HUMAN FACTORS IN ENGINEERING 0906481

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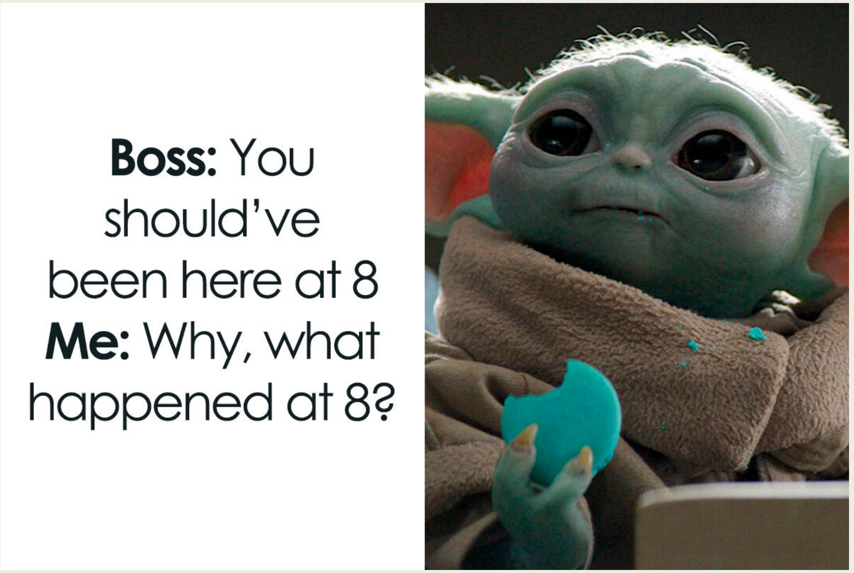
Definition

- Human factors focuses on human beings and their interaction with products, equipment, facilities, procedures, and environments used in work and everyday living. The emphasis is on human beings (as opposed to engineering, where the emphasis is more on strictly technical engineering considerations) and how the design of things influences people.
- Human factors seeks to change the things people use and the environments in which they use these things to better match the capabilities, limitations, and needs of people.
- Balance between job demands and the human capacities.



BALANCE IS THE KEY

TARGET VS. CAPABILITIES

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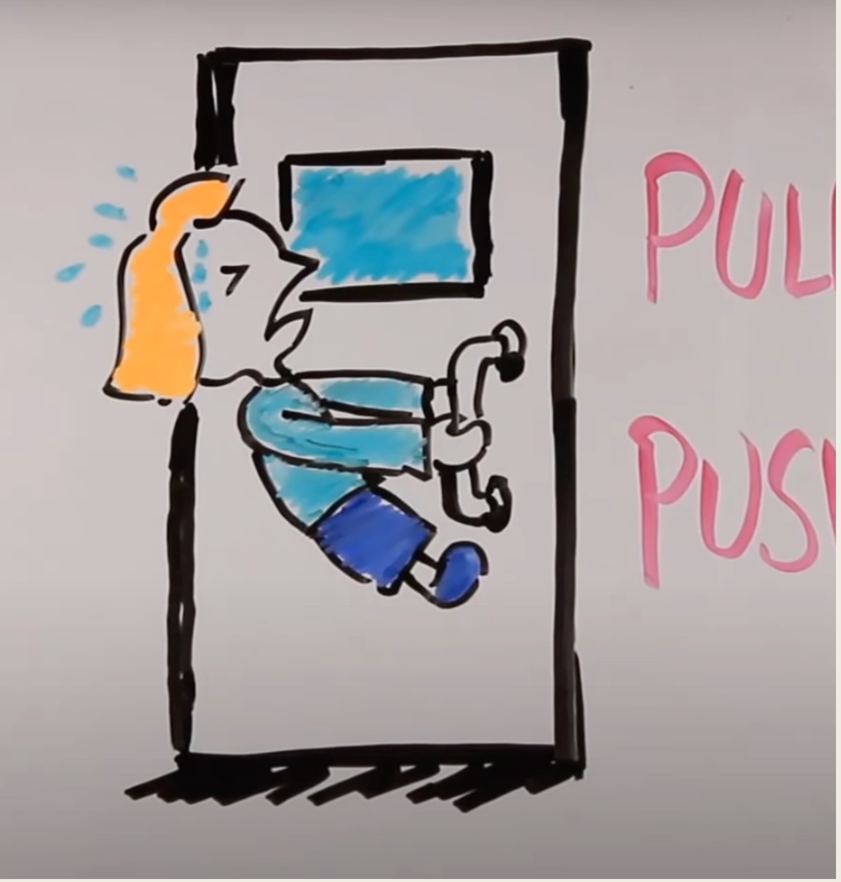
Objectives of Human Factors

