

DVTE (MR) MANUAL

DVTE(MR) MANUAL Science and Technology in Employment of Persons with Mental Retardation

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PART- 2

Scanned
04/05/2013



Rehabilitation Council of India
(A statutory body of Ministry of Social Justice and Empowerment)

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MANUAL**

**Science and Technology
in Employment of Persons
with Mental Retardation**

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Science and Technology in Employment of Persons with Mental Retardation

PART-2

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Rehabilitation Council of India
in association with

KANISHKA PUBLISHERS, DISTRIBUTORS
NEW DELHI-110 002

KANISHKA PUBLISHERS, DISTRIBUTORS

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*Science and Technology in Employment of Persons
with Mental Retardation (Part-2)*

First Published 2006

Edition 2009

© Rehabilitation Council of India

PRINTED IN INDIA

Published by Madan Sachdeva for Kanishka Publishers, Distributors,
4697/5-21A, Ansari Road, Daryaganj, New Delhi-110 002, Typeset by
Sunshine Graphics, Delhi, and Printed at Rajdhani Printers, Delhi.

Foreword

"A book that fills the mind with beauty and opens the heart to what is lovely and lovable is a treasure forever." It allows transmission of knowledge from generation to generation and from place to place. Books have always been our best friend and a source of learning. We read and write for many purposes, most of the time they are either social or academic.

This manual attempts to serve the academic needs in the field of Special Education and Rehabilitation. Disability Studies are mostly dependent on western books and literature with very little being available within the country. An effort has been made to fill in the gaps that existed, by preparing the manuals that would be simple in approach, easy to understand and serving the students needs. We hope that they will prove to be an effective tool not only for students and teachers, but also for parents, NGOs and organizations of persons with disability. The manual attempts to consciously follow the course syllabus and in the process explore the general and disability specific issues. In the process of creating such specifically tailored manuals for the courses, there are possibilities of oversights or errors despite our being careful. The Council would like to invite your suggestions and comments so that the subsequent editions, revised versions can be improved upon.

Time and again, it was emphasized that there is a great dearth of study material for the students as well as the teachers for the various diploma level courses in discipline of Special Education and Rehabilitation of the Council. This set the Council to take up the onerous task of manual preparation. Lots of effort has gone into the process, by the authors and the editors. Searching for the appropriate and relevant material that should go into the manual, readily understood by the trainee has been a gigantic responsibility executed with extreme care by the specialist team chosen for this purpose.

The Council would like to thank everyone associated with the project for their contribution. We hope that the manuals are able to unlock the doors of knowledge and successfully develop an insight into the world of persons with disability.

(Dr. J.P. Singh)
Member-Secretary

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Environmental Restructuring

Unit-1

**Technology and its Application in the Service of Man
Technology and Science as Applied to Machines,
Ability to Simplify Life, Enhance Productivity, Make Life
Comfortable, Create Jobs, Direct Economy**

STRUCTURE

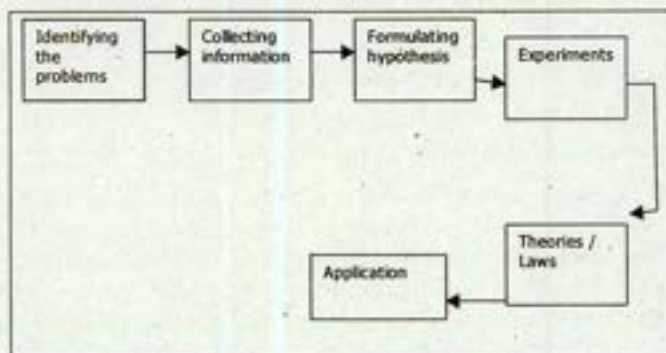
- Introduction
- Objectives
- Basic Needs
- Food
- Clothing
- Shelter
- Security
- Health and Essential Services
- Unit Summary
- Check Your Progress
- Points for Discussion/Clarification

Technology and its Application in the Service of Man Technology and Science as Applied to Machines, Ability to Simplify Life, Enhance Productivity, Make Life Comfortable, Create Jobs, Direct Economy

Introduction

Man has always tried to understand the world around him. In trying to do so, new ideas and concepts are formed. Over the ages this effect has lead to development of a body of knowledge, which we call science. Different scientific theories or laws are formulated on the basis of the existing informations. Different experimentations are carried out to test the laws or theories.

The theories are then applied for the use of humans. So the technology may be called as the practical application of scientific



theories/laws proposed in the form of theories and finding out the practical approach, which can be used for upliftment of human's ability or life.

If we look back to our ancient time and compare with the modern ages it is obvious that the life becomes easier without having much of difficulties to survival in modern time and it is due to the advancement of science and technology.

Objectives

1. To visualize what is science and technology.
2. To determine how science helps the nation to build its economy.

Basic Needs

In 1950 the world population stood at 2.5 billion. In 2000 it has been reached at around 6.2 billion, an increase of 250 percent in just 50 years. Over 90 percent of that increase has occurred in developing countries. Now around 1 billion people are living below the poverty line and struggling to meet their basic needs. These basic needs are:

Food

Enough food for everyday to generate the energy needed for living and working.

Clothing

Enough clothing to afford protection from adverse weather conditions and to permit bodily cleanliness.

Shelter

A shelter that provides protection under healthy conditions and that is equipped with certain household equipments and furniture.

Security

Security against violence and unemployment, and that provides for one's personal needs in sickness or old age.

Health and Essential Services

Essential services are safe drinking water, sanitation, access to energy use, medical care, education and a means of transport. For better-off segments of the population, the aspiration is to raise their standard of living further and improve their quality of life. Quality of life is an improvement in the quality of those basic needs, and in

the range and quantity available so that a person exerts the option of choice among various alternatives, for example in housing, clothing or food. Human aspirations also extends to a desire for a healthier and cleaner environment, cultural activities, the ability to have and make use of leisure time in an enjoyable manner, and an income that would allow a person to support these various endeavors.

For a society or a nation to raise the standard of living of its population, it must strive to maximize the return from its resources or improve productivity so that the economy can grow and sustain a better quality of life.

What is Productivity?

$$\text{PRODUCTIVITY} = \text{OUTPUT} / \text{INPUT}$$

This definition applies in an enterprise, a sector of economic activity or the economy as a whole. The term productivity can be used to assess or measure the extent to which a certain output can be extracted from a given input. While this appears simple enough in cases where both the output and the input are tangible and can be easily measured, productivity can be more difficult to estimate once intangibles are introduced.

A lot of advancement in communication, transportation, and engineering sector make our life more comfortable and easier. Again in places where technology plays a pivotal role, a wide range of products with good quality are available for utility. Using advanced technology a good quality of quantity product can be produced and thereby decreases the cost of product, which in turn captures a greater market share as more users can purchase the product. More output means more productivity. Thus, G.N.P. of nation will be more. Again to have a good range of product, better infrastructural support, better industrial support is necessary. When these many numbers of systems are in function obviously better job opportunities with better facilities, better per capita value will generate which will give a sound economy of a nation. Sound economy gives the opportunity of the people to earn better and spend more. So more money circulation in the form of product comes into the market, which will enhance the business opportunities also. Thus by proper using of technology by any country must have a bright future by producing more products by creating more job opportunities, enhancing direct economy.

Unit Summary

Application of engineering concepts is called technology. Using technology more product with good quality can be produced. More produced product will enhance the "Gross National Product" of the country which will help to increase the per capita value of the people. Thus increment per capita value helps a lot of money circulation in the market, which indicates the sound economy of the country. This will help to enhance the business opportunities. Thus by using technology, a country can produce more product, which in turn create more job opportunities, enhance direct economy and quality of life of the persons with mental retardation.

Check Your Progress

1. Discuss role of technology in human's life.
2. How technology helps to improve the quality of life?
3. Write short notes on:
 - (a) Quality of life.
 - (b) Science and technology.

Points for Discussion/Clarification

Environmental Restructuring

Unit-2

Spatially/Cognitive Adjustment for Removing Barriers to Performance Arrangements in the Work Environment, Freedom of Movement of Hands, Legs, Visual Fields, Optimum Location of Components, Removal of Architectural Barriers, Optimum Lighting, Ventilation, Seating, Environmental Assistance to Reduce Effect of Cognitive Deficiencies

STRUCTURE

- Introduction
- Objectives
- Physical Environment
- Psychological Environment
- Anthropometrics
- Some Useful Terms
- Climate Conditions
- Working in the Cold Environment
- Working in a Wet Environment
- Control of Thermal Environment
- Ventilation
- Freedom of Movement of Visual Field
- Noise and Vibration
- Unit Summary
- Check Your Progress
- Points for Discussion/Clarification

2

Spatially/Cognitive Adjustment for Removing Barriers to Performance Arrangements in the Work Environment, Freedom of Movement of Hands, Legs, Visual Fields, Optimum Location of Components, Removal of Architectural Barriers, Optimum Lighting, Ventilation, Seating, Environmental Assistance to Reduce Effect of Cognitive Deficiencies

Introduction

People spend most of the time engaged in the performance of tasks. Tasks are the activities with specified goal. Tasks are carried out in the home, at the work place, on the road, in leisure and sports and on the battlefield. Thus, a task may involve setting up and operating an industrial lathe, using a computer, digging a hole with a garden spade or driving a motorcar. A person using some tools or machines carries out very many tasks; the machine is employed in order to extend human ability, to enable people to do things they cannot do unaided or to make the task easier to perform. Task however is not carried out in a vacuum. In all cases the interaction between user and machine takes place within some workplace which itself is located in an environment.

Objectives

1. To approach the physical understanding about workplace and environment.
2. To design a workplace considering static anthropometrical measures.
3. To approach the cognitive aspects of user-machine interface.

Physical Environment

The characteristics of the workspace and the environment will affect the performance of tasks. The workspace is described in terms of the size and layout of chairs, tables, controls and other equipments. These will affect the position, postures and reach of the expected range of users and hence comfort and efficiency.

All activities take place in an environment, the characteristics of which may be expressed in terms of climate (hot/cold, draughty/stagnant, dry/humid), the amount of noise and vibration, the nature and amount of illumination. Research as well as everyday experience has shown that these environmental factors are important determinants of the user's effectiveness with which equipments and machines are used.

Psychological Environment

The circumstances in which people work- the structure of the organization and the role of the individual in the physical environment affect the psychological environment.. The psychological environment will have profound effect on the attitude of working people, their satisfaction in work, the quality and quantity of the output and eventually the success of the organization.

Anthropometrics

Space requirement for a comfortable and safe body position at work should be derived from anthropometrical considerations that take into account of variation in the size of workers. Anthropometrics is the study of dimensions and certain other physical characteristics of the human body such as weight/mass, volume, center of gravity, internal properties of body segments and strength of various muscle groups. Anthropometrical measurements are critical elements in equipments and workplace/workspace design. Utilization of anthropometrical data will enable designers to accommodate a desired position of the potential user population in their design.

The anthropometrical data may also be classified for various percentiles of population e.g. 5th, 10th, 50th, 90th and 95th percentiles.

Some Useful Terms

Percentiles: Percentiles corresponds to the value of a variable below, which a specific percentage of the group fall. For example, the 5th percentile standing height for males is 63.6 inch (162 cm). This means that only 5 percent of males are smaller than 63.6 inch (162 cm). The 50th percentile male height is 68.3 inch (173 cm) which is the same as the median since 50 percent of males are shorter than this value and 50 percent are taller. The concept of percentile is especially important in using anthropometrical (body dimension) data for designing of objects, workstations and facilities. The basic application of anthropometry in design is finding appropriate dimensions to be incorporated in the design. There are two types of dimensions that determine what the design dimension should be—*clearance* and *reach* dimensions.

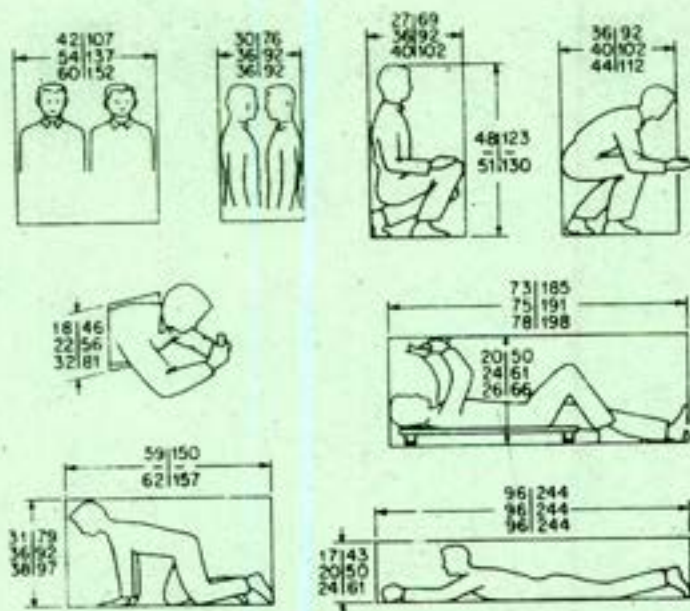


Figure 2.1: Clearances for Certain Work Spaces that Individuals may be

Clearance: These dimensions determines the minimum space required for a human being to perform work activities in the work place, such as operating and maintaining machines and so on. The larger people from the expected user's population establish clearances. (e.g., the size of a door frame is determined by the size of the largest expected user). People sometimes have to work in, move through or even just fit into some restricted or awkward spaces. This is especially true for some type of maintenance work. For illustrative purposes examples of clearances required for certain types of work situation are given below. In most cases heavy clothings adds 4-6 inch (10-15 cm) to the requirements.

Reach: These dimensions determine the maximum space allowable for the human beings who operate the equipments and are established by the smaller people in the expected user population (e.g., control height is determined by accommodating shorter people).

Design for a range: The most common design criteria is to design for a range of the population. A typical range of the 5th to 95th percentile of the population is used. Such a design would be expected to accommodate 90 per cent of the design population. Design range can be wider or narrower and are typically determined by task criticality and cost.

Anthropometrical data: There are two types of anthropometrical data:

1. Structural measurement data.
2. Functional measurement data.

Structural (static) measurements: These measurements are concerned with the dimensions of the body segments at stationary position (not in motion). They include body's contour dimensions (e.g., stature, sitting height, length of upper arm, hip breadth etc.) and skeletal dimensions (e.g., the distance between center of joints, such as distance between hip and knee).

Functional measurements: These measurements are concerned with the dimensions of the segments during physical activities. Though there is no systematic procedure for translating static anthropometrical data into dynamic measurements, "Kroemer" (1983) offers the following rules of thumb that may be helpful in designing:

- *Heights (stature, eye, shoulder, hip):* Reduce by 3 per cent.
- *Elbow height:* No change or increase up to 5 per cent if elevated at work.

- *Knee or popliteal height:* Sitting; no change except with high heel shoe.
- *Forward reaches:* Decrease by 30 per cent for convenience.
- *Lateral reaches:* Increase by 20 per cent for extensive shoulder and trunk motion.

All work/activities take place in an environment, the characteristics of which may be expressed in terms of climate (hot/cold, draught/stagnant, dry/humid) the amount of noise and vibrations, the nature and amount of illumination. Research as well as everyday experience, has shown that these environmental factors are an important determinant of the effectiveness with which the equipments and machines are used.

Climatic Conditions

Control of climatic conditions at the workplace is paramount to the worker's health and comfort and to the maintenance of higher productivity. With excess heat or cold workers feel uncomfortable, and their efficiency drops. In addition this can lead to accidents. The following are some examples of hot working environment:

- Iron and steel industries.
- Non-ferrous foundries.
- Brick firing and ceramics.
- Glass product manufacturing.
- Rubber product manufacturing.
- Boiler operation and maintenance.
- Kitchen, laundries, bakeries.
- Mining.
- Building construction, road construction.
- Roofing and home repair.
- Steam tunnel.

Work premises in tropical countries may on account of general climatic condition, be naturally hot. When sources of heat such as furnaces, kilns or hot processes are present or when the physical workloads are heavy, the human body may also have to deal with excess heat.

In such hot working environments sweating is almost the only way in which the body can lose heat. As the sweat evaporates the body cools. There is a relationship between the amount and speed of evaporation and a feeling of comfort.

The more intense the evaporation, the quicker the body will cool and feel refreshed. Evaporation increases with adequate ventilation.

However, when there is high relative humidity, evaporation is less effective in cooling the body. Certain climatic conditions such as those in many tropical countries, the certain working environments like those found in deep mines, textile mills and sugar refineries, expose to the worker to a hot humid environment with little possibility to cool through evaporation. Another working environment, which is uncomfortable result from hot, dry, "desert like" heat combined with high air temperature. This type of working environment can be found in iron and steel foundries, around surface treatment furnaces and in glass works, hot rolling mills and forges. In all cases it is necessary to consider thermal burden in relation to the energy expenditure required by the work. The more burden some the climatic conditions, the longer the work break should be.

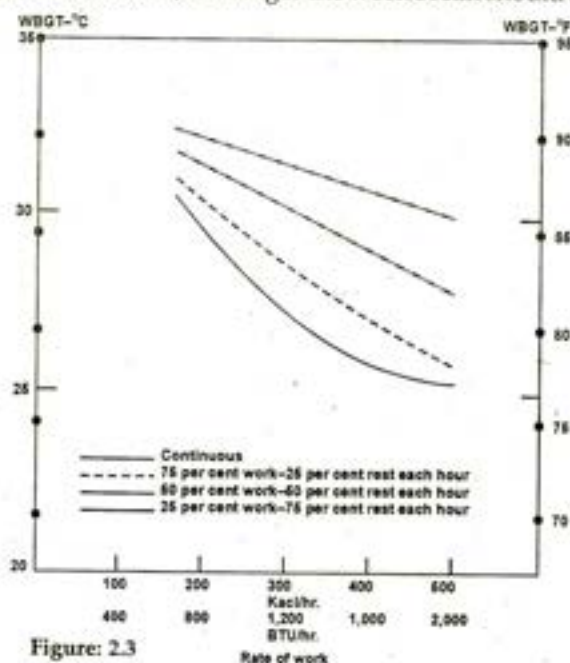


Figure: 2.3

Working in the Cold Environment

Working in cold environment was once restricted to non-tropical or highly elevated regions. Now as a result of modern refrigeration system various group of workers, even in tropical countries are exposed to a cold temperature.

Exposure to cold for short period of time can produce serious effect especially when workers are exposed to a temperature below 10 degree centigrade. The loss of body heat is uncomfortable and quickly affects the work efficiency.

Protection Against Cold Working Condition

Human's primary defense mechanism against the cold is to seek shelter, or to add more clothing. In order to provide protection against cold:

- The worker should wear more clothing and especially, protect the neck, head, chest, hand, ears, nose and feet.
- The worker should wear a waterproof, wind resisting outer layer of clothing, preferably with a layer of wool inside.
- The worker should wear a warm hat because heat loss through the head takes place very rapidly.
- The worker should have spare dry clothing because the body losses heat more rapidly when it is wet.
- The worker should not work alone in the cold.
- The worker should consume high-energy food and snacks that provide more calories to produce more body heat.
- The employer should provide non-alcoholic liquid for the worker to maintain body fluid balance.

Working in a Wet Environment

High level of humidity is poorly tolerated at high temperature, in particular when there is a significant workload. The temperature (as indicated by the wet bulb temperature) at the workplace should not exceed 21 degree centigrade. It is extremely difficult to keep within this limit in hot countries, in circumstances where (as in textile industries) the process requires a high level of atmospheric humidity or (as in laundries, canning plants and various chemical plants) produces large quantity of steam. Excess steam should be prevented from spreading in the atmosphere by local exhaust where possible,

and by controlling the quantity steam introduced for humidification. Increasing air velocity will provide a degree of comfort in hot humid atmosphere.

Excessive humidity is also poorly tolerated in combination with low temperature. Relative humidity should be kept within a range of 40-70 per cent.

Control of Thermal Environment

There are many ways of controlling the thermal environment. It is relatively easy to assess the effects of thermal conditions, especially when excessive heat or cold is an obvious problem. To solve the problem, however consistent effort using a variety of available measures are usually necessary. This is because the problem is linked with general climate, production technology, which is often the source of heat or cold and varying condition of work premises as well as work methods and work schedules. Personal factors such as clothing, nutrition, personal habits, age and individual differences in response to be given thermal conditions also need to be taken account during consideration of thermal comfort to the worker.

In controlling the thermal environment one or more of the following principles may be applied:

1. Regulating the work room temperature by preventing outside heat or cold from entering (improved design of roof, insulating materials or installing air conditioning system).
2. Provision of ventilation in hot work places by increasing natural ventilation through openings or installing ventilation devices.
3. Separation of heat sources from working area, insulation of hot surfaces and pipes or places of barriers between the heat sources and the workers.
4. Control of humidity with a view to keeping it at low levels, for example by preventing the escape of steam from pipes and equipments.
5. Provisions of adequate personal protective clothing and equipments for workers exposed to excessive radiant heat or excessive cold (heat protective clothing with high insulation value may not be recommended for jobs with long exposure to moderate or heavy works it prevents evaporative heat loss).

6. Reduction of exposure time, for example by mechanization, remote control or altering work schedule.
7. Insertion of rest pauses between work periods with comfortable, if possible air conditioned, resting facilities.
8. Ensuring a supply of cold drinking water for workers in a hot environment and of hot drinks for those exposed in cold working environment.

It is sometimes seen that in particular the heat at the workplace may still be excessive in spite of various available measures. In this consideration should be given to drastic technical solution, such as changing the production methods, or processes, purchasing machines which do not contribute to excessive heat in the environment or providing air conditioned workrooms. The different air temperature recommended for various types of work as shown below:

Sedentary work-centigrade.	20-22 degree
Light physical work in a seated condition-centigrade.	19-20 degree
Light work in a standing position-centigrade. (e.g. work on machine tools)	17-18 degree
Moderate work in standing position-centigrade. (e.g. in assembly)	16-18 degree
Heavy work in standing position-centigrade. (e.g. heavy drilling)	14-16 degree

Ventilation

Ventilation is somewhat different with air conditioning. Ventilation replaces contaminated air, whereas the second merely moves the air without renewing it. Where the air temperature and humidity are high merely to circulate the air is not only ineffective but, beyond certain limits, increases heat absorption by convection.

Workplace Ventilation

- Disperses the heat generated by machines and people at work; consequently, where machines or workers are grouped together, ventilation should be intensified.
- Dilutes atmospheric contamination.
- Maintain the feeling of air freshness.

Above all adequate ventilation should be looked upon as an important factor in maintaining the workers health and productivity.

Except for confined spaces, all working premises have some minimum ventilation. However to maintain the necessary air flow (which should not be lower than 50 cubic meters of air per hour per worker), air usually needs to be changed between four and eight times per hour in offices, between eight and twelve times per hour in workshops and as much as 15 to 30 times per hour for public premises and where there are high levels of atmospheric pollution and humidity.

The air speed used for workplace ventilation should be adapted to the air temperature. For sedentary work it should exceed 0.2 meter/sec. But for a hot environment the optimum speed is between 0.5 and 1 meter/sec., certain type of hot work can be made tolerable by directing a stream of cold air at the workers.

