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Human Factors in Industrial Engineering Design

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Abstract

The current interest in Human factors engineering arises from the fact that technological developments have focused attention on the need to consider human beings and the irinteraction with machines, materials, information, procedures and environments in such developments and in designing a technological system. The aim is to ensure that human beings and technology work in complete harmony, with the equipment and tasks aligned to human characteristics. Industrial engineering involves the synthesis and application of scientific principles to analysis, design, installation and improvement of integrated systems of humans, materials, equipment and information to provide the most efficient and effective operating and work environment. In this concern, this analytical article explores the relevant information on details of human factors and the interdisciplinary nature of human factors as well as the implications of human factors in industrial engineering and design. Moreover, it presents the basic relationship between human factors engineering and industrial engineering and the importance of learning human factors for an industrial engineer since an industrial engineerwith a background in human factors is ideal, as he can analyze different design alternatives for machinery and processes, make trade-offs in the selection of equipment, and arrive at a better solution.

Keywords: Humanfactors, industrial engineering, physiological cost, productivity, workstation.

Introduction

Human factors and their interaction with machines, materials, information, procedures and environments used in work and everyday living (Sanders et al., 1992) Human factors discovers and applies information about human behavior, capabilities, limitations, and other characteristics to the design of products, machines, systems, tasks, jobs, and work-environments for productive, safe, comfortable, and effective human use.

The International Labor organization (ILO) has defined the term‘Human Factors’ as“the application of human biological sciences in conjunction with engineering sciences to the worker and his work environment, so as to obtain maximum job satisfaction, which at the same time enhances productivity” (M. Helander, 1995). Human factors engineering is the science of fitting the job to the worker. In a phrase, the task/ job must ‘fit theperson’ in all respects, and the work situation and

environment should not compromise with human capabilities andlimitations. In general human factors finds out the best possible match between the physical and mental demands of work and the capabilities of the individual members of the workforce in order to optimize both the productivity of the organization and the physiological cost of human beings. In a sense, the goal of human factors is to guide the applications of technology in the direction of benefiting humanity.

Human factors engineers or Ergonomists come from a variety of professional fields. This mixed background is well demonstrated by the membership of the professional societies, which typically consists of engineers, physiologists, and individuals from the medical profession (R. S. Bridger, 1995).

To successfully implement ergonomics in industrial functions and manufacturing system design and planning, it is often an advantage to be an engineer. Physiologists, medical doctors and industrial nurses can certainly diagnose many ergonomics problems relevant to industrial safety,but sometimes have an insufficient technical back ground to suggest how a technical system can be redesigned to optimize the physiological cost of human beings. Engineers with a background in ergonomics are ideal, as they can analyze different design alternatives for machinery and processes, make trade-offs in the selection of equipment and arrive at a better solution.

Ergonomicsisoftenimplementedbyworkgroups where the members have expertise in different areas. Groups composed of workers, engineers, managers and nurses can propose new design solutions. The establishment of such groups is typical of complex decision making found in modern manufacturing.

ObjectivesofHumanfactors

Human factors engineering has two major objectives. The first is to enhance the effectiveness and efficiency with which work and other activities are carried out. This includes such things asincreased convenience of use, reduced errors and increased productivity. The second objective is to enhance certain desirable human values, including improved safety, reduced fatigue and stress,increased comfort, greateruseracceptance, increased job satisfaction, and improved quality of life.

To develop the optimal conditions for the worker inworkenvironment,toreducephysiologicalcosts, to improve productivity, to facilitate instrument handling, to maximize the efficiency of operationand production system, and to minimize humanerrors ergonomics is essential.

Industrial engineering

Industrial engineering deals with the analysis, design and control of productive systems. By a productive system is meant any system that produces either a product or a service. Industrial engineering tells how to analyze and design productive systems and about the control procedures (i.e., directing human effort) for efficiently operating such systems.

