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Human Factors Industrial Engineering

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ABSTRACT

The current interest in human factors engineering stems from the need to consider human beings and their interactions with machines, materials, information, procedures, and environments in such developments and in the design of a technological system. The goal is to ensure that humans and technology coexist in imperfect harmony, with equipment and tasks tailored to human traits. The synthesis and application of scientific concepts to the study, design, installation, and improvement of integrated systems of persons, materials, equipment, and information to offer the most efficient and effective operating and work environment is referred to as industrial engineering. In this regard, this analytical study delves into pertinent information on human factor details, the interdisciplinary nature of human factors, and the consequences of human factors in industrial engineering and design. Furthermore, it discusses the fundamental relationship between human factors engineering and industrial engineering, as well as the importance of learning human factors for an industrial engineer, because an industrial engineer with a background in human factors is ideal because he can analyse different design alternatives for machinery and processes, make trade-offs in equipment selection, and arrive at a better solution. We shall talk about Human Factors Industrial Engineering in this paper.

Keywords: *Human, Factors, Industrial, Engineering, processes, design, machines, materials, information, procedures, environments, manufacturing, construction, transportation*

INTRODUCTION

Industrial engineering is concerned with the efficient operation of manufacturing, construction, transportation, or even commercial enterprises of any kind, in which human labour is directed to achieving any kind of job. Industrial engineering has drawn on mechanical engineering, economics, sociology, psychology, philosophy, and accounting to create a distinct body of research of its own. The incorporation of economic and human components, in particular, distinguishes industrial engineering from the more established divisions of the profession. [1] Industrial engineers must perform both technical and administrative tasks; that is, they must be responsible for both the design and character of the product, as well as the economics of its manufacturing. According to Towne, the industrial engineer as the man responsible for the daily operation and, still more, for the vitality and growth of a large industrial plant, must be a many-sided Engineer.

He must think about the planning and construction of new buildings. He must also deal with the issue of power and its distribution, steam engines and boilers, electric generation and transmission, shafting and belting, in many cases pumping and the use of compressed air for a variety of purposes, in all cases heating, ventilating, plumbing and sanitation, and in large plants, internal transportation. He must select the right men for the various positions to be filled, and inspire them with ambition. He must coordinate their efforts in order to achieve the greatest possible outcome, as well as comprehend and direct technical activities and determine whether or not they are being carried out correctly. Industrial engineers integrate two functions in one personality: technical knowledge and executive abilities, and a person with aptitude for both subjects has limitless prospects in the field of industrial engineering. [2]

Industrial Engineering:

Historians generally agree that the foundations of the industrial engineering profession may be traced back to the Industrial Revolution. The innovations that helped mechanise conventional manual textile industry operations, such as the flying shuttle, spinning jenny, and, probably most critically, the steam engine, created economies of scale that made mass manufacturing in centralised places appealing for the first time. The factories developed by these developments gave birth to the concept of the production system. It has also been proposed that Leonardo da Vinci was the first industrial engineer because there is evidence that he applied science to the examination of human activity around the year 1500 by examining the rate at which a man could shovel dirt. Others claim that Charles Babbage's research of factory operations, notably his work on the manufacturing of straight pins in 1832, sparked the industrial engineering profession. However, it has been widely stated that while these early efforts were informative, they were essentially observational in nature and did not attempt to engineer the tasks investigated or boost overall productivity. [3]

Industrial engineering is concerned with the study, design, and control of manufacturing systems. A productive system is any system that creates a product or a service. Industrial engineering teaches how to analyse and build productive systems, as well as how to implement control techniques (i.e., directing human labour) to keep such systems running efficiently. The skills of an engineer and a management are combined in industrial engineering. This requires proficiency in mathematics, statistics, and economics, as well as basic engineering sciences, as well as an interest in all types of professions, machinery, and the people who generate the products, as well as the capacity to analyse, synthesise, and integrate technical knowledge in practical ways. [4] Industrial Engineers work out how to improve things. They make major contributions to employers by saving money and improving the workplace for their coworkers. Industrial engineering is the engineering branch most closely tied to human resources since we use social skills to work with all types of personnel, from engineers to salespeople to top management. An Industrial Engineer's main objective is to enhance people's working surroundings - not to change the worker, but to transform the workplace. We work to improve the way people work. We place a high value on writing and presenting skills. To promote communication, morale, and leadership, we assess employee aptitude and motivation.

