

1. DESIGN FOR STANDING WORKERS :-

As a rule of thumb all objects that are used by standing workers should be placed between hip and shoulder height to minimise postural stress caused by stooping or working with hands and arms elevated. When carrying out heavy work a lower work surface is needed and when carrying out fine work a higher work surface is needed. This to promote ease of work and better performance standards. Some of the common evaluation mechanisms used for standing aids are the following :-

a) Footrests and Footrails :-

- Bridger and Orkin determined the effect of a footrest on a pelvic angle in standing. It was raised to 250mm above surface and the net pelvis rotation was 4-6 degrees.
- Whistance confirmed that the use of a footrail reduced anterior pelvic tilt, straightened the support leg and increased the plantar flexion on the supporting foot.
- Use of a flat or a 15° tilted platform was perceived to be better than use of a simple footrail, but all standing aids were preferred to standing on a bare floor.
- Average switchtime of foot from footrest to platform was found to be 90 seconds.

b) Compression Stockings :-

- Knijnen evaluated the effects of rubber floor mats and compression stockings on the leg volume of standing workers suffering from chronic venous insufficiency.
- The wearing of compression stockings brought a significant reduction in leg swelling and in complaints.
- Male workers found stockings to be comfortable.

c) Anti-fatigue Mats :-

- Stuart-Buttle report that prolonged standing causes significant localised leg muscle fatigue, particularly in the gastrocnemius muscles.
- There are many reasons why standing workers should not have to stand on hard and sometimes cold concrete floors during work hours.
- Mats or Carpets provide provide a more yielding surface and better insulation.
- Kong's research found out that mats was received well among the working community over the concrete floor.

d) Toespace :-

- Panels or obstructions in front of benches cause users to stand further away from the workspace. The postural adaptation is for people to bend forwards.
- Whitson found out that it was a combination of pelvic tilting and lumbar flexion which placed stress on the spine.
- Toespace can help avoid this complexity and Delaura & Kony, came up with a set of standing and sitting postures that accounted for toespace.

2. DESIGN OF REPETITIVE TASK :-

The design of tools and workspaces can have a profound effect on the posture of the body. The control of finger movements depends on many small muscles that can easily become fatigued, with prolonged work with inadequate rest periods and poorly designed tools. Bringing about a mechanical edge to all products in terms of handling them was the problem at hand for designers.

a) HANDLE DESIGN :-

- Pheasant and Neil investigated the design of handles in terms of gripping and turning task. They found that strength deteriorated when handles greater than 5cm in diameter were used for the purpose.

→ knurled cylinders were found to be superior to smooth cylinders because of the increase in friction at the hand-handle surface.

→ The handle should be at a size that it permits the slight overlap of thumb and fingers of a worker with small hands.

→ Grip strength depends largely on the posture of the wrist. When the wrist is extended, the finger flexors are lengthened and can therefore exert more tension resulting in a stronger grip. When the wrist is flexed, the opposite occurs and grip strength is weakened.

Eg:- Tools such as saws and pliers can be designed with obliquely set handles to enable the wrist to be maintained at neutral. Tools such as soldering iron use a pistol grip handle for ease of access.

→ DeQuervain's Syndrome leads to inflammation of the tendons due to poor handle grips and continual work.

→ Tools can be redesigned and fitted with longer handles, or handle extensions can be fitted to the worker's vertical reach, obviating the need for the hands to be raised above shoulder height.

b) KEYBOARD DESIGN:-

- Typewriters had to be stopped after a carriage line and had to be handled manually to restart and correction of errors was a tedious task.
- All of these tasks provided changes in posture and broke up the continuity of the typing task.
- The major challenge in designing keyboards means a reduction in musculoskeletal problems in keyboard operations.
- Zipp investigated the posture of the hands and wrists noting marked ulnar variation and fatigue.
- This brought about the design of different banks in a keyboard which was aptly kept separated from one another.
- A mechanical typewriter wanted a degree of force for a keypress whereas the electronic one produced strain on the shoulders. A force of 0.5 N is needed for a keystroke.
- Guard provided evidence that conventional computer keyboards can be improved by enhancing the auditory feedback when keys are pressed.

3. DESIGN FOR SEATED WORKERS

For workers performing their tasks in a seated manner, there are some basic ergonomic principles that are followed to assist their work. They are the following:-

a) OFFICE CHAIRS :-

- Research suggests that chairs must be designed in a forward tilted manner.
- These chairs must permit users to sit in an erect manner, and less posterior pelvic tilting and flattening to the lumbar curve because the tilt of the seat increases the trunk-thigh angle.
- Chairs are designed to preserve the lumbar lordosis in sitting.

KEY FEATURES OF STATIC SITTING :-

- Seats should swivel and be height adjustable and footrests must be provided.
- There must be ample leg space under the seat to place the knees in a comfortable position.
- The seat must be slightly hollow to support the buttock area.
- The backrest must support the trunk by providing lumbar and thoracic support.

DYNAMIC SITTING:-

- The prime function of a seat is to support the body mass against the forces of gravity. The second function is to stabilise the open chain system.
- The comfort of a seat depends in a dynamic sense, on the extent to which it permits muscular relaxation while stabilising the open chain system of body links.
- Every user would prefer a tiltable seat, and flexibility to change posture.
- The application of these gentle twisting motions was found to ~~result~~ result in increase of spinal length over a 1-hour period of sitting - significantly more than subjects sat in a static control chair.
- These findings support that fact of rotation applied to the vertebrae during sitting reduces pressure in the nucleus pulposus, allows fluids to enter, increasing disk thickness and improves the nutritional status of the disc.

b) WORK SURFACE DESIGN:-

- Important considerations in improving the situation of workstations is to provide increased tilt, and provision for free space in the working area.

