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ERGONOMICS IN WORK ENVIRONMENT AND ITS CONTROL

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ABSTRACT:

The principal objective of Ergonomics is to fit the task to the user and not the user to the task. Incorporating Ergonomics principles in the work environment guarantees productivity, quality, reliability and job satisfaction while maintaining sound occupational health and safety. The purpose of this paper is to identify various critical components of ergonomics work environment and their control with a proactive approach. The critical components are Anthropometry, work related musculoskeletal disorders, manual material handling, workstation design for static works.

1.0 INTRODUCTION:

Ergonomics is the study of the interaction between people and machines, equipments, work stations, tools etc and the factors affecting the interactions. Ergonomics is the process of designing the work station, machinery and systems etc so as to fit them to the user while maintaining the health and safety of the user. Its aim is to improve the performance of the system by improving human-system interaction. This can be achieved by proper design of human-system interface and the work environment. In general, the aim of Ergonomics is to fit the task to the user and not vise a versa and developing and implementing necessary controlling measures that will improve productivity and reduce risks to safety and health.

This paper focuses on important ergonomic issues like anthropometry, Ergonomic design consideration for various controls, working postures for material handling in respect of manual material handling such as lifting, lowering, pushing, pulling and carrying heavy objects, postures for tasks associated with seat-stand position, Musculoskeletal disorders caused due to various types of tasks like assembly work, grinding, hammering welding etc. The paper also discusses the various controlling measures to be implemented in the organizations to eliminate or reduce the Ergonomic hazards by improving work policies and adopting inclusive ergonomic program and other measures like adjustable design approach, anthropometric design principles etc.

2.0 ANTHROPOMETRY:

Anthropometry is the study of bodily dimensions of the people for the purpose of designing equipments, workstations facilities etc that suit the people who use them. These should be designed to fit the bodily dimensions of the users to make them convenient, comfortable and productive to use.

Anthropometric measures are usually expresses as percentile. The most common are 5th, 50th and 95th percentile measures as shown in the following table.

Percentile	Description
5th percentile	5% of population is smaller
50th percentile	Average value
95th percentile	95% of the population is smaller

Different anthropometric measures (e.g. popliteal height, seating height etc) of the persons are measured and 5th percentile, 95th percentile values are calculated. These anthropometric measurements of the person are compared with the values of general population. A person whose body stature is above 95th percentile means he is taller that 95% of the persons. Generally the smallest value denotes 5th percentile female and the largest value denotes 95th percentile male.

The common procedure is to design the equipments, workstations, facilities etc for a range of populations from 5th percentile (smallest person) to 95th percentile (largest person). This is because there are large differences in body size due to gender and genetics, for example, a chair used by a male is oversized and uncomfortable for a female and vice a versa. The principle of “let the small person reach and let the large person fit” may be used for designing work station. It implies that reach distances should be designed for the small (5th percentile person) and clearance dimensions may be designed for the large (95th percentile person).

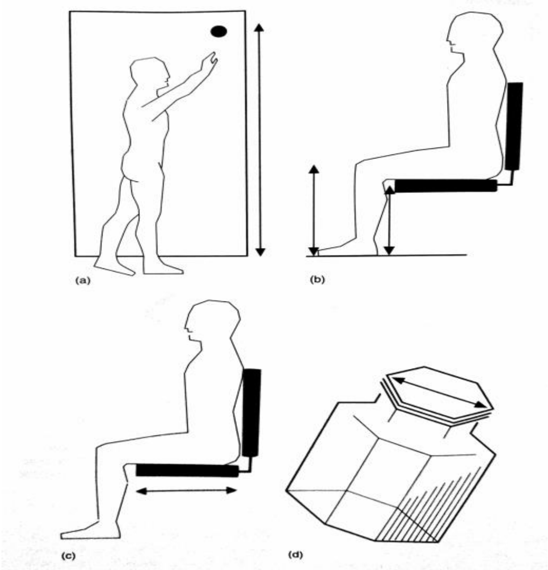

Figure 1: Examples of maximum allowable dimensions. (a) A door lock must not be higher than maximum vertical reach of a small person. (b) Seat height and (c) depth must not be higher than popliteal height and buttock-knee length of small users. (d) Screw-top lids must be wide enough to ensure sufficient contact area to provide adequate friction. Also it must not exceed grip dimension of small person.

