GE105
Introduction to Engineering Design
College of Engineering
King Saud University

Lecture 6.

Human Factors in Engineering Design

FALL 2016

What is Human Factors in Design?

- Considering information about human behavior, abilities, characteristics and physical limits
- Ensuring that the final product can be effectively utilized by the end user, without exceeding their capabilities
- 'Fitting the Job to the Man' rather than 'Fitting the Man to the Job'
- Optimizing Efficiency, Health, Safety and Comfort of people through better designs

Human factors Must be considered during the design phase:

"You can use an eraser on the drafting table or a sledge-hammer on the construction site."

Frank Lloyd Wright (Architect)

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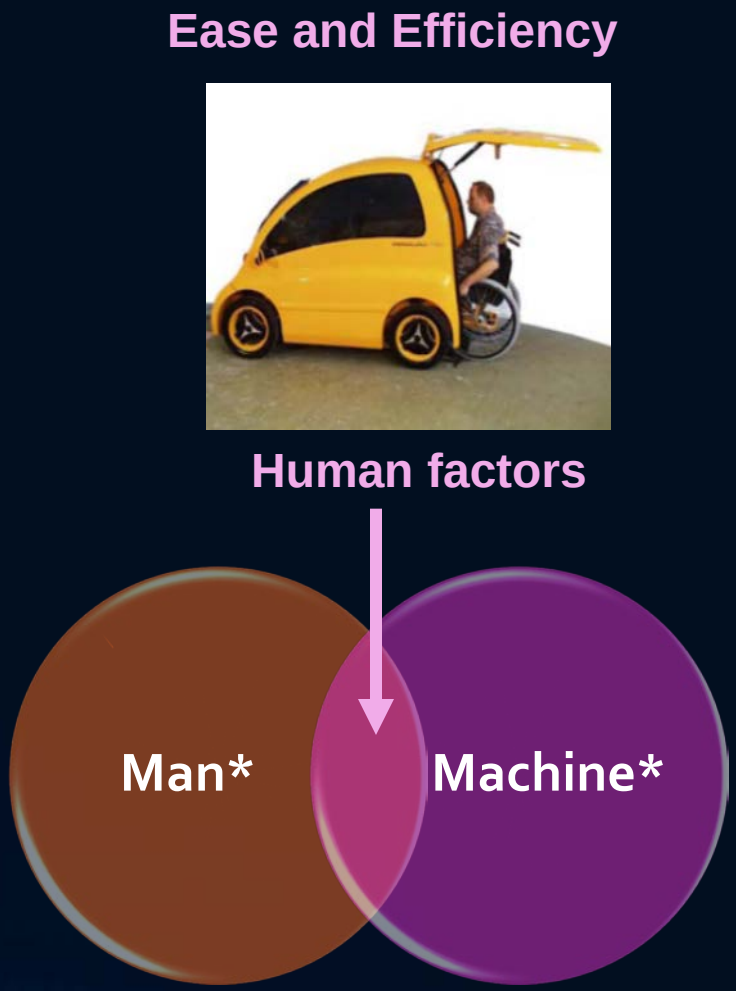
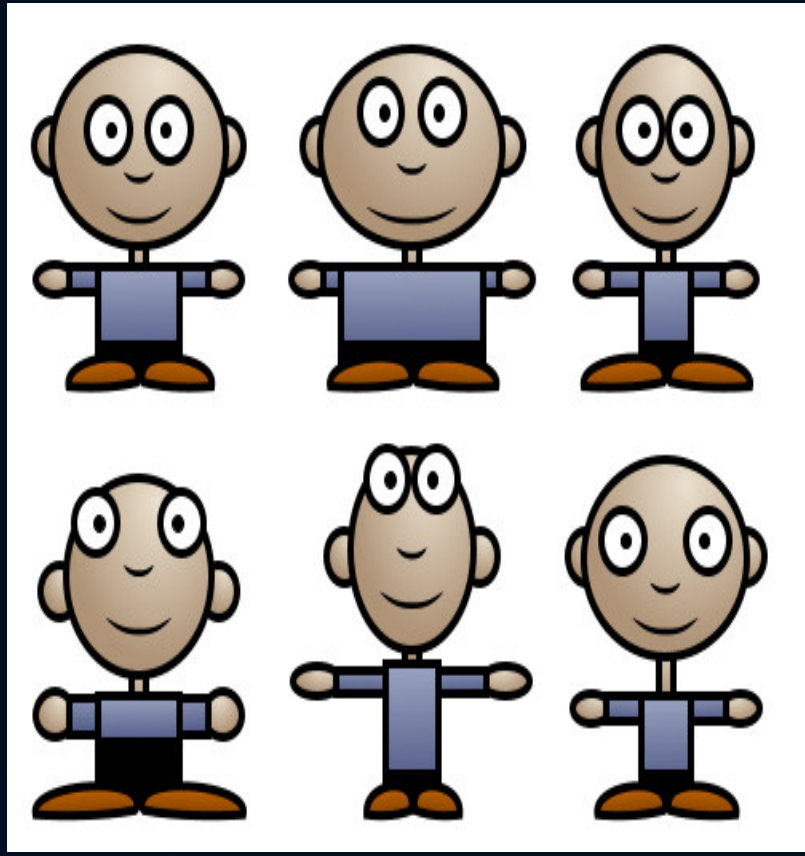
Importance of Human Factors in Design

