

MP482

PRODUCT DEVELOPMENT AND  
DESIGN

# MODULE V

- Ergonomics in product design. Aesthetics in product design. Concepts of size and texture, colour .Psychological and Physiological considerations.
- Creativity Techniques: Creative thinking, conceptualization, brain storming, primary design, drawing, simulation, detail design.

# Aesthetic Consideration in Design

Aesthetics derived from greek word  
“aesthetikos” means sensory perception

A set of principles concerned with the  
nature and appreciation of beauty.

The branch of philosophy which deals  
with questions of beauty and artistic  
taste.

# Importance of Aesthetics

- However there are number of products in the market, having same qualities of efficiency, durability and cost.
- Hence the customers is attracted towards the most appealing product.

- **The word Aesthetics is defined as a set of principles of beauty.**
- It deals with the appearance of the product.
- The growing realization of the need of aesthetic consideration in the product design given rise to a separate discipline known as industrial design.
- The industrial designer is to create new forms and shapes which are aesthetically pleasing.
- Ex- chromium plating of an automobile component improve the corrosion resistance along with appearance.

# Guidelines in Aesthetic Design

- The appearance should contribute to the performance of the product e.g. the aerodynamic shape of a automobile will decrease air resistance results in improve fuel economy by decreasing fuel consumption.
- The appearance should reflect the function of the product e.g. the aerodynamic shape of car indicate the speed.

- The appearance should reflect the quality of the product.
- The appearance should not be at too much of extra cost unless it is the prime requirement.
- The appearance should be suitable to the environment in which the product is used.
- The appearance should be achieved by the effective and economical use of the material.

# Aspects of Aesthetic Design

- The various aspects of the aesthetic design are
  1. Shape (form) and Size
  2. Colour
  3. Variety
  4. Continuity
  5. Style
  6. Contrast
  7. Symmetry and balance
  8. Material and surface finish
  9. Texture
  10. Harmony



# 1A). Shape (form)

- There are basic five shapes of the product namely step, taper, shear, streamline and sculpture.
- The external shape of any product can be given is based on the one or combination of basic shapes.
  - a) **Step form** – The step form is a stepped structure having vertical accent. It is similar to the shape of a multistory building.
  - b) **Taper form** – The taper form consists of a tapered blocks or tapered cylinders.

- c) **Shear form** – The shear form has a square outlook(sharp).
- d) **Streamline form** – The streamline form has a streamlined shape having a smooth flow as seen in automobile and aero-plane structure.
- e) **Sculpture form** – The sculpture form consists of ellipsoids, paraboloids and hyperboloids.

# 1 B). Size

- Due to miniaturization of the advance technology developed in electronics and other field the designer can now use previously unacceptable housing got integrated items.
- So freeing them from many of design constraints, new design of telephone is an example of integrating the entire telephone in a single component provide good balance, proportions and ergonomic styling.
- This freedom of design now manifest in the choice.

## 2. Colour

- Colour is one of the major important factor to the aesthetic appeal of the product.
- Such as creating interest, eliminating eye fatigue, assisting memory, directing attention.
- The choice of colour should be compatible with the conventional ideas of the operator.
- **Morgon** has suggested the meaning of the colour as shown in the table.

COLOUR	MEANING
Red	Danger – Hazard - Hot
Orange	Possible Danger
Yellow	Caution
Green	Safety
Blue	Caution - cold
Gray	Dull

### 3. Variety -

- Variety is particularly important in marketing range of products like refrigerator, fans, stereo system, vehicles, etc.

### 4. Continuity –

- A product which has good continuity of element is aesthetically appealing.
- Continuity is thus associated with the order or tidiness of the product.
- **For example – a fillet radius at the change of cross section adds the continuity to the product and hence improve the appearance.**

## 5. Style –

- Style is visual quality of the product which set it apart from the rest of the functionally identical products.
- Good style, with skillful work increase the product attraction.
- The product designed with aesthetic not only look nice but should also create an impression that it work more efficiently.
- Bold style provides a feel of strength and ruggedness
- Flowy style provides a feel of softness and compactness
- Jagged style suggests aggression
- The product should gives the impression of the satisfactory performance or purpose.