1. Enhance the effectiveness and efficiency with which work and other activities are carried out. Included here would be such things as increased convenience of use, reduced errors, and increased productivity. (for organization favor)

2. Enhance certain desirable human values, including improved safety, reduced fatigue and stress, increased comfort, greater user acceptance, increased job satisfaction, and improved quality of life. (for worker favor)

- **Both objectives are correlated**



HUMAN FAULT OR DESIGN FAULT ?!

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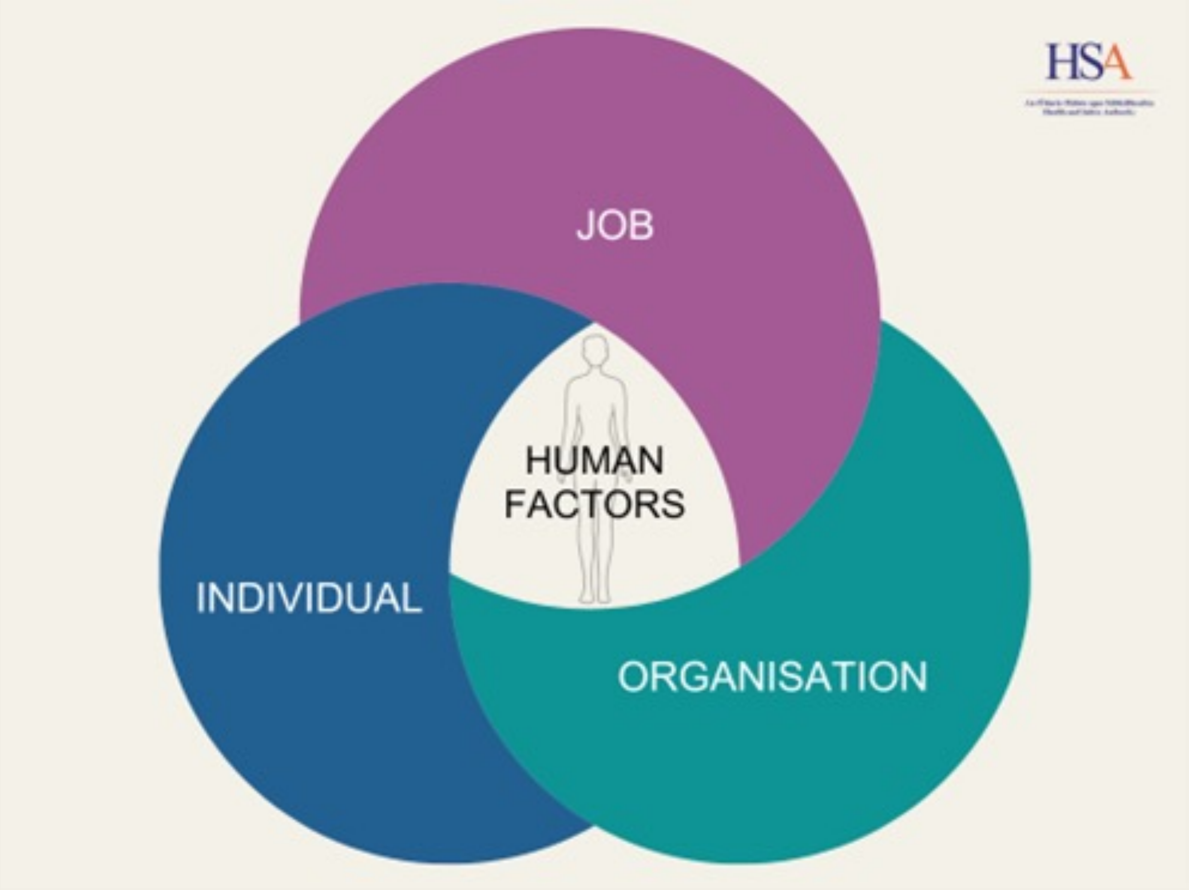
FOCUS OF HUMAN FACTORS