- Improve productivity
- Improve safety
- Improve comfort
- Improve satisfaction
- Decrease errors
- Reduce fatigue
- Reduce the learning curve
- Meet user's needs and wants
- Positive perception of product



Difficulties of Human Factors

- Humans are flexible and adaptable
- Large individual differences
  - Obvious differences: Physical size and strength
  - Non-obvious differences: culture*, style, and skill



Forms of Human Factors

1. Anthropometric

   (Human interaction in static sense; dimensions of body)

2. Ergonomics

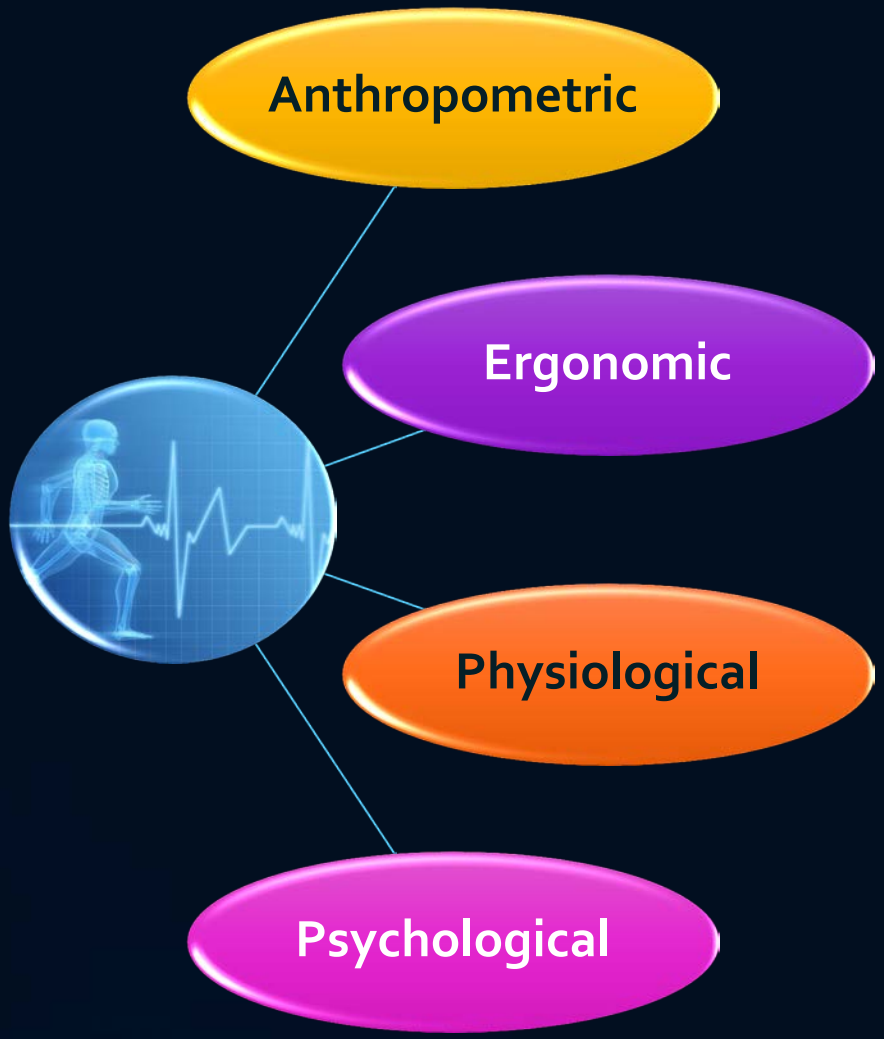
   (Human interaction in dynamic sense; repeated tasks)

