EST 200 : DESIGN AND ENGINEERING MODULE 4

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SYLLABUS

- Design Engineering Concepts:-Project-based Learning and Problem-based Learning in Design. Modular Design and Life Cycle Design Approaches. Application of Biomimicry, Aesthetics and Ergonomics in Design. Value Engineering, Concurrent Engineering, and Reverse Engineering in Design.

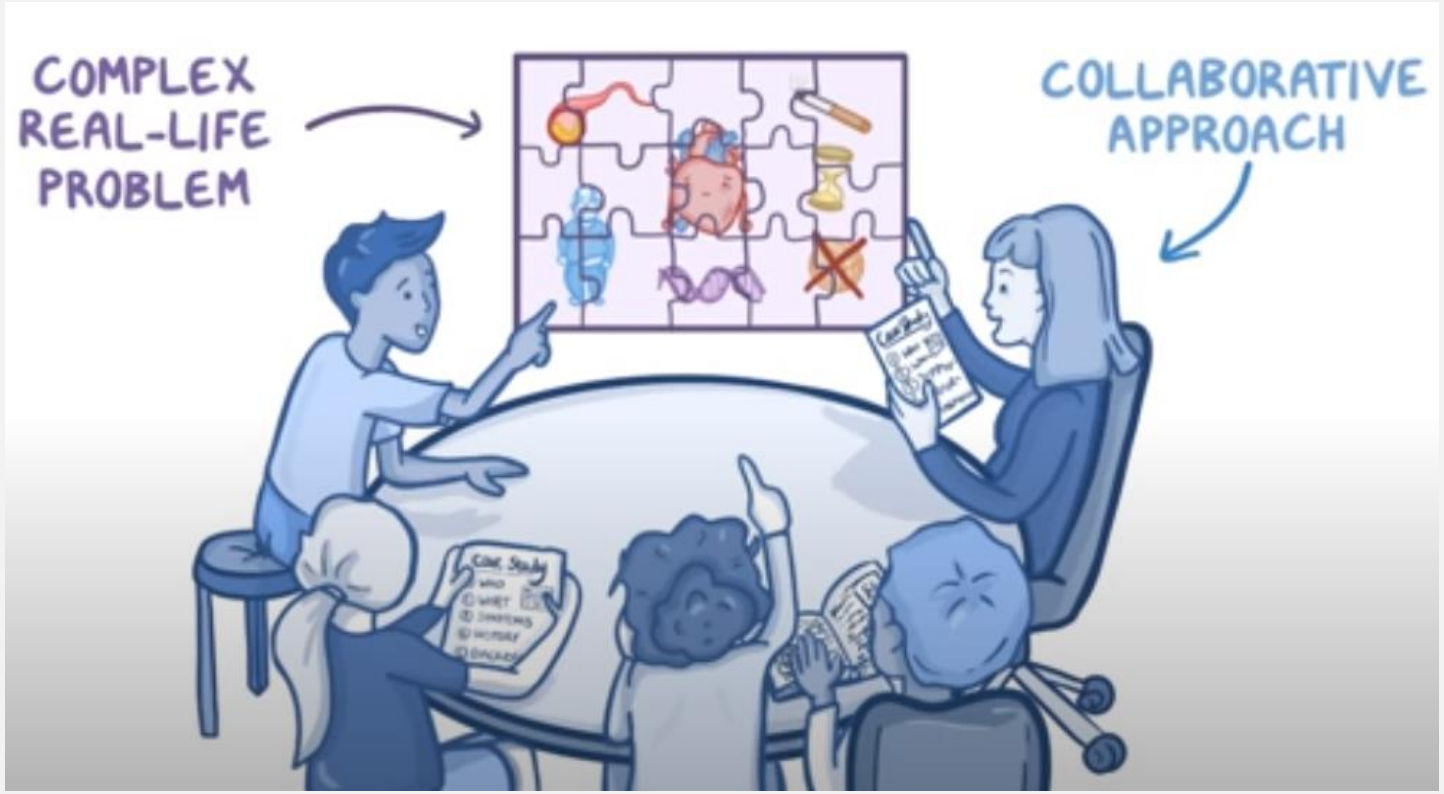
PROBLEM-BASED LEARNING

- It empowers learners to conduct research, integrate theory and practice, and apply knowledge and skills to develop a viable solution to a defined problem,'
- It is a teaching pedagogy that is student- centered
- Students learn about a topic through the solving of problems and generally work in groups to solve the problem where, often, there is no one correct answer.