3.0 WORK RELATED MUSCULOSKELETAL DISORDERS:

MSDs are the conditions that affect the musculoskeletal system of human body. It presents in the muscles, joints, blood vessels, nerves of the limbs and back. Symptoms include discomfort, numbness, pain and severity differs from mild to chronic.

Repetitive jobs are the concerns to the ergonomics because of its potential to cause musculoskeletal disorders (MSDs). MSD is the single largest group of work related injuries among all types of work related injuries. Prolonged sitting with wrong postures often cause these types of disorders. MSDs mainly include three types of injuries (i) Muscle pain, (ii) Tendon injuries and (iii) Nerve injuries. Most important localizations of work related MSDs include the following: (i) Upper extremities i.e. shoulder neck, arm, hand wrist (ii) Lower back and (iii) Knee.

The MSDs caused due to various types of jobs are as follows.

(i) The MSDs caused due to Overhead assembly work-

The MSDs on the affected area of shoulder and arm are: Myofascial pain syndrome, Tension neck syndrome, Rotator off syndrome & Compartment syndrome.

The MSDs on the affected area of neck: Myositis, Fibrositis, Muscle pain, Tender pain, Trigger point, Myalgia, Fibromyalgia, Muscular rheumatism.

(ii) The MSDs caused due to Welding: Tension neck syndrome, Carpel tunnel syndrome, Lower back pain, Knee pain, Bursitis, Triger finger, Tenosynovitis.

(iii) The MSDs caused due to Grinding: Carpel tunnel syndrome, pronator teres syndrome, tenosynovitis

(iv) The MSDs caused due to manual hammering: Carpel tunnel syndrome, Tennis elbow, Epicondilitis, Ulnar nerve entrapment

The guidelines to eliminate/reduce work related MSDs include the following.

(i) Formulate and develop policy on prevention and management of WMDs.

(ii) Conduct ergonomic assessment to identify factors to cause MSDs

(iii) Create awareness about the causes of MSDs and to provide proper training on ideal working postures for manual material handling such as lifting, lowering, pushing, pulling and carrying heavy objects and postures for tasks associated with seat-stand position.

(iv) Encourage people for early reporting of discomfort to proactively prevent discomfort into an injury.

(v) Formulate, develop and maintain Standard Operations Procedures (SOP) ensuring zero risk of MSDs involved with safe and healthy work environment including guidelines on accidents and near miss reportings and investigation.

(vi) Create healthy and safe working environment

(vii) Formulate injury management system including rehabilitation and back to work

(viii) Internal control on compliance to SOPs and policies by conducting regular audits.

4.0 MANUAL MATERIAL HANDLING:

Among all industrial accidents, a large proportion is associated with manual handling of material due to wrong working postures. While manual handling like lifting, carrying of heavy loads, compressive and shear forces act on the spinal structure and quick lifting of load increases the magnitude of these forces. Quick lifting of loads requires greater forces to be applied and it imposes heavy load on spinal structure. Due to asymmetric posture while lifting or carrying heavy loads, additional pressure is acted on the spine and to counteract the pull of gravity, greater muscle forces are required. Moreover, lifting load with asymmetric posture and acceleration of the trunk develops muscle contraction around the trunk. The abdominal muscles stabilize the spine while lifting the object. While forward leaning to lift the object, the flexion develops in the spine and the back muscle contracts to counteract this flexion. When the heavy object is lifted the compression at spinal structure increases and its magnitude increases further when the object is lifted quickly. Thus the wrong postures while lifting, lowering and carrying heavy objects affect the efficiency of lifting.

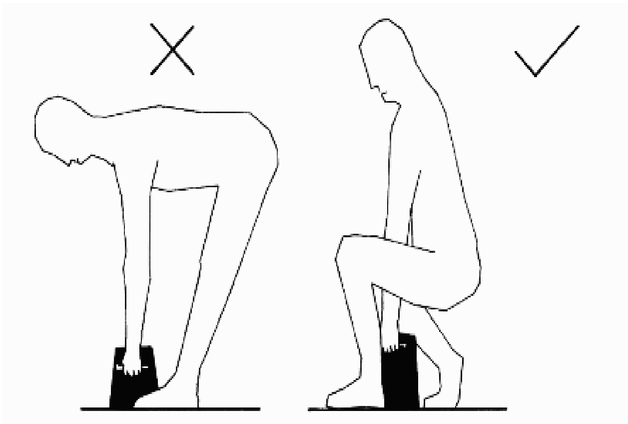

Figure 2: Correct lifting technique (Lift with knees and not with the back)

The recommendation for correct lifting and lowering the tasks and general guidelines for reducing the risk in manual material handling include the following.