Natural ventilation obtained by opening windows or walls or roof vents, may produce significant airflows but can normally be used only in relatively mild climates. When ventilation most needed, air ventilation is often least effective; moreover it is relatively difficult to regulate. In addition for natural ventilation to be effective the outlet vents must be correctly located and of sufficient size, especially in hot countries where ventilation apertures are, only too often, too small.

Where natural ventilation is inadequate, artificial ventilation should be used. A choice may be made between a blown air system, an exhaust air system or a combination of both (push-pull ventilation). Only push-pull ventilation system allows for better regulation of air movement.

Where concentration of contaminants cannot be reduced by ventilation local exhaust system must be used. They usually include hoods or enclosures, ductwork leading to an exhaust fan, an air cleaning devices for air pollution and finally discharge to the outside air. An external point is to ensure that the exhausted air does not pass through the worker's breathing zone.

Lighting: It is estimated that 80 per cent of the information required in doing a job is perceived visually. Good visibility of the equipment, the product and the data involved in the work process is an essential factor in accelerating production, reduces the number of defective products, cutting down waste and preventing visual fatigue and headache among the workers. It may also be added that

both inadequate visibility and glare are frequently causes of accidents.

Visibility depends on a number of factors. These are the size and color of the work piece, its distance from the eyes, the lighting intensity and the contrast of color and lighting levels with background. All these factors should be studied, especially in the case of precision work, work in a dangerous environment or there are other reasons for dissatisfaction or complaint. Lighting is probably one of the more important physical factors and one is easiest to correct.

In principle, lighting should be adapted to the type of work. However, the level of illumination, measures in "lux", should be increased not only in relation to the worker's age, since older people require a higher level of illumination than young ones, especially if they are to recognize details and to maintain a sufficiently rapid visual reaction. Moreover older people are highly susceptible to glare since their recovery time is longer. The accumulation of dust of the light sources cut down the level of illumination by 10–15 per cent of the original level. The gradual drop in the level should therefore be compensated for when designing the lighting system. Regular cleaning of lighting fixtures is obviously essential.

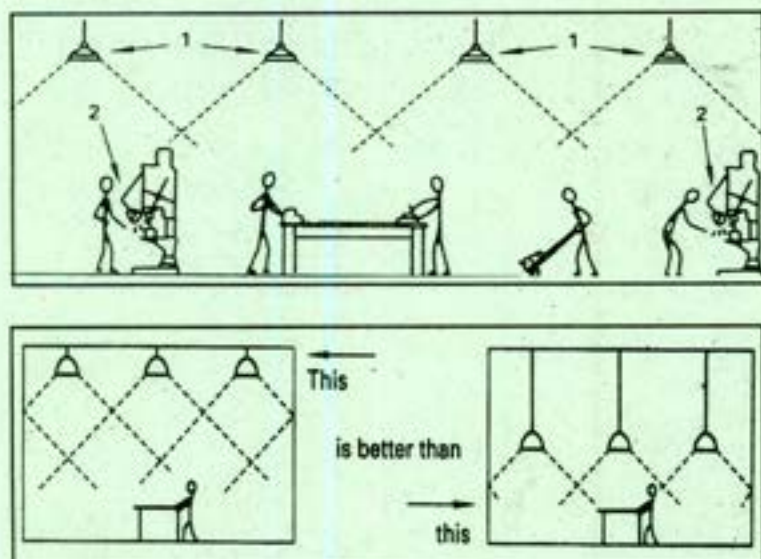


Figure: 2.4

The use of natural light should be encouraged. This can be achieved by installing windows, which are recommended to have an area equal to at least one-sixth of floor area. However, daylight varies with the season, the time of the day, the distance of workstations from the windows. For this reason it is essential to have artificial lighting available all the time should the need to use it to maintain proper vision and will ensure that the lighting intensity ratios between the tasks, the surrounding objects and the general environment are maintained.

Glare: Glare is the sensation produced by the brightness within the visual field, which is sufficiently greater than that to which the eyes can adapt. Glare can cause annoyance, less visual performance and visibility and discomfort. Glare can, therefore be referred to as light noise since it is any light level in excess of what is required for performing the visual tasks under a comfortable visual condition.

An extreme example of industrial glare is the flash of a welding process, ultra-violet and infrared rays of energy. Ultra-violet rays can cause damage to the cornea and infrared rays can cause damage to the retina.

Recommended Minimum Values of Illumination
for Various Classes of Visual Tasks

<i>Class of visual tasks</i>	<i>Minimum illumination of task (lux)</i>	<i>Typical examples</i>
Casual seeing	100	Boiler house (coal and ash handling), storage of rough and bulky materials.
Ordinary seeing	150	Rough, intermittent bench and machine work, rough inspection and counting of stock parts, assembly of heavy machinery.
Moderately critical tasks	300	Ordinary office works e.g., reading, writing filing etc. Medium bench and machine work, assembly inspection.

Freedom of Movement of Visual Field

Removing all objects, which interfere with visual tasks or obstruct the size.

Visual Environment: It includes not only the immediate task area but also other areas that will be seen continuously during working.

The following rules should be followed to achieve visual comfort:

- All objects and major surfaces in the visual field should be equally bright.
- The working field should be brightest in the middle and darker towards the edges.
- The use of polished surfaces or reflecting material on machines, table-tops, switchboards or other apparatus should be avoided.
- To reduce direct visual glare, the angle between the horizontal line of sight and a line from the eye to the light source must be more than 30 degree. If an angle of less than 30 degree cannot be avoided the light must be screened on the side.

Noise and Vibration

High level of mechanization, increased machine speed and the density of machinery at the work place cause high vibration as well as noise.

Noise means any disagreeable or undesired sound. Sound level meters are used to measure the pressure variation producing audible sound. The practical unit of measuring noise is decibel (db.).

Noise affects:

- Job performance.
- Health of employee.
- Employee's morale.

Sources of noise in industries:

Source	Distance (meter)	Intensity (decibels)
Hydraulic press	1	130
Large pneumatic riveter	1.25	128
Pneumatic chipper	1.5	124
Automatic punch press	1	112

Noise can be reduced by:

- Proper lubrication and maintenance of machines.
- Isolating noise sources from other machinery.

- Mounting machines on spring, rubber, felt or use vibrating isolator.
- Redesign the plant for better acoustical properties.

Unit Summary

Environment may be classified into two groups: (1) Physical environment. (2) Psychological environment. The physical environment consists of different climatic conditions e.g., working in hot condition, wet condition, cold condition, noise and vibration, lighting, ventilation etc. The environment should be within the sustainable limit so that the persons can perform their work comfortably. Anthropometrics is the measurement of body dimensions and an important factor in determining the dimensions of equipments and workplace. Anthropometrical data are of two types: (1) structural measurement data—the measurements are concerned with the dimensions of the body segments at stationary position. (2) Functional measurement data—the measurements are concerned with the body dimensions of the body segments during physical activities.

Check Your Progress

1. Describe anthropometrics and anthropometrical data.
2. Describe in brief the different climatic conditions, which should be considered during workstation design.
3. Write short notes on:
 - (a) Percentile.
 - (b) Working in cold conditions.
 - (c) Working in hot conditions.
 - (d) Noise.
 - (e) Lighting in workstations.
4. Tick the right answer:

Ventilation system will be better

 - (a) Using exhaust fan.
 - (b) Using push-pull ventilation.
 - (c) Combination of (a) and (b).

Points for Discussion/Clarification

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Environmental Restructuring

Unit-3

Introduction to Work Environment

STRUCTURE

- Introduction
- Objectives
- Industrial Setting
- Manufacturing Process
- Assembly Process
- Processing
- Service Setting
- Social Setting
- Semi-Rural and Rural Setting
- Unit Summary
- Check Your Progress
- Points for Discussion/Clarification

3

Introduction to Work Environment

Introduction

Work environment should have hazard free working condition. But hazards are present everywhere, including workplaces. Single exposures to hazards are not dangerous. However repeated exposure to a concentration of a hazard for a sufficient length of time may make it dangerous. Thus, hazard free working environment is the ideal condition to deploy the capabilities of persons for a long time. Now work environment means different types of settings generally available in our country. In case of persons with mentally retardation, we have to find out which general skills required for those settings. In industrial setting where the elementary work being mostly repetitive and routine in nature which demand the ability to stand, sit, walk, bend, lift, push, pull, hold manipulate by hands and fingers, see, hear, eye-hand co-ordination, hand-leg co-ordination, the persons with mental retardation can be well placed and may earn a reasonably decent wages.

Objectives

1. To understand the different work environment/settings.
2. To justify the different skill levels required for those settings.
3. To justify the inappropriate aspects of the different environment.

Work environments are principally divided into the following categories:

1. Industrial setting.
2. Service setting.

3. Social setting.
4. Semi-rural and rural setting.

Industrial Setting

It can be again subdivided into—Manufacturing, Assembly and processing.

Manufacturing Process

Manufacturing industries converts the basic raw materials into finished products or components. Today most of the processing in this sector is by machines. The work requirement will be primarily to operate the machines, to feed the raw materials and to take out the finished product.

Special industrial training will be required to operate the machine and the training required for the operators with an emphasis on safety.

Here simpler and safe jobs will include— injection moulding, food processing, garment manufacturing etc.

Assembly Process

It is the process where components are brought together either manually by individuals or by a team or by automation. These assemblies can be done either by the aid of different hand tools (screwing, soldering, welding etc.) or without tools (pressing, plugging etc.). Both these type of operation can be done by mentally retarded persons with proper training (excluded welding). In conveyor line type of assembly workstation mentally retarded persons can be employed for feeding.

Processing

The industries, which are includes are—Food processing, tanning, seasoning, cotton to yarn, chemical plants, cement industries etc. With minimum training food processing and cotton to yarn be the most appropriate for the persons with mental retardation. Because task analysis and job simplification can be easily applied to these types of industries.

Service Setting

This includes—Petrol pump attendant, laundry, nursing aid, school aid, hotel and office attendant etc.

Mentally retarded persons with minimum or no behavioral problems will be most suitable and should be easily trained in this type of social skill.

Social Setting

Servers, shop attendants etc., are the types of social setting.

The persons with mental retardation are not generally not suitable for these types of job as these types of jobs implies the requirement of social skills and social attitude.

Semi-Rural and Rural Setting

This is ideally suitable for the persons with mental retardation because of the simplicity of job requirement and social acceptance. There should be a special need to study the work environment in very great depth as also the potentials of the disabled persons in order to match the same. The result of such study will enable the setting up of work environments for the disabled persons in general and the persons with mental retarded in particular so that they may contribute maximally.

The followings are the steps to be followed for the employment in semi-rural and rural settings:

Stage 1: Identification of rural adults with mental handicap.

Stage 2: Individual assessment of the identified adults with mental handicap.

This stage involves individual assessment, family assessment followed by community assessment.

Stage 3: Identification of rural based vocations for the selected group of adults with mental handicap.

The guidelines adopted for matching the individual's skills to specific jobs involved with emphasis on:

- Low investment-high return vocational jobs.
- Continuation of family hereditary occupations.
- Non-mechanized jobs.
- Jobs directly facilitating end products/finished goods.
- Jobs involving easy marketability.
- Jobs enabling proximity to the family/open community.

Stage 4: Individualized work rehabilitation program.

An individualized work rehabilitation program should be designed to accommodate the individual needs, assets and deficits of identified rural adults with mental handicap to their family and community resources.

Stage 5: Job placement tryout in a rural community.

The various avenues for job placement for mentally handicap persons in rural areas are:

- Family self-employment.
- Employment in rural co-operatives/self-help group.
- Sheltered workshops.
- Open employments.

Stage 6: Programme evaluation.

Example of jobs in rural and semi-rural area for adults with mental handicap. Horticulture, sericulture, gardening, poultry, dairy, fishery, leather craft, cane and bamboo work, soaps, detergents, cycle workshop, door mats etc.

Inappropriate aspects in those work environments:

The jobs detailed in different settings can be performed by the disabled persons with the same perfection or correctness like normal persons, provided they are helped to overcome their disability by using suitable aids and environmental restructuring. The physically handicapped could move about if crutches or wheel chairs are provided. Similarly the mentally retarded persons require suitable restructuring of the working environment and adequate training. The restructuring contemplated should address the shortcomings like decision-making, discriminating, use of cognitive, intellectual skill and limited memory power.

Such well-planned environments and environmental restructuring will make the mentally retarded persons to perform the task as good as normal persons.

Work environment should have (a) adequate ventilation, (b) lighting, and (c) low noise level, (d) work tables and stools of appropriate design to suit specific needs of persons with mental retardation. All these provisions will help to reduce fatigue and thereby promote higher productivity.

Unit Summary

Work environments means different types of settings which are generally available. The general categories of different settings are: (1) Industrial setting, (2) Service setting, (3) Social setting and (4) Semi-rural and rural setting. Again Industrial setting is sub-divided into (1) manufacturing process—includes food processing, garment manufacturing etc., (2) assembly process—using different hand tools or without tools when a number of parts are brought together and (3) processing—which includes different processing industries like chemical plants, cotton to yarn processing etc.

Service setting—includes different service oriented jobs like laundry assistant, in nursing aids etc. Semi-rural and rural setting which includes horticulture, sericulture, gardening etc., are the most suitable setting for the persons with mental retardation.

Check Your Progress

1. Describe the different work environments in which the persons with mentally handicap can be employed.
2. Write short notes on:
 - (a) Industrial settings.
 - (b) Service and social settings.
 - (c) Rural settings.
3. Describe the different steps to be followed for the employment of persons with mental retardation in semi-rural and rural settings.
4. Persons with mental retardation are generally not suitable in
 - (a) Social settings.
 - (b) Industrial settings.
 - (c) Semi-rural settings.

Points for Discussion/Clarification

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Environmental Restructuring

Unit-4

Concept of Environmental Restructuring

STRUCTURE

- Introduction
- Objectives
- Physical Needs
- Emotional Needs
- Economic Needs
- People with Impaired Mobility
- People with Impaired Vision
- People with Impaired Hearing
- People with Learning Disabilities and Mental Retardation
- Anthropometrics
- Unit Summary
- Check Your Progress
- Points for Discussion/Clarification

4

Concept of Environmental Restructuring

Introduction

Environmental restructuring means some modification either to workstation layout, or for the process itself, for the machineries and equipments for the execution of jobs as to suit the level of the disabilities of the person with mental retardation. Restructuring also intended to make the workplace, buildings and facilities accessible to and usable by the people with such disabilities as the ability to walk, difficulty in walking, reliance on walking aids, blindness and visual impairment, speech and hearing impairment, lack of stamina, difficulty in interpretation and reacting to sensory information and extreme in physical size.

Objectives

1. To understand the anthropometrical data for wheel chair user which is useful to design a workstation.
2. To justify the special needs for disabled.

To understand the need of the disabled person it is necessary to understand Maslow's hierarchy of human needs. It also contributed to a better understanding of human motivation.

Behavioral scientists believe that individuals are motivated to act in a certain way by a desire to satisfy certain needs. Abraham Maslow developed one of the widely accepted notions about needs, which postulated that there are certain essential needs for every individual and that these needs arranged themselves in a hierarchical pattern. Maslow argues that it is only when one need becomes largely satisfied that the next need in the hierarchy will start to exert motivating influence.

At the bottom of hierarchy are physiological needs. There are the basic needs that must be met to sustain life itself. Satisfying ones physiological needs will be the primary concern of any person, and until one has done so, one will not be concerned with any other issue. However, once an individual feels reasonably sure of fulfilling their needs, they will seek to satisfy the next need in the hierarchy, that of security. Security is taken to mean the feeling of protection against physical and psychological harm as well as security of employment. For workers who have already satisfied both their psychological and their security need the next motivating factor is that of affiliation or need to belong that is wanting to belong to a group or an organization or to associate to others and society or social group. Next on the hierarchical scale is the need to be recognized or self-esteem or ego-status is motivated by the desire for recognition as an individual by means of his contribution. Self-esteem is followed by the need for fulfillment or self-actualization—the need to develop ones potentialities i.e., to do what he/she is capable of doing. The last need expresses the desire of people or workers to be given an opportunity to show their particular talent.

Maslow's of Hierarchy of Needs

Fulfillment

Recognition

Affiliation

Security

Physiological

Self-actualization is supported to be the top need in the hierarchy of needs. The higher needs can be satisfied only after those lower downs have been satisfied, the higher needs often remain unfulfilled.

In practice most people satisfy some of these needs in part and are left with some that are unsatisfied. In developing countries people are probably preoccupied more with their basic needs. In developed countries on the other hand, where physiological and security needs are normally met in large part, people would seem to be motivated more by needs at the upper end of the hierarchy. So the needs can be classified—

1. Primary need or essential needs in general.
2. Acquired needs for individual.

3. Special needs.

Special need in this context brought about by the disability and the consequence resulting from it. The environment restructuring depends on the level of disability of the person. To overcome the disability some special needs to be identified which could be some electrical gadgets, self-inspecting devices or modification of tools. Better working environment, living environment with the better quality of life can be created in term of efficient system evolves which will enable the people to work more efficiently.

Each disabled person has a unique set of needs to be met. These have to be identified individually as disability is somewhat unique for each individual. The followings are the different needs to be met for disabled person in general:

Physical Needs

Para-plegic (lower limb)
providing

Removing architectural barriers, mobility access to operate with feet by introducing different facilities.

Hemi-plegic (upper limb)
Mental retardation

Restructuring to overcome cognitive domain.

Emotional Needs

Being loved:

Being accepted by the family and society despite their disabilities.

Economic Needs

Opportunity to earn and economic Independence.

Opportunity to work and contribute to social growth.

Disability can be classified of four major categories:

1. People with impaired mobility.
2. People with visual impairment.
3. People with hearing impairment.
4. People with learning disability and mental retardation.

People with Impaired Mobility

Wheel chair users.

The main problem of wheel chair users about moving and working from a sitting position; these requirements are associated with the dimensions and other aspects of wheel chair. The major dimensions of wheel chair:

The overall length of wheel chair varies generally between 1100 mm to 1200 mm + Approximate 50 mm (for user feet) to be added.

The width of wheel chair varies between 60 mm to 700 mm. To propel a chair manually by operating the rims of the main wheel a clearance to be added about 100 mm.

Space requirement for maneuvering are always related to the activities to be performed. Different users act in different ways depending on individual performance and the type of chair used. When planning space in buildings to cater for wheel chair turning a guide to impose on the plan to provide a circle of 1500 mm diameter. Where a high degree of accessibility is required, such as in hospital buildings, space should be more generous. For wheel chair access to a workbench, washbasin or table a clear space for knees and footrest is needed. This should be at least 800 mm wide, 480 mm deep and 750 mm high.

People with Impaired Vision

For people with impaired vision design and plan arrangement should be simple and uncomplicated. Contrasting colors and warning blocks should be used to aid the identification of doors, stairs, ramps, passageways etc., surfaces can be varied to indicate path ways, changes of direction etc. Handrails can be used as a location aid.

To minimize the risk of falls and injuries, hazards such as posts, single steps and projections from wall should be avoided wherever possible. If unavoidable, projection should be placed higher than 2000 mm from the floor.

People with impaired vision often have difficulty to read sign and other printed information. Blind people are restricted to tactile reading. Visual information as for example, railway station and airports should be supplemented with audible information.

People with Impaired Hearing

People with impaired hearing have a particular difficulty in

comprehending sounds and words in the environment. Room should be acoustically well insulated.

In public buildings, loud-speaking system should be clearly audible. Supplementary visual information should be provided in, for example railway stations and airports.

People with improved hearing may rely on lip reading; this is helped if there is good overall light that is non-reflective. They may have difficulty using telephones, etc. Audible signals may, in certain cases, be supplemented with visual signals.

People with Learning Disabilities and Mental Retardation

There is much different type of disabilities in this group. In addition to congenital deficiencies and various kinds of central nervous system diseases and brain disorder, it covers disabilities caused by an accident or a cerebral hemorrhage.

A considerable number of persons among the mentally impaired are paralytic. In addition to being mentally disabled they may have difficulties in co-ordinating and controlling their movements.

When moving about outdoors, persons in this group are confronted with the special problem that they may find difficult to perceive, comprehend or interpret information such as signs. They may also have spatial orientation difficulties and in some cases lack the ability to distinguish colour or to differentiate between left and right.

It may be difficult to meet all their needs but minimum provisions would include:

1. Clear and easy to grasp information at an aid to orientation.
2. Even road surfaces.

Anthropometrics

Reach

Forward reach for wheel chair users:

Without obstructions: Maximum forward reach is 1200 mm from the floor and minimum forward reach is 400 mm from the floor.

Over obstruction: The maximum reach over an obstruction 500 mm deep is 1100 mm from the floor.

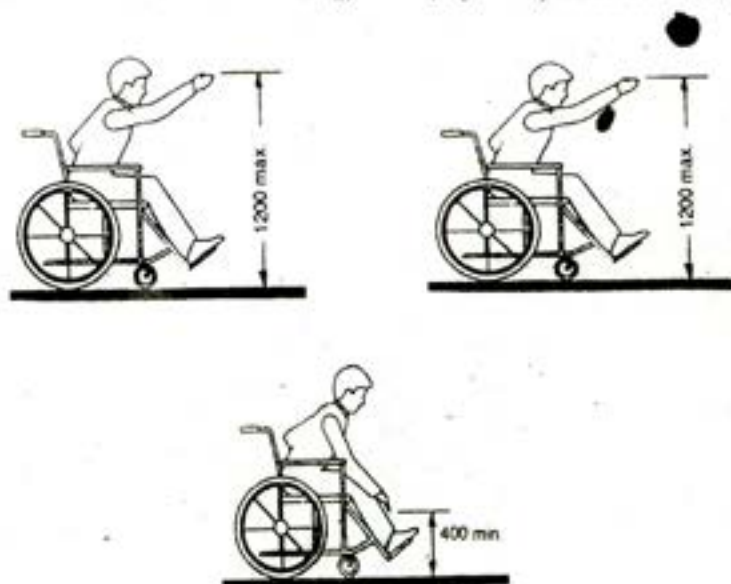


Figure: 4.1

Side reach for wheel chair users:

- *Without obstruction:* The maximum side reach without obstruction is 1300 mm from the floor and the minimum side reach is 250 mm as shown in the following Fig 4.2.

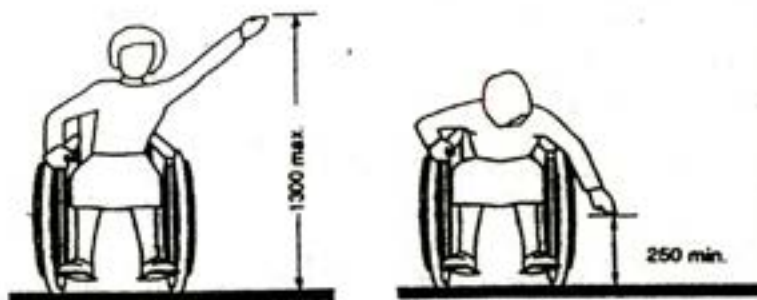


Figure: 4.2

Walkway width for people using crutches. Although the person who use walking aids can maneuver through door openings of 900 mm clear width, they need wider passageways for comfortable gaits as shown in Fig 4.3.