3. Physiological

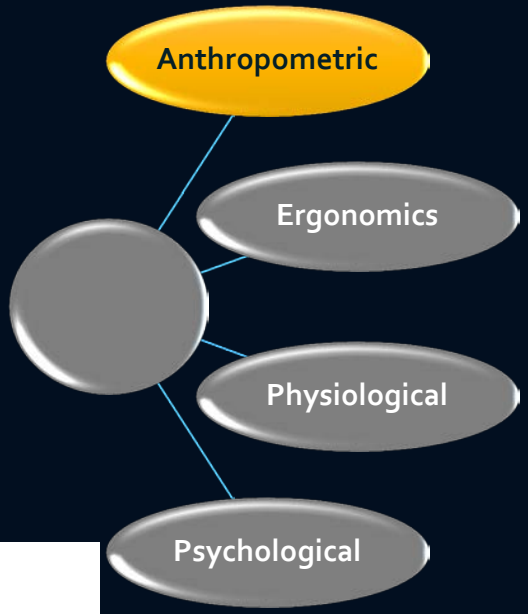
   (Human interaction with body characteristics)

4. Psychological

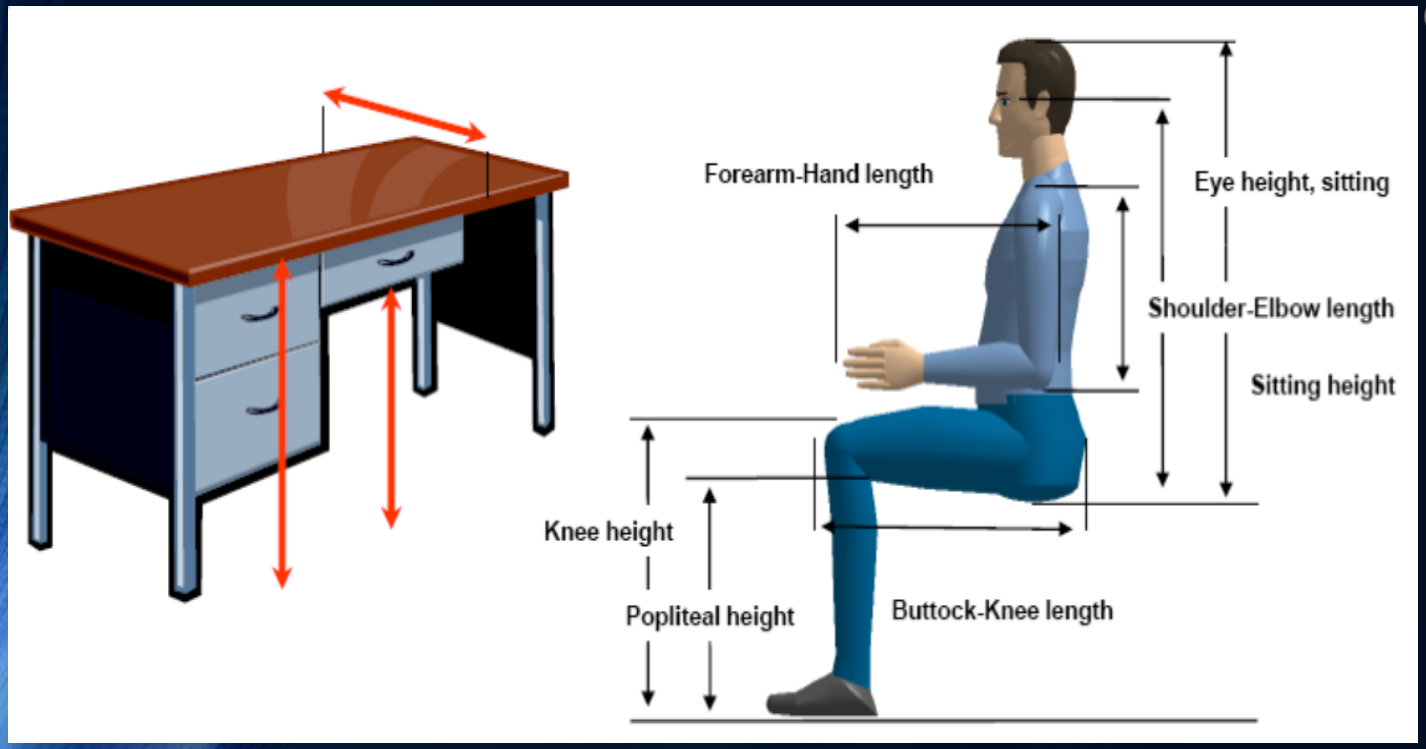
   (Human interaction with mental activities)