PROBLEM-BASED LEARNING

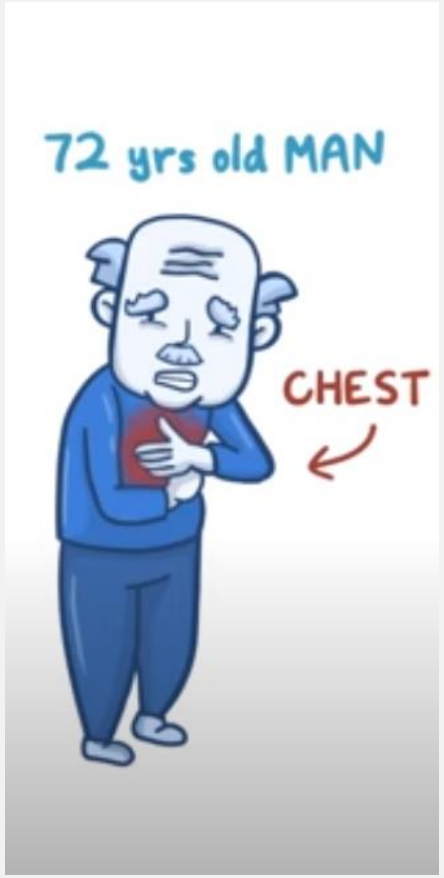
- Problem-based learning typically follow prescribed steps:
  1. Presentation of an "ill-structured" (open-ended, "messy") problem
  2. Problem definition or formulation (the problem statement)
  3. Generation of a "knowledge inventory" (a list of "what we know about the problem" and "what we need to know")
  4. Generation of possible solutions
  5. Formulation of learning issues for self-directed and coached learning
  6. Sharing of findings and solutions

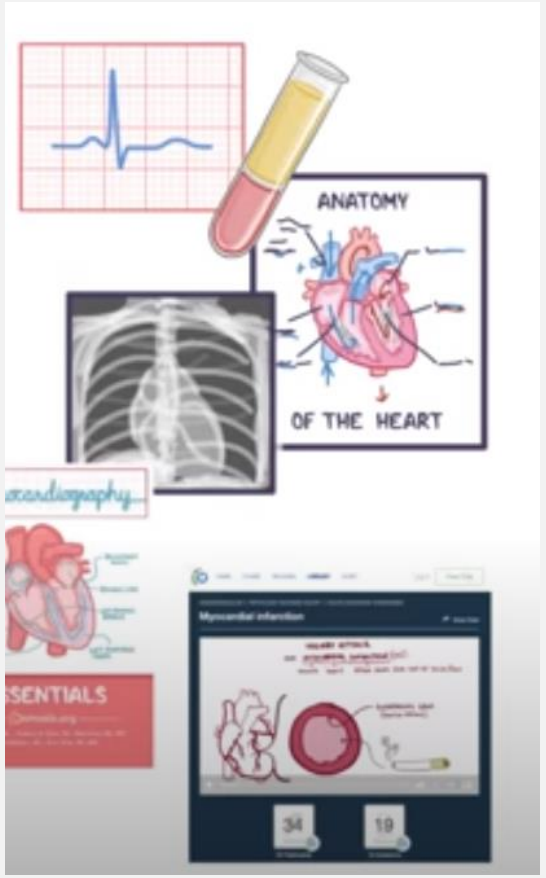
PROBLEM-BASED LEARNING (PBL)



PBL - EXAMPLE


WHERE is the PAIN ?
WHEN did it START ?
OTHER SYMPTOMS ?
MEDICAL/ FAMILY HISTORY ?
OTHER PROBLEMS ?