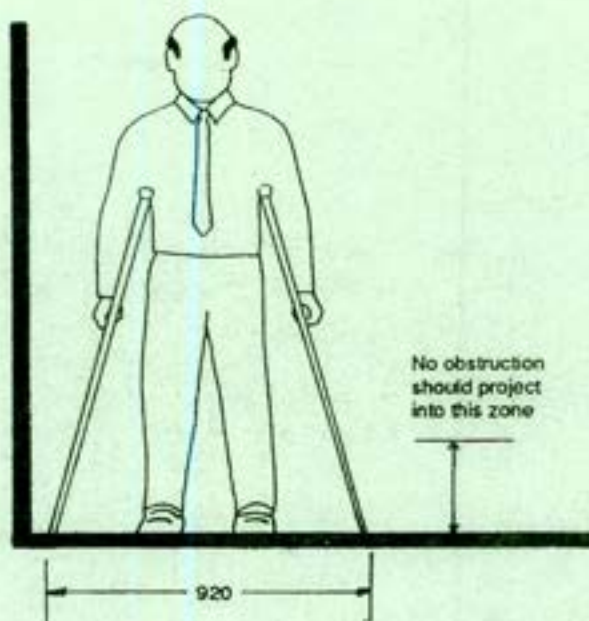


Figure: 4.3

In general the working environments to meet the general needs of the mentally handicapped persons are:

- The working environment should be circumscribed by the functional and reach and most things they need to handle should be arranged within this environment. (a) Vertical, (b) Sloping, and (c) Horizontal—These surfaces should desirably be obtained from anthropometrics consideration.
- Horizontal work surfaces should be planned around—
 - (a) *Normal area*: This area that can be conveniently reached with a sweep of the forearm, with the upper arm hanging in natural position at the side.
 - (b) *Maximum area*: This is the area that could be reached by extending the arm from the shoulder.
- Amongst the important elements to be considered are—
 - (a) Work surface height (seated)—(Elbow height—20 mm) should be the height of work surfaces to enable the fore-

arm to slope down slightly. Table top height should be the 750 mm.

- (b) Seat height averaging (+ adjustment for 100 mm) should be around 450 mm.
- The concepts of optimum location of components.
This should takes into account—
 - (a) *Importance in the operation*: The operational importance or the degree to which the performance of the activity with the component is vital.
 - (b) *Frequency*: Frequency of use in the operation.
 - (c) *Sequence of operation*: Sequence or pattern of use of components. Relationship that typically or frequently occurs.
 - (d) *Functional requirements*: Arrangement for the grouping of components according to their functions.

The above can be arrived at through—

- Film analysis.
- Eye movements recordings.
- Observations.
- Anthropometrics.

Unit Summary

Environmental restructuring means some modification of the workstation or in the process itself. Each disabled person has its own unique set of needs to be met. The disability can be broadly classified of four major categories. (1) People with impaired mobility. (2) People with visual impairment. (3) People with hearing impairment. (4) People with learning disability and mental retardation. People with impaired mobility should use wheel chair. The overall length of wheel chair varies between 1100–1200 mm. In case of people with impaired vision design and plan should be simple and uncomplicated. Visual informations should be supplemented with audible information. But in case of impaired hearing audible signals should be supplemented with visual signals. It is very difficult to meet all the needs of the persons with mental retardation but minimum provisions which includes: (1) clear and easy to grasp information at an aid to orientation, and (2) even road surfaces.

Working environments to meet the general needs of the persons with mental retardation are the concept of optimum location of components in horizontal work—table, work table height, seat height etc.

Check Your Progress

1. What do you understand by environmental restructuring?
2. Why Maslow's hierarchy of needs are important in case of environmental restructuring?
3. How many types of disabilities are there? Describe in brief.
4. Describe the Maslow's hierarchy of needs.
5. Write short notes on:
 - (a) Maslow's hierarchy of needs.
 - (b) Environmental restructuring.
 - (c) General needs in working environment.
6. Tick the right answer.
 - (a) Work surface height should be:
 1. At elbow level.
 2. A little below the elbow level.
 3. 100 mm below the elbow level.

Points for Discussion/Clarification

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Environmental Restructuring

Unit-5

Motion Economy Principles and Assisted Movements

STRUCTURE

- Introduction
- Objectives
- The Principle of Motion Economy
- Normal Working Area
- Maximum Working Area
- Foot Operated Tools and Fixtures
- Design of Foot Pedals
- Operation Criteria of Physical Activities
- Range of Movements
- Strength and Endurance
- Assisted Movements
- Material Handling
- Eliminating or Reducing Handling
- Unit Summary
- Check Your Progress
- Points for Discussion/Clarification

5

Motion Economy Principles and Assisted Movements

Introduction

In considering the movements of workers and materials on the larger scale, we have been concerned with more efficient use of existing plant and machinery (and where possible materials) through the elimination of unnecessary idle time. The more effective operation of processes and the more efficient use of the services of labor through the elimination of unnecessary and time-consuming movement within the working area of factory, department or yard. But when we come to the study of individuals at the work place, the way in which they apply their effort and the amount of fatigue resulting from the manner of working become primary factor affecting their productivity.

Objectives

The major objectives are:

- To know the different motion economy principles used in workstation.
- To design the workplace considering motion economy principles, placing of different bins and different operational criteria of physical activities.
- To have an idea of effective use of different assisted movement equipment used in a workplace.

Before going on detailed study of an operator doing a job at a single workplace, it is important to make certain that the job is in fact necessary and is being done as it should be done. The questioning

technique must be applied as regards:

Purpose: To ensure that the job is necessary.

Place: To ensure that it is being done where it should be done.

Sequence: To ensure that it is in its right place in the sequence of operations.

Person: To ensure that the right person is doing it.

Means: By which the job is being done.

The Principle of Motion Economy

There are number of principles concerning the economy of movements which have been developed as a result of experience and which form a good basis for the development of improved methods at the workplace. They may be grouped under three headings:

- (a) Use of human body.
- (b) Arrangement of workplace.
- (c) Design of tools and equipment.

They are useful in shop and office work and although they cannot always be applied, they do form a very good basis for improving the efficiency and reducing the fatigue of manual work.

(a) Use of Human Body

When possible:

1. The two hands should begin and complete their movements at the same time.
2. The two hands should not be idle at the same time except during period of rest.
3. Motion of arms should be symmetrical and in opposite directions and should be made simultaneously.

The above three principles are closely related and can best be considered together. It seems natural for most people to work productively with one hand while holding the object being worked on with the other hand. This is usually undesirable. The two hands should work together, each beginning a motion and completing a motion at the same time. Motion of the two hands should be simultaneous and symmetrical.

It is obvious that in many kind of work can be accomplished by using both hands than by using one hand. For most people it is advantageous to arrange similar work on the left and right hand sides of the workplace, thus enabling the left and right hand to move together, each performing the same motion. The symmetrical movements of the arm tends to balance each other, reducing the shock and jerk on the body and enabling the worker to perform the task with less mental and physical effort. There is apparently less body strain when the hands move symmetrically than when makes unsymmetrical motion, because of the matter of balance.

4. Hand and body motions should be confined to the lowest classification with which it is possible to perform the work satisfactorily.

The five general classes of hand motions are listed here because they emphasize that material and tools should be located as close as possible to the point of use, and that motions of the hands should be as short as the work permits. This classification is built up on the pivots around which the body members must move as shown in table below:

Classification of Movements

Class	Pivot	Body movements needed
1.	Knuckle	Finger.
2.	Wrist	Hand and fingers.
3.	Elbow	Forearm, hand and fingers.
4.	Shoulder	Upper arm, forearm, hand and fingers.
5.	Trunk	Torso, upper arm, forearm, hand and fingers.

As desirable as it may be to keep the hand motions as short as possible, it is incorrect to assume that finger motions are less fatiguing than motions of the forearm.

In one investigation it was found that finger motions were more fatiguing, less accurate and slower than motions of the forearm. All evidence seems to show that the forearm is the most desirable member to use for light work and that in highly repetitive work motion about wrist and elbow are superior to those of the fingers or shoulders.

5. Momentum should be employed to assist the worker wherever possible and it should be reduced to minimum if it must be overcome by muscular effort.

The momentum of an object is its mass multiplied its velocity. In most kinds of factory work the total weight moved by the worker may consists of three component: the weight of the material moved, the weight of the tools or devices moved, and the weight of the part of the body moved. It is often possible to employ momentum of the hand, the material or the tool to do useful work. When the forcible stroke is required the motion of the operator should be so arranged that the stroke is delivered when it reaches its greatest momentum. In addition the velocity of the motion should be kept low by using the shortest motion possible. A number of tools are most effective when they are made as light in weight as possible. Such tools do not depend upon momentum or the use of a blow to function properly. For many kinds of work, a heavy shovel or a heavy trowel is more fatiguing to use than a light one of the same dimensions and same rigidity.

6. Smooth continuous curved motions of the hands are preferably to straight-line motion involving sudden and sharp changes in direction.
7. Ballistic movements are faster, easier and more accurate than restricted or controlled movements.
8. Work should be arranged to permit an easy and neutral rhythm whenever possible.
9. Eye fixations should be as few and as close together as possible.

(b) Arrangement of Workplace

1. There should be a definite and fixed place for all tools and materials. The operator should always be able to find the tools and materials in the same location. Similarly finished parts and assembled units should be disposed of fixed places. Definite stations for materials and tools aid the workers in habit formation, permitting the rapid development of automaticity. It cannot be emphasized too strongly that it is greatly to the worker's advantage to be able to perform the operation with the least conscious mental

direction. Frequently materials and tools are scattered over the workplace in such a disorderly fashion that the operator must not only exert mental effort, but must also hunt around in order to locate the part or tool needed at a given instant. The workers are very much in favour of having stations for materials and tools, because this reduces fatigue and saves time.

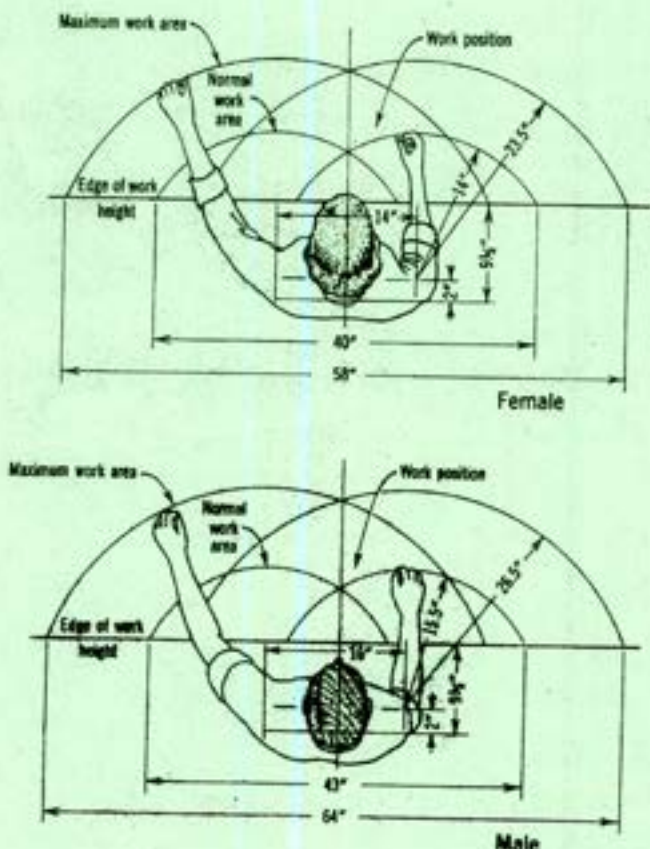


Figure 5.1: Dimensions of Normal and Maximum Working Areas in the Horizontal.

2. Tools, materials and controls should be located close to the point of use. Very frequently the workplace, such as a bench, a machine, desk or table is laid out with tools and materials

in a straight line. This is incorrect for a person naturally works in areas bounded by lines, which are arcs of circle.

Normal Working Area

Considering the horizontal plane there is a very definite and limited area, which the worker can use with a normal expenditure of effort. There is a normal working area for the right hand and for the left hand, working separately, and for both hands working together. The normal working area for the right hand is determined by an arc drawn with a sweep of the right hand across the table. The forearm or'y is extended and the upper arm hangs at the side of the body in a natural position until it tends to swing away as the hands moves towards the outer part of the workplace. The normal working area for the left hand is also determined in a similar manner. The normal arc drawn with the right and left hand will cross each other at a point in front of the worker. The overlapping area constitutes a zone in which two handed work (assembly work) may be done most conveniently.

Maximum Working Area

There is a maximum working area for the right hand and for the left hand, working separately and for both hands working together. The maximum working area for the right hand is determined by an arc drawn with a sweep of the right hand across the table, with the arm pivoted at the right shoulder. The maximum working area for the left hand is determined in a similar manner by an arc drawn with a sweep of the left hand. The overlapping area formed by these two maximum arcs constitutes a zone beyond which two handed work cannot be performed without causing considerable disturbance of posture, accompanied by excessive fatigue.

Each hand has its normal working space in vertical plane as well as horizontal plane, in which work may be done with the least time and effort. A maximum workspace in the vertical plane may also be determined, beyond, which work, cannot be performed without disturbing the posture. In locating materials or tools above the workplace consideration should be given to these facts.

The figures emphasize the importance of arranging the material around the workplace and as close as possible.

Gravity feed bins and containers should be used to deliver material close to the point of use.

Drop deliveries should be used wherever possible: Many people do not appreciate the amount of time that may be used in disposing of finished parts. A study was made of gauging small pins in a fixture mounted on the front edge of the table and disposing of them by tossing them into a box located first at a distance of 3 inches behind the fixture, then at a distance of 10 inches, and finally at a distance of 20 inches. The time required for the motions transport loaded and release load was least when the pins were tossed into the bin nearest the fixture. Eighteen percent more time was required for the bin at 10 inches and 34 percent more at 20 inches.

Materials and tools should be located to permit the best sequence of motions: The material required at the beginning of a cycle should be placed next to the point of release of the finished piece in the preceding cycle. The position of the motion in the cycle may affect the time for its performance. For example, the time for the motion transport empty is likely to be longer when it is followed by the motion select than when it is followed by a well-defined motion such as a grasp of pre-positioned part. The reason for this is that the mind begins to select during the transport empty. When the motion transport loaded is followed by a position motion, it is slowed down by the mental preparation for the position. The time for the motion grasp is affected by the hand velocity preceding the grasp. A satisfactory sequence of motions in one kind of work may aid in determining the proper sequence in other types of work.

Provisions should be made for adequate conditions for seeing. Good illumination is the first requirement for satisfactory visual perception.

Visual perception may take place under such widely varying conditions that adequate provisions for seeing in one kind of work are not always most suitable for another. For example, the provision for seeing on such very fine work as watch making would be different from those recommended for inspecting plastic sheet or tin plate for surface defects. If adequate illumination is provided however seeing is made easier in every case, although this may not be the complete solution to the problem. By adequate illumination is meant: (a) light of sufficient intensity for the particular task, (b) light of the proper color and without glare and (c) light coming from the right direction.

The height of the work place and the chair should preferably be arranged so that alternate sitting and standing at work are easily possible.

Workers should be permitted to vary their position by either sitting or standing as they prefer. Such an arrangement enables an individual to rest certain sets of muscles and a change of position tends to improve the circulation of blood. Either sitting or standing for long period of time produces more fatigue than alternately sitting or standing.

A chair of type and height to permit good posture should be provided for every worker.

When a person is standing properly, the different segment of body—head, neck, chest and abdomen—are balanced vertically one upon the other so that weight is borne mainly by the body frame work and a minimum of effort and strain is placed upon the muscles and ligaments. In this posture, under normal conditions the organic functions—respiration, circulation, digestion etc., are performed with least mechanical obstructions and with greatest efficiency.

When the worker is seated the chair should aid and not hinder in maintaining good posture. A good chair should have the following features—the chair should be adjustable in height so that it may be readily fitted to the particular individual who is to use it. It should be rigidly built, preferably of steel frame with lightly padded and backrest. The edges of back and seat should be rounded so that no

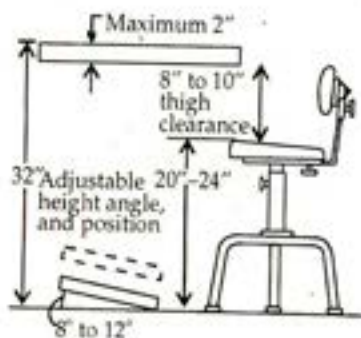


Figure 5.2:
Sitting Work place for Males

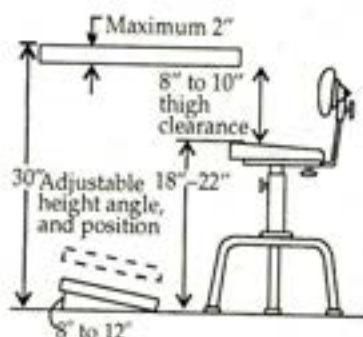


Figure 5.3:
Sitting Work place for Females

sharp corners can cause discomfort and impede the circulation. The seat should be of sufficient width to accommodate the body—at least 17 inches. The seat should not be over 15–16 inches deep. A deep seat tends to cut off the circulation of the blood through the underside of the thigh. For normal work the front edge of the chair should be approximately 1 inch higher than the back edge.

A back-rest should be provided and it should be 6–8 inches high and 10–12 inches wide. It can be so designed that it will not interfere with the movements of the individual's arms while working. It is important that the back rest be adjustable and that it to be fitted to the worker's body. When the worker lean forward while working, the chair back is of no use, however, the worker can use it while resting and it serves a valuable purposes for momentary relaxation.

Foot Rest

An adjustable foot-rest should be provide wherever possible. It may be attached to the floor or worktable. The foot-rest should be of ample width and depth to permit the entire bottoms of both feet to rest on it and allow for some movements. It requires a depth of 12 inches or more and should be inclined to 8–12 inches.

(a) Design of Tools and Equipments

1. The hands should be relieved of all work that can be done more advantageously by a jig, a fixture or a foot-operated device.
From observation of tools and fixtures found in factories, the fixtures are made for hand operations only whereas foot operated equipments would permit the operator to have both hands free to perform other motions.
2. Two or more tools should be combined whenever possible. It is usually quicker to turn a small two-ended tool end-for-end than it is lay on tool down and pick up another. There are many examples of two tool combinations—two ended wrench, pencil eraser—and the designer of handset telephone used this idea when he incorporated the transmitter and the receiver in one end.
3. Tools and materials should be propositioned whenever possible. Pre-positioning refers to placing an object in a predetermined place in such a way that when next needed it may be grasped in the position in which it will be used. For

Pre-positioning tools a holder in the form of socket, compartment, bracket or hanger should be provided into which or by which the tool may be returned after it is used and where it remains in position for the next operation.

4. Where each fingers performs some specific movements, the load should be distributed in accordance with the inherent capacities of the fingers.

The normally right handed persons performs work with less fatigue and greater diversity with the right hand than with the left hand. Although most people can be trained to work equally well with either hand on most factory operation, the fingers have unequal inherent capacities for doing work. The first and second fingers of the two hands are ordinarily superior in their performance to the third and fourth fingers.

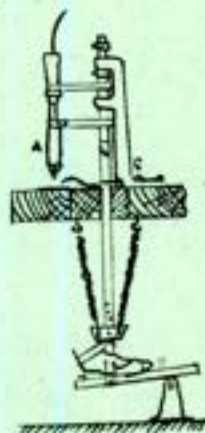
5. Levers, hand wheels and other controls should be located in such positions that the operator can manipulate them with the least change in body position and with the greatest speed and ease.

Unless a machine is fully automatic the amount of work that it will produce depends to some extent upon the performance of the operator. The more convenient the machine is to operate the greater the production is likely to be. The operator should not be required to leave his normal working position to operate his machine. The control should be in such a way that he need not bend over or twist his body in an uncomfortable manner when manipulating them. Where the ideal condition cannot be provided the nearest approach to it should be adopted.

Foot Operated Tools and Fixtures

One of the principle of motion economy related to design of tools and equipments is "the hands should be relieved of all work that can be done more advantageously by a jig, a fixture or a foot operated device". From this principle it is found that foot operated equipments are more advantageous because it would permit the operator to have both hands free to perform other motion. A hand tool often be attached to or incorporated with a simple foot press in such a way that the tool is manipulated entirely by the foot. It is also sometimes possible to use two-feet pedals to actuate different parts of a jig, fixture or

machine. We are all familiar with the fact that the automobile has several pedals, which the driver manipulates with ease, often while traveling at high speed.



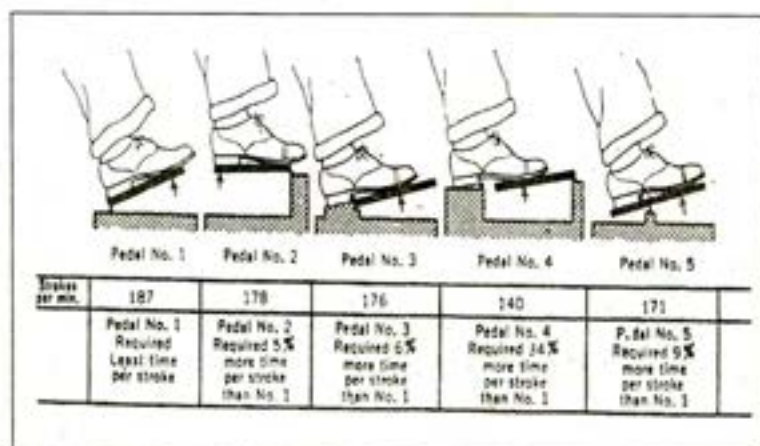
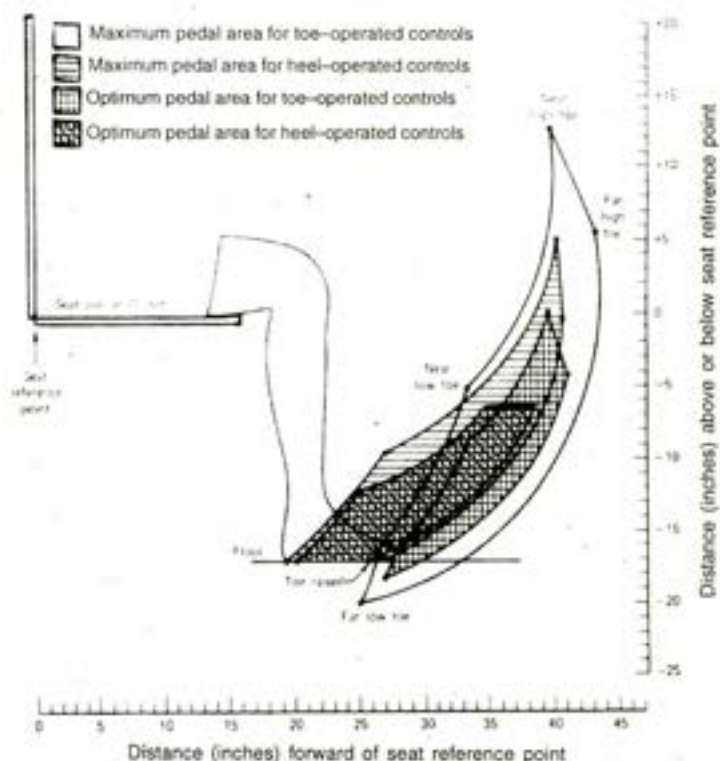
Design of Foot Pedals

Design of pedal requirements are affected by such factors as: whether they are leg operated or ankle operated, the force requirement to actuate the pedals, the speed and travel distance, the location of the fulcrum if the pedals are hinged and the precision required.