(i) If the object to be lifted is asymmetric then re-arrange it and if it is heavy go for mechanical lifting aid.
(ii) Ensure stable base before lifting. To ensure proper balance, place one leg ahead of the other.
(iii) If close approach of the task finds difficult then slide the object towards the body before lifting.
(iv) While lifting, keep the body straight with knee in bending posture.
(v) Ensure shoulder level and body face to be in the same direction.
(vi) Gripping the object should be done with the palm and not with fingers.
(vii) Arms should be kept close to the body to ensure proper support
(viii) The object should be held close to the body at wrist level while keeping the arm straight.
(ix)The object should be carried with straight arms because it lowers the strain in shoulder and upper arm.
(x) The body should not be twisted while carrying the load to avoid damage to tissues at the back.
(xi) Increase the height of lifting point and decrease it at the termination point.
(xii) The storage of heavy parts in the shelves between shoulder and knuckle height.
(xiii) Ensure functional reach, provide free space around and under the work.
(xiv) Ensure some free space for the entire body to turn.
(xv) Prefer swivel chairs for seated work.
(xvi) Minimize the frequency of lifting as far as possible.
(xvii) Job rotation of workers should be followed.
(xviii) Reduce the weight of hand tools as far as possible (use plastic tools wherever possible)
(xix) Increase wheel size of the trolleys to minimize the pushing/pulling efforts.
(xx) Stacking of objects should be done above the shoulder height.

5.0 STATIC WORK POSTURES (SEATING AND STANDING WORK):

5.1 SEATING WORK:

Seating is the most common and frequent body posture. More than half of the people from industrial sector involved in prolonged seating activities are suffered from one or other form of back injuries. The lumbar is the area that is damaged the most. It occurs due to prolonged seating with wrong work posture and with poor seating design. Human bodies have different sizes and shapes so design for one person may not be appropriate for other and therefore seating chair must be designed to suit the wide range of people, for example, the chair should be designed such that it should be suitable for a 5 feet female to 6 feet male.

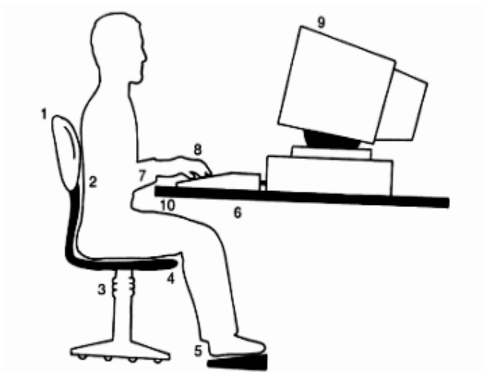

Figure 3: Seating posture

1. Seat back adjustability
2. Good lumbar support
3. Seat height adjustability
4. No excess pressure on underside of thighs and back of knees
5. Foot support if required
6. Space for postural change
7. Forearms approximately horizontal
8. Minimum extension and deviation of wrists
9. Screen height and angle should allow comfortable head position
10. Space in front of key board to support hand/wrist during pauses in keying

The key features of chair design include the following.

(i) Swiveling arrangement with heights adjustable between 39-54 cm.
(ii) Foot rests must be provided for short users.

(iii) A 5-point base must be provided to ensure stability.
(iv) Free space for legs should be provided under the work surface to allow knee extension and under the seat to allow the user to flex.
(v) A backrest of height approximately 50 cm above the seat should be provided for lumbar support to ensure stability of trunk.
(vi) Lumber support should be strengthened by providing extra cushioning.
(vii) Open space should be provided between lumbar support and seat pan to allow for posterior protrusion of the buttocks.
(viii) The seat pan must have a slight hollow area in the buttock area to prevent the user pelvis from sliding forward.
(ix) The armrests should be high enough to supports the forearms when the user is sitting erect.
(x) Thin layer of high density padding should be used as layers of thick foam tend to destabilize the sitter.