## 6. Contrast

- Contrast is distinction between adjustment elements of the product which have clearly different characteristics and functions.
- The contrast improve the appearance of the product.
- The choice of the colours can be particularly important.



# 7. Symmetry and balance

- Symmetry suggest a state of order but asymmetry can create a greater sense of interest.
- Both have been used successfully in architecture.
- Symmetrical arrangement of identical component on a board contributes to an impression of order and tidiness.
- The computer system is an example of functional requirements to led the use of asymmetrical arrangement.
- This increase visual attraction.

## 8. Material and surface finish

- The material and surface finish of the product contribute significantly to the appearance.
- The production of smooth and harder surface is necessary for greater strength and bearing load is depend upon the property of material e.g. the material like stainless steel gives better appearance than the cast iron, plain carbon steel or low alloy steel.
- It was found that the bearing properties, wear qualities and fatigue life of any machine component have a directly related to surface texture.

- Hence to increase the life of any machine component subjected to various types of load the working and non working surfaces must be very good finish.
- The component or the product with better surface finish are always aesthetically pleasing.
- The surface coating processes like spray painting, electroplating, anodizing etc. greatly enhance the aesthetic appeals of the product.

# 9. Texture

- Refers to surface quality
  - Smooth
  - Metallic
  - Sandy
  - Leathery
  - Rubbery
  - Feathery
  - Spongy

# 10. Harmony

- Rhythm or Harmony
- It is the presentation of a design in accordance with the context or background,

# Ergonomics in Design

- ***Ergonomics*** is defined as the relationship between man and machine and the application of anatomical, physiological and psychological principles to solve the problem arising from this relationship.
- The word ergonomics is coined from the two Greek words ‘**ergon**’ which means ‘**work**’ and ‘**nomos**’ which means ‘**natural laws**’.
- Ergonomics means the natural law of work.
- **Ergonomics is scientific study of man and machine(which he works ) ) and environment (in (which he works)**

# Ergonomics in Design

- The main objective of the ergonomics is to make machine fit for the user rather than to make the user adapt himself to the machine.
- It aims to increase the comfort and productivity also decreases the physical and mental stresses of the users.

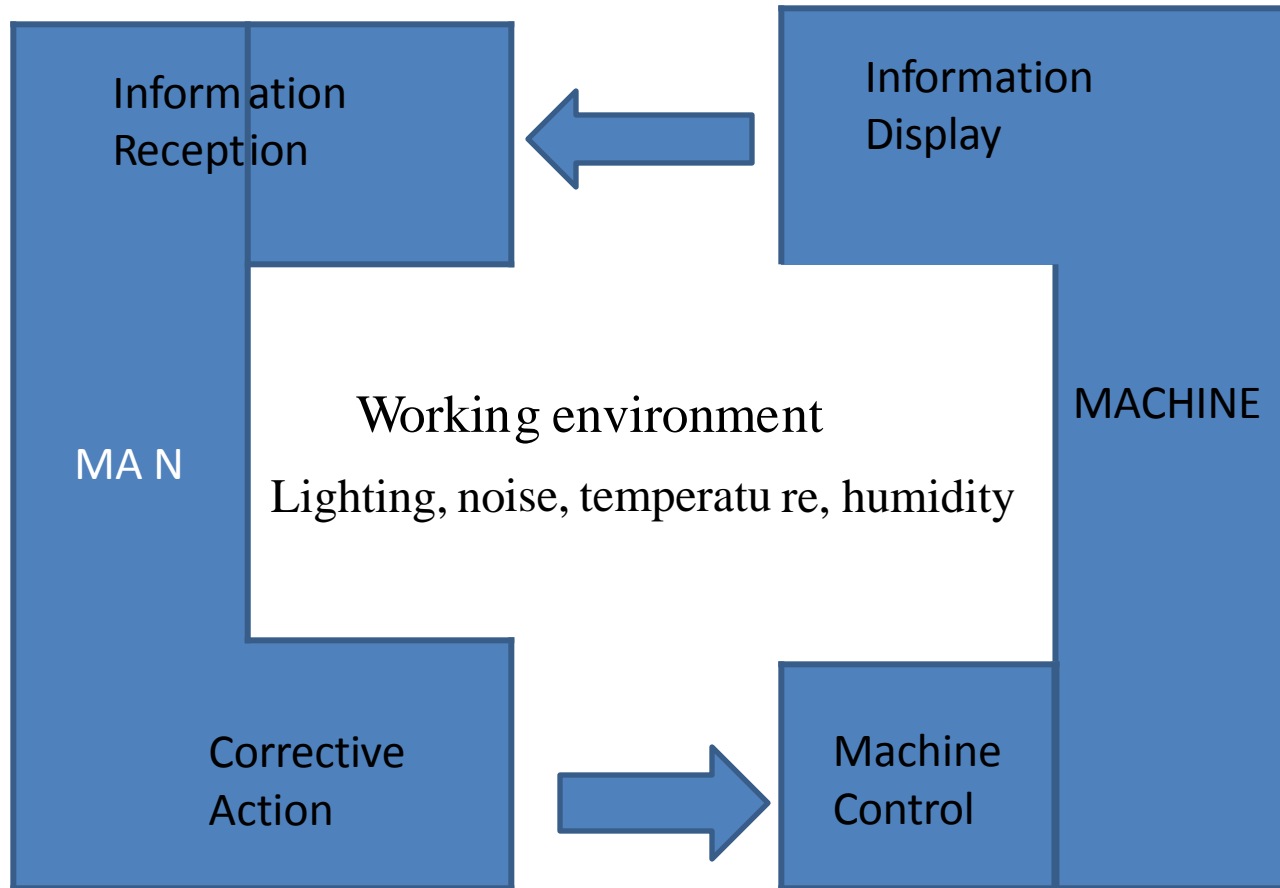
# Factors considered in ergonomic design/ Areas of Ergonomics