The pedal should be wide enough to accommodate either foot if the operator has to use it while standing. The displacement for a leg operated should be 2-4 inches. If ankle operated the displacement should be 2 inches. If the operator is seated the height of the pedal above the floor is determined by the height of the chair and the kind of the pedal.

Operation Criteria of Physical Activities

Operational criteria include technique for measuring the performance of the body or body member. It is obvious and most common that operational criteria relate to the performance of body members in making specific types of movements and such performance generally falling into the following groups: range of movements, force applied during activities (strength), endurance, speed and accuracy. For measuring and recording of the above, various kind of gadgetries are used such as timing device, motion picture camera, strain gauges, dynamometer and certain electronic and mechanical techniques.



Range of Movements

The biomechanics of motion deals with the various aspects of physical movements of the body and body members. Certain of the movements, which the arms, legs and other body members are capable of performing, can be considered as basic movements. Some of them are given below:

- *Flexion*: Bending or decreasing the angle between the parts of the body.
- *Extension*: Straightening or increasing the angle between the parts of the body.
- *Adduction*: Moving towards the midline of the body.
- *Abduction*: Moving away from the midline of the body.
- *Medial rotation*: Turning toward the midline of the body.
- *Lateral rotation*: Turning away from the midline of the body.
- *Pronation*: Rotating the forearm so that the palm faces downward.
- *Supination*: Rotating the forearm so that the palm faces upward.

In fact, the above are the description of the body members in terms of functioning of the muscles (e.g., flexion and extension) and of the direction of movements relative to the body (e.g., adduction and abduction).

However, in performing specific activities, as in work the movements of the body members can be well-described in more operational terms. Such as:

1. *Positioning movements*: These type of movements are those in which the hand or foot moves from one specific position to another, such as reaching for a control knob.
2. *Manipulating movements*: These type of movements are those in which require muscular control adjustment of some type during movements, as in operating steering wheel of a car or guiding a piece of wood through a band saw.
3. *Repetitive movements*: These type of movements are those which the same movements are repeated as in hammering, operating a screw driver and turning a hand wheel.

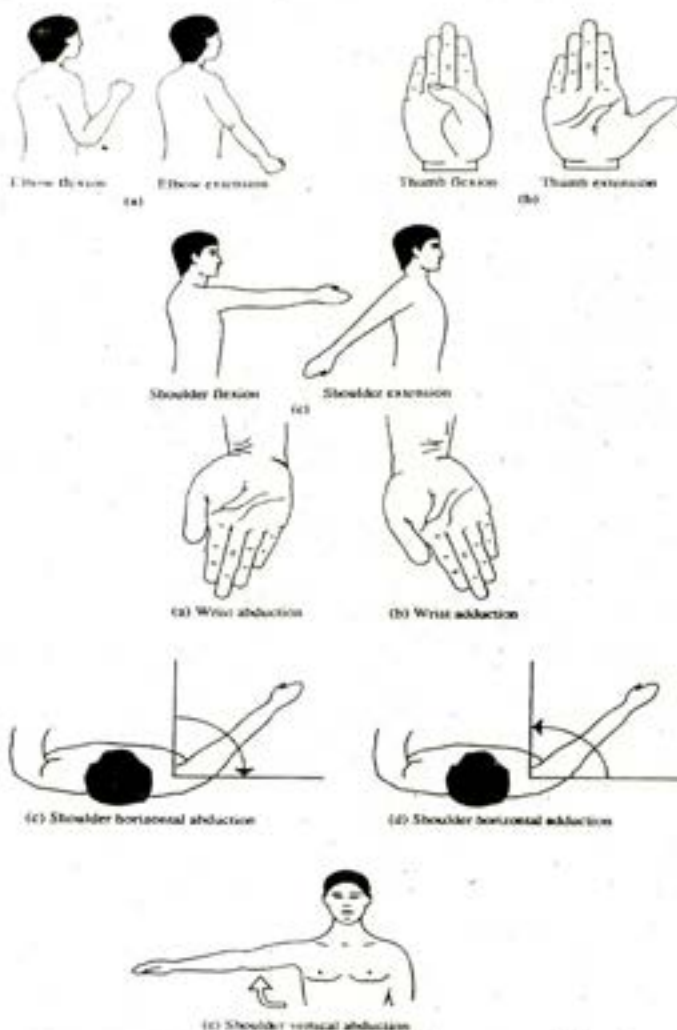


Figure 5.5: Abduction and adduction of the wrist and shoulder.



Figure 5.6: The elbow rotation.

4. These are the several relatively separate, independent movements in a sequence such as in operating a keyboard or starting a car on a rainy night, which might include turning on the ignition, pressing a starter button, turning on the lights and turning on the wiper.
5. *Static adjustment*: It is the absence of a movement, consisting of maintaining a specific position of a body member for a period of time.

Strength and Endurance

Strength is the maximum muscular capacity to exert force under static condition. Strength is measured usually by the use of external devices such as hand dynamometer or the devices for measuring force exerted against some object. The measurement of such forces however depends not only on the intrinsic muscle strength but also on the subject motivation, the experimenter's instruction and even on the measurement index used (whether the peak value or average value of two or three efforts are used).

Endurance of peoples means to maintain a given muscular force for a duration of time. So endurance is such ability which is related to the magnitude of force.

From Fig. 5.7 it is clear that people can maintain their maximum effort very briefly whereas they can maintain a force of around 25 per cent or less of their maximum for a some what extended period. (10 min. or more).

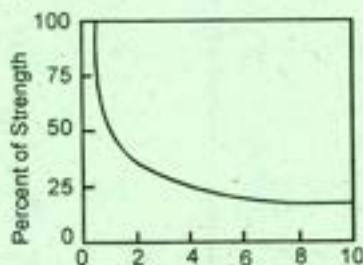


Fig. 5.7: Minutes

So in the field of work environment the concept of endurance refer to the ability to keep up some general body activity over a period of time. In this frame of reference the "endurance" of individuals would be a function of total energy cost of the activity and the energy expenditure, the individual can reasonably maintain over time. Followings are the some biomechanical data given with reference to strength and endurance:

Lifting action: In lifting heavy object to various levels, weights can be lifted males from 17 to 32 tears of age to a low level of 42 cm than to a intermediate level of 104 cm or to a higher level, the values

for short, medium and tall males being respectively:

Height in cm	Short	Medium	Tall
Low level	56 kg.	62.5 kg.	66 kg.
Intermediate level	33 kg.	42 kg.	43.5 kg.
High level	24 kg.	29.5 kg.	30.5 kg.

So it is obvious from above table lifting from the floor is less efficient in energy cost than lifting from the intermittent level.

Grip strength: The grip strength of a sample of 552 male industrial workers ranging 34 to 77 kg, getting a mean of 57 kg.

Strength also depends on the following factors also:

Age: Strength reaches a maximum by the middle to late 20's and decline slowly but continuously from then on, until at about age 65 strength is about 75 per cent of that exerted at youth. Despite such reduction in strength however, there are indication that continuous work capacity of men does not decrease of age up to about 60.

Sex: Women's strength is about two-thirds that of men.

Body build: Although the body build is related to strength and endurance, the relationships are complicated. For example, athletic looking individuals generally are stronger than others but less powerfully built persons may be more efficient.

Exercise: Exercise can increase strength and endurance within limit.

Speed: Speed generally is the primary requirements in executing movements that are demanding such as in applying the brake pedal of an automobile or reaching for parts to be assembled.

Accuracy: Accuracy is the primary requirement in executing such movements as those in which continuous control is required in certain positioning action or in certain manipulative activities that require precision and control.

Response time: Many movements are triggered by some external stimulus such as changing traffic light or auditory warning signal. The time to make a movement following such stimulus actually consists of a combination of delays: the nature of these delays and the range of typical times in milliseconds (ms) have been summarized by "Wargo" as follows: Receptor's delays 1 to 38 neural transmission to the cortex, 2 to 100; central process delays 70 to 300 neural

transmission to muscle 10 to 20; and muscle activation time 30 to 70. These add up to a total ranging from 113 to 528 ms. The total time to make a response following stimulus frequently is referred to a 'reaction time': so the time taken to initiate a movement may be called as reaction time and the time to make the movement called movement time.

Simple reaction time: Simple reaction time is the time to make a specific response when only one particular stimulus can occur, usually when an individual is anticipating the stimulus (as in conventional laboratory experiments). Reaction time is usually shortest in such circumstances.

Choice reaction time: If there are several possible stimuli, each with its own response, the time goes up largely because of the additional central process time required to make a decision. Such reaction time is called 'choice reaction time'.

Movement time: The time to effect a movement following a signal would of course vary with the typical distance of movement, but it has been estimated that a minimum of about 300 ms can be expected for most control activities. Adding this value to an estimated reaction time of 200 ms would result in a total response time of about 500 ms. However, the nature and distance and location of the response mechanism can influence the total time.

So the speed requirement for example can be reduced by taking actions such as using sensory modalities with shortest reaction time, presenting stimuli in a clear and unambiguous manner, minimizing the number of alternatives from which to choose, giving advance warning of stimuli if possible, using body members that are close to cortex to reduce neural transmission time, using control mechanism that minimize response time and training the individual.

Energy expenditure in physical activities: Although the human beings are not now used as energy sources, some occupations still require substantial physical effort, at least at certain time or as accumulated over the work day. For different kinds of physical activities there would be different numerical values of energy expenditure or physiological costs. The following examples are given in kilocalories per min as energy expenditure in some different activities:

Sleeping - 1.3, Standing - 2.25, and Sitting - 1.6.

In connection with rate of body movement (as in walking and running) the physiological costs goes up with increasing rate. This is shown quite clearly in the following Fig. 5.8:

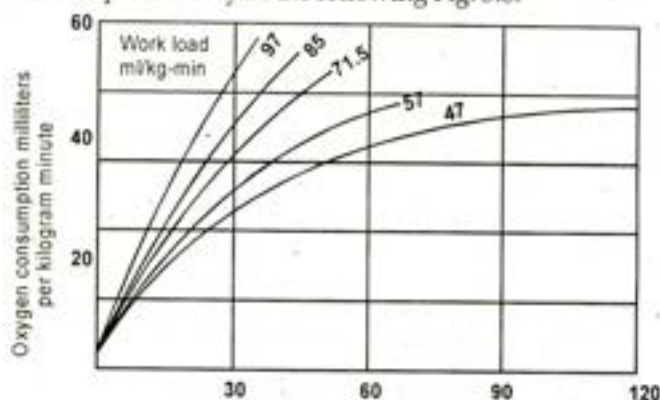


Figure 5.8: Time on Treadmill, Seconds.

Energy expenditure of specific activities: The energy expenditures of various types of activity vary somewhat for individuals but estimates of the approximate energy costs for certain specific types of work are given in the following Fig 5.9:

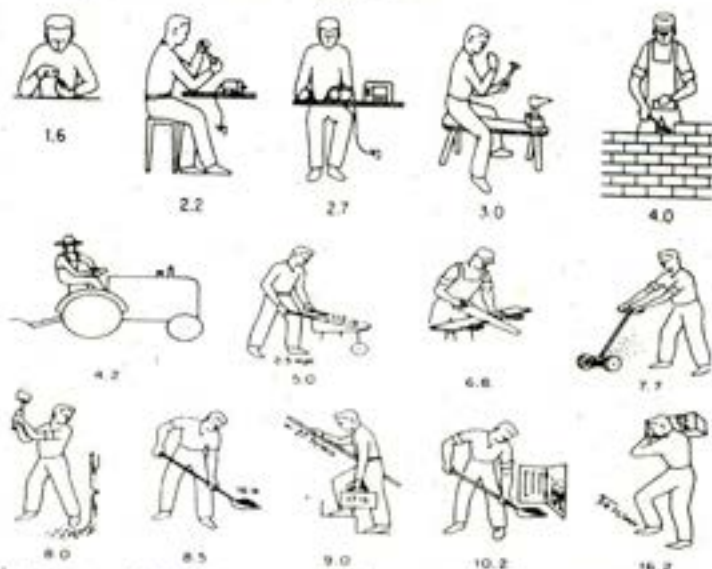


Figure 5.9: Examples of Energy Costs of Various Types of Human Activity.

However, the energy cost for certain types of work can vary with the manner in which the work is carried out.

*Energy expenditures of different postures:*³ The postures of workers when performing some tasks is another factor that can influence energy expenditure. In this regard certain agricultural tasks in particular have to be carried out at or near ground level. The energy costs of certain such posture were measured in a study by "Vos" in which he used a task of picking up metal tags placed in the floor. A comparison of the energy expenditure of five different postures are given in following Fig. 5.10:

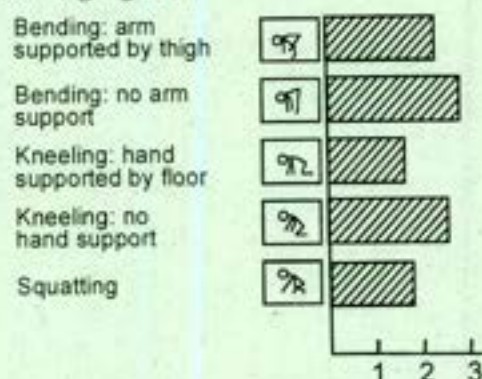


Figure: 5.10: Energy expenditure Kcal/min.

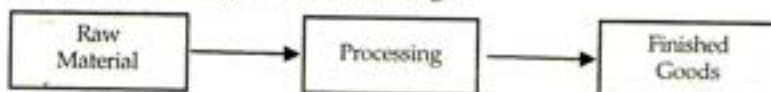
Keeping energy expenditure within bound: If those who are concerned with the nature of human work activities (design engineers, industrial engineers etc.) want to keep energy costs within reasonable bounds, it is necessary for them to know both what those bounds should be and what the costs are for specific activities. Energy costs of different grades of work are given below:

Grade of work	Energy expenditure		Approx. Oxygen consumption (lit/min)
	Kcal/min	Kcal/8 hr.	
Unduly heavy	Over 12.5	Over 6000	Over 2.5
Very heavy	10-12.5	4800-6000	2.0-2.5
Heavy	7.5-10	3600-4800	1.5-2
Moderate	5.0-7.5	2400-3600	1.0-1.5
Light	2.5-5	1200-2400	0.5-1.0
Very light	Under 2.5	Under 1200	Under 0.5

The energy expenditure over the period of the conventional working day "Lehman" estimates that the maximum output a normal man can afford in the long run is about 4800 kcal/day, subtracting his estimate of basal and leisure requirement of 2300 kcal/day leaves a maximum about 5 kcal/min. But although he proposes this as a maximum he suggests about 2000 kcal/day as a more normal load, this averaging out to be about 4.2 kcal/min.

Assisted Movements

In a workplace movements may be mainly on materials and to some extent of tools. Movements of materials are called 'material handling'. During the processing of materials or during any job to be done, there are plenty of movements of materials or tools are involved in different stages i.e., in the stage of raw material, in the stage of processing or in finished stages.



In cases of movements of tools if the tools or the equipments are mounted in such a way that after use they returns automatically to a definite location it will be easier to perform the operation by operator with less fatigue and it also be easier to train the operator to develop habituated motion pattern. The usual method of effecting this type of location is to use spring arm or counter balance weight. The main advantages of this type of locations are:

- Some degree of support can be given to tool.
- Operators fatigue is reduced to a minimum.

Some examples are given below:

Spring driver stand: With this type of location of tool, which is attached to the stand and is capable of being moved up, down, forward and sideways.

Tools suspended from beam and counter balanced which returns automatically after use due to counterbalance weight. As shown in figure multiple spindle air operated nut runner can tighten all the five wheel nuts at a once and returns back after use. It is suitable for heavy tools and it also keeps workplace clear.

In cases of material handling, gravity flow type material handling should be used and if not possible then selection of mechanical handling system may be used. In gravity flow type material handling

system where gravitational force is used to flow of material is called 'gravity assisted movement'.

In gravity assisted movement raw material and finished goods can be transported by manual pushing using trolleys, hand carts etc. In processing stage, gravity fed bins and containers should be used to deliver the materials close to the point of use. A bin with sloping bottom permits the materials to be fed in front of the operator by gravity, thus relieves the operator of having dip down into the container to grasp parts. However, it is always not always possible to slide the material into position.

In cases of manual pushing if the manufacturing processes are of continuous type, there should be some gradient (say 1: 100) towards from the entrance of material and to the processing plant and further where finished goods are to be stocked.

Material Handling

A good deal of time and effort is often expended in moving material from one place to another in the course of processing. The aim would be to move materials by the most appropriate methods and equipments at the lowest possible cost and with regard to safety. This aim may meet by:

- Eliminating or reducing handling.
- Improving the efficiency of handling.
- Making the correct choice of material handling equipments.
- Safe handling.

Eliminating or Reducing Handling

There is often ample scope for eliminating or reducing handling. In practice it is obvious that there is a need to improve an existing situation when certain symptoms are observed e.g., too much loading and unloading, repeated manual handling of heavy weights, material travelling considerable distance, frequent damage or breakage resulting from handling and so on.

Improving the efficiency of handling: The observation of certain perception can improve the efficiency of handling. Those perceptions are:

1. Increase the size or number of units being handled at any time. If necessary review the product design and packaging to see if this result can achieve more readily.

2. Increase the speed of handling if this is possible and economical.
3. Let gravity work as much as possible.
4. Have enough containers, pallets, platforms, boxes etc., available in order to make the transportation easier.

Making the correct choice of material handling equipments:

Different types and kinds of material handling equipment exist. Although there are literally hundreds of various types, these may be classified in five major categories:

Conveyors: Conveyors are useful for moving material between two fixed work stations either continuously or intermittently. They are mostly used for continuously or mass production operation. Conveyors are of various types with either rollers, wheels or belts to help move the material along; there may be power driven or may roll freely. The decision to provide conveyors must be taken with care, since they are usually costly to install.

Industrial trucks: Industrial trucks are more flexible in use than conveyors since they can move between various points and are not permanently fixed in one place. They are therefore most suitable for intermittent production and for handling various sizes and shapes of material. There are many type of trucks—petrol driven, electric, hand powered and so on. Their greatest advantages lie in the wide range of attachments available; these increase the trucks ability to handle various types and shapes of material.

Cranes and hoists: The major advantages of cranes and hoists are that they can move heavy materials through overhead space. However, they can usually serve only a limited area. Here again there are several types of crane and hoist, and within each type there are various loading capacities. Cranes and hoists may be used both for intermittent and for continuous production.

Containers: There are either 'dead' containers (e.g., cartons, barrels, skids, pallets etc.) which hold the material to be transported but do not move themselves or 'live' containers (e.g., wagons etc.). Handling equipments of these kind can both contain and move the material and is usually operated manually.

Robots: Many types of robots exist. They vary in size and in function. While many robots are used for handling and transporting

materials others are used to perform operations such as welding, spray painting etc. An advantage of robot is that they can perform in a hostile environment such as unhealthy conditions or carry on repetitive movement of heavy materials.

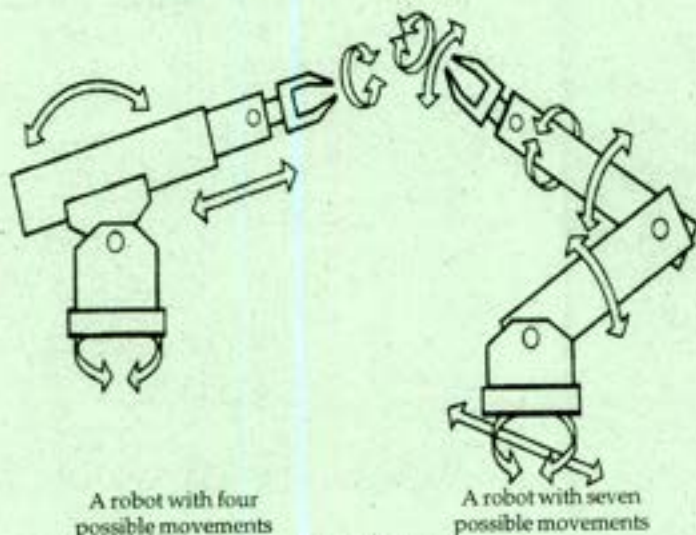


Figure: 5.11

The choice of material handling equipments among various possibilities that exists should be in very careful manner. The Fig. 5.11 shows the various possibilities of material handling.

Important factors to be taken into consideration when choosing material handling equipment are:

- *Properties of material:* Whether material is in solid, liquid or gaseous state and in what size shape and weight. Whether it is fragile, corrosive or toxic etc.
- *Layout and characteristics of the building:* Availability of space for handling.
- *Production flow:* Whether the material flow is fairly constant between two fixed position or direction changes occasionally from one point to another.
- *Cost consideration:* By calculating and comparing the total cost for the items of equipments under consideration a more rational decision can be reached on the appropriate choice.

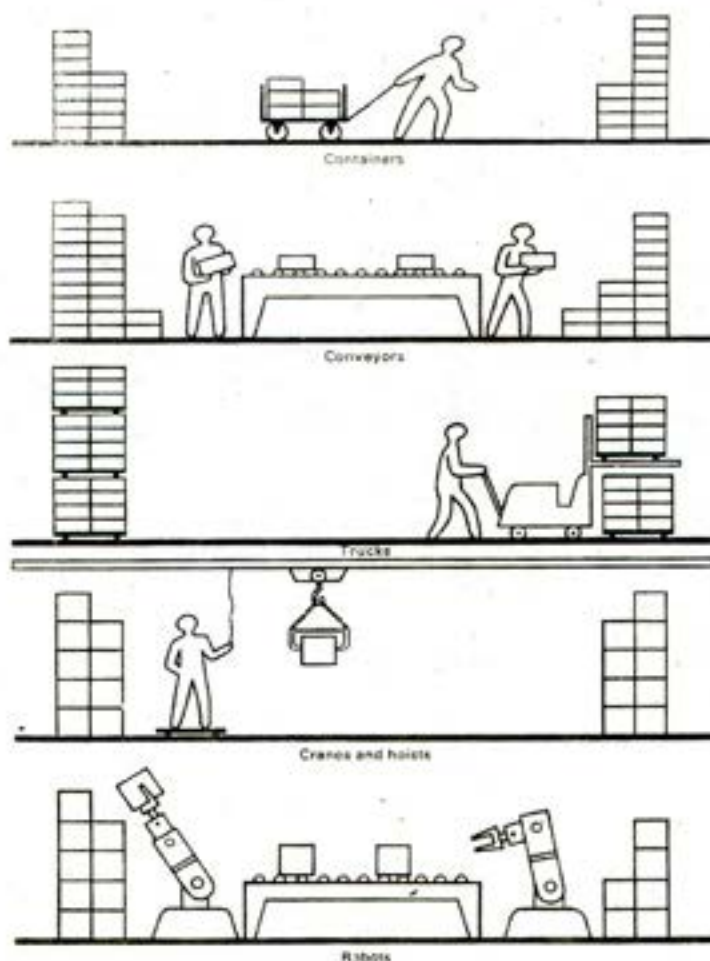


Figure: 5.12

Mechanization: It aims at replacing manual work by machine work when feasible. In this way some monotonous repetitive manual work has been replaced by machinery capable of performing these operations. Still, in mechanization a worker operates a machine and adjusts it to perform the desired quantity of goods to the desired level of quality. Though quality in this case depends to a large measure on the worker's skill in addition to the condition of machine and tools that are being used.

