

FATIGUE

- One of the main objectives of work study is to reduce fatigue and to make the work as easy and satisfying as possible
- Hence, it is desirable to examine the nature of fatigue
- The term fatigue has several meanings. In industry, it refers to three related phenomena:
 - A feeling of tiredness
 - A physiological change in the body (nerves and muscles fail to function as well or as fast as is normal because of chemical changes in the body resulting from work)
 - A diminished capacity for doing work

Feeling of Tiredness:

- Commonly associated with long period of work
- Subjective in nature and extent of tiredness cannot be determined by an observer
- May be localized in some particular muscle or a general sensation of weariness
- The feeling of tiredness does not seem to be a valid basis for judging the effect of work on the individual, because a person may feel tired and yet may work as efficiently as ever, or may feel normal and yet may be actually working at a low rate because of physiological fatigue.

Physiological Changes Resulting from Work:

- The human body may be thought of as a machine which consumes fuel and gives out useful energy.
- The main mechanisms of the body are:
 - Circulatory system
 - Digestive system
 - Muscular system
 - Nervous system
 - Respiratory system
- Continuous physical work affects these mechanisms both separately and collectively.

- **Fatigue is the result of an accumulation of waste products in the muscles and the blood stream,** which reduces the capacity of the muscles to act.
- The central nervous system may also be affected by work, causing a person to slow down when tired.
- Muscular movements are accompanied by chemical reactions which require food for their activities.
- The food is furnished as **glycogen**, a starchlike substance which is carried in blood stream and is readily converted into sugar.
- When the muscles contract, the glycogen is changed into lactic acid, which is waste product restricting activity of the muscles.
- In the recovery phase, **oxygen is used to change most of the lactic acid back to glycogen.**
- **The supply of oxygen and the temperature affect the speed of recovery.**

Effects of Physical Environment on the Worker:

- The physiological cost of doing work is affected by environmental factors.
 1. Temperature
 2. Humidity
 3. Air movement
 4. Atmospheric contamination

Decrease in Output an Indication of Fatigue:

- Some people believe that fatigue can be measured in terms of reduced output resulting from work.
- However, one cannot say definitely that a reduction in output results from fatigue.
- There may be other reasons for reduction in output.
- If the work is light, a fairly uniform output throughout the day will be maintained by the operator.
- In fact, it is uncommon to find an operator actually increasing speed during the last hour of the day when a delay has existed earlier in the day causing him to fall behind, or when a rush job has been put into production.

Factors Affecting Degree of Fatigue:

- Hours of work, i.e. The length of working day and the weekly working hours
- Number, location and length of rest periods
- Working conditions, such as lighting, heating, ventilation and noise
- Work itself

Work – Rest Scheduling:

- A 5.33 kcal/min limit energy expenditure for an 8 hour work is acceptable.
- This number corresponds to 1/3 the maximum energy expenditure of the average male.
- If the overall workload is exceedingly high (exceeds the recommended limits), aerobic metabolism may not be sufficient to provide all of the energy requirements and the worker may rely on greater amounts of anaerobic metabolism, resulting in fatigue and buildup of lactic acid.
- Sufficient recovery must be provided to allow the body to recover from fatigue and recycle the lactic acid.

$$R = D * (W - 5.33) / (5.33 - 1.33),$$

Note: At most $D * (W - 5.33)$ can be less than or equal to 25 kcalories otherwise a worker may feel exhaust.

D: Duration of work in minutes.

R: time required for rest, as a percent of total time

W: average energy expenditure during work (kcal/min)

Lighting, Heating and Ventilation:

- They have a definite effect upon the physical comfort, mental attitude, output, and fatigue of the worker. Their requirements are properly understood by the industries these days, and necessary equipment is also available.

Noise and Vibration:

- They are annoying, undesirable and should be reduced or eliminated as far as possible.
- It may be desirable to reduce the noise by covering the ceilings and walls with acoustic board, as is done in many places.
- Many companies enclose noisy equipment with solid walls of sound absorbing materials.