Industrial engineering is concerned with developing a production system efficiently that produces the required quantity of products at an appropriate cost and quality. It combines principlesof human behavior with concepts of engineering procedure and analysis (P. H. Hicks, 1994).

Industrial engineering combines the abilities of an engineer and manager. This employs an aptitude for mathematics, statistics, and economics as well as for the basic engineering sciences and interest in all kinds of jobs and the machines and the people who produce the products and the ability to analysis, synthesis and integrate technical knowledge in practical ways.

Insummary,itisnecessarytoknowthetechnical details of each of the production processes in a productive system and then to integrate all the elements of a production system (workers, materials, equipment, information, management, etc.) so that a quality product can be made at the right time and at an appropriate cost i.e., industrial engineering (P. H. Hicks, 1994).

SpecialtiesofIndustrialEngineering

Industrial Engineering is generally seen as a combination of four major areas. First is ‘operations research’, which provides application of scientific methods for the general analysis and design of integrated systems of men, machine, material,money, and management. Operation research (OR) includes optimization, decision-making science, stochastic processes, and simulation modeling. ‘Production / operations function’ generally includes such aspects as economic analysis, production planning and control, quality control, facilities design,andotheraspectsofworld-class

manufacturing. Third is 'manufacturing processes and systems'.

Manufacturing process deals directly with machining science, i.e., materials removing as for example materials forming, cutting, shaping, planing, etc. and chip less and chip forming processes. Manufacturing systems focus on the integration of manufacturing processes, usually through computer control and communications (for example CIM and CIE). Manufacturing function represents assemblage of technical knowledge and skill to keep all the production processes under control in a productive system. Essentially Human Factors deals with the human beings. Physical human factors view the human as a biomechanical device while informational human factors examine the cognitive aspects of humans.

Weaknesses of Production Engineer

The typical weaknesses of production/ manufacturing system engineer (PE) identified include, among others:

- Lack of proper knowledge in human factors causes problems to PE's in today's environment of productivity management, operations management and continuous productivity improvement approach.
- Many companies are seeing this weakness and are providing human factors engineering training to PE's.
- There is a major effort in manufacturing to improve health and safety, reduce injuries and workers physiological costs, which is foreign to traditional PE's. This can be effected by implementing human factors in production design and planning.
- Many companies are demanding industrial engineers with proper knowledge of human factors application in the design of products and equipment, workstations and working environment, systems and methods of operation. Ergonomics or Human factors will give industrial engineers an edge over traditional PE's with high potential for job and work experience.

Effect of poor Human Factors Application in Manufacturing

- Less production output
- Increased lost time
- Higher physiological cost
- Higher material cost
- Increased absenteeism
- Increased risk of accidents
- Higher employee turnover
- Low employee morale
- Increased fatigue and injury rate
- Increased risk of errors

Indicators of Human Factors Weakness

Industrial and manufacturing system engineering where there is no application of human factors indicates the following drawbacks:

- High material waste, scrap and rework
- Operators doing frequent mistakes
- High number of employee complaints
- High absenteeism and turnover
- Incidents of near-misses of accidents
- Employee staking frequent breaks
- Supervisor constantly missing schedule
- Employees requesting frequent job transfer
- Workers complaining about aches & pains
- Large number of employees wasting time

Industrial Engineering approach Vs Human Factors approach

Industrial Engineering approach is based on principles and techniques of scientific management developed by Fredrick Taylor. It is based on the analysis of operations using method-time-motion study on elements of the task. Fatigue factor is provided by standard allowance to develop the production rate whereas ergonomics / human factors approach uses physiology & biomechanics to identify fatigue factors that are neutralized by engineering & administrative controls (M. Helander, 1995).

The approach of human factors is the systematic application of relevant information about human capabilities, limitations, characteristics, behavior, and motivation to the design of things and procedures people use and the environment in which they use them (Sanders et al., 1992). This involves scientific investigation to discover relevant information about human beings and their responses to things, equipment, procedures, and work environments, etc. The human factors approach also involves the evaluation of the things designed to ensure that they satisfy their intended objectives.