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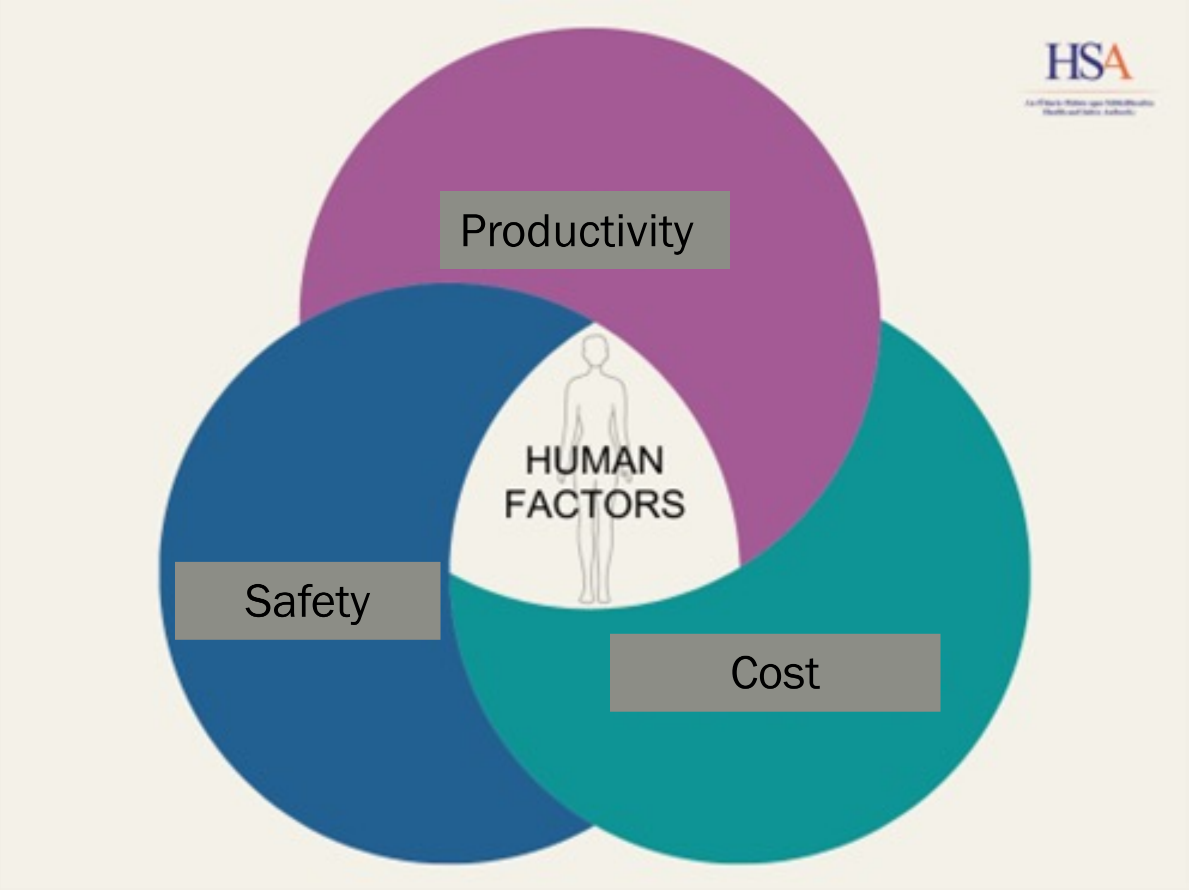