Automation: In automation few workers are involved. The machine receives the instructions from a computer into which all the desired informations has been fed, and therefore they continue to operate on their own and with minimum operator interference. The development of robots has given the boost the automation.

Unit Summary

The motion economy principles are the most important tools in designing the workstations, tools and equipments. The different motion economy principles are: (1) Motion economy principles using human body. (2) Motion economy principles related to the arrangements of work place. (3) Motion economy principles related to the design of tools and equipments. The bio-mechanics of motion deals with various aspects of physical movements of the body and body members especially in terms of functioning of muscles. They are flexion, extension, adduction, abduction, medial rotation, lateral rotation, pronation and supination. However, in performing specific activities the movement of body members can be describe in more operational terms. They are positioning movements, manipulating movements, repetitive movements, sequential movement and static condition. Strength is the maximum muscular capacity to exert force under static condition and endurance means the ability to keep up some general activities over a period of time. Assisted movement means the movement of materials with the assistance of gravitational force or by mechanical means. This may also be named as material handling.

Check Your Progress

1. Describe the motion economy principles related to work station design.
2. Describe the motion economy principles related to human body.
3. Describe the motion economy principles related to the design of tools and equipments.
4. What are the main features should be considered during a chair design?
5. What are the different movements of body members when performing some activities?
6. Describe the major types of material handling equipments used in industrial sectors.

7. What are important factors when choosing the correct material handling equipments?
8. Write short notes on:
 - (a) Foot operated tools and fixtures.
 - (b) Design of foot pedals.
 - (c) Basic physical movements of body members.
 - (d) Mechanization and automation.
 - (e) Strength and endurance.
 - (f) Material handling.
 - (g) Speed and accuracy.
9. Short questions:
 - (a) What is physiological cost and why it is important to work design?
 - (b) Describe the assisted movement of tools.
 - (c) What should be the aim when selecting the material handling equipments?
 - (d) What is the energy expenditure at different postures?
10. Choose the correct answer:
 1. Conveyors are useful for movements of material
 - (a) Between two fixed points.
 - (b) When there are no fixed points.
 - (c) When the distance between two points are very large.
 2. In mechanization quality of work depends on
 - (a) Workman's skill.
 - (b) Workman's interference does not required.
 - (c) None of the above.

Points for Discussion/Clarification

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Environmental Restructuring

Unit-6

Modification of Hand Tools

STRUCTURE

- Introduction
- Objectives
- Some Common Terms
- Use of Hand as a Tool
- Bio-mechanical Principles for Hand Tool Design
- Basic Safety Rules for Tool Used
- Unit Summary
- Check Your Progress
- Points for Discussion/Clarification

6

Modification of Hand Tools

Introduction

Hand tools are such a common part of work life that workers do not think they may pose hazards. Although the hand tools are manufactured with safety in mind, tragic accidents often occur. Tool hazards may be due to improper tool design or lack of worker training in recognizing the hazards associated with various types of tools and the required safety precautions to avoid hazards. The latter includes misuse and improper maintenance of tools, which are the greatest source of hazards.

In fact, hand tools are the extension of human hand. They enhance the capabilities of the users in performing their tasks so efficiently that the task would otherwise be difficult, if not possible. Poorly designed tools are one of the common factor contributing the development of Cumulative Trauma Disorder (C.T.D.). Improper use of tool regardless of its design can also lead to C.T.D. problems. Well-designed and properly used tools can reduce or prevent such problems. Most work tools are purchased from external vendors rather than designed and manufactured internally by the employers. So modification of hand tools is necessary to fit perfectly the specialized needs of the users or persons with mental retardation.

Objectives

1. To impart the knowledge regarding the work tool/hand tool design.
2. To know the bio-mechanical principles used for hand tool design.
3. Correct use of hand tools.

Some Common Terms

Grip strength: According to BAZAR (1978) grip strength is the maximum momentary force exerted on a hand dynamometer.

Endurance: According to BAZAR (1978) endurance is the length of time a person can exert a specified force.

Consideration of grip strength and endurance is very important in the design and use of hand tools requiring gripping force and manual material handling.

Handle design: Pheasant and O'Neill (1975) investigated handle design in a gripping and turning task (such as using a screwdriver). They found that strength deteriorated when handles greater than 5cm in diameter were used and that, to reduce abrasion of the skin, hand-handle contact should be maximized. Knurled cylinders were found to be superior to smooth cylinders because of the increase in friction at the hand-handle interface. The authors concluded that, the forceful activities, the size of a handle rather than its shape was most important. A useful rule of thumb for evaluating handle diameters is that handle should be of such a size that it permits slight overlap of the thumb and fingers of a worker with small hands.

Grip strength depends very 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, grip strength is severely weakened.

Tools such as saws and pliers can be designed with obliquely set handles to enable the wrist to be maintained in the neutral position. Tools such as soldering irons can be redesigned using a 'pistol grip' handle rather than traditional straight handle for the same reason. When using straight handled tools there is a tendency for the wrist to be bent outward ('ulnar deviated').

Powered tools tend to be considerably heavier than their non-powered counterparts and has a potential source of wrist strain comes from the weight itself, particularly if the handle is placed at one end rather than its middle. Fitting the handle at the tool's center of mass so that tool is counterbalanced can reduce wrist loading.

Finally, tools can be redesigned and fitted with longer handles or handle extensions can be fitted to increase the workers vertical reach, obtaining the need for the hands to be raised above shoulder

height. Some examples are handle extenders for paint brushes when painting ceilings.

Followings are the major hazards regarding use of hand tools should be avoided:

Use of Hand as a Tool

Frequent tapping with the heel of the hand, even lightly, can injure the nerves, arteries and tendons of the hands and wrist. In addition to the hands and wrist the impact shocks can be transmitted to the elbow and shoulder and damage these joints. Examples of occupational tasks in which the hand is used as a hammer for tapping can be seen in many assembly operations, including hitting electrical. Parts to tighten them after insertion, and hitting doors or wheel covers to align them after assembly. Small or rubber hammers should be provided for these purposes.

Repetitive finger action and pinch grips: Repetitive use of index finger to operate triggers on many hand tools can cause fatigue in the finger, and a condition called trigger finger. Trigger finger causes jerky motion of the afflicted finger during extension. Sometimes the finger cannot be extended without help. This condition most often occurs through the use of hand tools that are so large that the operation of the trigger requires the flexion of the distal phalanx while the middle phalanx must be kept straight. However, it can also occur with repetitive use of small handles.

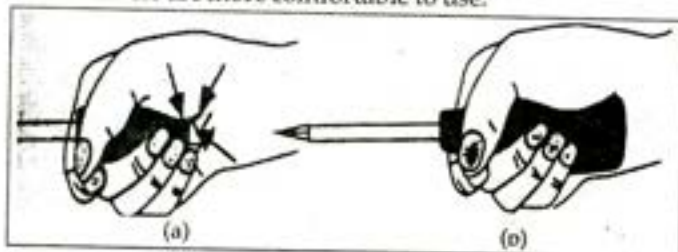
Repetitive hand-arm vibration: Operation of hand held power tools (e.g., power saws, drills, riveting hammers sanders, grinders, pneumatic wrenches) can cause CTDs. Exposure to hand-arm vibration, especially in cold climates, can lead to vibration white finger. The tool vibration causes constriction of the blood vessels, resulting in reduced blood flow to the hand and fingers causes chronic hand injuries.

Ergonomic Principles for Hand Tool Design and Evaluation

- Avoid rigid, form fitting handles with grooves for each finger. Such handles do not improve the grip strength and function unless they are sized to a particular user's hand.
- Avoid hand tools, which require awkward movements, or cannot be operated effectively with neutral wrist posture and low force. Tool handles should be designed so that the

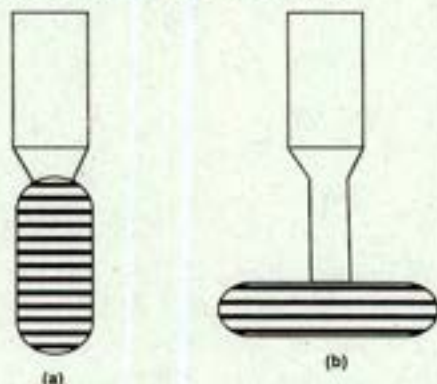
user can maintain the hands in line with the forearms as much as possible.

- Avoid tool handles with sharp corners, edges or pinch points. Tool handles should be either round or oval.
- The tool handle surface should be compressible, non-conductive and smooth. However, handles should have enough coefficient of friction to minimize hand-gripping forces required for tool control.
- Avoid hand tools that impose concentrated pressure over the soft tissues of the hand, which can impair circulation and the nerve function in the hand. A short handle screwdriver can dig into the palm of the hand. Long handled screwdrivers are more comfortable to use.



- Tool handles should fit the hand. This means that handles should be of the proper thickness, shape, and length so that the stress bearing area of the hand is as large as practical. The optimal grip with fingers, palm and the hand is achieved by a span size (diameter) between 6.25 and 9.00 cm.
- Choose or design tools that can be used by either hand. Left-handed workers should not be forgotten in the design of tool. Many power tools (chain saws, sanders and drill) are equipped two handles, one of which is the primary handle (usually with a trigger and used by the dominant hand) and the other is a secondary handle, used as the stabilizing handle. The handles should be designed so that the stabilizing handle can be adjustable to either side of the tool to accommodate both right handed and left handed individuals. Such a design will also permit the user to alternate the triggering hand from time to time to avoid excessive fatigue and to reduce the risk of chronic hand injuries.

- Choose or design the tools that can be used effectively by both men and women.
- Choose or design special purpose tools for specific tasks.
- Consider the angles of grip, forearm and tool to minimize the wrist deviation.
- Consider provisions for tool safety.
- Avoid tools presenting excessive vibration.
- Avoid tool handles (e.g., putty knives, paint scrapers and chisels) that place concentrated pressures on the pressure sensitive areas overlying the blood vessels and nerves in the base of the palm of the hand. The use of this type of handle obstructs blood flow leading to fatigue, tingling and pain in the hand. The long-term effect is the development of chronic hand injuries. Such handles should be modified to transmit the force through a tougher area of the hand—the area between the thumb and index finger.



- Choose ergonomically designed tools to maintain a more natural position of the wrist and to insure better distribution of grip forces during task performance. Examples are bent handled tools, such as bent handled pliers. The wrist should be maintained straight during the tool use.
- Design and locate fixtures and jigs to permit tasks to be performed using the normal range of arm movements.
- Avoid hand tools with fluted handle surfaces. They concentrate stress over a small surface in the hand.

- Fixtures should be used to mount work-pieces at angles, which reduce the wrist deviation.
- Provide workers with tools and machine control, which can be operated most effectively with neutral body part posture and low forces.
- Substitute power tools for hand tools that require high force level. However make certain that power tool is properly designed. It should have adequate grip size (6-9cm circumference), not develop excessive vibration, be light enough to handle easily (or be counterbalanced), should not require excessive trigger action and should be easy to use.



The modification of tools is the concept of changing the external tool dynamics to enable a person to hold and execute the given job comfortably.

Bio-mechanical Principles for Hand Tool Design

Tichauer (1978) recommends the following fundamental principles of bio-mechanics for prevention and solution of problems associated with use of hand tools.

1. The force required for operating a tool should be sufficient to provide proper sensory feedback to the Musculo skeletal system, and particularly to the tactile surface of the hand. Therefore, the required force must be optimized. For example, in performing a certain task on a given work piece if the ratio of force output to force input is too large, the work piece can be damaged and/or the worker injured. On the other hand, if this ratio is too small the task must be repeated a large number of times, which makes the task fatiguing.
2. The tool should provide a precise and optimal amount of stress concentrated at a specific location on the work piece. The tool should be so shaped that it will be automatically guided into the intended position where it will do its job

best without either injuring the worker or damaging the work piece. Tool blades (axes and scrapers) should be adequately sharpened so that the tasks are performed with the minimum number of repetitions but not so sharp that the blades require frequent sharpening or become fragile.

3. The tool should provide a contact surface area between its handle and the user's hand large enough to avoid concentration of a high compressive stress. Otherwise pressure and impact acting on the hand can squeeze the vessels and/or nerves between the handle and bones in the hand and wrist preventing proper blood supply and damaging the nerves, which can cause numbness and tingling of the fingers.

Safety Guidelines for Tools Used

Since work-tools can be hazardous when improperly used employees should be trained in the proper use of all tools, especially power tools. They should also learn to recognize the potential hazards associated with the different type of tools and the safety precautions for avoiding those hazards. Employees and employers must work together to establish safe working procedures; otherwise safety goals will not be achieved.

Basic Safety Rules for Tool Used

All safety hazards associated with the use of work-tools can be controlled by the following five basic safety rules:

1. Keep all tools in good condition with regular maintenance.
2. Use the right tool for the job.
3. Examine each tool for damage before use.
4. Operate tools according to manufacturer's instructions.
5. Provide and use the right protective equipment.

It is usually quicker to turn a small two-ended tool end-for-end than it is to lay one tool down and pick up another. So redesign and modification of hand tools is particularly important for the persons with mental retardation. For the proper and easy utilization of the tools. There are many examples of two-tool combination—two-ended wrench, pencil and eraser etc. Two-ended convenient tools, which have been developed at a mid-western electrical equipment company.

The first one replaces the screwdriver and tweezers—it holds screw while it is being assembled. The second tool replaces a wrench and a screwdriver. This device permits the bolt to be set to the proper position and at the same time allows the operator to lock the nut in place by means of the 'sleeve wrench' which slips over the screwdriver.

Unit Summary

Hand tools can be considered as the extension of human's hand. In designing a handle of hand tools grip strength plays an important role. Again grip strength depends very largely on the posture of the wrist. When one using obliquely set handles such as in hand saws, pliers the wrist should be maintained in neutral position. Beside this there are a number of ergonomic principles for hand tool design and evaluation, which are very useful in designing proper and convenient hand tools. There are also bio-mechanic principles, which should use during the design of hand tools and tool handles. The basic rules for safe use of hand tools should always kept in mind when using hand tools. The important safety rules are: (1) keep all tools in good condition, (2) use the right tool, (3) examine the tools before use, (4) use the tools according to manufacturer's instructions, and (5) use the right protective equipments.

Check Your Progress

1. What are the major hazards during the use of hand tools?
2. What are the ergonomic principles used during design of hand tools?
3. Describe the bio-mechanical principles for hand tool design.
4. Write shortnotes on:
 - (a) Basic safety rules of using tools.
 - (b) Grip strength.
 - (c) Hand tools.
 - (d) Tool handle design.
5. Mark the right answer:
 - (a) The optimum diameter of fingers, palm and hand should be:
 1. 7.25 cm.

2. 5.25 cm.
3. 10.25 cm.

Points for Discussion/Clarification

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Environmental Restructuring

Unit-7

Self Inspecting Devices

STRUCTURE

- Introduction
- Objectives
- Design Self Inspecting Devices
- Unit Summary
- Check Your Progress
- Points for Discussion/Clarification

7

Self Inspecting Devices

Introduction

It is required to perform certain operation when an item or product or component is to be manufactured. The act of checking whether a component actually does so or not is called inspection. In the word inspection means checking the acceptability of the manufactured product. Inspection measures the quality of a product or services in terms of pre decided standards. Product quality may be specified by its strength, surface finish, chemical composition dimensions etc. The normal person can do this inspection work using their discriminating ability. They may use several tools, fixtures or gauges etc. for the inspection easily. But the persons with mental retardation, it is very difficult to get the job inspected properly.

Objectives

The main objectives are:

1. To explain that inspection separates the defective parts from non-defective one and thus ensures the adequate quality of product.
2. To introduce self-inspecting devices to make the inspection process easier.

Constant attention and almost continuous use of eyes are required in many kind of inspection work. Perception of defect must be followed by instant action on the part of the inspector to reject the defective part. Some individuals are able to see smaller differences than others and to perceive the same differences with greater speed. Because reaction time and visual acuity are important elements in

most inspection work; so it is essential that persons be selected by means of suitable tests before being employed such work.

If the persons with mental retardation are doing the same type of job it is also very important to check the product with the specified quality. Now to employ a person with mental retardation to check the quality it is essential to use the self-inspecting devices. Self-inspecting devices are those, which can inspect the product quality at their own without using the discriminating ability. If the mentally retarded persons can do inspection work it will also motivate them to do the job correctly every time. It also reinforces and encourages them to do more and more of such correct job. This reduces the overhead expenditure of employing a separate inspector to inspect the job. In this context it is also essential to ensure that the workstation arranged for doing the work also have facility for inspection, which will takeover the cognitive skill or discrimination required and permit the mentally retarded persons to do the inspection themselves. The self-inspecting fixtures, which may also called as self-inspecting devices should facilitate the mentally retarded persons to pass the correct job and to reject the defective jobs which can be followed and understood very easily by them.

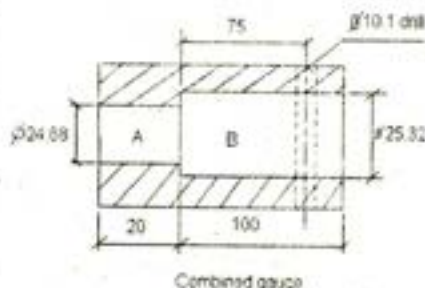
"Go" and "No Go" gauges are the example of self-inspecting devices, which can check the shape, dimensions, length etc. Gauges and templates can be modified to inspect the linear dimensions, shapes and profiles, with ease by mentally retarded persons as to use these do not require any discriminating ability.

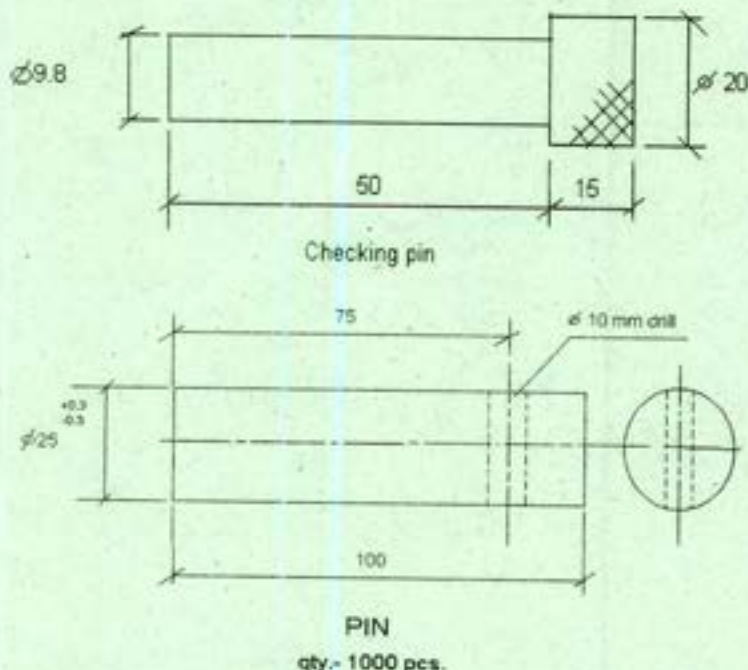
For example 'pins' (as per sketch) of $\varnothing 25 (+0.3, -0.3)$ has to be inspected.

Design Self-inspecting Devices

To make the self-inspecting device of the product, (1) a combined 'Go' and 'No Go' gauge and a pin (2) is enough to check the product.

Now to check the part first we have to insert the part into the combined gauge. It is obvious that the





only correct one will enter in the combined gauge. Thus we can check the dimensional accuracy of diameter. It also checks the length of the pin, because only right pin will flush the end along with combined gauge. Now to check position of hole, drill diameter, drill length and perpendicularity of drill hole we have to use the checking pin. The checking pin will easily pass through the hole of combined gauge only in the right pin. Thus this is a device, which can inspect at its own of all the prescribed criteria in drawing.

So with the use of self-inspecting devices one can easily check the linear dimensions, shape and other dimensions without using their discriminating abilities.

Unit Summary

Self-inspecting devices are the devices by which any one can check the component part of their size, shape, linear dimensions, position etc., without using the discriminating ability i.e., the component can be checked at its own. Gauges, templates are the examples of self-inspecting devices. Self-inspecting device should facilitate the

persons with mental retardation to pass the correct job and to reject the defective job, which can be followed and understood, very easily by the persons of mental retardation. So the concept of self-inspecting devices is very important particularly to the vocational instructor.

Check Your Progress

1. Describe in brief the "self inspecting devices" with an example.
2. Write short notes on—Self-inspecting fixtures.
3. Tick mark on right answer

Self-inspecting devices are:

- (a) Devices, which can inspect at their own.
- (b) The devices used in production.
- (c) The device, which is used to reject the wrong part.

Points for Discussion/Clarification

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Environmental Restructuring

Unit-8

Application of Task Analysis to the Design of Workstation

STRUCTURE

- Introduction
- Objectives
- Job Analysis
- Skill
- Some Definitions
- Unit Summary
- Check Your Progress
- Points for Discussion/Clarification

8

Application of Task Analysis to the Design of Workstation

Introduction

People spend most of their time engaged in performance of tasks. Tasks are the activities with specified goals and may be paid or unpaid. Tasks are carried out at homes, at work, on the road and in everywhere.

Objectives

The main objectives are:

1. To find out the best method of doing work.
2. To find out the skills required doing the work.
3. To understand the usual processes of analyze a work.

Job Analysis

Job analysis is used to describe the process. As the beginning point the job is divided into five general stages. These stages are:

Preparation: What steps are necessary to prepare the worker for performing the jobs?

Observation: What informations and data must the worker have to perform the job?

Control: What steps (decisions and mental processes) must the worker take to control the job processes?

Physical demand: What physical tasks must the worker do to perform the job?

Termination: What steps must the worker take to terminate the job?