Industrial Engineers are appealing to a diverse range of employers, and you will have the option to work in a variety of industries. The most distinguishing feature of industrial engineering is its adaptability. Whether it's minimising the time passengers wait for a roller coaster ride, arranging the usage of an operating room, devising a global distribution strategy, or making improved autos, - for an industrial engineer, it's all in a day's job.

You will do the following as an Industrial Engineer:
- Earn a high salary.
- Collaborate with others to make things better, faster, safer, and more rewarding.
- Assist a company in saving money and being competitive
- Enjoy personal and professional fulfilment year after year
- Collaborate with people at various levels of a company or organisation.

Characteristics do Industrial Engineers Have:
Common characteristics of an Industrial Engineering include:
- Inquisitive mind
- Negotiation skills
- Listening skills
- Creative problem solving
- Diplomacy
- Patience
- Ability to adapt to many environments and interact with a diverse group of individuals
- Good common sense
- Continuous desire to learn
- Leadership skills
- Resourcefulness
- Desire for organization and efficiency
- Good math skills
- Strong time management skills
- Mechanical aptitude
- Excellent communication/salesmanship
- Quantitative skills
- Technical competency
- Continuous drive for improvement
- Passion for improvement [5]

Review of Literature:
Human factors are concerned with people and their interactions with equipment, materials, information, procedures, and surroundings used in the workplace and in daily life (Sanders et al., 1992). [6]

The goal of industrial engineering is to create an efficient production system that generates the required amount of items at a suitable cost and quality. It blends human behaviour principles with engineering method and analysis techniques (P. H. Hicks, 1994). [7]

The first industrial revolution was characterised by the use of steam-driven systems, the second by the use of electrically powered systems, and the third by the use of information technology and automation. Broadly speaking, I4.0 refers to the increasing digitization and integration of information technology, which includes applications such as the internet of things, cloud-based systems, and cobots [8].

However, many in industry and research are still unsure of what fully realised I4.0 applications would look like or how they might operate. For most practitioners, the digital transformation and its consequences for business processes remain a mystery. The transformation of production as a result of both technological and paradigmatic factors leads to major changes in organisations and processes, and ultimately in human work (Matt et al., 2015). [9]

Objectives:

- To protect the comfort, health, safety and well-being of personnel.
- Industrial engineering may be defined as the art of utilizing scientific principles human operating procedures.
- Designs and installs better systems of integrating tasks assigned to a group.
- Industrial Engineering is Human Effort Engineering and System Efficiency Engineering.

Research Methodology:

This study's overall design was exploratory. Human factors engineering is concerned with understanding the capabilities and limitations of human abilities and applying that knowledge to the design of human-machine systems. This entry covers the fundamentals of human factors engineering and usability testing. [10] As a result, the proposed approach can represent a viable answer to the above-mentioned research issue, summarising a human-centered design for safety unified framework that can assist engineers in closing the gap between theory and practise. Although this research work cannot be regarded thorough, and the stated technique may appear to be a too easy answer to provide a precise means of augmenting the design and management of work equipment and technical systems, it can be considered a start, It unquestionably provides a potent way to bringing to light both safety and ergonomic elements of work circumstances in an industrial context, hence expanding knowledge in this burgeoning study subject. [11]

Result and Discussion:

Industrial engineering is a branch of engineering concerned with the optimisation of complex processes, systems, or organisations through the development, enhancement, and implementation of integrated systems of people, money, knowledge, information, and equipment. Manufacturing activities rely heavily on industrial engineering. [12]

Industrial engineers specify, anticipate, and evaluate the effects of systems and processes by applying specialised knowledge and skills from the mathematical, physical, and social sciences, as well as engineering analysis and design principles and methods. In the manufacturing industry, various industrial engineering concepts are followed to ensure the efficient flow of systems, processes, and operations. Lean Manufacturing, Six Sigma, Information Systems, Process Capability, and Define, Measure, Analyse, Improve, and Control (DMAIC) are all examples. [13] These principles enable the development of novel systems, processes, or circumstances for the useful coordination of labour, materials, and machines, as well as the improvement of the quality and productivity of physical and social systems. Depending on the subspecialties, industrial engineering may also overlap with operations research, systems engineering, manufacturing engineering, production engineering, supply chain engineering, management science, management engineering, financial engineering, ergonomics or human factors engineering, safety engineering, logistics engineering, or others. [14]