1. Anthropometric Factors

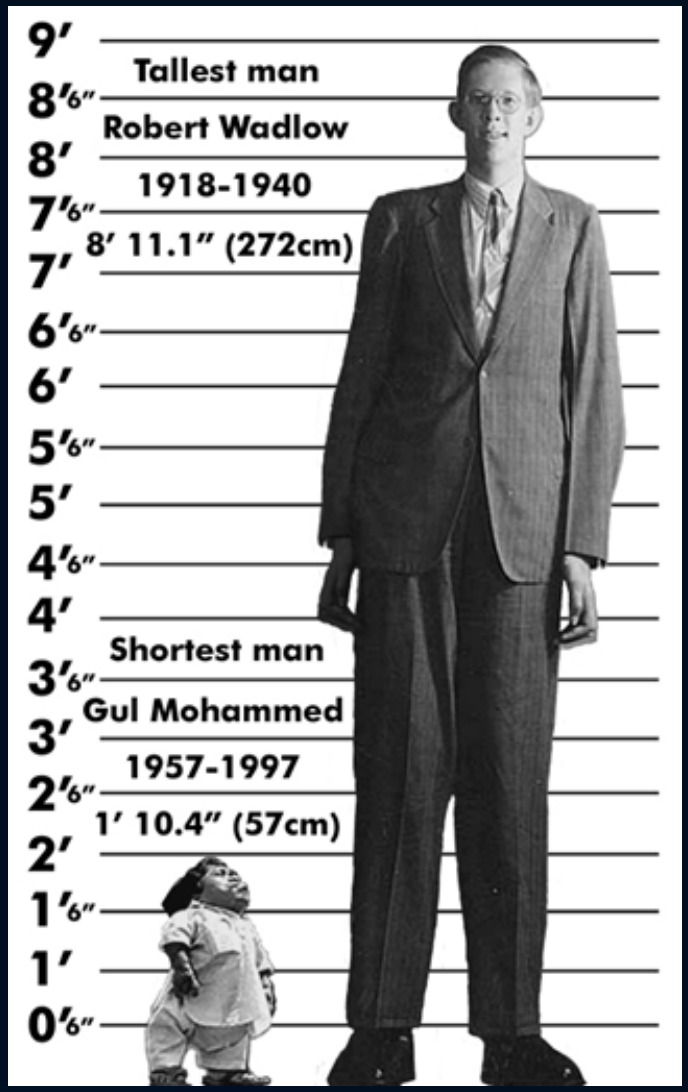


Anthropometric human factors are related to the physical size of humans; it is man-machine interaction in static sense



