REVIEW"

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Abstract

Role of ergonomics in manufacturing industries and computerized world is discussed in this paper by reviewing some literature available in the area of ergonomics, its relevance in our day to day working environment in the area of manufacturing industry and human interface with consoles/panels on different machines in particular. In today's industrialized and high technological scenario, back, neck and shoulder discomforts in human beings are very common in different work fields. If such discomforts prolong for a long time without suitable rest period, they can lead to musculoskeletal disorders (MSD's). Relief to human being from such discomforts can be provided by implementing the different ergonomic practices like redesigning of work stations and seating apart from training the individuals in basic ergonomic principles. The aim of ergonomics is to improve the efficiency of operation by taking into account a typical person's size, strength, speed, visual acuity and physiological stresses such as fatigue, speed of decision making and demands on memory and perception. The different case studies conducted by researchers have resulted in solution for various problems that mainly occur during different types of work in an industry or day to day life, these are presented in the paper.

Introduction

In ergonomic research, man, machine, and the environment are regarded as an integrated system. The main subject of ergonomic research is man-machine system. Ergonomics studies the characteristics of a man, the machine, and the environment that are manifested under specific conditions of interactions and works out method for taking these characteristics or factors into account when modernizing and developing equipments and technology. In addition , it studies such questions as the proper distribution of functions between man and machine , the operation of man machine systems, and the means of determining criteria for optimizing such systems; the criteria developed take into account the abilities and traits of the working of person or group.

The first study on ergonomics which took place directly was in 1920's, when physiologist, psychologist, physicians and engineers in USA, Japan , Great Britain undertook the interdisciplinary study of man at work ,with the aim of making maximum use of his physical and pschycological capacities. The term ergonomics was proposed by polish scientist W.jastrzebosky in 1857, but it came into common practice after 1949. Ergonomics has developed intensively in many countries throughout the world since the mid-1950. The international ergonomics association, with members in more than 30 countries, was founded in 1961. Considering the importance of ergonomics, the international ergonomics congress is held every three years.

Ergonomics

According to Barry Baith "human factors engineering is an applied science that take research about human abilities, limitations, behaviour, and processes and uses this knowledge as a basis for the design of tool, products and systems". Applying human factors principles leads to design that are safer, more acceptable, more comfortable, and more effective for accomplishing their given tasks. Ergonomics is a multi disciplinary field in which individuals trained in human factors come from such diverse backgrounds as engineering, psychology , computer science, anthropology, and informational science.(source; MDDI-medical device and design industry magazine,)

According to an Italian ship research company CETENA "ergonomics is the study of human performance and its application to the design of technological system, the goal of this activity is to enhance productivity, safety, convenience and quality of life". Thus ergonomic study include models and theories of human performance, design and analytical methodology, human-computer interface issues, environmental and work design, and physical and mental workload assessments. Human factors engineering requires input from disciplines ranging from psychology and environmental medicine to statistics.

Literature Review

Ergonomics best practices for manufacturing – Ohio- manual for ManufSafeGrant elaborates on following issues and best ergonomic practices for the industries.

Ergonomic issues in industries

The following are the issues related with ergonomics in different industries;

Manual material handling: It is the main source of injuries in any of the industry, and 4 out of 5 of these injuries affect the lower back. The following risk factors are common which can increase back injuries-

Lifting heavy loads, carrying bulky loads or loads far away from the body, Frequent lifting, bending the trunk (when picking items up off the floors or when reaching into a bin), twisting the trunk, static loading (as holding or carrying objects for long time period) and pushing or pulling etc.

Stretch wrapping: stretch wrapping material on pallets by hand creates awkward postures in trunk and in the shoulders. Workers often hold these postures for extended periods as they apply stretch-wrap around the pallets.

Hand tools use: prolonged or repetitive hand tool use can lead to increased rates of upper extremity CTD's such as tendinitis or carpel tunnel syndrome. The increased risk originates from following risk factors-

High force requirements, awkward risk postures (bending the wrist), repetitive motions, contact stresses (such as when the base of the tool presses against the base of wrist) etc.

Work station design: almost all the manufacturing industries have workstations where parts are cleaned assembled or packed. The following risk factors are always presents at these workstations ;

Prolonged standing on hard surfaces can lead to poor blood flow in the legs, feet and back, fatiguing the worker.

Prolonged sitting can also create stresses on the back by forcing the back to curve outwards. Seats with inadequate padding and adjustability also can place contact stresses on the legs and buttocks, which implies blood flow.

Reaching into small parts bins or boxes often causes the worker to flex the wrist. Frequent wrist flexion is associated with an increased risk of CTD's. it can also lead to stresses on the shoulders and back.

Manual labour involved in assembly, processing and material handling: a variety of situations exist in manufacturing where hands-on ,labour intensive activity is required, for example when a worker manually removes the welding flash with a sharp hand tool. This repetitive activity creates awkward wrist postures, and high forces on the base of the wrist.

Best ergonomic practices in manufacturing

Lifting aids: one can install lifting aids to lift, tilt or turn materials, these devices don't eliminate the need of handling but they can aid in locating materials so employee can handle them with minimal trunk flexion and minimal reaching.