Figure 1: Industrial Engineers in a Factory

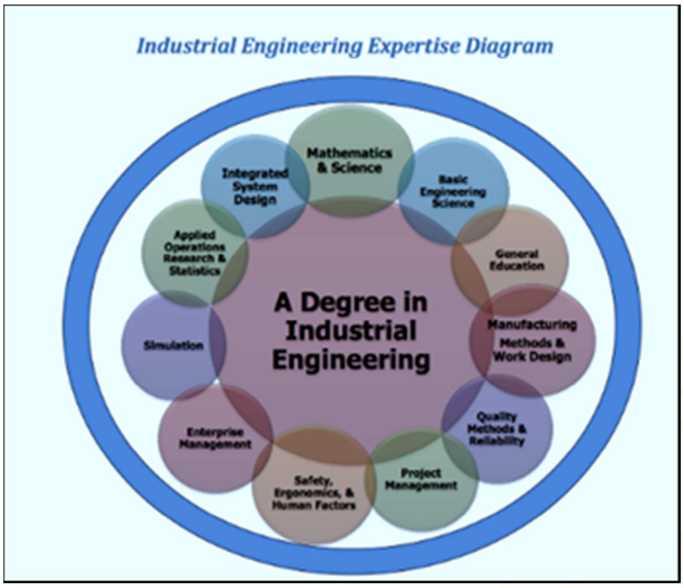

Figure 2: hierarchy of Industrial Engineers

Environmental, tools and fixtures, safety and security, reliability, human factors and ergonomics, standards and certifications, quality, maintenance and support, waste and disposal, business and management, finance, supply chain, inventory, ordering, training, simulation, system dynamics, automation, robotics, planning, facilities and work-spaces, human resources, communication [15]

Aside from lowering the likelihood of severe incidents, the use of HFE is critical for decreasing occupational safety risks and maintaining the health and well-being of the offshore workers, which saves downtime. HFE concepts can also increase operational efficiency and maintainability by streamlining processes, optimising workloads, and designing ergonomically. With the enormous expenses associated with even minor delays in operations, this should be a primary motivator for considering HFE. [16]