- The relation between man and machine.
  - Anthropometry: The anthropometric data (dimensions of human body)
  - Physiological Considerations
  - Psychological Considerations
- 
- Anatomy(One part is anthropometry) basically deals with the human beings
  - Physiology is about the strength, speed, the body dimensions
  - Psychology is about, that how the information is processed by the operators or worker during the operation and what kind of action he takes, while he is in work.



# Man-Machine Relationship

- Any machine can not be continue working for a longer period of time without the aid of man.
- The work can be perform by a man machine system.
- Hence a man-machine system may be defined as a combination of activities between man and machine to get the desire output from the given input.



- From display instruments, the operator can get the information about the operation of machine.
- If he feels that the correction is necessary then he take the corrective action to operate the control or lever.
- This corrective action of man alter the performance of the machine.
- Which will be indicated on display panel.
- The contact of man machine system in a closed loop system arise at two places – information display instrument which gives information to the man and control which will operate by man to adjust the machine.

# Design of Equipment for Control

- Which may include a graduated dial or a display or signal to indicate the response of the machine to the instructor.
- The type and size of the control devices selected depends upon the following number of factors, the principle ones are –
  1. The required speed of operation.
  2. The required accuracy of the control.
  3. The required operating force.
  4. The direction of movement for on/off or increase/decrease.
  5. The required range.

# Types of Controls

1. Hand wheel –
2. Small Crank –
3. Round knob –
4. Joysticks –
5. Push buttons –

## Ergonomic consideration in design of control

- The control should be easily accessible and logically positioned.
- The control operation should involve minimum motion and avoid awkward movements.
- The shape of the control component which come in contact with the hands should be in conformity with the anatomy of human hands.
- Proper colour produces beneficial psychological effect.
- The control should be painted in red colour with the gray background of machine tool to call for attention.

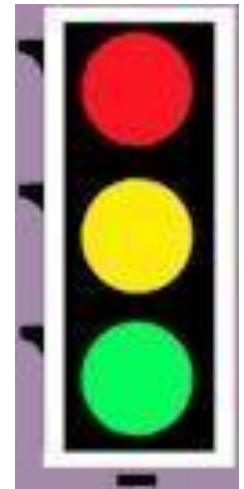
# Design of Display Control

- The displays are the devices through which the man receives the information from the machine.
- The display in one which allows the proper combination of speed, accuracy and sensitivity of display.

