

Introduction to Ergonomics

Week 1st

Robert W. Proctor and Trisha Van Zandt (2008). Human Factors in Simple and Complex Systems. 2nd Edition. Taylor & Francis.
Vivek D. Bhise (2012). Ergonomics in the Automotive Design Process. 1st Edition. Taylor & Francis.

Ergonomic in Product Design

- ▶ Designing a product involves the integration of inputs from many disciplines (e.g. designers, body engineers, manufacturing engineers, product planners, market researchers, ergonomics engineers, electronics engineers)
- ▶ The design activities are driven by intricate coordination and simultaneous consideration of many requirement (e.g. customer, engineering functional, business, government regulatory, manufacturing).
- ▶ The design would be trade-off between the requirement of different system in the product.
- ▶ The system should not only function well, but they must also satisfy the customers who purchase and use the products

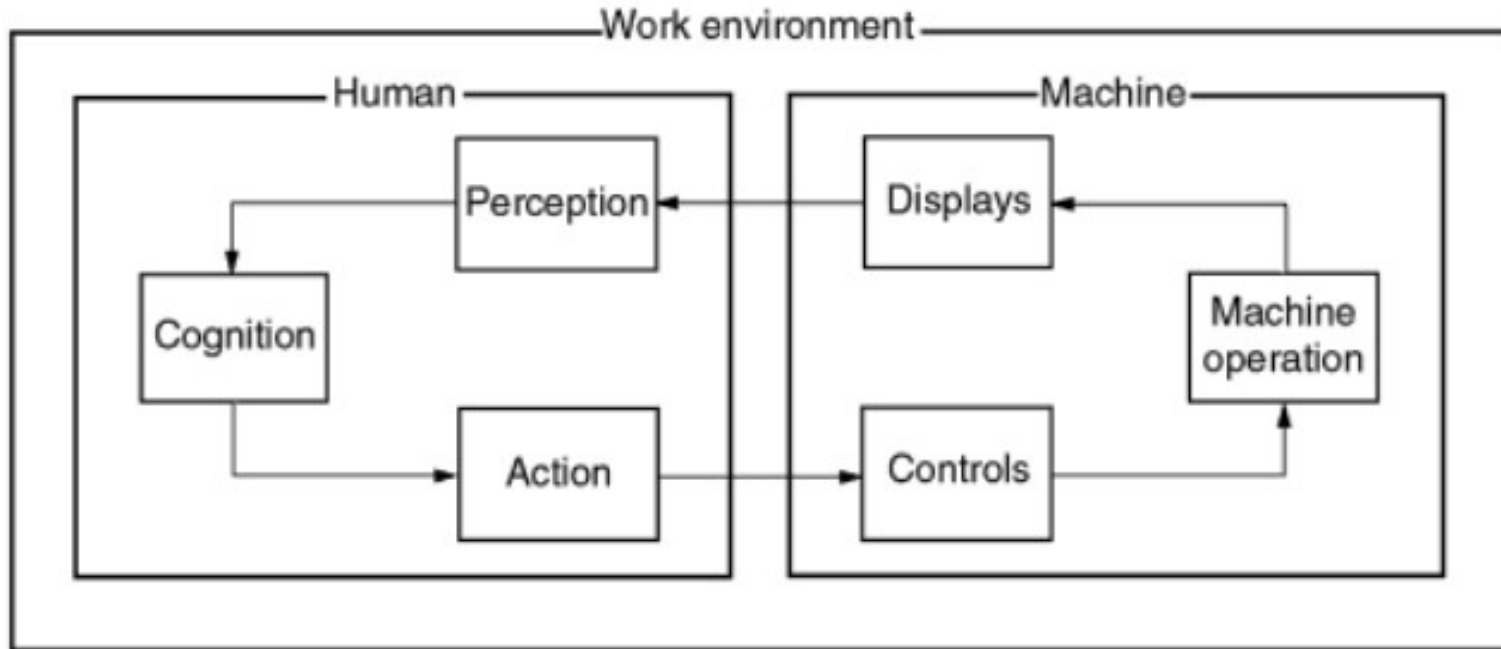
Ergonomic in Product Design

- ▶ The field of ergonomics or human factors engineering in the product development involves working to assure that all important ergonomic requirement.
- ▶ Issues are considered and resolved to accommodate the needs of the users i.e. vehicle product: drivers, passengers, personnel involved in assembly, maintenance and while using (or working on the product)