Lift assist devices: it uses mechanical means to lift materials, thus reducing work exposure to the risk factors commonly associated with manual materials handling. This reduces force on the body by mechanical means (usually electric, hydraulic or pneumatic) to provide the lifting power. Such devices include hoists, cranes, manipulators and vacuum lifters.

Transport devices: manually transporting involves lifting, carrying, pushing or pulling. These activities generate large forces in hands, wrists, elbows and shoulders, which can lead to severe injuries. Transport devices reduces these risks Mechanical means include carts, conveyers, tugs, power trolley's and forklifts.

Stretch wrapping machine: these are commercially available that automatically wrap the material. generally a fork truck or pallet jack delivers pallet of the materials to the machine , and employees then activate the machine. Once the machine wraps material, employees remove the pallet of material.

Powered hand tools with ergonomic design features: ergonomic hand tool design can reduce the CTD's factors. The consideration of following guidelines in hand tool manufacturing reduces the risks-

Use power tools whenever feasible, the power tool must have trigger design, thumb activated tool is preferred over those activated by use of other fingers (min two fingers use for activation), Isolate or dampen vibration, provide protection from exhaust and heat generated by motor or tool bit and use of counterbalance mechanism for heavy loads.

Ergonomic best practices for manufacturing: some general ergonomic practices includes the following-

Shape , size and orientation: this includes the following-

Avoid ridges and flues, length of handle should be minimum of 4 inches, minimum handle diameter must be 3 inches and handle span should be maximum of 3 inches

Handle material: It should be non porous, non conductive and padded. It must provide good friction.

Grasping force must be minimised, power grip to be preferred over pinch grip, tool grip size shall be proper and there shall be two handed grip to distribute force exertion.

Posture (wrist should be in line with the hand and forearm).

Ergonomic work station design: incorporate good ergonomic principles into workstations. Some of them are as follows;-

Anti fatigue floor mats:- anti fatigue floor mats should be provided in areas where employees stand for long periods of time. The matting should have bevelled edges to avoid tripping , be of sufficient thickness and size and be durable

Chairs with proper ergonomic design features: the chair on which the workers need to sit must have good features like, adequate lumber support, adequate adjustability (especially in height to fit a wide range of users), controls should be easy to reach and operate and should be stable with 4 to 5 feet base.

Automation : when automation is implemented , the process is completed entirely by machine. The worker now usually has the role of operating, monitoring and sometimes loading the machinery. Example of automation includes CNC machines , automatic case packers and palletiser .

Semi automation: when semi-automation is implemented, a particularly hazardous part of the job is usually automated. However the interventions still requires substantial operator involvement such as operating the machine and providing continuous control. Example of semi-automation includes controlled lathes, saws, grinders and presses.

ERGONOMIC DESIGN OF HUMAN CNC MACHINE INTERFACE

Ergonomic Design of Human – CNC Machine Interface (www.intechopen.com) by Imtiaz Ali Khan has elaborated on CNC machine (EDM) – human interface work based on experimentation conducted by him. Vital findings based on his work are reported below.

After the evolution of industrial revolution, industrialisation has been at the core of the economic development of the country. In a simple sense , industrialization means replacement of human labour by machinery to manufacture goods.

Ergonomics is concerned with the fit between people and their technological tools and environments. It takes account of the users capabilities and limitations in seeking to ensure the task , equipment, information and the environment suit each user. To asses the fit between a person and the technology used, ergonomists considers the job being done and the demands on

the user ; the equipment used (its size , shape, and how appropriate it is for the task) ,and the information used.

The ergonomics commonly refers to the designing work environments for maximizing safety and efficiency . Biometrics and anthropometrics play a key role in the use of the word ergonomics. Anthropometry refers to the measurement of the human individual for the purpose of understanding human physical variation.

One of the most notable component of this hi-tech era is the emergence of human _CNC machine interaction. It basically comprises of CNC workstation and an operator. The use of CNC is increasing exponentially. This is accompanied with a proportionate increase in occupational stresses too in human operators. The problems associated with the use of CNC machine could be traced in terms of physical characteristics of the CNC workstation , visual factors, psychological factors and postural factors. The improper postural factors are responsible for musculoskeletal disorders. Many occupations are associated with high risk of arm and neck pain.

Working with hands at or above the shoulder level may be one determinant of rotator cuff tendinitis. Industrial workers exposed to the task that require working over shoulder level include panel controlled CNC machine operators , shipyards welders, house painters and so on. Disorder and pain in the arm have been related to the gripping an instrument and awkward posture. Several factors which are considered to influence the static activity of the shoulder muscles and horizontal distance between the worker and the working place , position of the task, height of the working table , shoulder joint flexion , abduction/adduction and the posture etc.

The CNC _ human interaction is increasing exponentially due to growth of automation in manufacturing and design. Therefore , the need of the moment is an efficient and effective ergonomic design of the CNC workstations.