# Types of Displays

## 1. Qualitative displays –

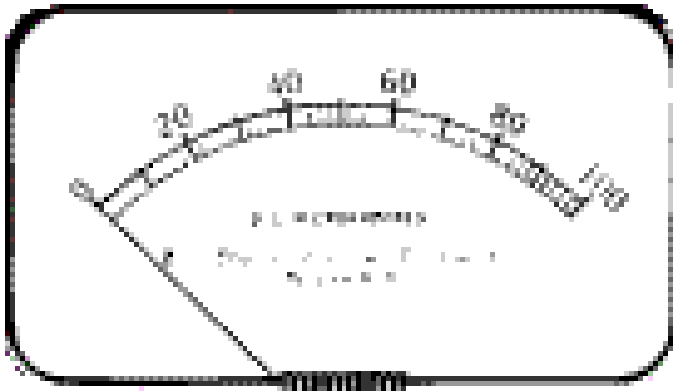
- The display or signal is used to indicate only the condition or state without giving the value are known as qualitative display.
- E.g. on/off response to open or closed the valve, power on/off traffic signals.





## 2. Quantitative display –

- This type of display gives the quantitative measurement or numerical information are known as quantitative display.
- E.g. Fuel indicator in motorcycle, voltmeter, ammeter, speedometer, watches, etc.



# Ergonomic consideration in design of display

1. The scale on the dial indicator should be divided in suitable linear progression.
2. The number of subdivisions should be minimum.
3. The vertical figures should be used for stationary dials and radically oriented figures should be used for rotating dials.
4. The pointer should have knife edge with a mirror to minimize parallax error.
5. Differentiation in display group should be made with the help of colour, shape and size.

6. The numbering should be increase in clockwise direction on a circular scale, upwards on vertical scale and rightward on a horizontal scale.
7. Important displays like warning, can be made more effective by the use of flashing lights.
8. The height of the letter or numbers should be

$$Height \geq \frac{Reading\ distance}{200}$$

# Anthropometry

- It is the science that measures the range of body sizes in a population.
- It is very important for a designer to remember that people come in many sizes and shapes while designing a product.
- Anthropometric data vary considerably between human races.
- Age and occupation of the user is also relevant in anthropometric study.

# Anthropometry

- Anthropometry is a combination of the two words, which involves anthro and pometry, in, these are the two Greek words, “anthro” means the man and “pometry” stands for the measurements.
- The literal meaning of this anthropometry is about measurement of the humans, which involves the measurement of the body dimensions of the human being, with respect to the different reference points.

# Anthropometry

- These anthropometric data, which has been generated can be effectively used to determine the boundary areas of the workplace and the height and the shape of the seats and work tables.
- The designing and locating the handles and the lever, so that they can be easily operated by the operator, during the use.

# Anthropometric Parameters

- Weight
- Stature
- Posture
  - Standing
  - Sitting
- Arm Span
- Head Length

# Steps in Design of Mechanical System using anthropometric data

- What are the important /relevant body dimensions?
- Define the relevant population who is likely to use
- This helps to establish the dimensional range that needs to be considered in design
- Design for extremes
- Design for adjustable range
- Design for average



# Physiological Consideration in Ergonomic Design

- The area of the study is mainly concerned with the determination of
  - Speed and accuracy with which body movements can be carried out.
    - The different body dimensions have the different accuracy speed and the capacity to apply force
  - Human stamina
    - Human being can deliver energy for carrying out the operation at particular rate.
    - If the excessive energy is required for carrying out the job, then he needs break.
  - Influence of working conditions on human performance

# Physiological Consideration: Speed, Accuracy and Force

- Information regarding the speed, accuracy and the force of movement of each body member helps in designing of the machines and the jobs in such a way that
  - heavy work is done by the big muscles and
  - the light work is done by the small ones.