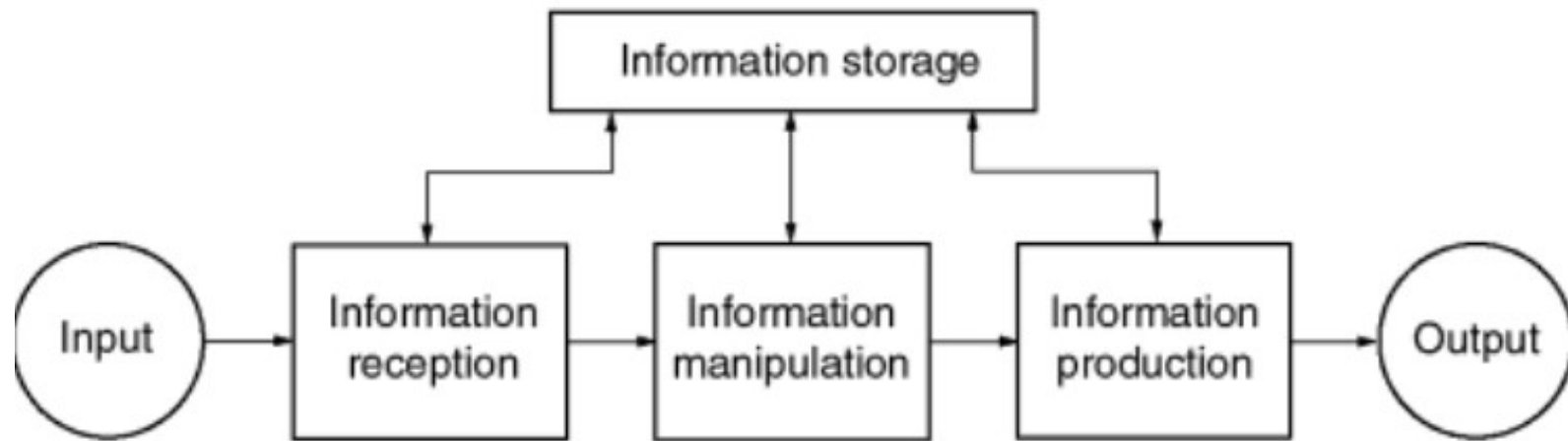
Definition

- ▶ The variables that govern the efficiency of the operator within a system called “*Human factors*”.
- ▶ The study of those variables that influence the efficiency with which the human performer can interact with the components of a system to accomplish the system goals. This is called “*Ergonomics*”.
- ▶ The human factors is the importance of basic human capabilities, such as perceptual abilities, attention span, memory span, and physical limitations.
- ▶ The human factors specialist must know the limits of these capabilities and bring this knowledge to bear on the design of system.
- ▶ The human factors specialist must consider people’s perceptual, cognitive, and movement capabilities when designing information displays and controls, such as those found in automobiles, computer software packages, and microwave ovens.

Fig1.4 Representation of the human-machine system



Information processing in humans and machines



Ergonomics: What is it?

- ▶ Ergonomics is a multidisciplinary science involving fields that have information about people (e.g. psychology, anthropometry, biomechanics, anatomy, physiology, psychophysics).
- ▶ It involves studying human characteristics, capabilities, and limitation and applying this information to design and evaluate the equipment and system that people use.
- ▶ The basic goal of ergonomics is to design equipment that will achieve the best possible fit between the users and the equipment.
- ▶ The users' safety, comfort, convenience, performance, and efficiency are improved.