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Where Human Factors Came From

- Commitment to the idea that things, machines, etc. are built to serve humans and must be designed always with the user in mind
- Recognition of individual differences in human capabilities and limitations and an appreciation for their design implications
- Conviction that the design of things, procedures, etc. influences human behavior and well-being
- Emphasis on empirical data (data observed through experimentation and observation and evaluation) in the design process
- Reliance on the scientific method and the use of objective data (observed through your senses of hearing, sight, smell, and touch) to test hypotheses and generate basic data about human behavior
- Commitment to a systems orientation and a recognition that things, procedures, environments, and people do not exist in isolation

What Human Factors Is Not

- *Human factors is not just applying checklists and guidelines:* There is not a checklist or guideline in existence today that, if it were blindly applied, would ensure a good human factors product. Trade-offs, considerations of the specific application, and educated opinions are things that cannot be captured by a checklist or guideline but are all important in designing for human use.
- *Human factors is not using oneself as the model for designing things:* Just because a designer can reach all the controls on a machine, that is no guarantee that everyone else will be able to do so. Human factors recognizes individual differences and the need to consider the unique characteristics of user populations in designing things for their use. Simply being a human being does not make a person a qualified human factors specialist.

What Human Factors Is Not

- *Human factors is not just common sense:* Knowing how large to make letters on a sign to be read at a specific distance or selecting an audible warning that can be heard and distinguished from other alarms is not determined by simple common sense. Knowing how long it will take pilots to respond to a warning light or buzzer is also not just common sense. Given the number of human factors deficiencies in the things we use, if human factors is based on just common sense, then we must conclude that common sense is not very common.

We Need Human Factors To Survive

- History is filled with evidence of efforts, both successful and unsuccessful, to create tools and equipment which satisfactorily serve human purposes and to control more adequately the environment within which people live and work.
- Why now?
  - *Technological revolution (complexity)*
  - *Competition (money over safety)*
  - *Awareness of occupational rights*

SYSTEMS

- A *system* is an entity that exists to carry out some purpose (Bailey, 1982). A system is composed of humans, machines, and other things that work together (interact) to accomplish some goal which these same components could not produce independently.