The most important consideration in the human CNC machine interaction environment are the angle of abduction (Fig. 3) and viewing angle (Fig. 4), which always plays a key role in system design of CNC control Panel (Fig.1).

COMPUTER – HUMAN ITERFACE

In today's working environment most of the white collar employees and in particular software professionals have to work for many hours on computers and for them although ergonomically designed seats, keyboards and mice are important (Fig. 2), perhaps the most beneficial aspect of ergonomics is teaching people to get up periodically and stretch as being advised by M/S Hewlett-Packard Company.

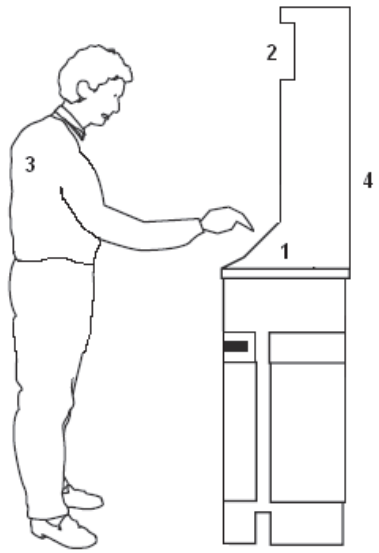

Fig. 1- Schematic representation of experimental setup: (1) Key-board (2) Visual display (3) Subject (4) CNC M/C

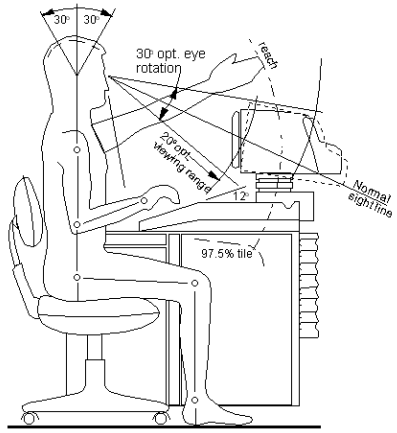

Fig. 2 - Computer – human interface (M/S HP)

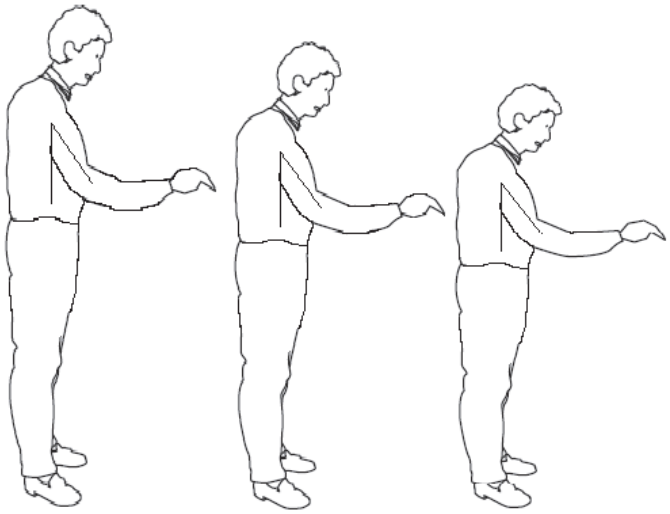

Fig. 3 - Showing the abduction angles (45, 55 and 60 degrees) for 5’9”, 5’6” and 5’4” tall

Subjects, respectively.

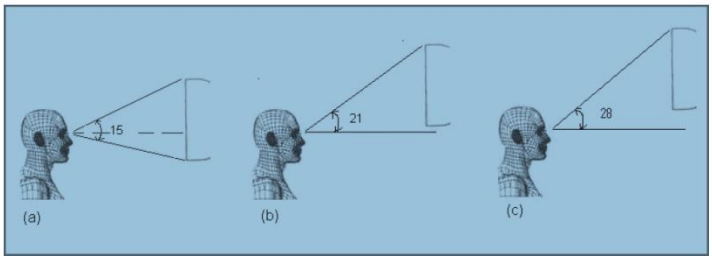

Fig. 4 - Showing the CNC monitor and considered viewing angles for (a) 5'9", (b) 5'6" and c) 5'4" height subjects, respectively.

Result

The ergonomics issues related to different industries and CNC M/C – human interface research reported by researchers is reviewed in details and the suggestions to overcome/reduce human related problems in different industries, computer – human interface and CNC M/C – human interface which are very useful are reported in this paper.

Conclusion

In today's industrialised and high technology world, back, neck and shoulder discomforts in human beings are very common in different work fields. If such discomforts/pain prolong for a long time without suitable rest periods they can lead to musculoskeletal disorders (MSD). MSD in industrial worker leads to inefficiencies coupled with huge compensations for such cases in advanced industrialised world. The suggestions on use of lifting devices, transport devices like trolley's, stretch wrapping machine, powered hand tools, ergonomic work stations and ergonomically designed CNC M/C – human interface and automation helps to reduce the human discomforts in present day industrialised world. It would also improve efficiencies in industries. Teaching/advising computer professionals, working for a long period continuously in front of computers, to get up periodically and stretch as reported by Hewlett – Packard is also very useful.

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