Stages 2 and 3 make up a feed back loop, in which the worker receives the information concerning the process and decides what control must be applied to the process to obtain the desired output? Once the control is applied, the process changes accordingly, then the information concerning the changes in the processes is fed back to workers to enable them to evaluate the result and take the next control action. The feed back (action-result) loop is graphically illustrated in Fig. 8.1



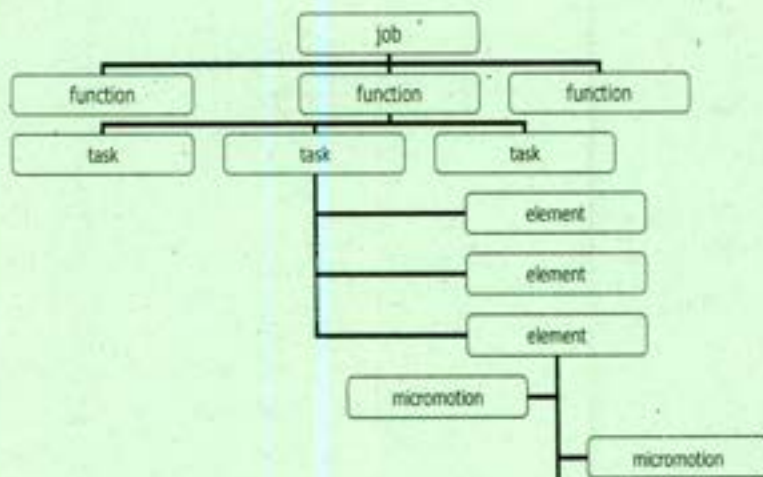
Figure: 8.1

In job analysis, each job is divided into functions, such as shipping and receiving, production and quality control. Each function can then be subdivided into its individual tasks or activities, such as manual material handling; hammering. Each task is in turn broken down into elements. For examples, lifting, carrying, lowering are elements of manual material handling.

Let us take an example of packaging.

The element of a packaging task for a given item may be as follows:

- Get 10 empty cartons and sheet of wrapping paper.
- Position a sheet of wrapping paper.
- Position an item on the wrapping paper.
- Wrap the item.
- Place the wrapped item in the carton.
- Close the carton and tape it.
- Label the carton.
- Set the packed carton aside.



Finally each element can also be analyzed in terms of micro-motions that are involved in performing the elements. Now, how far the job should be divided, it depends upon the objective of the job analysis? If the objective is to determine the worker's duties, the task level seems to be sufficient. If the objective is to remove the potential health hazards or to worker's efficiency it may be necessary to break the job down to the level of micro-motion. Whatever, the objective is the job should be divided into small segments of manageable size such that the segment can be analyzed. So how far the job should be analyzed it depends the order of progress of job and the skills of operator and as it is hierarchical in nature it may be called as H.T.A. (Hierarchical Task Analysis).

Once the job breakdown is established the task analysis can begin. The analysis involves a number of questions about each task, element or micro-motion that is being analyzed. The following are some critical question:

1. What is the cause or stimulus that results in the requirement of a job analysis in the first place?
2. What action must be taken? What steps must be performed by the worker and/or machine to achieve the desired result or output?
3. What potential errors are possible? What is the cost these

errors in terms of damage of equipments, materials or worker's well-being?

4. What potential hazards are present that can cause an injury or illness to the worker?
5. What tools, equipments are required to complete the task or elements?
6. Where the task or element being preferred? What is the physical location and structure of the workplace in which the task or element is performed?
7. What physical demands are placed upon the worker to perform the task or element?
8. What skills and knowledge are required of the worker to perform the task or element?

So skill analysis is an important factor in respect with task analysis. Now what is skill?

Skill

The level of energy expenditure in performing a certain task may vary among individuals due to the degree of skill they possess. This may be best explained by the fact that a skilled person exhibits more economical movements and makes fewer mistakes and expends less energy in performing a skilled task compared to a trainee who is learning the task.

For the persons with mental retardation, job analysis is a process, which involves proper matching of the skills and assets of the persons. Skill analysis of a person with mental retardation is the assessments of generic skills (i.e., cognitive, personal, social, communication, functional academics, domestic, motor functioning, work habits and behavior) are carried out thoroughly to assess the current level of functioning. Skills can be developed with proper training. After assessing the skills of a person with mental retardation can be identified and with proper training they can be fitted in actual work i.e., in task stage or element stage or in a micro-motion stage.

Task analysis can result in improved productivity, lower costs, improved morale, and lower employee turnover and improved labor utilization. Using task analysis the job, workplace, tools and equipment can be modified to fit the worker's characteristics also.

Some Definitions

Job: All the tasks performed by a person in order to fulfill the duties of his/her occupation.

Job analysis: The systematic collection of data, describing the tasks that comprise a job and the knowledge, skills, abilities and other characteristics that enable a person to carry out those tasks.

Task: An important element of a job, which can be identified as achieving the specific result.

Task analysis: A systematic analysis of the behavior required to carry out a task with a view to identifying areas of difficulty and appropriate training techniques and learning aids necessary for successful instruction.

So the task analysis is a detailed study of different operations involved in doing the piece of work. Task or operation analysis develops an improved and easier method. The analysis mainly considers the movements of limbs and it aims at finding out a simpler and economical method of doing work.

The first step in developing a better and easier working is to get an accurate picture of present method. This picture may be obtained by making a list of all the details of the process. It is important to have a bird's eye view of the process from start to finish by recording in a sheet of paper all the steps involved in the process in the form of a process chart.

After a careful recording every step of the process is broken into small elements or package of small operations starting from the most important operation i.e., the operation, which has a greater potential of improvement.

The above procedure of developing a better method should be analysed in smaller and manageable or teachable units for the persons with mental retardation. Here the potentials of the learner and their limitations have to be taken into account while breaking the tasks into smaller unit.

Thus, task analysis plays an important role in workstation design. Task analysis assesses the requisite skills to perform the job. It also helps to find out the dimensions of work-surface height, nature of workstation—standing/seated and others.

Unit Summary

Tasks are carried out at homes, at work, on the road in the battle-field and in everywhere. In job analysis, there are five different stages: (1) Preparation, (2) Observation, (3) Control, (4) Physical demand, (5) Termination. Among these stages 2 and 3 makes a close loop in which action is taken for result i.e. the desired output. Here jobs can be broken down into different functions namely: (1) shipping, (2) receiving, (3) production, (4) quality control. Each function can be divided into tasks. Again each task is to be divided into sub-tasks or elements. So once job analysis is established the task analysis can begin. As the task analysis is hierarchical in nature it is also called Hierarchical Task Analysis. Thus task analysis is the first step and most appropriate tool to design a workstation.

Check Your Progress

1. Describe the different stages of job analysis.
2. Analyse the task of bolting of two plates.
3. Write short notes on:
 - (a) H.T.A.
 - (b) Assessing of skill.

Points for Discussion/Clarification

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Environmental Restructuring

Unit-9

Application of Job Simplification to the Design of Workstation

STRUCTURE

- Introduction
- Objectives
- Tabulation of Task Analysis Leading to Job Simplification
- Assessing Difficulty
- Bins
- Composite Workstation
- Unit Summary
- Check Your Progress
- Points for Discussion/Clarification

Application of Job Simplification to the Design to Workstation

Introduction

Job simplification reduces the complexity of manufacturing procedure either by the conjunction of similar nature of job or with the incorporation of jigs and fixture, special work tools and work methods. Job simplifications, which can be used to analyze repetitive motion tasks, identify the stressful ones, and reduce such stresses. It also eliminates repetitive movements, excessive forces or awkward postures.

Objectives

The main objectives are:

- To develop the ideas regarding job redesign and job modifications.
- To develop a better method of doing work.
- To assess the difficulty level of doing work for the persons with mental retardation.

For job simplification first step is to make the process chart or flow process chart using task analysis. The next step is to develop a better and easier work method, job redesign. Developing a better method can be done by:

1. Eliminating all unnecessary work.
2. Combining similar operations or elements.
3. Change the sequence of operation.
4. Adopting jigs, fixtures or special tool bins.
5. Job redesign.

The job performed by workers in a problem area should be investigated to pinpoint job element, which may be responsible for problems. Some repetitive tasks may not be necessary at all and should be eliminated. Some task may be easier to perform. If the job requires a limited number of repetitive tasks, then the job should be enlarged so that worker can perform a variety of job tasks, different in nature, during the course of work shift. Higher repetitive manual tasks should be automated whenever possible. The following guidelines should be considered in job redesign and job modification:

- All repetitive tasks performed in awkward postures or that require excessive exertion should be eliminated.
- Jobs should be enlarged to consist of more tasks, requiring different movements.
- Design fast-paced tasks with a cycle length of longer than 30 sec. Preferably 1.5 min.
- Avoid keeping the same posture even a good posture for too long. Allow and encourage postural change.
- Minimize pinch grips. Use the whole hand as much as possible when grasping is required.
- Hold an object near its center of gravity so that its weight is balanced.
- Avoid activities requiring excessive forces. Try to minimize lifting, pushing, pulling and grasping.
- Avoid contact forces. For example pressing against a hard surface.
- Avoid tasks requiring the same movements repeated over and over for a long period of time. Frequent rest pauses, help tensed and fatigued muscles to recover their normal effectiveness.
- Frequent movements become much riskier if they are combined with poor postures and excessive forces.
- Highly repetitive and strenuous tasks should be automated if economically and technologically feasible.

So job simplification is the simplification of job achieved by job redesign considering the above guidelines and ultimately makes it easier to the design of workstation.

Tabulation of Task Analysis Leading to Job Simplification

It is the concept of building a bridge between the task analysis and job simplification. Thus in the tabulation of task analysis first step is to make the charts of different tasks involves for a given job. Second step is to mark the most stressful task, repetitive task and make the tasks simplified using jigs and fixtures, special gadgets and job redesign. Thus job simplification makes the net reduction of required skill, discrimination authority to complete the job, which is very helpful for the persons of mental retardation.

Assessing Difficulty

It is the estimation of difficulty level in execution of a given job, taking into account of the level of disability, skill level of persons working in a system.

Such estimation is very much important for finding out the requirement of training, motivation, special gadgets, fixture or jig which will make fit for the disabled to execute the job.

Bins

Bins are specially designed containers where materials, tools etc., are placed. So the bins are of different sizes, shapes according to the types of materials, tools are being used.

A bin with sloping bottom permits the materials to be fed to the front by gravity and so relieves the operator of having to dip down into the container to grasp parts. More frequently bins such as those shown in the following Figure 9.1 is used. Where many different parts are required it becomes necessary to nest the bins one above the other in order to have the material within convenient reach of the operator.

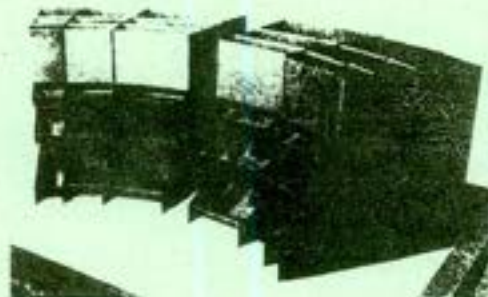
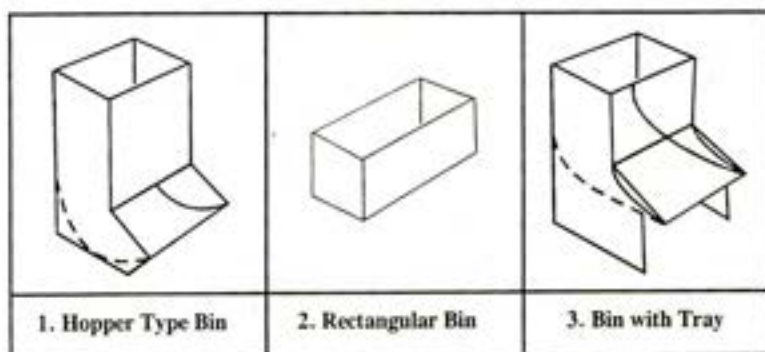


Figure 9.1: Standard bins of the Gravity-feed Type



Composite Workstation

Composite workstations are those where more than one work are accomplished and assemblies are done.

In continuous production large quantity and small variety of products are important. Here conveyor system can be used for material handling either for different parts in assembly or finish part section. Conveyors are employed to transport materials over fixed path, which may be horizontal or inclined to different location in a factory. They prove economical if the flow of materials continuous.

Conveyors may be of different types according to the type of path and the type of materials e.g., belt conveyor, roller conveyor etc.

Unit Summary

Job simplification means the modification of job, restructuring the workstation, which reduces the complexity of manufacturing products. Developing a better method from task analysis and process chart job simplification can be made. Use of jigs and fixture, special tool bins, changing the sequence of operation, eliminating all unnecessary repetitive tasks may help to get the job easy and simple. Task analysis is the first step of job simplification, which makes the net reduction of the required skill and discriminating ability. So job simplification is the most important tool to employ a person with mental retardation in a complicated job with assessment of difficulty level.

Check Your Progress

1. What are important guidelines to be considered for job redesign?

2. Describe the methods of job simplification.
3. Write short notes on:
 - (a) Bins.
 - (b) Composite workstation.

Points for Discussion/Clarification

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Environmental Restructuring

Unit-10

Designing and Setting up of Workstation

STRUCTURE

- Introduction
- Objectives
- Workplace and Workspace
- Workplace Design Problems
- Seated Workstations
- Standing Workstations
- Sit-Stand Workstations
- General Principles for Workstation Design
- Ergonomics Principles for Workplace Design
- Using Anthropometrical Data in Workstation Design
- Recommendations for Seated Workstations
- Recommendations for Seating Postures
- Recommendations for Seat Design/Selection
- Ergonomic Guidelines for Standing Tasks
- Recommendation for Standing Posture
- Recommended Work-Surface Height for Standing Work
- Unit Summary
- Check Your Progress
- Points for Discussion/Clarification

10

Designing and Setting up of Workstation

Introduction

A strong relationship exists between the comfort of workers and their productivity. Unfortunately this fact has not yet been accepted by many industrial organizations, where the management expects the productivity of the organization and the quality of the products to be a function of pay rate only. This is an indication of a lack of understanding of the concept of 'human factors in engineering' and the roles of its principles for designing an effective workplace. Management should understand that worker discomfort due to long standing instead of sitting, puts additional energy demands on the employee that by no means contribute to the worker's productivity. In addition to fatigue and the resulting deteriorated worker's performance an awkward workplace design can result in development of occupational injuries to the worker.

The goal of human factors in engineering is not just to reduce effort; it is rather to maximize the worker's productivity at a level of effort, which is not harmful to the worker. So human factor in engineering rather attempt to minimize the incompatibilities between the capabilities of workers and the demand of their jobs, with resulting increase in productivity, enhanced safety performance and reduced overall cost.

Objectives

1. To design a perfect workplace.
2. To design a seated workstation.
3. To design a standing workstation.

Workplace and Workspace

Most workers spend a major portion of their time in a small work area called workspace or "work envelope". A workspace is a three dimensional region surrounding the worker, defined by the outmost points touched by various parts of the body and by the controls, tools, or other equipments used by the worker. The term workplace is more comprehensive and can be as varied as assembly stations, offices, warehouses, vehicle cabs or any other area where work is performed. The design specifications of the workplace in relationship with workers' physical characteristics and job requirements have significant impact on their productivity, and physical and mental well-being. Both static and dynamic anthropometrics of the users population must be considered in workplace design.

Workplace Design Problems

The workplace should be designed in such a way that employees will be able to perform their jobs effectively. To achieve this crucial goal the workplace designer should keep two design factors in mind. The first factor is that there is a large variability in size of people in the workforce population. The second factor is to understand the user population: that is culture education, training, skill, attitude, physical and mental ability, etc. Therefore, designer should be cautious that the worst design mistake they can make is, probably to design their own personal specification (the syndrome of "If I can use it, it must be designed well"). Such a mistake can be avoided by using the relevant anthropometrics data in design of workplace for the workforce population.

Workstations are typically designed either for seated or standing work. The main factor that determines whether the workstation must be a seated or standing workstation is the nature of the job performed in the station. Sometimes the job requires both sitting and standing postures. In this case the workstation should be so designed to permit alternating between sitting and standing.

Seated Workstations

Seated workstations are recommended for the following situations:

- All items needed during the routine task cycle can be easily supplied and handled within the seated workstation.
- The job being performed does not require reaches more than

40 cm (16 in) forward or higher than 15 cm (6 in) above the work-surface.

- The job does not require large forces, such as handling objects heavier than 4.5 kg (10 lb).
- The job involves writing or light assembly for a major part of the shift.
- The job requires precision or fine manipulative movements that need a level of stability.
- The job includes foot control operation that is performed more easily and safely while sitting and maintaining good posture.

Standing Workstations

Standing workstations are recommended in the following circumstances:

- The workstation doesn't have knee clearance (suitable leg-room) for a seated operation.
- The job involves handling objects weighing more than 4.5 kg (10 lb).
- The job requires high, low, or extended reaches frequently.
- The job requires frequent movement from one station to others.
- The job requires the exertion of downward forces, as in packaging and wrapping operations.

Sit-stand Workstations

Sit-stand workstations are recommended in the following situations:

- The job requires frequent reaches more than 41 cm (16 in) forward or more than 15 cm (6 in) above the work surface.
- The job consists of multiple tasks some of which are best performed in the sitting position, and others are best performed while standing.

Prolonged work in the same position whether sitting or standing will cause discomfort. Prolonged sitting without provision for adjustment can first affect natural curvature of the spine which in turn may disturb the functions internal organs of breathing and digestion and second weaken the abdominal muscles. These problems will become profound when awkward sitting postures are assumed and poorly designed seats are used. In prolonged

standing on the other hand workers are trying to balance their body, which imposes a static load on the muscles involved (especially in the back and legs) and can cause blood pooling in the lower extremities.

Prolonged sitting is probably as bad as prolonged standing. A clear example of prolonged sitting with a variety of postural problems is work at visual terminals (VDTs). Nevertheless, sitting has certain advantages over standing:

1. Taking the body weight off the legs.
2. Ability to avoid unnatural body postures.
3. Lower energy consumption due to less muscular activity for maintaining the postures. This helps avoid or delay the onset of fatigue.
4. Less demand on the cardiovascular system.
5. Providing more stability needed for tasks requiring precision or fine manipulative movements.
6. Ability to operate foot controls more easily, precisely and safely while maintaining good working postures.

General Principles for Workstation Design

The general principle for designing individual workstations is to provide an efficient and safe location in which the work can be performed. To establish this general principle of workstation design, one must answer the following six key questions:

- What must the worker see while on the job? This includes; parts of the workplace that must be visible to the worker; number, types, and location of controls that must be utilized by the worker and the types of actions required to operate them; interaction with other workers; and necessity to view the job activities performed by other workers.
- What must the worker hear? This includes the oral communication during job performance, auditory signals that must be heard by the worker, and the requirement of hearing mechanical operation of the equipment used.
- What tasks must the worker perform? The designer must determine the required movement and job tasks performed by the worker. It must be determined whether the job requires

lifting, carrying and positioning of materials. The type of tools needed to perform the job must also be considered.

- What is the sequence of job activities? The designer must understand the nature and sequence of the job activities that must be performed by the worker.
- What clearances are required? The designer must determine and make provisions for clearances that are required in order for the worker to perform the job efficiently and safely. The designer must consider the size of the workers who will perform jobs at the workstation and clearances for their clothing and movements. The designer should also consider any possibility of accidental activation of controls, and injuries by striking against objects in the workplace.
- What storage is required? The designer must make provisions for the storage of raw materials, in-process work pieces, and finished product as well as the work tools and other job aids that must be used and stored at the workstation.

Ergonomics Principles for Workplace Design

The ergonomic recommendations for determining the dimensions of the workplace are based on the following three factors, with the first-two being the most important:

1. Anthropometrical data.
2. The nature of the job.
3. Behavioural patterns of workers.

An effective workstation for the human operator involves incorporation of certain established design principles from the fields of ergonomics, work-study and motion analysis. Conducting system analyses of the job and function allocations—among operators and between workers and machines—helps determine the types and number of tools and equipment necessary for the operators to perform their functions in the work system. Once the required tools and equipment are determined they must be so arranged or positioned that operators can effectively perform their functions. In general the workplace design must satisfy the following important criteria:

- Be economical.
- Enhance the worker's efficiency.

- Allow good working postures.
- Minimize fatigue.
- Minimize health-and-safety risks, such as stresses on the Musculo-skeletal system.

Workplace design based on the dimensions and capabilities of workers can be ergonomically correct. It is however not practical to determine universal design specifications for all work space or workstations because their dimensions depend upon the physical characteristics of their users as well as their intended applications. Nevertheless, the following principles of ergonomics, work-study (motion economy principles) should be used as general guidelines for workplace/workspace design. The designer should also apply common sense and empirical principles.

- Workspace must be designed for the expected users population. Thus all dimensions should be determined based on relevant anthropometrical data.
- Workspaces must have adequate clearance for user's head, torso, arms, knees and feet. The largest individuals who will use the workspace determine the amount of clearance needed.
- Bent or unnatural postures should be avoided. Bending the trunk or the neck sideways is more harmful than bending forward.
- Keeping an arm outstretched either forward or sideways should be avoided. The further the elbows are away from the body the more fatigue will be developed as well as loss of precision and level of skill in using the hands and arms. Raised or outstretched arms result in an undesirable static muscle loading of the shoulders.
- Design the work for more sitting than standing. Prolonged work in the same position should be avoided, whether seated or standing. Therefore, some movements should be incorporated into the task whenever possible and workplace should permit easy postural changes. This provision minimizes employee discomfort and fatigue.
- Arm movement should be either in opposition to each other or otherwise symmetrical. One has better nervous control in symmetrical movements.

- The location of the working field should be at the best distance from the eyes of the operator.
- All tools and parts needed by the worker should be placed in the order in which they are to be used so that the path of the worker's movement is continuous. Furthermore, the knowledge that a tool or part is always in the same place eliminates the time and annoyance of searching for it.
- Tools should be prepositioned in such a way that they can be conveniently picked up for use. For example, power screwdriver that is repeatedly used in a job can be suspended just above the task area using a coil spring. In this situation workers do not even need to raise the head to see the tool; they merely grasp and pull it down into the required position for immediate use.
- All tools and parts should be placed within a comfortable reaching distance. It becomes fatiguing if the worker must repeatedly change positions to over-reach beyond the maximum grasping area, or work beyond the normal working area. All the work activities should be performed within the maximum reach arc. Work activities beyond the maximum reaching distance should not be required. As a general rule, hand grips, operating levers, tools and materials should be arranged around the workplace in such a way that the most frequent movements are carried out with the elbows bent and near to the body.
- Handwork can be raised by using supports under the elbows, forearms and hands.
- Use rubber or padded strips to cover sharp edges or corners of work tables and benches with which operator's body (e.g., hands or arms) may come in contact.
- Torso twisting action should be prevented. Twisting is especially dangerous when performed in conjunction with lifting.
- Lifting heavy or bulky objects above shoulder height should be prevented. Such objects can generate large torque loads on the lower back.
- Wrist bending in repetitive tasks should be prevented. It is

especially important to avoid bent wrist when the application of large forces is required.