- Research proved that chairs with forward tilting seats should be used with desktops the tilt towards the user is about 15° to lessen the visual angle and encourage a more upright posture.
- The effects of tilted seating is seen on subjects seated on both conventional and sloping seats.

PLACEMENT OF WORK OBJECTS:-

- Pearcey has shown that the twisting mobility of the back is increased in sitting compared to standing.
- This is due to morphology of the lumbar facet joints permits more axial rotation of superior vertebral body over the inferior body when the spine is flexed.
- This involves the asymmetric handling of loads from a seated position.

c) VISUAL DISPLAY UNITS:-

- The design of VDUs is important for achieving a balance between the user and the workspace for interactive computer work.
- The guidelines proposed in the standards specify use space requirements and to define appropriate furniture in functional & physical terms.
- VDUs support activities of varied styles and professions and there is no single correct workspace arrangement to satisfy all requirements.

A. FACTORS AFFECTING DESIGN OF WORK CAPACITY, STRESS & FATIGUE:-

There are several factors that affect the person's capacity to carry out physical work. They are the following:-

a) BODY WEIGHT:-

- * Body weight influences all activities in which the worker stresses his/her body.
- * Relatively we express VO_2 max as the person's oxygen consumption to body weight.

b) AGE:-

- * Age is a significant factor that affects work capacity.
- * VO_2 max gradually declines after 20 years of age.
- * A 60-year old has an aerobic capacity of 70% of a 25-year-old. This is due to reduction of cardiac output.
- * Heart is essentially a muscle which explains the loss of aerobic capacity with age.

c) SEX:-

- * Women have a lower VO_2 max than men but have a higher % of body fat.
- * The Cardiac o/p per litre of oxygen intake is higher in women than men.
- * There are some ergonomic implications as well, in terms of upper body strength being better for women and lower body strength is better for men.

d) ALCOHOL :-

Alcohol may increase or decrease the cardiac output in submaximal work, thereby reducing cardiac efficiency.

e) TOBACCO SMOKING :-

- * Tobacco smoke has 4% of CO which has an affinity for haemoglobin.
- * It reduces the capacity to work by reducing the oxygen carrying capacity of the blood. It causes chronic damage to the respiratory system, which impairs oxygen transportation.
- * Non-smokers who work in the same space as smokers end up suffering the same effects by breathing in the smoke laden air.

f) TRAINING :-

- Work capacity can be enhanced by physical training, and job training for efficient work methods.
- Specific training methods can be developed to strengthen the particular musculoskeletal system, with the goal of improving performance and preventing injury.
- Over a period of time, muscle fibres tend to strengthen owing to an overall increase in strength.

2) Nutritional Status and General Health:-

- A balanced diet is important to ensure adequate amounts of necessary vitamins and lesser body fat.
- Saturated fat tends to increase problems of cholesterol. cholesterol affects the artery thus hampering flow of blood.
- The hampered bloodflow increases the risk of Cardiac Attacks and decreases performance.

h) Food intake and Food Supplements:-

- Energy requirements are not met to an appreciable level in most countries. so there is an increase in the usage of supplements to meet the energy needs.
- Workers tend to maintain their level of work OHP but they reduce the amount of energy they spend on leisure activities.

i) Motivation:-

Motivation is an extremely important quality for work capacity. Intrinsic factors such as personality, goals, need for achievement, work culture, peer group. tends to demotivate employees and causes a lot of mental ailments.

j) Air Pollution :-

- It tends to increase the resistance of air flow in our respiratory system, and can cause lung damage.
- Carbon Monoxide is one of the crucial contributors which leads to decrease in work capacity.
- The work capacity of people doing heavy manual work in urban areas is degraded by air pollution.

5) DESIGN OF MANUAL HANDLING TASKS:-

NIOSH has produced a work practices Guide for the design of manual handling tasks and an equation for determining safe loads. The 3 principles of industrial medicine are to first remove the threat, second to remove the operator and third to protect the operator. Some of the ergonomic principles to be followed are the following:-

a) TASK REQUIREMENTS :-

- Having to grasp or hold the load at a distance from trunk
- Having to twist the trunk from load lifting.
- Having to lift or lower objects below knee or above shoulders
- Lifting while seated.
- Carrying loads frequently.
- Lifting loads for long periods of time.

→ Lifting or moving load through large vertical or horizontal distances.

b) WORKSPACE DESIGN:-

→ Confined Spaces - The ability to exert force decreases with space limitations.

Eg:- less use of legs and load on trunk.

→ Height of Object - Only items with height between knees and elbow height must be lifted.

→ Flooring - Space for the feet should be provided both underneath the load and around the worker.
Avoid slippery floors.

c) Design of lifting Tasks:-

There are several factors that influence the design of lifting tasks they are :-

Increase lifting Time:-

- Reduce lifting frequency.
- Follow proper work-rest cycles.
- Job rotation for partitioning the work.
- Increase the time for the job.

Minimise the weight:-

- Work as a team.
- Use smaller containers.

- Automate the process.
- Machines should transfer loads between surfaces.
- Change the job from lifting to lowering, lowering to carrying, carrying to pulling, pulling to pushing.
- Use handles and hooks for better grip.
- Reduce the weight of Containers.
- Balance the weight to avoid sudden shifts.
- Hold containers close to body.
- Work surfaces should allow easy movement of containers.

Minimise Reach and lift distances :-

- Increase initiation height and decrease termination height.
- Stack objects should not be above shoulder.
- Avoid deep shelves.
- Avoid lifting in seated position.
- Storage bins should have spring bottom.
- Use sloped surfaces to gravity feed items to point of lifting.
- Provide free surface around and under work surface for increase in functional reach.
- Provide access space around components for reducing manual repositioning.
- Store heavy objects in shelves between shoulder & knee height.