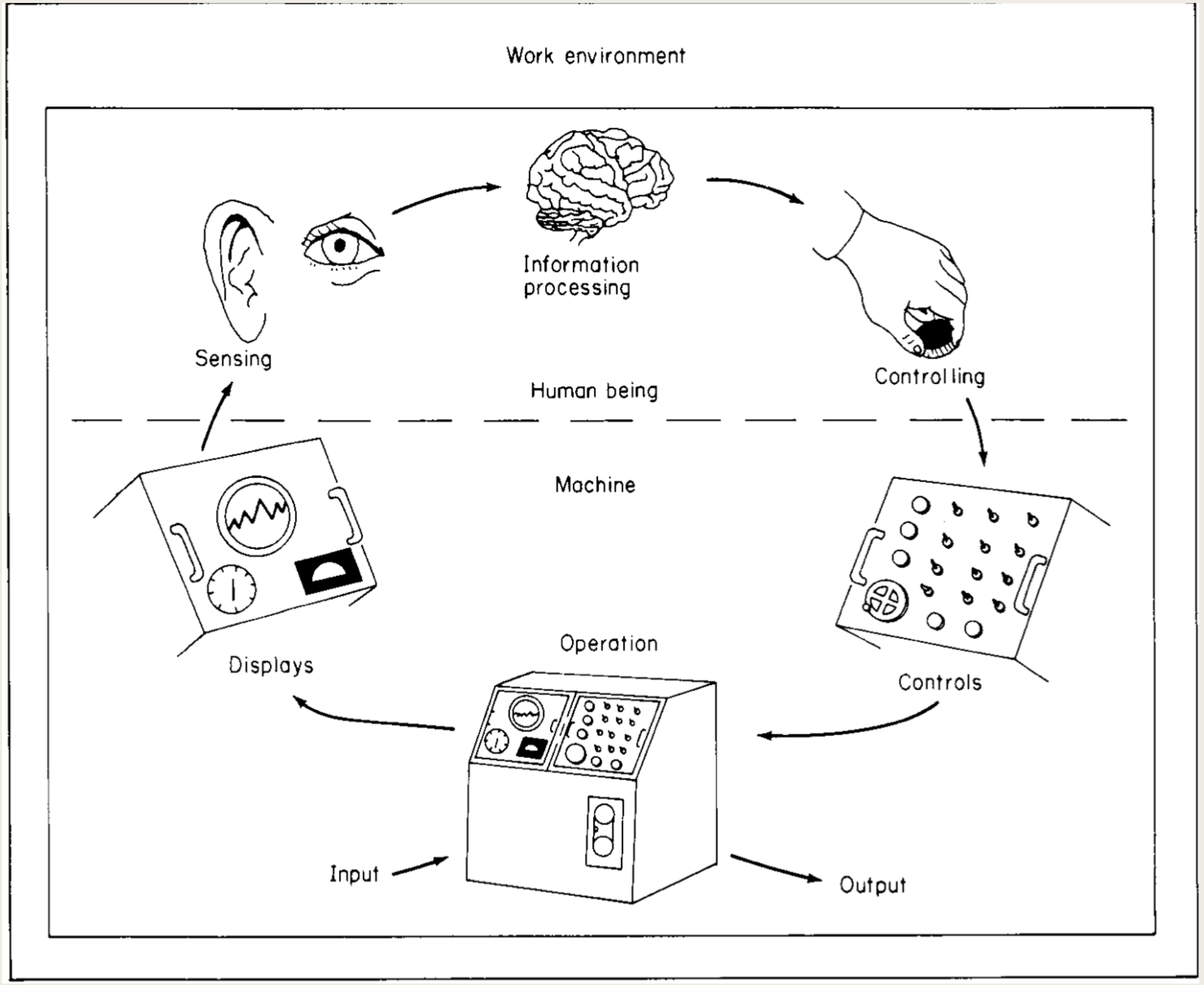
- As Bailey (1982) states: The concept of a system implies that we recognize a purpose; **we carefully analyze the purpose**; **we understand what is required to achieve the purpos**e; **we design the system's parts to accomplish the requirements**; and **we fashion a well-coordinated system that effectively meets our purpose.**

Human-Machine Systems

- *Human-machine system* as a combination of one or more human beings and one or more physical components interacting to bring about, from given inputs, some desired output.
- A person with a hoe, a hammer, or a hair curler
- A person with an automobile, an office machine, and a lawn mower
- A person with aircraft, bottling machines, telephone systems, and automated oil refineries
- The servicing systems of gasoline stations, hospitals, the operation of an amusement park, a highway and traffic system, and the rescue operations for locating an aircraft downed at sea.

Human-Machine Interaction

- One way to characterize human-machine systems is by the degree of manual versus machine control.
- We can generally consider systems in three broad classes: manual, mechanical, and automatic.



Human-Machine Systems Types

- **Manual** Systems A *manual system* consists of hand tools and other aids which are coupled by a human operator who controls the operation. Operators of such systems use their own physical energy as the power source.
- **Mechanical** Systems These systems (also referred to as *semiautomatic* systems) consist of well-integrated physical parts, such as various types of powered machine tools. They are generally designed to perform their functions with little variation. The power typically is provided by the machine, and the operator's function is essentially one of control, usually by the use of control devices.
- **Automated** Systems When a system is fully automated, it performs all operational functions with little or no human intervention. Robots are a good example of an automated system. Some people have the mistaken belief that since automated systems require no human intervention, they are not human machine systems and involve no human factors considerations.
- All automated systems require humans to install, program, reprogram, and maintain them. Automated systems must be designed with the same attention paid to human factors that would be given to any other type of human-machine system.