# Physiological Consideration: Human Stamina

- Knowledge of human stamina helps in organization of the human work ie work and rest schedules.
- In general, an average energy expenditure for a human being is, at the rate of 4 kilo calorie per minute(280Watts). is maximum, that a man is capable to deliver for long period without need of rest.
- So, for the work that demands more energy, than the 4 kilo calorie per minute, worker will have to use his energy reserves and eventually he needs rest, so that, his muscles can recover

# Physiological Consideration: Influence of the working conditions

- If the working conditions are not proper, they lead to the very poor performance by the operator and which in turn will reduce output from the worker
- A poor ventilation, illumination, high temperature, noise level in the industry are frequently encountered and these lead to, the loss of efficiency and increased rate of accidents

# Physiological Consideration: Influence of the working conditions

- The working environment affect the man-machine relationship.
- The environment affect the efficiency and the health of the operator.
- The most important factors which affect the efficiency of human are
  - Lighting
  - Noise
  - Temperature
  - Relative Humidity
  - Ventilation, air quality and thermal comfort
  - Vibration

## 1. Lighting –

- Working in dim or overbright work environments can result in eyestrain, headaches, irritability and, inevitably, reduced productivity.
- Light sources, including the sun, can create unwanted reflections, glare and shadows in the workplace that can cause discomfort and distraction
- Low levels of lighting can cause depression, which for some people may be severe.

## 2. Noise –

- Excessive exposure to loud noise can irreversibly damage the ear, resulting in noise-induced hearing loss.
- ‘Nuisance’ noise can be annoying and distracting and result in reduced job performance and satisfaction.
- Noise may also be unsafe if it impairs communication in the work environment, such as by overpowering auditory alarms.

### 3. Temperature –

- For an operator to perform the task efficiently, he should neither feel hot or cold.
- When the heavy work is done, the temperature should be relatively lower and when the light work is done, the temperature should be relatively higher.



#### 4. Humidity and Air Circulation–

- Humidity has little effect on the efficiency of the operator at ordinary temperatures.
- However, at high temperatures, it affects significantly the efficiency of the operator.

## 5.Vibration

- Whole body vibration can affect comfort and performance even at low levels and can cause damage to the spine, stomach pain and gastrointestinal complaints.
- Hand-arm vibration, such as from hand tools, can have negative effects on muscles and the skeleton, and can contribute to carpal tunnel syndrome, low-back pain and vibration white finger, for example.

# Psychological Considerations in Design

- The psychology, in ergonomics is mainly concerned with the human behavior and his ability to work under the working conditions.
- That is, mainly related with the mentally strain and the fatigue.
- In ergonomics, psychology is mostly concerned with the processing of the information and the which, basically involves the sequence of the signal.
- Signal-Reception —channel- decision -action

# Psychological Considerations in Design

- For efficient performance of the task, it is necessary that, the operator receives the information correctly, process the information properly, makes the correct interpretation and based on that it takes suitable decision and then corrective action, or the action which is required for success of the process.
- The efficient performance of the task therefore, to a great extent depends on, how the received has been interpreted, for taking suitable decision.

# Man Machine System

- Combination of Man and machine, interacting with each other to get desired outputs from given inputs.
- Based on man involvement
  - Closed loop system
  - Open Loop system
- Based on mode of operation
  - Manual System
  - Mechanical System
  - Automatic system

# Creativity

- Creativity is defined as the skill of being able to produce something – new – be it a product, an idea, a concept, a process or a solution to a specific problem – having some value.
- Creativity is characterized by the ability to perceive the world in new ways, to find hidden patterns, to make connections between seemingly unrelated phenomenon.

# Creativity Techniques

- Brainstorming
- Mind Mapping
- Six thinking hats
- Morphological analysis

# What is brainstorming?

- Brainstorming is a means of generating ideas.
- Brainstorming can be used to identify alternatives, obtain a complete list of items and to solve problems.
- Brainstorming is "a conference technique by which a group attempts to find a solution for a specific problem by amassing all the ideas spontaneously by its members
- To brainstorm is to use a set of specific rules and techniques which encourage and spark off new ideas which would never have happened under normal circumstances
- Brainstorming is a group activity based on the principle of suspending judgment that is idea generation and evaluation phases are separate.