5.2 STANDING WORK:

Work in standing postures is more tiring than seating and therefore standing for prolonged time with incorrect posture is unhealthy. It puts higher strain on legs and feet and requires more energy than seating. The objects involved in standing postures are placed between hip and shoulder height to reduce postural stress caused by working with hands and arms elevated. The height of the working surface should be standing elbow height of the worker depending upon the tasks. When involving with fine work, higher work surface is preferred to allow worker to stabilize the forearms by resting them on the work surface. On the other hand while involving heavy works a lower work surface is preferred to permit the worker to apply vertical forces by transmitting body parts through the arms.

5.3 GENERAL GUIDELINES FOR WORKSTATION DESIGN FOR SEATING AND STANDING POSTURE:

(i) Proper clearance should be provided between desks and benches so that foot and knee position are not constrained.
(ii) The area around the work surface should not be used as storage space.
(iii) The feet should not be confined to small area as this reduces the balance.
(iv) For every task, an optimum visual and manual distance should be maintained.
(v) The foot rails should be provided for standing workers and foot rests for seating workers.
(vi) The sit-stand work station may be designed and standing workers may be allowed to sit 50 % of the day.
(vii) Height adjustable working platforms should be provided for standing workers.
(viii) For seated worker, height that will fit taller workers should be preferred and footrests should be provided for shorter workers.
(ix) Simultaneous use of hand and feet should be used wherever possible.
(x) The wrist should be flat with respect to forearm and it should not be bent forwards or backward.
(xi) Upper arm should be used to use mouse and mouse should not be handled by side-to-side movements of the wrists.
(xii) Minimum necessary force should be applied on the key/button.
(xiii) Neutral wrist position should be maintained while performing activities like manipulating mouse of computer.
(xiv) While gripping the tool the middle finger should be in alignment with the forearm and not be angled forward the thumb or small finger.

6.0 CONCLUDING REMARK:

Ergonomics suggests scientific ways of efficient working with minimum muscular exertion. Benefits of Ergonomics reflect in many forms, in productivity, reliability, quality & job satisfaction while maintaining sound occupational health and safety. The scope of Ergonomics is not restricted to only industrial sector but it also encompasses all aspects of human lives.

Understanding the importance of ergonomics and incorporating the ergonomic practices in the work environment is the key to success of the business with effective human resource utilization. In this paper the emphasis was given on various critical components of ergonomics pertaining to work environment and various controlling measures with proactive approach were suggested. The proactive approach is more effective than responding to injuries after its occurrence. The scope of Ergonomics seems to be significantly expanded to every aspect of our lives.

REFERENCES:

1) Maria-Eena Boatca, Anca Draghhici, Nicoleta Carutasu, Management Department, Polytechnica, University of Timisora, Romania, Department of Machines and Manufacturing systems, University Polytechnica of Buchrest, Romania, A knowledge management approach for ergonomics implementation within organizations
2) Robin Burgess-Limerick, Sustainable Minerals Institute, The University of Queensland, 4072, Australia, Participatory ergonomics: Evidence and implementation lessons

3) Céline Chatigny, Ana Maria Seifert & Karen Messing, (1995), Universite du Quebec, Canada, Repetitive Strain in Non repetitive Work: A Case Study, International Journal of Occupational Safety and Ergonomics
4) R S Bridger, Text book on Introduction to Ergonomics, Third edition-2015
5) Martin Helander, Text book on Ergonomics of Manufacturing
6) Jeffrey E. Fernandez, Michael Goodman, Exponent health group, Alexandria. Ergonomics in the workplace.
7) Guidance on the Prevention and Management of Musculoskeletal Disorders (MSDs) in the Workplace, published in 2013 by the Health and Safety Authority, The Metropolitan Building, James Joyce Street, Dublin.
8) Enrico Del Fabbro, Daria Santarossa, Electrolux Professional 33170 Pordenone ITALY, 48th CIRP Conference on Manufacturing systems - CIRP CMS 2015, Ergonomic analysis in manufacturing process, A real time approach
9) Johannes Labuttis, Siemens AG – Corporate Technology, Otto-Hahn-Ring 6, Munich 81739, Germany, Ergonomics as element of process and production optimization