Using Anthropometrical Data in Workstation Design

During design of workstation one may deal with several interrelated and/or conflicting criteria and try to combine them in some trade-off fashion. In a complex situation the designer should the routine steps of design procedure. The following are the general steps in a systematic design procedure (Woodson and Conover, 1956).

Preparation: All necessary information with regard to the jobs to be performed in the workplace. All capabilities and limitations are assessed. In this stage the following information should be collected:

- Types of job functions (tasks).
- The human-machine interface.
- The workplace requirements and constraints.
- The workplace environmental conditions.
- The characteristics and requirements of the equipment used in the workplace.
- The descriptions and capabilities of work populations.

Identification of all feasible design alternatives: The collected information is assembled to link the design components together to explore all feasible design alternatives that effectively combine components to satisfy the design constraints. The following should be considered in this step:

- Functional characteristics.
- Reliability of the alternative designs under the expected conditions.

Selection of the best design alternative: All identified alternatives are compared to select the best alternative. The criteria used for comparison of the alternatives and selection of the best alternative should include:

- Economy of production.
- Efficiency of operation.
- Ease of maintenance.

Examination of the final alternative: The selected final design alternative should be evaluated experimentally to insure that the design objectives have been achieved and the constraints are satisfied. It should be noted that the workplace design problem may not be just of dimensions; they can also be of safety, environmental, psychosocial or other problems.

When anthropometrical data are used it is important for designers to apply their common sense, too. For example, assigning a short operator to a parts assembly task at a very high workstation can lead to the development of cumulative trauma disorders in the operator's upper extremities (i.e., in the shoulder, elbow, and wrist areas) due to the awkward posture assumed during the work. In contrast, assigning a very tall person to a task performed at a low level can lead to that person developing lower-back fatigue and pain due to a bent posture. However, modification of the workplace is not always economically feasible and can be very costly. In such a case selecting a "right" people for the jobs could be appropriate. This concept is known as "fitting the person to the task" as opposed to the main goal of ergonomics, which is "fitting the task to the person". In summary the following two general methods can be used for improving workplace effectiveness: modification (redesign) of the workplace ("fitting the task to the person concept"), and selecting the worker who fits the workplace ("fitting the person to the task" concept). The later is done by assigning the worker, who has capabilities appropriate the job. However, the design engineer should aim at the accommodation of the majority of workforce population.

There are three basic design criteria for establishing the dimensions of workplace (Sanders and McCormick, 1993), each of which is appropriate for a particular situation:

- Design for the extreme.
- Design for the average.
- Provide adjustability.

In designing for extremes, reaches are designed for the smallest and clearances are designed for the largest individuals. For example, if the shortest person can reach a push-button control, the tallest person would reach it with no trouble.

Many components of assembly operations are designed for the "average persons". This criterion can be applied to the workplaces

(especially conveyors) that are fixed and cannot be adjusted. The concept behind the designing for the average person is that the resulting design will inconvenience a small number of people a minimum amount. It must be kept in mind in most cases designing for the average person would inconvenience the majority of population. For example, when designing a seat height for the average person, it would be too high for the shorter 50 per cent of the workforce and too low for taller 50 per cent. Facilities used by many different people for relatively short period of time are appropriate for "designing for the average person".

The third design criterion providing adjustability would accommodate a larger proportion of the workforce. The disadvantage of this criterion includes cost of design and manufacturing, maintenance costs and reliability.

Recommendations for Seated Workstations

It is inappropriate to determine design specifications for a universal seated workstation since its dimensions will vary according to its intended purpose and user's physical characteristics. Special purpose seats (pilot seat, school children's chairs, factory work benches) and their corresponding surrounding workspaces differ significantly in size, shape and component materials. On the other hand, there are general-purpose seat used in offices, homes, and in passenger vehicle. The design of car type seats should accommodate as large a portion of the general population possible.

The recommendations and guidelines that follow will develop specific value for the workplace dimension and ranges of adjustability. However, no matter how precise the analysis, the workstation should be designed to allow the worker to make frequent adjustments easily. Postural changes are essential to effective and efficient workstation.

Recommendations for Seating Postures

It is often seen that in most sitting position the seated person is constantly seeking a more comfortable position. This is done by many position changes of legs, thighs or buttocks. An ergonomically designed chair is one of the most important parts of a workstation. It can favorable affect posture, circulation, the amount of effort required to maintain a position, and the amount of pressure on the spine. Unless otherwise mandated by the nature of the task, a seated

workstation should generally be so designed that its user can assume a posture characterized as follows:

- The upper arms and lower legs are vertical.
- The forearms and thighs are horizontal.
- The feet are flat on the floor.
- The seat back-rest supports the inward curvature of the lumbar region of the spine.
- The weight of the upper body is evenly distributed on a large surface area of the buttocks and thighs.

The followings are the common principles for design of sitting workstations:

- Everything workers need while performing their task must be accessible and easy to handle in the seated position.
- The sitting workstation design should not require the hands to work at more than 15 cm (6 in) above the work-surface.
- Provide mechanical assists or eliminate the requirement of large forces. The worker should not handle objects weighing more than 4.5 kg. (10 lb.) manually.
- Provide an ergonomically correct chair. The chair should allow users to keep their spine and head upright to prevent back and neck strain.



- Eliminate lifting from the floor.

Recommendations for Seat Design/Selection

The seat should adjust to the user, not vice versa. The following criteria are recommended which to be considered in designing and/or selecting the work seat.

- Chair should be stable, and fully and easily adjustable from the seated position. Mobile chairs are not recommended for use on the shop floor where the risk of tipping over is present.
- Where mobility is required (e.g., for office employees), wheels or castors should be fitted to the chair (hard castors for soft floor and soft castors for hard floors to increase stability). Mobility is not recommended for a slippery floor, which makes it difficult to keep the chair in the desired position.
- Where wheels or castors are not fitted, the chairs should have five legs to decrease the risk of tipping over.
- The chair should have a padded backrest that is at least 18 cm high and 33 cm wide. The back-rest should be adjustable up and down (7–15 cm above the seat) and forward and backward (35.5–42 cm from the front edge) for proper lumbar (lower-back) support.
- The depth of the seat should be about 38–40 cm and its width should be 42–46 cm respectively.
- There should be enough clearance between the front edge of the chair and the back of the knees (about 5–15 cm).
- The seat pan should slightly slope backward (1° – 5°) to prevent the ejection effect of the seat.
- The angle between the back-rest and the seat should be about 100° .
- Torso twisting during the task performance should be avoided. If frequent lateral movements are required the seat swivel.
- Where the seat height is fixed and excessive, foot-rest should be provided for users to be able to maintain their thighs horizontally and relieve the pressure under their thighs from the chair front.

- If a foot-rest is required it should be slightly angled toward the person. It should support the soles of both feet; a surface of 27-30 cm in depth by 40 cm in width should be adequate. The foot-rest surface should be a non-slip material.
- Arm-rests should be provided if the task requires the arms to be held away from the body. The distance between arm-rests should be about 47 cm to accommodate most users. If the arm-rests are too close to each other it would be difficult for large-size users to get in and out of the seat. On the other hand, the further the arms are held away from the body, the greater would be the fatigue and the lower the manual dexterity.
- Arm-rests should be padded and covered with an absorbent non-slip material.
- Hand-rests should be provided for intricate tasks (such as fine assembly or inspection).
- Head-rests should be provided where the head must be tilted forward or backward for prolonged period of time. An example of head-rest application is for the use of optical viewing tools such as microscope.
- In order to achieve a good posture it may necessary to adjust the work surface height. For example, typewriter should be placed on lower work-surfaces at secretarial workstations.



Ergonomic Guidelines for Standing Tasks

It is desirable to design the workplace for sit-stand work, in which workers can perform their assigned job sitting or standing. Due to

the nature of the task, sometimes sitting is not possible. For such a situation the workstation has to be designed for standing work.

Recommendation for Standing Posture

- Standing still in one place for long period of time should be avoided. The activity of the leg muscles acts as a pump and assists the veins in returning blood to the heart. Prolonged standing stops the pumping action and causes swelling of the lower extremities.
- When fully adjustable work-tables cannot be provided for standing work or the operating level at a machine cannot be varied, the working heights should be set to suit the tallest operator, while the smaller operators can be accommodated by giving them something to stand on.
- When the work requires fine or precise manipulations, working heights must be raised to a level at which operator can see clearly while keeping their back in a neutral position.
- When the handwork calls for great force or much freedom of movement it is necessary to lower the working surface.
- If prolonged standing is inevitable padded or rubber mats for the operator to stand on should be provided to reduce fatigue.

Workstation Heights for Various Ranges of Mixed Populations:

Adjustable table and Fixed table/ adjustable Seat.

Percentage fitted	95 %	98 %	95 %	98 %
Seat height: Minimum	37.7 cm.	36.8 cm.	51 cm.	52.3 cm.
Maximum	51.1 cm.	52.0 cm.	58.1 cm.	60 cm.
Range of adjustability	13.4 cm.	15.2 cm.	7.0 cm.	7.8 cm.
Table height:				
(under table)—Min	48.2 cm.	46.6 cm.	68.6 cm.	70.2 cm.
Maximum	68.6 cm.	70.2 cm.	68.6 cm.	70.2 cm.
Range of adjustability	20.4 cm.	23.6 cm.	0	0
Table top ht				
Minimum	50.4 cm.	48.4 cm.	71.1 cm.	72.7 cm.
Maximum	75.6 cm.	77.6 cm.	71.1 cm.	72.7 cm.
Range of adjustability	25.2 cm.	29.2 cm.	0	0

(Contd.)

<i>Percentage fitted</i>	95 %	98 %	95 %	98 %
Foot-rest height				
Minimum	0	0	0	0
Maximum	0	0	20.4 cm.	23.6 cm.
Range of adjust ability	0	0	20.4 cm.	23.6 cm.

Recommended Work Surface Height for Standing Work

Determining an optimal height of the work surface is a crucial role the designer can play in enhancing the worker's well-being and productivity. If the working height is too low, the back and neck must be excessively bent forward which can result in fatigue and pain in back and neck. On the other hand, if the work height is raised too high the workers have to lift their shoulders frequently during the job performance which can result in neck and/or shoulder cramps. In either case the development of cumulative trauma disorder in the back and neck region should be expected.

In general the preferred working height for standing manual work is 5-10 cm below elbow level. However, the nature of work performed at the workstation is a major factor in determining the work height. The recommendation given in table account for the nature of the work.

<i>Type of work</i>	<i>Recommended height</i>	<i>Males</i>	<i>Females</i>	<i>50-50 mixed males-females</i>
Precision work (e.g., drawing and sorting fine items)	5-10 cm Above elbow height	110-129.5 cm. 43.3-50.9 in.	109.4- 124.3 cm. 43.0- 48.9 in.	108.2-128.2 cm 42.6 - 50.8 in.
Light work (e.g., assembling small parts)	10-15cm Below elbow height	90-109.2 cm. 35.4-43.0 in.	89.4- 104.3 cm 35.2- 41.0 in.	88.2-108.1 cm 34.7-42.6 in.
Heavy work (e.g., metal cutting)	15-40 cm Below elbow height	75-94.2 cm 29.5-37 in.	74.4- 89.37 cm 28.8-36.7 in	73.2-93.1 cm 29.3-35.1 in

Unit Summary

The concept of human factors in engineering and the role of its principles for designing and effective workplace are the main criteria in the employment of persons with mental retardation, specially in sheltered workshop. Workstations are typically designed either for

seated or standing work or both sitting and standing posture, which depends on the nature of job to be performed. Though prolonged work in the same position whether sitting or standing will cause discomfort. During seated workstation design there are some recommendations and guidelines, following which will develop specific values for the work seat dimensions and ranges of adjustability again it is desirable to design the workplace for sit-stand work in which workers can perform the assigned job in sitting and standing positions. There are also some guidelines for designing this type of workstations.

Check Your Progress

1. What points should be considered during seat design?
2. What should be the posture characteristics in seated conditions?
3. Point out some recommendations for seated workstations.
4. Point out some guidelines for standing workstation.
5. Write short notes on:
 - (a) Work surface height.
 - (b) Table layout.
 - (c) Normal working area.
6. Tick the right answer:
 - (a) Recommended work table height for heavy work:
 - (i) 15 cm below the elbow height.
 - (ii) 30 cm below the elbow height.
 - (iii) 10 cm above the elbow height.

Points for Discussion/Clarification

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Environmental Restructuring

Unit-11

Determining the Requirement of Workstation

STRUCTURE

- Introduction
- Objectives
- Product Requirement
- Client's Requirement
- Spatial Requirement
- Infrastructural Requirements
- Some Principles
- Check Your Progress
- Points for Discussion/Clarification

Determining the Requirement of Workstation

Introduction

In general we have to face two main types of manufacturing situation. Firstly, if manufacturing is done on the customer's order, then one has to wait for the sale order before starting the manufacturing, such as industrial machinery, locomotives, power generating equipments etc. The other situation is when the product is made to stock the manufacturing is done without any sale order like televisions, canned food, electric fittings and appliances etc. The customers orders are fulfilled from the stock of finished goods. For production control for these two situations we adopt two types of production—Intermittent production as the production is fully dependent on client, and the other is continuous production as the production is fully dependent on product.

Objectives

The main objectives are:

- (a) To develop an idea for the requirements of workstation.
- (b) To justify what types of workstation should be.

For setting up a workstation the requirement may be as followed:

Product Requirement

The requirement of the product will be based on the processes or operation proposed to be done in the workstation. If processed items like papad, jam, jelly etc., they require a proper packing and hygienic handling. The product like envelop, Agarbati etc., need proper suitable packing and ready for sale with commercial appeal.

For industrial product like small assembly, electrical appliances etc., the requirements are proper standards and adherences of norms and sizes prescribed by the authority. The above work of assemblies or manufacturing goods may be of completely finished or semi-finished condition depending on further work to be done on work or assemblies.

The product made of steel may require proper protection on rusting—e.g., coating of paints or rust preventing oil etc. Some of the engineering products may require pre-processing or preparatory work like deburring, descaling, buffing etc.

The following are the important factors for product requirement workstation:

- Large quantity and small variety is essential.
- Machine capacity and work loads are balanced.
- Special purpose machines are required.
- Highly skilled operators are not needed, few highly skilled operators can manufacture the total output.
- Raw material inventories are low.
- Conveyor system can be used for material handling.

Advantages

- (a) Low unit cost is the main advantage.
- (b) Continuous process cuts man hours to great extent.
- (c) Employment of semi-skilled operator further reduce the cost.
- (d) There is cut in transportation cost.

Disadvantages

- (a) Product changing difficulties.
- (b) Rigidity of output rate.
- (c) Less flexible.

Client's Requirement

When sub-contract work is done the client requirement will dictate the work to be done. The design of work station will be decided based on the clients requirement.

It is desirably to put the clients requirement in writing and in

clear terms. Above all finish, packing and other commercial aspects will be based on the client's requirement.

The followings are the important factors (characteristics) for client's requirement workstation:

- Most of the product adopted are made in small quantities.
- Work load is different in different departments.
- General purpose types of machines are used.
- Machine operators should be highly skilled.
- Raw material inventories are high.
- Method employed for material handling are crude and non-smooth.
- Required more floor spaces, storage spaces etc.

Advantages

- (a) Best thing of this type of workstation is its flexibility.
- (b) Can accept the production of numerous orders of small quantity.
- (c) Emergency rush order can be pushed more effectively.
- (d) There is less risk due to sudden change in market trend.
- (e) The initial investment is less.
- (f) Break-down of one or two machines never creates much trouble.

Disadvantages

- (a) Transportation cost is high.
- (b) Skilled operators are required.

Spatial Requirement

The space within which a person works is called work space envelops. This envelops may be circumscribed by the functional arm reach and most things needed for work should be arranged within this envelop. Work envelop consists of vertical sloping and horizontal work surfaces. These surfaces are decided by the anthropometrical dimensions.

Manual work are carried out on the horizontal surfaces such as work benches, tables etc. Sufficient moving spaces and sufficient

space for free movements of hands, arms and legs are the requirement of work space.

Infrastructural Requirements

This will include the basic requirements of good and hygienic working place with proper protection from natural disturbances. Facility of work preferably in sitting position, work bench with proper seat, lighting ventilation, sanitation reduced dirt and noise, good supply of drinking water etc.

Some Principles

Those tools and parts that must be handled several times during an operation should be located closer to the fixture or working position than tools or parts which are handled less.

Tools materials, controls should be located within the area covered by arcs, so that they can be operated without changing the body position.

There should be definite location for tools and materials. Definite station for materials and tools help the worker in habit formation, permitting the rapid development of automatic way of working. This also prevent the worker from hunting around to locate the parts or tools needed. It helps the worker to perform the work with least conscious and material direction. Definite position of tools and materials also reduces fatigue and saves time.

Check Your Progress

1. Describe the different requirements for setting a workstation.
2. What are the major advantages and disadvantages for the client's requirement workstations?
3. Write short notes on:
 - (a) Spatial requirement workstation.
 - (b) Infrastructural requirement workstations.
4. Tick the right answer:

Intermittent production is fully dependent on:

 - (a) Production, which produce the product intermittently.
 - (b) Requirement of client.
 - (c) Requirement of product.

Points for Discussion/Clarification

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Environmental Restructuring

Unit-12

Few Typical Workstations

STRUCTURE

- Introduction
- Objectives
- Sheltered Condition
- Partially Sheltered Condition
- Open Employment Condition
- Service Related Condition Through Adaptation
- Some Jobs in Rural Area for Adults with Mental Handicap
- Check Your Progress
- Points for Discussion/Clarification

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Few Typical Workstations

Introduction

Vocational instructor would need to gather general information's on the labor needs of the local community and should begin the process of more specific *job development*. Individuals may be severely disabled and severely limits their ability to function independently in one or on more of the major life domains such as the work, domestic, recreation and community environment. This means that they are unable to function in these major environments for everyday living without some assistance or modification made to the environment. That is why supported employment approach is made suitable to them. There are the different models of supported employment (i.e., individual placement, enclave, mobile work crew or bench work) which provide for varying level of supports to be provided—either continuous intense support and supervision or intense support during initial period of placement and training, with support and supervision gradually fading to intermittent and finally it is being totally withdrawn (open employment).

Objectives

The main objectives are:

- To develop and train the persons with M.R. at different settings.
- To justify how much support is needed in different workstations.
- To consider the use of adaptive devices and modify which meets the needs of individual.

Workstation may be classified mainly into the following categories:

1. Sheltered condition.
2. Partially sheltered condition.
3. Open employment condition.
4. Service related condition through adaptation.

Sheltered Condition

Workstations with sheltered condition means the specially structured condition/place where training and employment facility for the mentally disabled persons can be imparted under the close control of specially trained supervisor.

In this set up the working conditions are restructured according to the individual retardation physical as well as emotional needs of the disabled are perfectly taken care of. Sheltered employment should be provided for those disabled persons who because of the nature and severity of their disability cannot be made fit ordinary employment.

In an ideal situation sheltered workshops should provide the following services:

- Medical services.
- Evaluation and adjustment.
- Vocational guidance.
- Vocational training.
- Vocational guidance.
- Vocational supervision.

Sheltered employment scheme are a good means of educating the public about the working abilities of the disabled. These scheme is also provide a stepping- off place for later establishment of further vocational rehabilitation services. If suitable production work, based on a careful market survey is introduced into a sheltered workshop, the prospects of creating a viable workshop are enhanced. The setting up of these workshops should be a social responsibility and in this responsibility the role of industry cannot be too strongly stressed. An ideal scenario will be one in which the Industry should set up Sheltered workshops to out sources some of their product and by doing so it would be benefited many trained persons with mental

retardation to becoming self-sufficient through productive contribution.

Partially Sheltered Condition

Workstation with partially sheltered condition means an exclusive working facility in a regular workshop with specially structured working condition for the disabled persons.

In this set up supervisors should be there to get immediate attention and looking the problems very carefully and provide proper guidance from time to time so that overall efficiency of the system can be improved. It is to be noted that the supervisors/vocational instructor should be well-trained so that they are well-acquainted with the emotional, behavioural and physical needs of the individual.

Open Employment Condition

Open employment condition means when the disabled persons are placed in working area along with normal persons with their help and co-operation and without any structuring. These are mostly in functional area of engineering manufacturing, assembling etc. The persons placed in open employment should be given adequate on job training to develop proper work habit and work pace. This type of employment may be suitable for mild and moderate retardates.

The key factors of successful employment of mentally retarded persons in the open market are the acceptance of retardate person as a co-worker by the other employees. This necessitates the proper counselling of employer and co-workers.

When the open employment is proposed for retardate persons the following points should be considered:

- For the selection of jobs, as far as possible such jobs should be selected that do not require changes in daily routine, does not involve customer interaction.
- Inform the disabilities to the co-worker and employer. Properly educate the co-workers regarding the disabilities.
- Initiate open employment for mild and moderate retarded individuals.
- Follow up programme should be there after employment.

Service Related Condition Through Adaptation

Use of adaptive devices in the work setting can enable a retarded

individual to successfully complete job duties. The role of vocational instructor is to identify the problems (e.g., motor related) and then arrange for the solutions to those problems by providing for appropriate and reasonable adaptation to tasks or equipments.

In considering the use of adaptive devices and modifications, the emphasis is on problem-solving to simplify task demands and on choosing adaptation that meet the needs the individual. If a person can function effectively and safely without special equipments then he/she may also fit more easily into a standard job setting. However, if adaptive devices improve positioning or reduce fatigue then long-term employment goals are enhanced by using these devices. Adaptation can include commercially available equipments, devices individually modified for use by a specific person or home made adaptation.

Service related jobs like aids in house-keeping, in hostels, supplying milk packets, newspapers, office boys etc., can be taken after necessary training.

Here it is suggested that some adaptive gadgets can be used in some cases to simplify the working conditions, as well as allow the person to learn more to improve his working skills to pay more attention in his job. Thus, it increase the rate of production and thereby the overall efficiency of the system.

Some Jobs in Rural Area for Adults with Mental Handicap

<i>Area</i>	<i>Jobs</i>
Agro based	Horticulture, sericulture, gardening, poultry, dairy, bee-keeping, mushroom, animal husbandry, pottery, nursery.
Arts and crafts	Leather craft, cane and bamboo work, dolls, bag making.
Cottage industry	Soaps, detergent, phenyl, masala supari.
Semi-skilled work	Carpentry, candles, agarbati.
Mechanical	Cycle repairing, electric wireman.
Tailoring/weaving	Cloth weaving, door mats, knitting wool, handlooms.

Unit Summary

Different workstations, which may be classified into four groups: (1) Sheltered condition—where proper training and placement can be done for mentally retarded persons with proper structuring and under control of specially trained supervisor. (2) Partially sheltered

condition—It is an exclusive working facilities in a regular workshop with specially structured working condition for the disabled persons.