What is Ergonomics

- Ergonomists study people and how they operate equipment in the home, in commerce, in factories, and in governmental activities
- Ergos means “work” and nomos means “natural laws”.
- Ergonomics means fitting job to the worker
- Ergonomics combines the knowledge psychologist, physiologist, atomist, engineer, anthropologist, bio-metrician.

What is Ergonomics

- Psychologist: deals with human minds and its functions (mental health and emotions)
- Physiologist: deals with normal functions of human parts (organisms of the body)
- Anatomist: deals with human body structure
- Engineer: deals with production process
- Anthropologist: deals with measurements of human individual
- Bio-metrician: deals with application of statistical analysis and biological data

What is Ergonomics

- Ergonomic engineers design:

products and tools	workplace layouts
Jobs	inspection stations and process-control interfaces
methods	job aids, wage administration programs, teams of personnel, and programs for personnel selection and placement
machine-tool interfaces	warning signs, abatement programs for undesirable environments, communication systems, error tracking systems
material-handling systems, machine adaptations for handicapped personnel, safety and health programs	questionnaires, interviews, human performance predicting systems

Human Centered Design/principles

- *Select people to fit their machines and jobs:*

This principle really means that at times ergonomic specialists need to choose people for particular jobs because of individual differences **in knowledge, abilities, and skills**. Many people cannot tolerate assembly lines because of the **monotony**, while others like them because the mental demands are so small.

Sometimes intelligent people like minimal demands because they want to concentrate on their own thoughts. Systems should be designed to account for these individual differences. Ergonomic specialists also need to modify employee knowledge, abilities, and skills through training.

In general, the objective of ergonomic design is to enhance human talents in the roles people serve. That enhancement may be direct, through training, or indirect, through changes in the system in which people work.

Human Centered Design/ principles

- *Be sure that the problem identified is the right problem and that it is formulated correctly:*

It is too easy to ignore this fundamental principle. After formulating a design problem, the designer must create a feasible solution. Part of this activity depends upon the designer's creativity. But a large part of this activity comes from acquiring knowledge about the system under design, the *roles* of people, and the *goals* and objectives of those roles. Part of the knowledge collection can be conducted by asking people informally or through the use of questionnaires and interviews.

- *Take advantage of human attributes by expanding requirements for human abilities so that people can better perform their roles:*

More simply stated, too much focus on human limitations may cause you to miss opportunities to improve the system. Besides this, many people prefer to work with systems in which their abilities shine.

Human Centered Design/ principles

- *Overcome human limitations so that those limitations do not become system limitations:*

There are many clear and obvious ways to accomplish this goal. Power tools magnify human motor abilities in terms of speed, strength, and durability. Magnifying glasses enhance visual sensitivity, and special sensors convert electromagnetic waves, outside of human sensory abilities, into important information. Production control systems and associated software help identify feasible and near-optimum production schedules. Quality- and inventory- control systems help identify causes of lost productivity.

These features need to be captured and harnessed to enhance human abilities, overcome human limitations, and to do these things in a way that promotes user-owner acceptance. Users want improved capabilities and management wants the benefits of those capabilities. It is the designer’s role and responsibility to ensure that both parties are satisfied.

Human Centered Design/ principles

- *Consider the activities of interest as to whether or not people are required to exercise significant levels of skill, judgment, and/or creativity:*

Generally, the lower the requirements are for human skill, judgment, or creativity, the more designers ought to consider automating the activity. When human operators contribute less in an activity, they usually care less about that activity, so it is likely to be forgotten in operation.