Implications of Human factors in Industrial engineering design

Human factors has a wide application in everyday living and domestic situations, however there are even more significant implications for efficiency, productivity, safety, health, and comfort in work settings. Among the many important roles identified, human factors engineering plays the following basic functional roles:

- Methods and operation design
- System and interface design
- Product and equipment design
- Task and job design
- Workstation, workarrangement andworking environment design
- Information design

Work station Design Guidelines

Work systems emphasize the fit between people and the process environment .Comfort and efficiency are combined in a workstation system that allows for task focused and operator-specific set-up and adjustments. A flexible base design, supported by a variety of modular components gives manufacturers the freedom to design a work environment that satisfies the needs of both the company and its workforce.

The recommended workstation height varies for different operators. The standing work posture for male differs from the standing work posture for female; similarly the seated work posture of male differs from that of female when designing the workstation. In setting the optimum level, it is important to keep in mind the size of the object being worked on and the position of the worker during the task (seated, standing or a combination of both).

If the object being worked on is large, it is advisable to set the height slightly lower than the recommended. This places the center of the object at a height more accessible to the operator. Fig. 1 and Fig. 2 show the workability of a worker both in sitting and standing position. Fig. 3 shows the reach ability of workers hand during working period.

Job design: One goal of human factors is to design jobs to fit people. This means taking account of differences such as size, strength and ability to handle information for a wide range of users. Then the tasks, the workplace and tools are designed around these differences. The benefits sought are improved efficiency, quality and job satisfaction.The costs of failure include increased error rates and physical fatigue or worse.

Product design: Even the simplest of products can be a nightmare to use if poorly designed. Now a days, the designers of products are often far removed from the end users, which makes it vital to adopt an ergonomic, user-centered approach to design, including studying people using equipment, talking to them and asking them to test objects. This is especially important with 'inclusive design' where everyday products are designed with older and disabled users in mind.

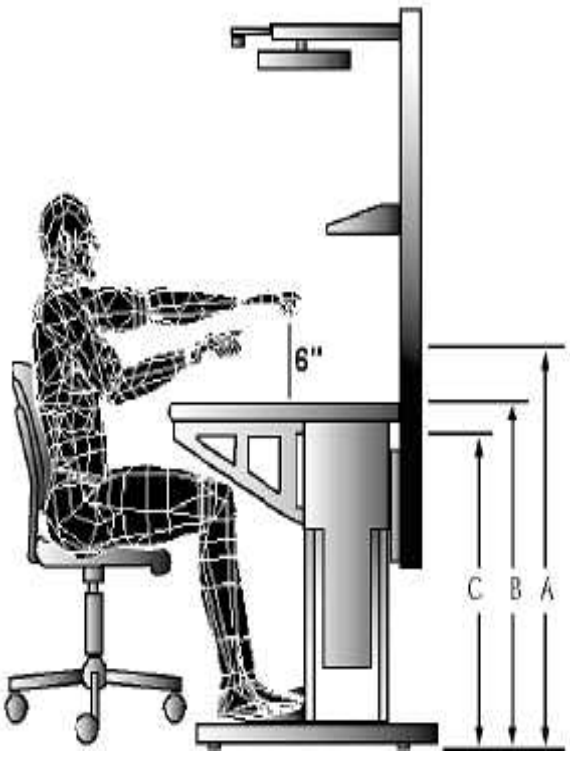

Figure1: SittingReachZone[6]

Conclusion :- The multi disclipinary nature of human factors is immediately obvious.The ergonomist/human factors engineer work in a team, which may be composed of other professionals namely, design engineer, industrial engineer, manufacturing engineer, computer analysts, industrial physicians, health and safety professionals , and specialists in human resources. The overall aim is to ensure that the knowledge of human characteristics &
Limitations is brought to bear on practical problems of human beings at work and the environment in which they work.

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