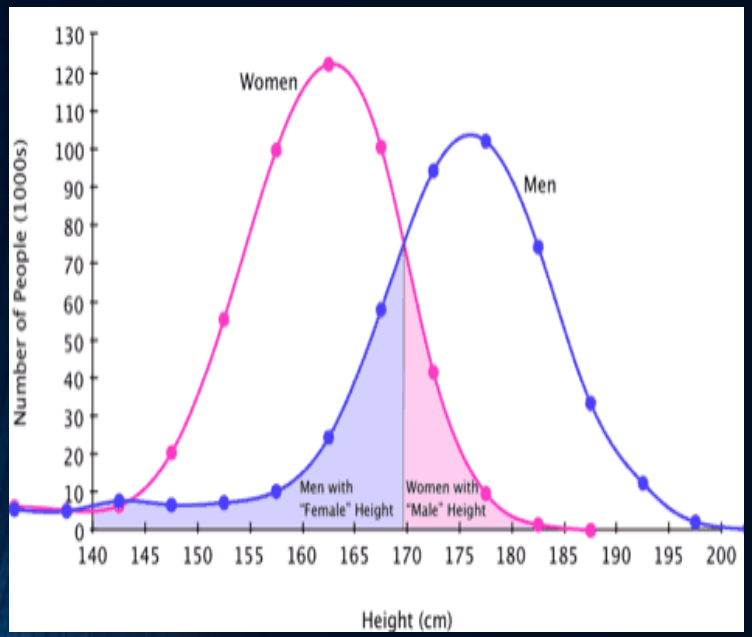
1. Anthropometric Factors

Adequate attention to the nature of the **physical dimensions of humans**

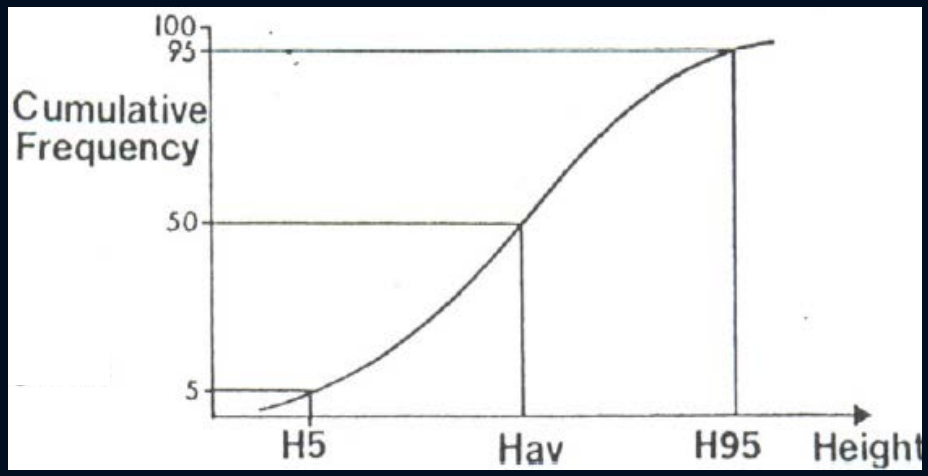


1. Anthropometric Factors

Statistical distribution (relative frequency) diagram for the height of people



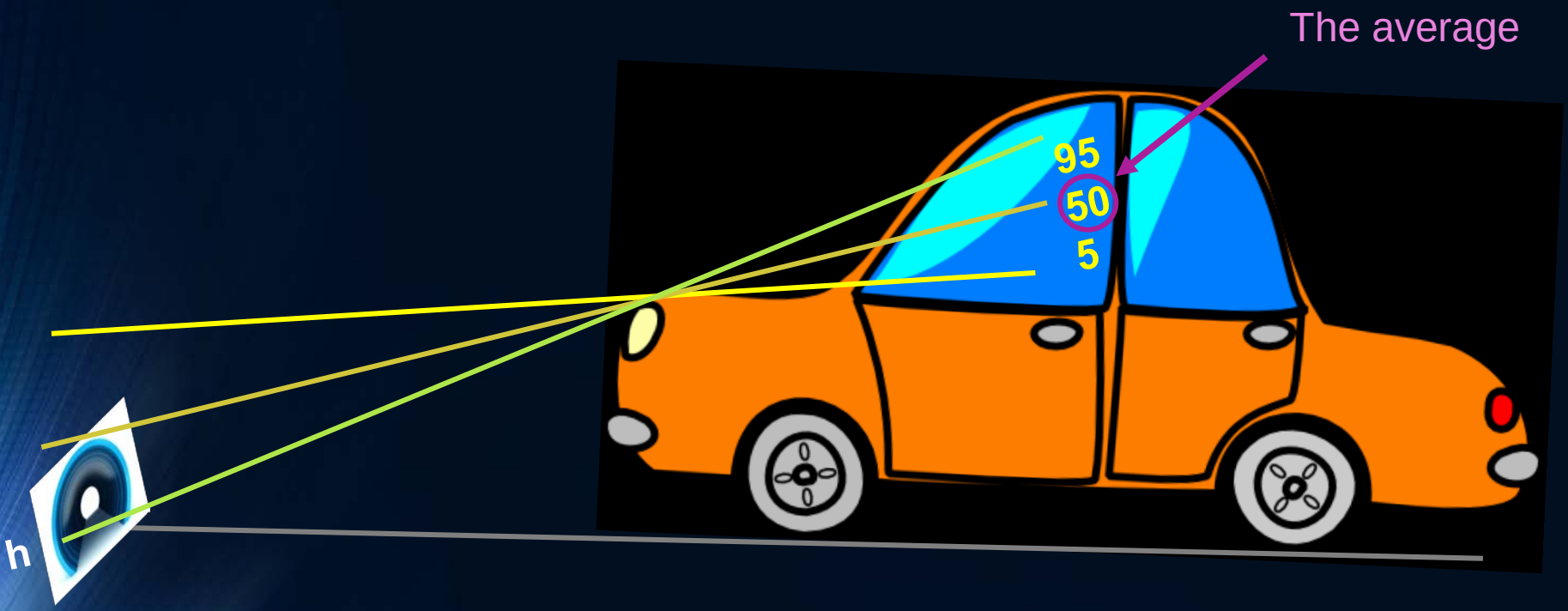
Cumulative distribution diagram is an alternative method to present the same information