- *Find out the degree to which people enjoy being involved with these activities:*

Professor Donald Norman asserts that ergonomic specialists should design systems that people find enjoyable to operate. He makes the point that ergonomic designers need to rise above the standard of merely acceptable systems.

Human Centered Design/ principles

- *Query human operators about their dissatisfaction to see if it is caused by: (a) a need to "feel in control," (b) a desire for achieving self-satisfaction in task performance, or (c) perceptions of inadequacies of technology for quality of performance, or ease of use.*

Responses to these inquiries provide useful design information on how to correct the design. For example, if the needs to be in control or to achieve self-satisfaction are *not* the central concerns, the designer must determine if the perceived inadequacies of the technology are well founded. If they are, the designer should eliminate the functions in question from the candidate set; if they are not, the designer should provide demonstrations to familiarize personnel with the actual capabilities of the technology. When people are in crews or teams where each member depends on all the others, one or more members who do not perform their jobs properly create a danger to the entire crew. The same is true when some team members are machines, either with or without new technologies. In either case, the team analogy provides an important perspective for ergonomic designers.

The scientific management movement

- The scientific management movement started back in the United States.
- The scientific management movement members are:
  - *Frederick W. Taylor*
  - *Frank Gilbert*
  - *Lillian Gilbreth*

- The principal approach of the movement:
  - *(1) motion study, aimed at finding the best method to perform a given task and eliminating delays*
  - *(2) time study to establish work standards for a job*
  - *(3) extensive use of standards in industry*
  - *(4) the piece rate system (workers paid per unit performed) and similar labor incentive plans*
  - *(5) use of data collection, record keeping, and cost accounting in factory operations*

Father of scientific management

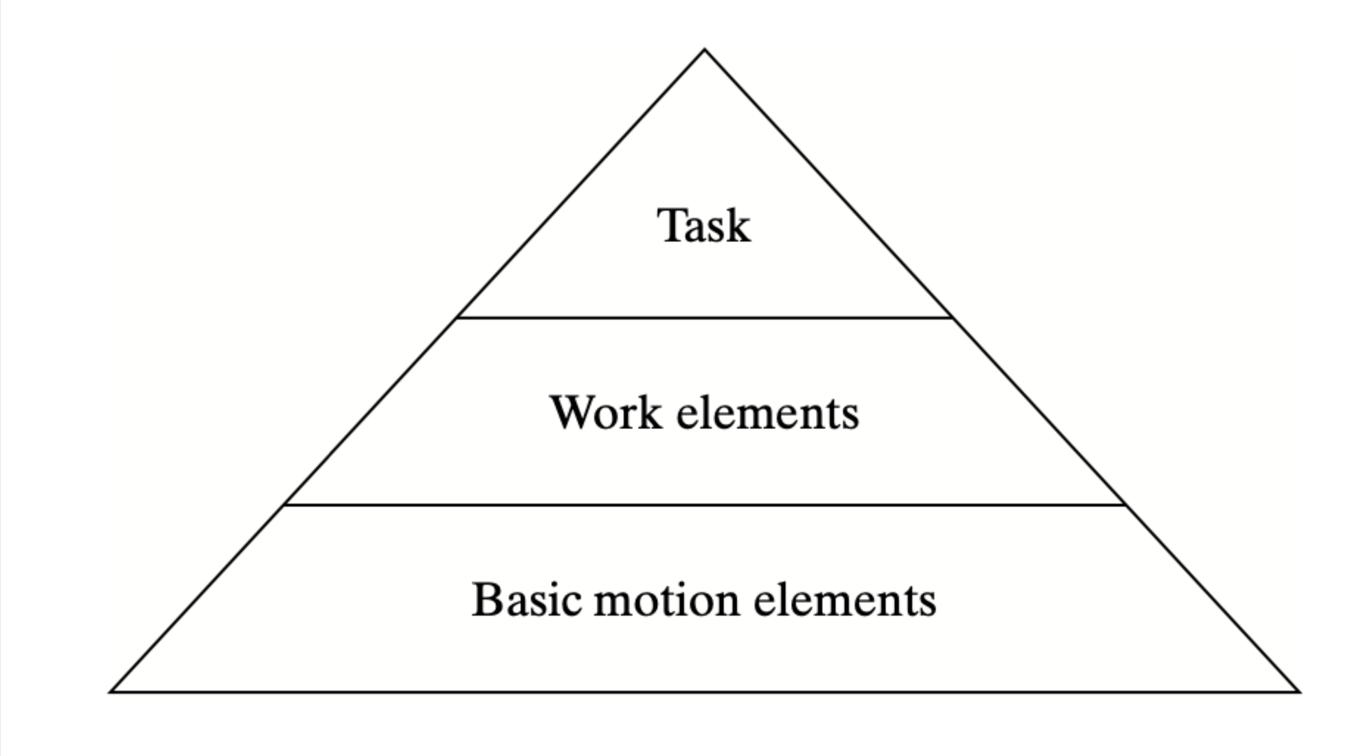
- ***Frederick W. Taylor*** (1856–1915) is known as the "**father of scientific management**" for his application of systematic approaches to the study and improvement of work. His findings and writings have influenced factory management in virtually every industrialized country in the world, especially the United States.
- ***Frank Gilbreth*** (1868–1924) is noted for his pioneering efforts in analyzing and simplifying manual work. He was associated with the scientific management movement in the late 1800s and early 1900s, in particular for his achievements in motion study. He is sometimes referred to as the "**father of motion study**." Two of his important theories about work were (1) that all work was composed of 17 basic motion elements that he called "therbligs" and (2) the principle that there is "one best method" to perform a given task.