(3) Open employment condition—It is an employment condition where disabled persons are placed in a working area along with normal persons without any structuring. (4) Service related condition with adaptation—It means the employment opportunity in service related jobs with the use of adaptive devices. Vocational instructor is to identify the problems of individuals and provide them the appropriate adaptive devices.

Check Your Progress

1. Describe the different workstations which may be employed for the employment of mentally retarded persons.
2. Write short notes on:
 - (a) Sheltered condition.
 - (b) Semi-sheltered condition.
 - (c) Open employment.
 - (d) Service related condition with adaptation.
3. What is your opinion regarding the open employment of mentally retarded persons?
4. Tick the right mark.
 - (a) Sheltered condition means:
 1. Specially structured working condition.
 2. Working condition without structuring.
 3. Work along with normal persons.

Points for Discussion/Clarification

Manufacturing Processes

Unit-13

**Non-Engineering Processes,
Engineering Processes,
Products and its Components**

STRUCTURE

- Introduction
- Objectives
- Non-Engineering Process
- Engineering Process
- Machining Process
- Fabrication
- Assembling
- The Product and its Components
- Unit Summary
- Check Your Progress
- Points for Discussion/Clarification

13

Non-Engineering Processes, Engineering Processes, Products and its Components

Introduction

Manufacturing processes can be mainly divided into two groups—Non-engineering process and engineering process. In the work-station where there are no such uses of technology, mainly run by the individual skill may be called as non-engineering process.

Objectives

Followings are the main objectives:

1. To provide information's of different manufacturing processes.
2. To anticipate the conditions and situations where the persons of mentally retarded persons can successfully placed.

Non-Engineering Process

Followings are some of the non-engineering processes can be adopted for vocational training of persons with mental retardation.

In open employment:

1. Rope making.
2. Pop corn making.
3. Book binding.
4. Chalk piece making.
5. Plastic wire bag knitting.
6. File, candle, paper envelop making.

7. Papad and other alike food product making.
8. Agarbati making.
9. Cardboard box making etc.

In sheltered employment:

1. Vegetable cultivation.
2. Home-made biscuit.
3. Garment making.
4. Brick making.
5. Screen printing work.
6. Toy making etc.

In service oriented employment:

1. Attender.
2. Office boy.
3. Helper.
4. Sweeper.
5. Gardener.
6. Newspaper, milk packet delivery boy etc.

Engineering Process

Mostly all general engineering processes are consisting of machining, fabrication, assembling and testing.

Machining Process

The operation of removing material from a piece of work by means of machine may be called as machining process. For this purpose we can employ different machines which the process demands. The machines, which are generally employed in a small workshop are lathe, shaper, drill, milling and bench grinder.

Fabrication

It is a process by which we can build, by putting together the parts by means of welding or by assembling or by any other means. In general structural works are called fabrication.

Assembling

It is the final stage, where using machines or manually we can put together the parts and forms a final product.

Testing: The process of inspecting/ checking in order to determine the product is within the prescribed limit or not.

The Product and its Components

The product to be taken up for production should preferably made simple and easy through task analysis, job simplification and restructuring. The more complicated product are more remunerative and it may also can be taken up for fabrication or assemblies in sheltered workshop. The raw materials and other inputs which are required, should be easily available or preferably from the sub-contractor.

It should be noted that the mentally retarded persons are capable of sustained work output, if the jobs are task analyzed and simplified to suit his/her ability. It is not necessary to select simple jobs as these are less remunerative. It is the instructor's task to simplify the difficult or complicated job—so that mentally retarded persons may earn as high a wage as possible.

After identifying the product that can be manufactured or assembled by mentally retarded persons the following analysis and studies are to be carried out in a systematic manner. At first the product is to be studied for all of its external dimensions, various parts, which are assembled and finish. They are to be noted down step by step. The final finishing, painting, labeling and other details such as packing, marking are also to be noted down. Then the product is to be studied for its component, the sub-assemblies required etc.

In case of assemblies the product is to be dismantled piece by piece and the sequence of dismantling should be noted down in an orderly fashion. This will help to finalize the assembling process. The component so removed are studied in details, the drawings are to be prepared, the raw materials and other inputs are required are to be identified and finalized. If the sub-assemblies are involved in product they are to be individually studied and the details are to be noted down by repeating the above process.

For sub-assemblies and other components, make or buy decision is to be taken very carefully and should be based on economic consideration. If decision is taken to buy a particular component or part strict compliance of specification is a must. If the same item is not readily available in the market, the alternative product has to be

considered and its suitability has to be verified and made sure that the alternative is no way inferior to the original in its performance, reliability and quality.

After listing down every components standard parts and sub-assemblies required, the exact process to be adopted for manufacturing such parts should be studied and written down. Simple, easy and economic method should be adopted. It should be always remembered that the job is to be completed by mentally retarded persons. Therefore, adequate care is to be taken for finalizing the process, workstation, jigs and fixture, self-inspecting fixtures and other restructuring.

The workstation is to be designed and restructured, to enable the mentally retarded persons to take up the production or assembly of their components, in error free manner. Self-inspecting devices are to be incorporated where possible in the production process itself. While working, safety of the persons should be given utmost importance. Work-station should be designed on the basis of the training procedure adopted for the mentally retarded persons.

Unit Summary

It is important to ensure that the mentally retarded persons are made to use both the hands simultaneously according to the training given to him/her. The workstation should be so designed that it can take up two assemblies at a time and no hand is kept idle. This method is estimated to increase the production by 20 per cent when compared to working with single hand.

Finally it should be ensured that the plus points or the strength available with the mentally retarded persons are utilized in a balanced way by creating a pleasant working atmosphere to facilitate easy, comfortable, fatigue free working environment.

Check Your Progress

1. Describe briefly the different manufacturing processes can be adopted for the persons of mentally retarded.
2. Describe the steps to be taken to assemble a part by mentally retarded persons.
3. Write short notes on :
 - (a) Non-engineering processes
 - (b) Engineering processes.

4. Tick the right answer:

The jobs should be taken to manufacture

- (a) Which should be very simple.
- (b) Which should be very complicated.
- (c) Which should be more remunerative.

Points for Discussion / Clarification

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Sourcing and Job Simplification

Unit-14

Sourcing Engineering, Non-Engineering and Light Engineering Employment

STRUCTURE

- Introduction
- Objectives
- Sourcing Engineering Employment
- Sourcing Non-Engineering Employment
- Sourcing Light Engineering Jobs
- Unit Summary
- Check Your Progress
- Points for Discussion/Clarification

Sourcing Engineering, Non-Engineering and Light Engineering Employment

Introduction

The setting up the specially structured (sheltered) workshop is a social responsibility and in this responsibility the role of industries cannot be too strongly stressed. An ideal scenario will be one in which the industry sets up sheltered workshop to out source some of their products and by doing so many trained persons with mental retardation would be benefited to become largely self-sufficient, through productive contribution and to contribute to growth of the society. The infrastructure and resources that are needed to set up are minimal to them. In this way industries can assist those who can not otherwise assist themselves.

Objectives

The main objectives are:

1. To arrange the employment opportunity in engineering industry.
2. To arrange the employment opportunity in non-engineering sector.

Sourcing Engineering Employment

Light engineering industries in urban and rural settings are very good sources for sub-contract work. The industries, which can sub-contract assembly work, are:

1. Telephone industries.
2. Automobile component manufacturing.
3. Electric hardware.

4. Domestic equipment.
5. Electrical equipment etc.

Sub-contract/contract with the industries in specially restructured or sheltered environment will provide considerable employment potential for the severe to moderately retarded persons.

In partially sheltered environment, the packing section of any small industries can be a good employment avenue. Mild and moderate retarded persons can be placed as attendant's or helpers both in production and non-production areas.

Sourcing Non-Engineering Employment

Scope of employment of the persons with mental retardation in non-engineering sector are immense. Organization manufacturing items like food products, textiles, garments, cosmetics, leather products, household articles etc., where engineering concepts are rarely used are the area's of non-engineering employment.

Here also the persons with mental retardation can be employed as assistant only. A careful survey of these products for the possibility of job simplification by incorporating jigs and fixtures, self-inspecting devices and modified hand tools and employment can be done both sheltered and partially sheltered workshop.

The vocational instructor's role is very important for employment of the persons with mental retardation. If a job opening is identified at the time of the job site visit that appears compatible with a particular individual's ability and the employer is receptive then the vocational instructor discusses the opening with the employer with special reference to the individual. In this role, the vocational instructor not only as an advocate and a personnel agent for the disabled consumer but as a human resource agent for the employer. The following table shows the model components and services provided by vocational instructor:

<i>Model components</i>	<i>Services provided</i>
Job development	<ul style="list-style-type: none">• Community job market screening.• Development of a responsive marketing program.• Specific employer contact.• Job analysis/environmental analysis.
Assessment	<ul style="list-style-type: none">• Assessment of individuals' gross and fine motor abilities.

(Contd.)

<i>Model components</i>	<i>Services provided</i>
Job placement	<ul style="list-style-type: none"> • Assessment of individual's vocational interest. • Assessment of individual's transportation, attendant care and other support service needs. • Match of individual's abilities and job requirements. • Assistance with transportation planning and training. • Counselling with parents, family. • Assistance with job interview. • Assistance with financial planning, implications of employment.
Job site enabling	<ul style="list-style-type: none"> • Assessment of individual's current skills, training needs, job modification needs and support need. • Provisions of systematic and behavioral training. • Provisions for adaptive equipments. • Advocacy between disabled, co worker and employer. • Advocacy between disabled and family.
Follow along	<ul style="list-style-type: none"> • Periodic assessment of employer/disabled satisfaction, productivity, appropriateness of adaptive equipments. • Assistance with retraining/job site modification (as needed).

Task Related to Light Engineering Industry and Employment in Service

Employment opportunity for the mentally retarded persons largely depends on four factors:

1. Nature and degree of residual ability.
2. Diversity and intensity of available employment opportunities.
3. Facilities of rehabilitation, training and sheltered employment available in the area.
4. Attitude of local community and families of mentally retarded persons toward their employment.

Mild mentally retarded persons have wider scope of open employment and are easier to place. As their severity of disability increases the scope of open employment opportunities are proportionally decreases and the process of placement also becomes relatively more difficult and complicated. On the skill hierarchy employment avenues of mentally retarded persons are mostly

restricted to elementary occupations. Even within the wide range of elementary occupations only a few are considered to undertake which constitute a typical job in this group independently. Most mild and moderate mentally retarded persons, however can perform one or more selected tasks after prolonged training. Similarly in sheltered or semi-sheltered condition the severely disabled are trained and assigned to such productive tasks keeping in view the nature and degree of disability. Placement of such persons is therefore essentially guided by job analysis of the various discrete tasks involved. How many and which tasks an individual can assigned depends upon the nature and degree of residual capability? Thus the employment/placement strategy of the persons with mental retardation should have three approaches:

- To pool information on availability of viable and feasible marketable set of tasks in the local employment market.
- To estimate how many more such set of tasks to be created in the open, sheltered and semi-sheltered environment to achieve reasonable placement.
- To examine which of the existing institutional training facilities can be exploited right away and which other facilities need to be augmented for the purpose.

Essentially the employment programme should be so planned the worker will be happy, satisfied, enjoys working condition and shows progress. The scope of earning and contributing to the family help to build self-esteem rapidly.

Sourcing Light Engineering Jobs

Light engineering industries in urban and rural settings are very good sources for sub-contract work. The industries, which can sub-contract assembly work, are:

1. Telephone industries.
2. Automobile component manufacturing.
3. Electric hardware.
4. Domestic equipment.
5. Electrical equipment etc.

Sub-contract/contract with the industries in specially restructured or sheltered environment will provide considerable

employment potential for the severe to moderately retarded persons.

In partially sheltered environment, the packing section of any small industries can be a good employment avenue. Mild and moderate retarded persons can be placed as attendee's or helpers both in production and non-production areas.

Unit Summary

Sub-contract with the large industries in specially structured condition will have a great potential to the persons with mental retardation. The job may be the small assembly, manufacturing of small parts etc. The packing section, painting section of large industries can be a good employment avenue for the mild and moderate persons of mentally retarded in partially sheltered condition. In non-engineering sector like food processing, garments etc., are the major sources of employment. A good market survey in these industries with proper training and some adaptive devices may help to increase the employment opportunity. Beside this job development, assessment, job placement, job site enabling and follow up are the main components should be carried out by a vocational instructor for employment of the persons with mental retardation.

Check Your Progress

1. What should be the essential components of a vocational instructor for the employment of disabled?
2. What are sources of employment opportunities of the persons with mental retardation in engineering and non-engineering sector?
3. Write short notes on:
 - (a) Sourcing engineering employment.
 - (b) Sourcing non-engineering employment.
 - (c) Light engineering Industries.
4. Choose the right answer:

Sub-contracting is the main sources for the employment:

 - (a) In sheltered condition.
 - (b) In partially sheltered condition.
 - (c) In open employment condition.

Points for Discussion/Clarification

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Sourcing and Job Simplification

Unit-15

Process of Job Simplification

STRUCTURE

- Introduction
- Objectives
- Job Simplification
- Task Analysis
- Maintenance of Equipments
- Basic Concepts
- Training
- Assessing Needs
- Unit Summary
- Check Your Progress
- Points for Discussion/Clarification

Process of Job Simplification

Introduction

At the time a new product or service is being designed or developed, consideration is nearly always given to the system or process that will be required to manufacture the product or provide the service. It is at this stage that one has greatest opportunity to use the design process and to come up with the best production system and methods. In searching for a better method the analyst should not unduly influenced by the current one, but should look at all ways by achieving the object rather than merely trying to make an improvement of present method. The following approaches should be considered in developing possible situation from which the preferred work method will be selected:

1. Eliminate all unnecessary work.
2. Combine operation or elements.
3. Change the sequence of operation.
4. Simplify the necessary operation.

Objectives

1. To understand how to make task analysis.
2. To justify the different skills to be developed.
3. Different training requirements.

Job Simplification

Job simplification is the process by which a job is made easy to understand. From task analysis the complex task is being broken

into small steps so that it makes easier to understand and simplifying the job within the comprehension or skill level of the individual is essential to enhance the productivity.

Task Analysis

Task analysis was defined by Snyder (1991) as:

An ordered sequence of tasks and sub-tasks, which identifies the performer user; the action, activities or operations; the environment; the goal state; the requirements to complete the task such as hardware, software or information.

Task analysis drives human-centered design by providing a system-specific context for the application of the fundamental ergonomic principle. Following are the questions to be asked before the task analysis is carried out.

- Who must be involved?
- What are the sub-components of the activity?
- How are participants involved in the various tasks?
- What information is required at each stage in the task?
- Where does the information come from?
- How is the information exchanged?
- How might any of the above be improved?

The main outcome of a task analysis consists of the following:

- A description of the behaviors required to carry out the task.
- A description of the system states that occur when task is carried out.
- A mapping of the task behaviors on to the system states.

The above information can be used for a variety of purposes:

1. Evaluation or the design of the human-machine interface.
2. Identification of the skills needed by an operator of the system.
3. Design of training materials and operating instructions.
4. Identification of critical elements of tasks to predict.

Level of Description of Task Analysis: An Example:

Job title: Fuel pump station operator

Assignments

- A₁ Inspection of environment, equipment and machinery.
- A₂ Execution of start up procedures for pumping.
- A₃ Monitoring the system condition when running.
- A₄ Execution of close down procedure.
- A₅ General maintenance.

Segments

- (A₁)S₁ General inspection; safety, lighting, house-keeping.
- (A₂)S₂ Start-up filtration of fuel in reservoir tank.
- (A₃)S₃ Periodic inspection of pumps.
- (A₄)S₄ Close down pumps motors.
- (A₅)S₅ Changing the filter elements.

Tasks

- (A₁S₁)T₁ Replace broken lamps in station.
- (A₂S₂)T₂ Start-up transfer pump.
- (A₃S₃)T₃ Check torque settings on pump retaining clamps.
- (A₄S₄)T₄ Close down pump motor 1.
- (A₅S₅)T₅ Remove filter element 1.

Operations

- (A₁S₁T₁)O₁ Switch off power to lighting unit at wall switch.
- (A₂S₂T₂)O₂ Press green button on transfer pump housing.
- (A₃S₃T₃)O₃ Using a torque wrench tightens nuts in clockwise direction until torque setting is displayed.
- (A₄S₄T₄)O₄ Press red button on pump motor 1.
- (A₅S₅T₅)O₅ With a spanner loosen nuts retaining filter element housing.

The above is an example of the stages involved in the hierarchical decomposition of a job from a job title to specific operation.

Now considering the persons with mental retardation, for the above job analysis one can identify the following pre-requisite skills are required when selecting a person for the job:

- Eye hand co-ordination.

- Sense of cleanliness.
- Ability to identify.
- Adequate fine motor.
- Ability to follow instructions.
- Ability to balance.
- Physical strength.
- Aware of danger of electricity.
- Aware of safety precautions.
- Safety handling of equipments.
- Differentiate between shape and size.

The task related skills, which should acquire by the person, are given below:

Maintenance of Equipments

- Maintains the equipments for ready use.
- Checks its functioning.
- Lubricate the parts of equipments.
- Cleans with cloth.
- Applies oil/grease wherever needed.
- Arranges the equipments for easy use.

Basic Concepts

- Matches shapes.
- Selects matching fasteners, bolts and nuts etc.
- Measures oil pressure.
- Has number concept up to 200.
- Do simple calculations.

Beside this the person should also acquire the following Basic Adult Independent Living skills through proper training:

1. Basic academics, which include self and family, job site information, money transaction and banking, signals and symbols.
2. Workplace behavior, which include etiquette and manner,

personal interaction, regularity and punctuality, communication/social behavior, quantity and quality of work.

3. Employability.
4. Sex education.
5. Self-advocacy, which includes basic rights, rights of living, decision-making, organizing self-advocacy group.

Further each sub-task can be well-divided by micro-motion analysis (i.e., grasp, with load, release load, positioning etc.) where the task may be in the form of only consists of movement of different body member. It may be appropriate to the mentally retarded persons as they have little ability to discriminate or to take the appropriate decision.

Transfer of skill: It is the skills learnt or acquired in one situation being transferred to another situation (e.g., learning in school and transferring to real life situation). This is one area having considerable difficulty for persons with mental retardation.

This area can be in some cases overcome through the application of technology. Training and employment of persons with mental retardation should be greatly assisted by the use of technology.

Training requirement and the length of time required should be based on time and motion study, task analysis, skill analysis, micro-motion analysis with special reference to the persons with mental retardation. Our aim should be the reduction of unnecessary movement and human effort even the smallest part of the body. The movement should be restricted to the lowest category and simple.

Training

The capacity to learn very effectively is one of the most distinctive attributes of humans. Within organizational settings, just as in other settings, people develop and change as time passes. Some of this development occurs in a rather unsystematic fashion and takes place as people learn from each other and learn how to integrate themselves into organization. Other development and change takes place in a more controlled and planned fashions, when programmes of planned training and development are organized in attempts to improve the knowledge and skill that people have. In most modern organizations such programmes represent an important component in their success and have significant cost-benefit implications. The

training and development process moves from an assessment of need, through the development of programmes (training design) to evaluation of what has taken place (transfer and evaluation of learning).

Assessing Needs

Assessing training needs is not a mechanistic procedure, and a significant amount of judgments is involved. The most convenient way of viewing needs assessment is to consider three basic level of analysis: organization, occupation and person.

At the organizational level, the first step in the assessment of need is to examine and identify the aims and objective of the organization. These can often be identified in general terms by examining plans and statement of policies and by discussion with senior personnel of the organization. Very broadly organizational training needs exist when there is or likely to be some sort of barrier hindering the achievement of organizational aims and objectives (either now or at some predicted future occasion). Production problems, for example, might be well solved more effectively by redesigning the job or equipment, improving recruitment and selection procedures, or providing job aids.

To bring about any form of training it is important to have a clear understanding of the target behavior that is to be developed and in most organizational settings this means a clear grasp of the main job components or activities involved. The closely related techniques of job analysis, skill analysis and task analysis have an important role here.

Job analysis: A great deal of job analysis is carried out in an organization in order to produce job description. Such descriptions include information about the condition of work, salary, physical surroundings and so on, but provide only a general description of tasks involved in the job and of the skills required.

Skills analysis: The term is usually reserved for procedures and methods of detailed analysis of the skilled physical movements involved in manual operations and they are useful in some training situations though their range of application is limited.

Tasks analysis: This is probably the most important form of analysis for training purposes. The technique focusses on the

objectives or outcomes of the tasks that people perform and provides an extremely flexible and useful method of analysis.

Hierarchical task analysis: A procedure for identifying the tasks involved in a job, which proceeds to increasingly detailed task units. Task breakdown ceases when predetermined criteria are satisfied, ensuring that the analysis is sufficiently detailed for the purpose in mind. (Work Psychology: John Arnold, Caryl Cooper, Ivan Trobertson.

Unit Summary

Job simplification can also be done with the help of jigs and fixtures. The persons with mental retardation can easily handle the simple jigs and fixtures which will help them to produce the quality job, as the simple jigs can also be considered as fool proofing device. Again using of jigs and fixtures are the main considering factor when we are going to produce a large number of similar products. Repetitive, similar jobs may be the main constraints for the persons of mental retardation to produce. So to produce a quality job by the persons with mental retardation, using of jigs and fixtures should be considered whenever possible. For example, suppose a job of simple rectangular plate having a drill hole at the center. In conventional process when we are going to produce the job the first task is the measuring and making a punch at the center (marking process). But this marking process, associating the measurement, can be considered as a skilful task may be avoided by using a simple jig, which may be the useful method to produce the job when we are considering the persons with mental retardation.

From the definition of time and motion study it is also obvious that the implementation of time and motion study can simplify the job drastically. The definition of time and motion study is the systematic study of work system with the purpose of:

1. Developing the preferred system and methods—usually the one with the lowest cost.
2. Standardizing this system and method.
3. Determining the time required by a qualified and properly trained person working at a normal pace to do a specific task or operation.
4. Assisting in training the worker in the preferred method.

Thus, the objectives of motion study to get the:

- Improved working processes.
- Better workplace layout, neat and clean working environment and working condition.
- Less fatigue to the worker.
- Better work quality.
- Effective utilization of man, machine and material.
- Reduced health hazards.

So if we eliminate the unnecessary and fatiguing work motions, by changing the sequence of operation or, combining operation or element or, just simplifying the operation it will help the mentally retarded persons to do the job successfully.

Check Your Progress

- Explain, how to conduct task analysis.
- Justify the different skills to be developed in mentally retarded children.
- Explain the training requirements.

Points for Discussion/Clarification

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Rs. 250
(Set Price)



Rehabilitation Council of India

(A statutory body of Ministry of Social Justice and Empowerment)

in association with



KANISHKA PUBLISHERS, DISTRIBUTORS

4697/ 5-21A, ANSARI ROAD, DARYA GANJ, NEW DELHI-110002

PHONES: 23270497, 23288285 FAX: 23288285

E-mail: kanishka_publishing@yahoo.co.in

ISBN 81-7391-883-X



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