- The peak in the relative frequency diagram is often close to the **average value**
- By designing for the average person we often **exclude 50% of the population**

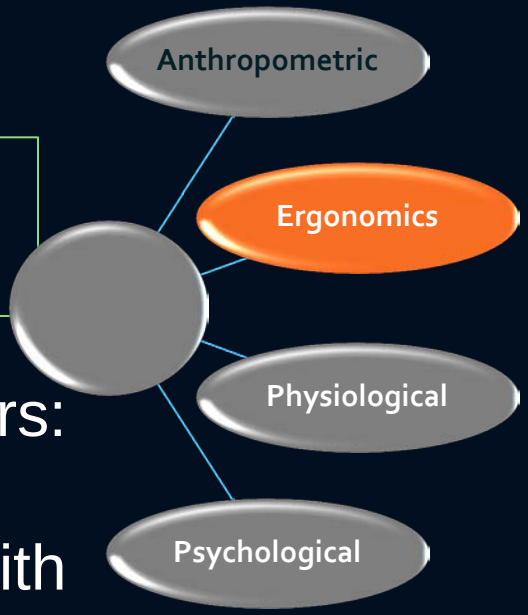
1. Anthropometric Factors example

Being able to <u>see</u> an obstacle of <u>height *h*</u> at a <u>minimum distance *L*</u> from the front of the car*