# Rules of Brain storming

- Criticism is not allowed-Judging ideas negatively should be avoided
  - Evaluation is done only later.
  - Participants are not expected to explain or defend ideas at this stage.
- Wild ideas are allowed and encouraged
  - Complete freedom to speak ones mind without being judged
- Generation of large number of ideas-quantity is the focus
  - Both flexibility(range of different classes of ideas) and fluency (greater number of ideas within each class)
- Participants are free to build on other ideas
  - They can take others idea and add on to it

# Brainstorming steps

- Brainstorming group consists of 10-12 people including a leader, a person in charge of noting down the proceedings and regular or guest members.
- Person who poses the problem is also usually present.
- Arrangements or process of brainstorming are
  - Set the environment
  - Setting the scene
  - Rules for the session
  - Running the brainstorming session
  - Affinity analysis
  - Summary and further action

# Brainstorming steps

- **Set the environment**
  - Location: preferable to be held away from normal place of work
  - Room: natural light, plenty of space
  - Materials: whiteboard and pens. Provide a pack of post-it notes and pen for each attendee
- **Setting the scene**
  - Explain the brainstorming technique.
  - Specify the rules.
  - Loosening up: use a free thinking exercise and/or a practice brainstorming session\*.

# Brainstorming steps

- Rules for the session
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# Brainstorming steps

- Running the session

- Questioner states the problem with necessary explanations and clarifications
- Problem is redefined with inputs from the team
- Questioner chooses the redefinitions that seem most relevant to him
- Ideas are generated keeping these redefinitions in view.
  - Allocate 3-5 minutes to write on the post-it notes as many ideas as possible – one idea per note
  - Each person quickly writes their thoughts onto the post-it notes regardless of how impractical, outrageous, extreme, crazy they may be

# Brainstorming steps

- **Affinity Analysis**
  - Each person in turn sticks their post-it notes on the whiteboard, putting their note near to an idea that is similar to theirs. This should result in clusters of post-it notes representing similar ideas.
  - Review the ideas by cluster. For each type of idea ask the group “How could we make this work?”

# Brainstorming steps

- **Summary and further action**
  - Write up a summary of each type of idea/solution presented.
  - Determine an action plan for working through the ideas.
  - The action plan may be to test or further research the alternatives identified to select a shortlist of the most suitable solutions for further evaluation.

# Six Thinking Hats

- *Six Thinking Hats* is a system designed by Edward de Bono which describes a tool for group discussion and individual thinking involving six colored hats.
- "Six Thinking Hats" and the associated idea parallel thinking provide a mean for groups to plan thinking processes in a detailed and cohesive way, and in doing so to think together more effectively



# Six Thinking Hats

- Six distinct directions are identified and assigned a color. The six directions are:
- Managing **Blue** – what is the subject? what are we thinking about? what is the goal? Can look at the big picture.
- Information **White** – considering purely what information is available, what are the facts?
- Emotions **Red** – intuitive or instinctive gut reactions or statements of emotional feeling (but not any justification).
- Discernment **Black** – logic applied to identifying reasons to be cautious and conservative. Practical, realistic.
- Optimistic response **Yellow** – logic applied to identifying benefits, seeking harmony. Sees the brighter, sunny side of situations.
- Creativity **Green** – statements of provocation and investigation, seeing where a thought goes. Thinks creatively, outside the box.

# Creativity vs Innovation

- Creativity is the process of developing new or interesting ideas
- Innovation is the process of transforming creative ideas into valuable or profitable solutions.

# Creative Thinking vs Critical Thinking

Creative thinking is a way of looking at problems or situations from a fresh perspective to conceive of something new or original.

Critical thinking is the logical, sequential disciplined process of rationalizing, analyzing, evaluating, and interpreting information to make informed judgments and/or decisions.

# Creative Thinking vs Critical Thinking

Critical Thinking	Creative Thinking
Analytical	Generative
Convergent	Divergent
Left brain	Right brain
Logical	Intuitive
Sequential	Imaginative
Objective	Subjective
Reasoning	Speculating
Reality Based	Fantasy Based
Vertical	Lateral
Probability	Possibility
Judgmental	Non-judgmental
Verbal	Visual
Hypothesis testing	Hypothesis forming
Closed-ended	Open-ended
Pattern Users	Pattern Seekers