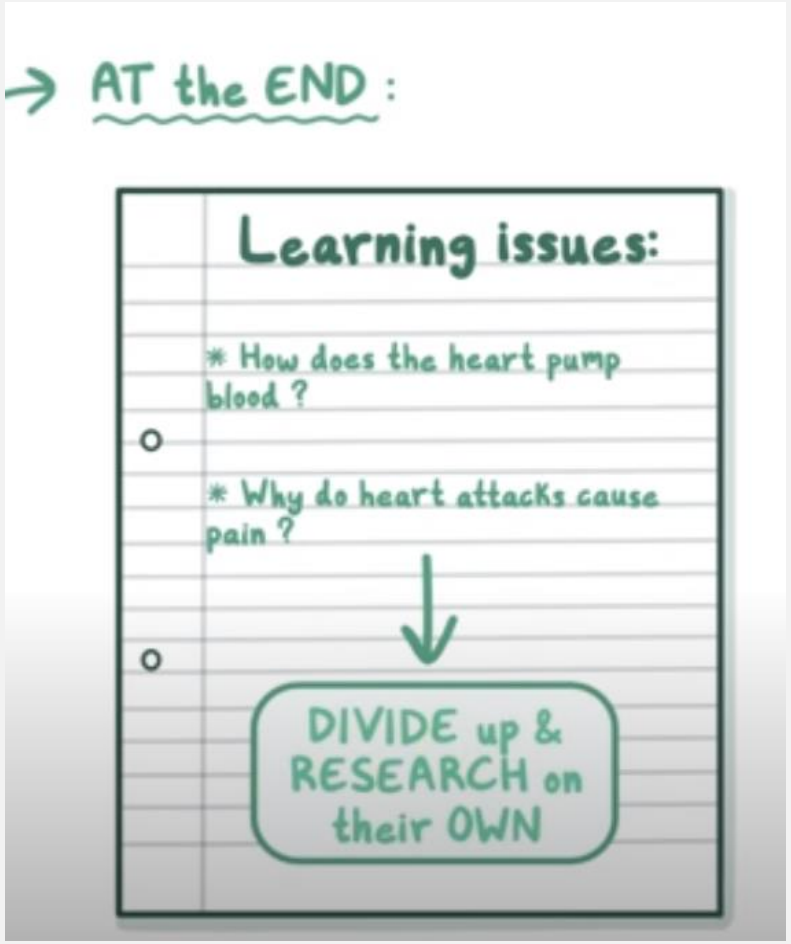

72 yrs old MAN
CHEST


ANATOMY
OF THE HEART

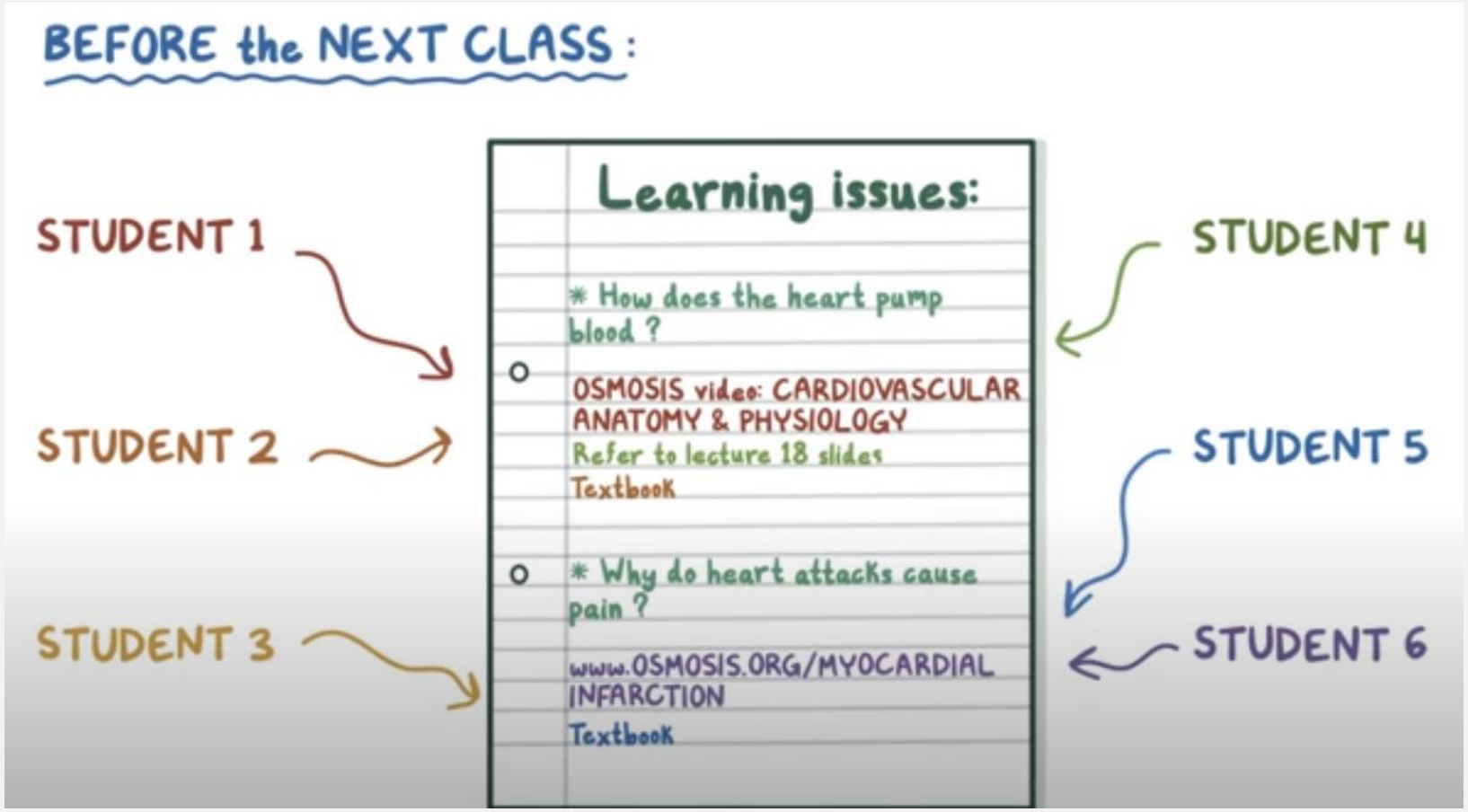
PBL - EXAMPLE


~ WHITEBOARD
~ SHARED DOC
~ CONCEPT MAP
SCRIBE
WHAT DO we KNOW ?
KNOWLEDGE GAPS ?
72 yrs old MAN
CHEST PAIN

PBL - EXAMPLE


AT the END :
Learning issues:
* How does the heart pump blood ?
* Why do heart attacks cause pain ?
DIVIDE up & RESEARCH on their OWN

PBL - EXAMPLE


BEFORE the NEXT CLASS :
Learning issues:
* How does the heart pump blood ?
OSMOSIS video: CARDIOVASCULAR ANATOMY & PHYSIOLOGY
Refer to lecture 18 slides
Textbook
* Why do heart attacks cause pain ?
www.OSMOSIS.ORG/MYOCARDIAL INFARCTION
Textbook
STUDENT 1
STUDENT 2
STUDENT 3
STUDENT 4
STUDENT 5
STUDENT 6

PBL - EXAMPLE

APPLY NEW INFO to the CASE

DEEPER and RICHER UNDERSTANDING

MORE EASILY REMEMBERED !