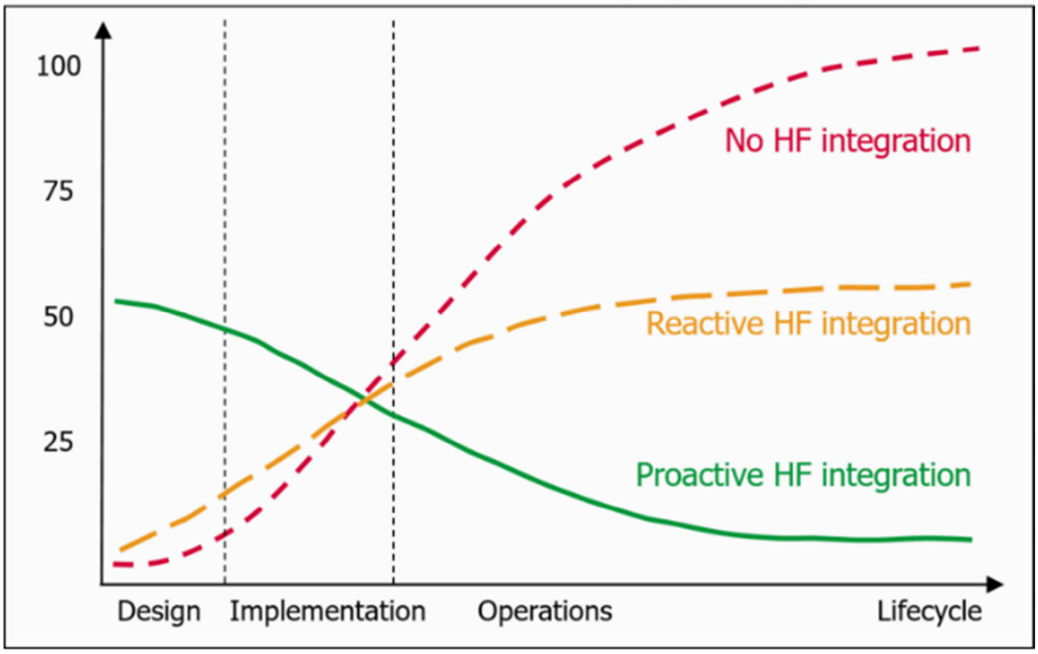

Figure 3: Cost of detecting and resolving HF issues

Based on the analysis, a maturity model integrating DFS and HFE tools can be developed, i.e., a unified strategy combining the key research trends identified in the existing literature. This framework focuses on the earliest stages of the design process, which are where major decisions are made, including planning, conceptual design, and embodiment design. However, comprehensive design, prototyping, and product launch processes need consideration as well, because a more complete modelling of work scenarios (i.e., the interaction of the technical system with its users and the workplace) can provide additional information on safety and ergonomic difficulties. [17] Table 1 summarises the entire strategy, indicating the primary activities and outputs for each step, as well as the tools and methods identified through the literature study. In particular, when deciding the general requirements of the technical system during the planning phase, the most relevant activities from the standpoint of safety and ergonomics should concern the definition of the users' needs and the analysis of accidents related to similar systems in order to collect information about the users' behaviour and the possible misuse of the system. [18] Then, in the second phase, where the conceptual design of the system is developed, more precise tools can be used to analyse the system's human safety. In this context, analysing work tasks and scenarios is critical not only for understanding human behaviour, but also for avoiding conflicts caused by the presence of other equipment in the workplace. During the embodiment design phase, the system knowledge is sufficient to use not only qualitative techniques, but also quantitative risk analysis approaches. As a result, more detailed HFE methodologies can be utilised to evaluate noise and vibration hazards, as well as the appropriate safety equipment. Furthermore, at this level of system design, information about the system's lifecycle is more precise: installation and maintenance operations can thus be incorporated in risk assessment activities.

Table 1: General scheme of the unified framework integrating HFE in DFS activities. [19]

PHASE	ACTIVITIES	OUTPUT	DfS and HFE TOOLS
PLANNING	• Analysis of mandatory requirements (Legislation, contracts, etc.) • Analysis of stakeholders' requirements (Manufacturer/Users/Operators' needs, maintenance service, etc.) • Analysis of the technical system's life-cycle and possible scenarios • Analysis of accidents' and incidents' reports and statistics	• Main requisites of the system • Feasibility analysis (production, installation, maintenance, disposal, etc.)	• Preliminary Hazard Analysis (PHA) • Interviews with users • Accidents' reports • Safety Function Deployment (SFD) • Axiomatic Design (AD)
CONCEPTUAL DESIGN	• Analysis of the system's functions and sub-functions • Evaluation of possible conceptual solutions • Preliminary risk assessment analysis • Life-cycle scenarios assessment • Human Reliability Analysis	• Conceptual model of the system	• Preliminary Human Safety Analysis (PHSA) • Hazard Function Deployment (HFD) • Function Behavior Structure (FBS) • Failure Modes and Effects Analysis (FMEA) • Fault Tree Analysis (FTA) • Variability Analysis • Safecharts
EMBODIMENT DESIGN	• Identification of the main features of the system (dimensions, materials, life-cycle, etc.) • Conformity assessment (EHSR, OHS, etc.) • Work situation analysis • Subsystem Hazard Identification • Subsystems Failure analysis	• Definition of the systems' main features • Definition of the systems' safety issues	• Computer musculoskeletal modeling (CMM) • Multi-Objective Optimization (MOO) • Failure Modes Effects and Criticality Analysis (FMECA) • Fault Tree Analysis (FTA) • Event Tree Analysis (ETA) • Semantic Distances Analysis • Function Behavior Structure (FBS) • Hazard and Operability analysis (HAZOP) • Safecharts • Safety Devices Evaluation

Conclusion:

Human factors' multidisciplinary nature is instantly apparent. The ergonomist / human factors engineer works in a team that may include design engineers, industrial engineers, manufacturing engineers, computer analysts, industrial physicians, health and safety practitioners, and human resources specialists. The overarching goal is to ensure that knowledge of human features and limitations is applied to real challenges involving humans at work and the environment in which they operate. The most valuable contribution that good Human Factors Engineering practises can make is an increase in the likelihood of Business Continuity for a system due to reduced outages and time requirements for maintenance interventions, which leads to improved results for a specific company in terms of avoiding production loss.

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