Ergonomics approach

Fitting the equipment to the users

- ▶ Ergonomics involves “fitting the equipment to the people (or users)”.
- ▶ The equipment should be designed such that people (population of users) can fit comfortably (naturally) within the equipment.
- ▶ People can use the equipment without any awkward body postures, movements, or errors.
- ▶ It should be noted that ergonomics is not about fitting the people to equipment.
- ▶ Some case, the equipment is designed such that only people with certain characteristics can fit or use them.

Ergonomics approach

Designing for the most

- ▶ Ergonomics involves “designing for the most”.
- ▶ To assure that most users within the intended population of the users of the product can fit within the product.
- ▶ The designer needs to know what the user population is and knows the distributions of characteristics, capabilities, and limitations of the individuals in that population.

Ergonomics approach

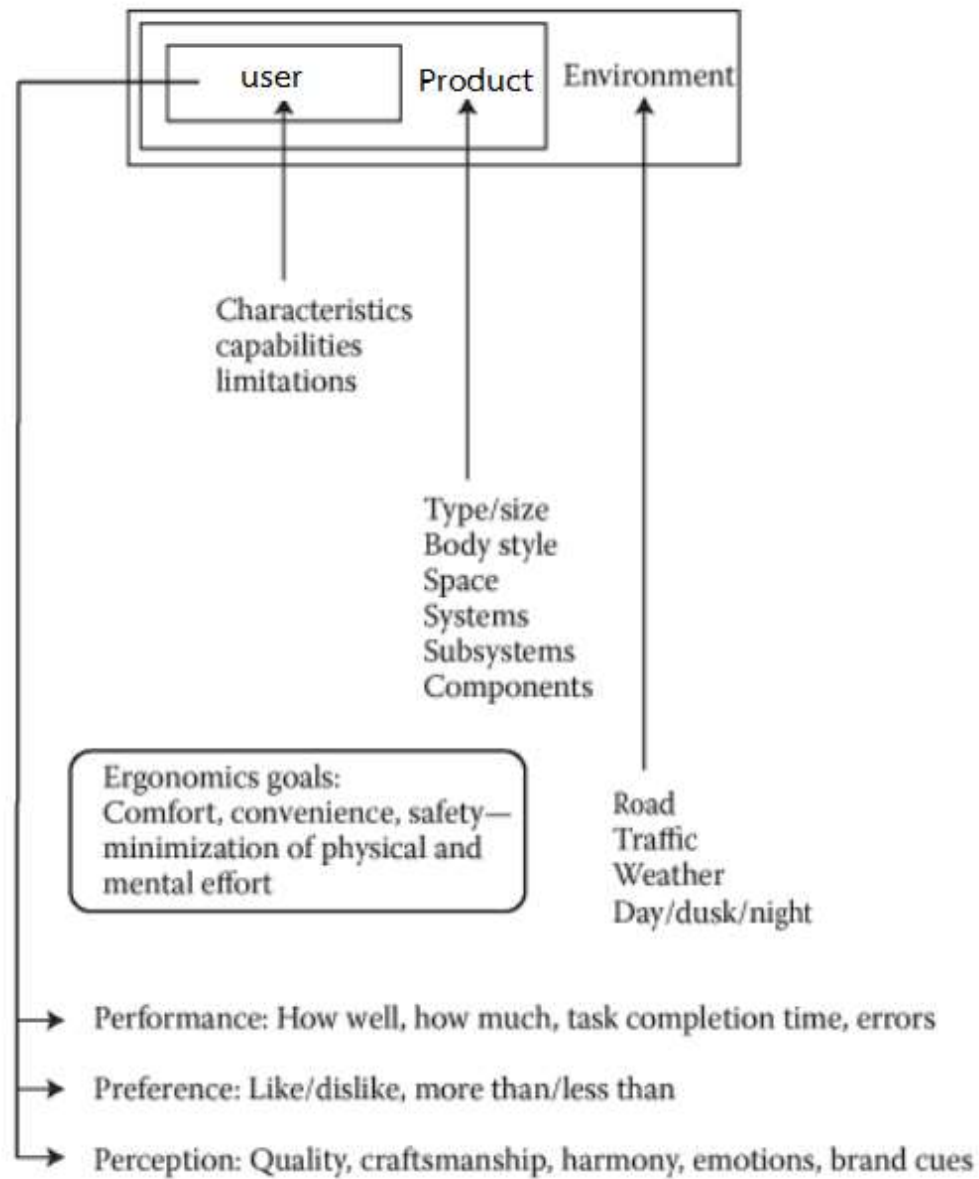
Systems approach

- ▶ The important consideration involves “humans as a systems component”.
- ▶ This mean that the designer must treat the human to be a component of the system that is being designed.
- ▶ The major components
 - ▶ The user
 - ▶ The product
 - ▶ The environment
- ▶ The product design should involve not only designing all the physical components that fit and function well but also making sure that the user is considered to be a human component.
- ▶ The user’s characteristics are measured and used in designing a product.

Ergonomics approach

Systems approach (cont.)

- ▶ The engineer designs each part of the product by paying attention to all of its properties (e.g. dimensions, material, hardness, color, surface, how it fits/works with other components).
- ▶ When the human is involved as an operator or the user of the product, all relevant human characteristics must be studied and used in designing the product.
- ▶ Thus, in designing a product, a thorough understanding of the intended user population and the operating environment (which consists of the weather, and operating conditions such as dawn, day, dusk and night) of the product must be considered



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- ▶ The ergonomics engineer must consider the characteristics of all the components in the system and evaluate
 - a) How user will perform various tasks
 - b) The preferences of user in using the product
 - c) The pleasing perceptions created by experiencing the product such as the quality.

Characteristics of ergonomically designed products, systems, and processes

1. **An ergonomically designed product should fit people well.**
 - Thus, when it is time to replace an old product, a customer will most likely purchase a newer version of the same product that fits him or her well.
2. **An ergonomically designed product can be used with minimal mental and/or physical work.**