Father of scientific management

- ***Lillian Gilbreth*** (1878–1972) was the oldest of nine children. She earned bachelor's and master's degrees at the University of California, Berkeley. During her marriage to Frank, she became the mother of 12 children and earned a doctorate at Brown University in 1915, a rare achievement for a woman at the time. Her other accomplishments were equally noteworthy. With her husband, she co-authored four books: ***A Primer of Scientific Management*** (1914), ***Fatigue Study*** (1916), ***Applied Motion Study*** (1917), and ***Motion Study for the Handicapped*** (1917). On her own, she wrote ***The Psychology of Management*** (1914) and several other books after Frank's death.
- The story of how Frank and Lillian Gilbreth practiced efficiency and motion study in their own home was humorously documented by two of their 12 children in 1949 with the publication of ***Cheaper by the Dozen.***

The nature of work

- The pyramidal structure of a task. Each task consists of multiple work elements, which in turn consist of multiple basic motion elements.



The nature of work

- ***Work*** is defined as an activity in which a person exerts physical and mental effort to accomplish a given task or perform a duty.
- A ***task*** is an amount of work that is assigned to a worker or for which a worker is responsible.
- A task may involve one or more steps in making a product or delivering a service. The worker performing the task must apply certain skills and knowledge to complete the task or duty successfully.
- The task can be repetitive (as in a repetitive operation in mass production) or nonrepetitive (performed periodically, infrequently, or only once).

The nature of work

- ***Basic motion elements*** are actuations of the limbs and other body parts while engaged in performing the task. These basic motion elements include reaching for an object, grasping an object, or moving an object. Other basic motions include walking and eye movement (e.g., eye focusing, reading).

- ***Work element*** is defined as a series of work activities that are logically grouped together because they have a unified function within the task. For example, a typical assembly work element consists of reaching for a part, grasping it, and attaching it to a base part, perhaps using one or more fasteners (e.g., screws, bolts, and nuts).

- Work elements usually take six seconds or longer, while a basic motion element may take less than a second. The entire task may take 30 seconds to several minutes if it is a repetitive task, while nonrepetitive tasks may require a much longer time to complete.

The nature of work

- The pyramidal structure of work.