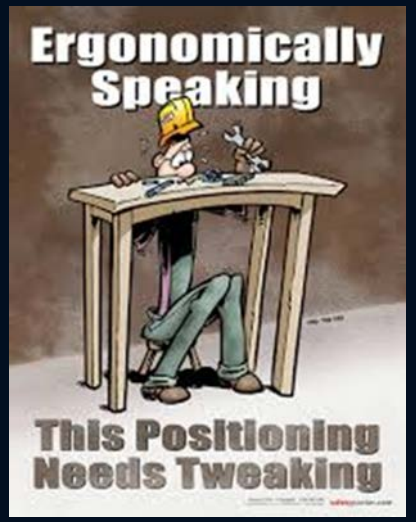


2. Ergonomic Factors

Greek Words: Ergon = work, Nomikos = law
Ergonomics= Study of Work Laws

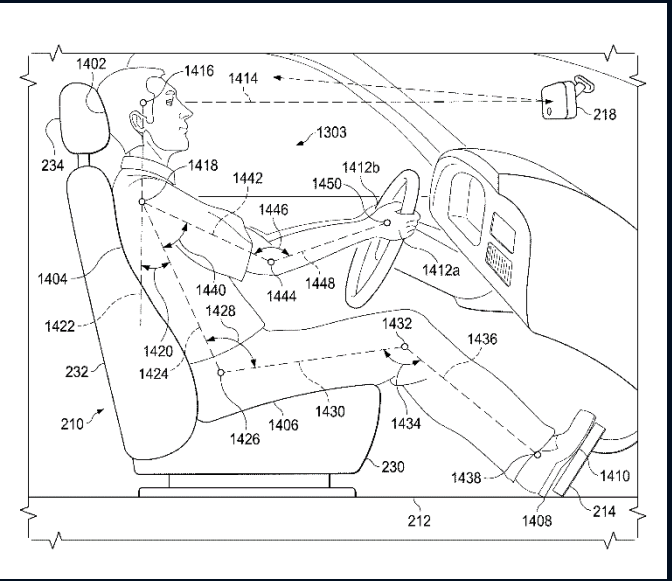


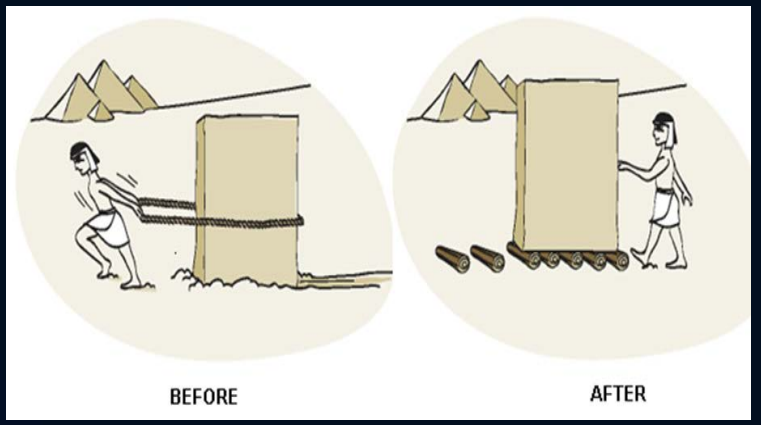
- The three aspects of ergonomic factors: **Safety, comfort and efficiency**
- Importance when the human is involved with the machine in a dynamic sense
- A human is required to exert a force or perhaps supply work to the machine
- The effective operation of a machine over long periods of time will depend upon the matching of requirements to human capability



The capability for performing many tasks depends on:

- The physical ability of the operator
- The range of movement required
- The speed of movement
- The duration of the activity
- The position of the operator
- The environmental condition





Ergonomic Factors (Aircraft Instrument Panel Example)

- **First, determine functions inter-relationships and their relative values**
- **A useful measure of the relative value of a relationship is the product of the importance of the particular event by the frequency of occurrence**

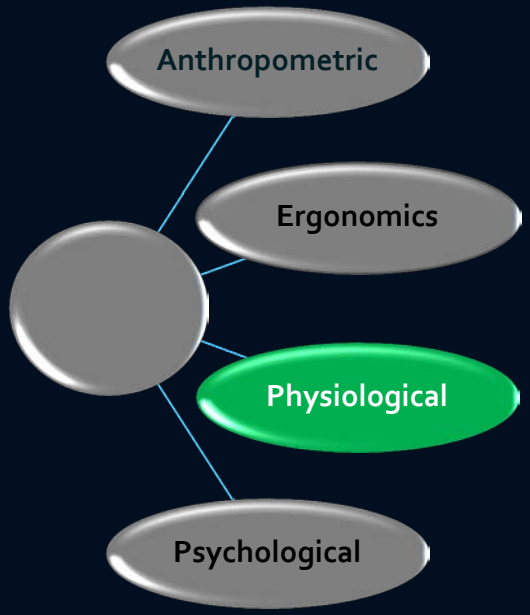
If these can be established the designer has a logic available to assist in planning the display

Aircraft Instrument Panel (Importance and Frequency)