 - Thus, as product usage increases, the customer will realize the ease, comfort, and convenience features and the absence of problems while using the product.
3. **An ergonomically designed product is easy to learn.**
4. **A product with usability problems (i.e., the absence of ergonomics) can be quickly noticed.**
5. **Ergonomically designed products are generally more efficient (productive) and safer (less injurious).**

Why apply ergonomics?

1. It created functionally superior products, processes or systems.
2. Costly and time-consuming redesign can be avoided (with early incorporation of ergonomics inputs in the design process, superior product or system can be developed without additional design iterations).
3. There are thousands of ways to design a product, but only a few designs are truly outstanding.

Ergonomics is not commonsense

- ▶ **Commonsense ideas/solution are often wrong.**
 - ▶ Ex, a designer wanted to create an instrument panel illuminated with “deep red” lighting for a new hot sports car.
 - ▶ The ergonomics engineer reminded him that about 8% of males have a color deficiency in perceiving the color red.
 - ▶ The designer said, “but the air force used red-colored instrument panels in airplanes”.
 - ▶ The ergonomics engineer reminded the designer, “color deficient persons cannot get a pilot’s license, but a car is a consumer product and you don’t want to annoy these color-deficient males in using your vehicle”.
 - ▶ If you want red, then we should add some yellow in it and make it orangish-red so that the red-color-deficient people can still read the instruments.”
- ▶ **Knowledge-based decisions are superior as they minimize usability problem.**

A brief overview of human characteristics and capabilities

▶ Physical capabilities

1. **Anthropometric characteristics** which involve measurements of human body dimensions.
 - The measurement made when a human subject is stationary (not moving)
 - The measurement generally are taken when a subject is standing erect or sitting in an anthropometric measurement chair.
 - The human body dimension measured when a subject is in a work posture (e.g., sitting in a car seat and performing a task).
2. **Biomechanical characteristics**: e.g., ability to product forces/strength and body movements.

A brief overview of human characteristics and capabilities

▶ Information – processing capabilities

3. **Mental (cognitive) capabilities**

- Involving the acquisition of information through various sensors (eye, ear, joint, vestibular tissues etc.)
- Transmitting this sensed information to the brain, recalling information stored in the memory, processing the information to make decisions (detecting, recognizing, comparing, selecting, etc.), and making responses (e.g. generating a body movement, activating a control, or making a verbal response).