Instrument	Duration of observation (sec)	No. of observations per min.	Relative value
Cross pointer	0	0	0
Air speed	0.67	22	14.7**
Directional Gyro	0.51	24	12.2*
Gyro. Horizon	0.59	26	15.3***
Engine Instrmnts	1. 13	5	5.6
Altimeter	0.47	10	4.7
Turn and Bank	0.39	5	2.0
Vertical Speed	0.17	12	5.6

Air speed, Directional Gyro, and Gyro. Horizon are the most important and must be very visible and close to each other

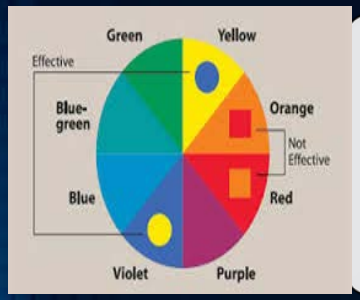
3. Physiological Factors



- Factors dealing with human sensations
- **These involve the neurological, muscular, respiratory, vascular and sensory systems**

- **They can be grouped according to the response to various inputs such as:**
  - **Visual**
  - **Auditory**
  - **Tactile (**the sense of touch)
  - **Kinesthetic** (detecting body position)
  - **Taste senses**
  - **Environment**

Physiological Factors (examples)



- Color
- Light

- Noise
- Speech

Vision

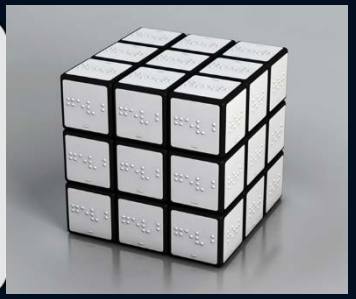
Hearing

Weather

Touch

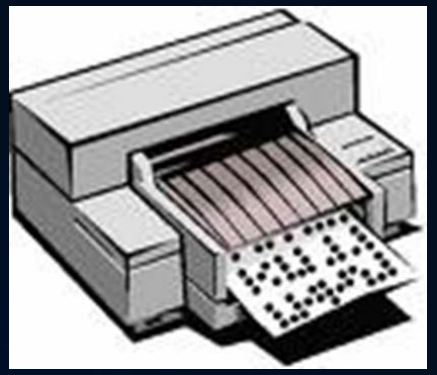
- Temp.
- Humidity

- Braille
- Comfort

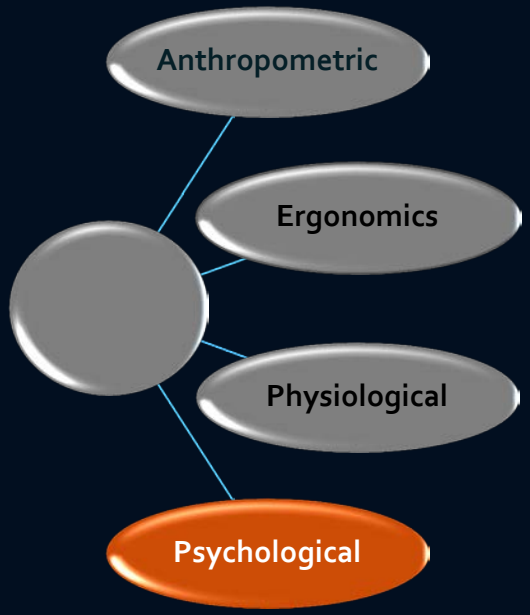


Physiological Factors

- It is necessary to achieve satisfactory intensity and color discrimination and resolution
- Need careful design of lighting systems and selection of materials and colors
- Consider the frequency analysis of the sounds
- Control the noise at its source
- The sense of touch is of great value in various recognition situations (e.g., Braille printing)
- The atmospheric environment in which the human performs his tasks may considerably affect his working efficiency and accuracy



4. Psychological Factors



They are concerned with the mental activity of the human during the use of the product.

This involves:

- Interpretation of information
- Motivation and fatigue
- Decision making
- Aesthetics (philosophy of art)

Psychological Factors

- Use presentations which will lead to minimum error of interpretation*
- Retain the usual method of operation (e.g., a power switch is ON when the operating lever is DOWN
- Use digital indicators for precise numerical values
- Use color coding on dials for fast recognition: green-normal, yellow-caution, red-danger
- Arrange control movement in a logical manner