ACTIVE ENGAGE IN LEARNING

- ✓MEMORIZE CONTENT
- ✓WORK TOGETHER
- ✓BUILD A STRONG WEB OF INTER CONNECTED INFORMATION
- ✓SOLVE REAL WORLD PROBLEMS

PROJECT-BASED LEARNING

- Project-based learning is an instructional approach where we learn by investigating a complex question, problem or challenge.
- It promotes active learning, engages students, and allows for higher order thinking
- Students explore real-world problems and find answers through the completion of a project.
- Students also have some control over the project they will be working on, how the project will finish, as well as the end product.

PROJECT-BASED LEARNING

- Involves
  - Knowledge
  - Critical thinking
  - Collaboration
  - communication

DIFFERENCE BETWEEN PROBLEM BASED AND PROJECT BASED LEARNING

- students who complete problem-based learning often share the outcomes and jointly set the learning goals and outcomes with the teacher.
- On the other hand, project-based learning is an approach where the goals are set. It is also quite structured in the way that the teaching occurs.

DIFFERENCE

PROJECT BASED LEARNING

- goals are set and quite structured
- often multidisciplinary and longer
- follows general steps
- involves authentic tasks that solve real-world problems

PROBLEM BASED LEARNING

- often share the outcomes and jointly set the learning goals and outcomes
- more likely to be a single subject and shorter
- provides specific steps
- uses scenarios and cases that are perhaps less related to real life

PROJECT BASED LEARNING
VS
PROBLEM BASED LEARNING

Similarities
Both PBLs: • Focus on an open-ended question or task • Provide authentic applications of content and skills • Build 21st century success skills • Emphasize student independence and inquiry • Are longer and more multifaceted than traditional lessons or assignments

Differences	
Project Based Learning	**Problem Based Learning**
Often multi-subject	More often single-subject, but can be multi-subject
May be lengthy (weeks or months)	Tend to be shorter, but can be lengthy
Follows general, variously-named steps	Classically follows specific, traditionally prescribed steps
Includes the creation of a product or performance	The "product" may be tangible OR a proposed solution, expressed in writing or in a presentation
May use scenarios but often involves real-world, fully authentic tasks and settings	Often uses case studies or fictitious scenarios as "ill-structured problems"

ASSIGNMENTS – PROBLEM BASED LEARNING

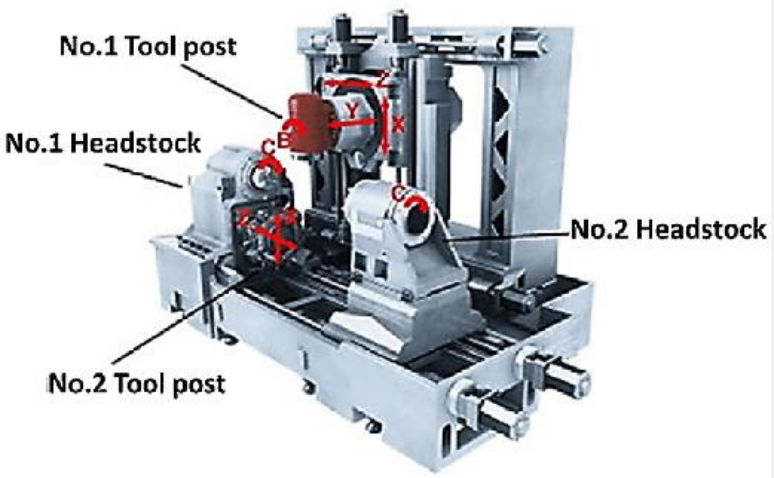
- Answer any two
  - Design a new waste management system in your residence area, especially for plastic waste
  - How can you market your own product within limited budget
  - Plan your relative's wedding by following covid protocol

ASSIGNMENT – PROJECT BASED LEARNING

- Answer any two
  - Analyzing the five most popular social media platforms for teens, then predict and design a new platform based on existing trends and past trajectory of change.
  - Solving the problem of negative and/or 'fake news.'
  - Imagine and discuss college education system in 2050

MODULAR DESIGN

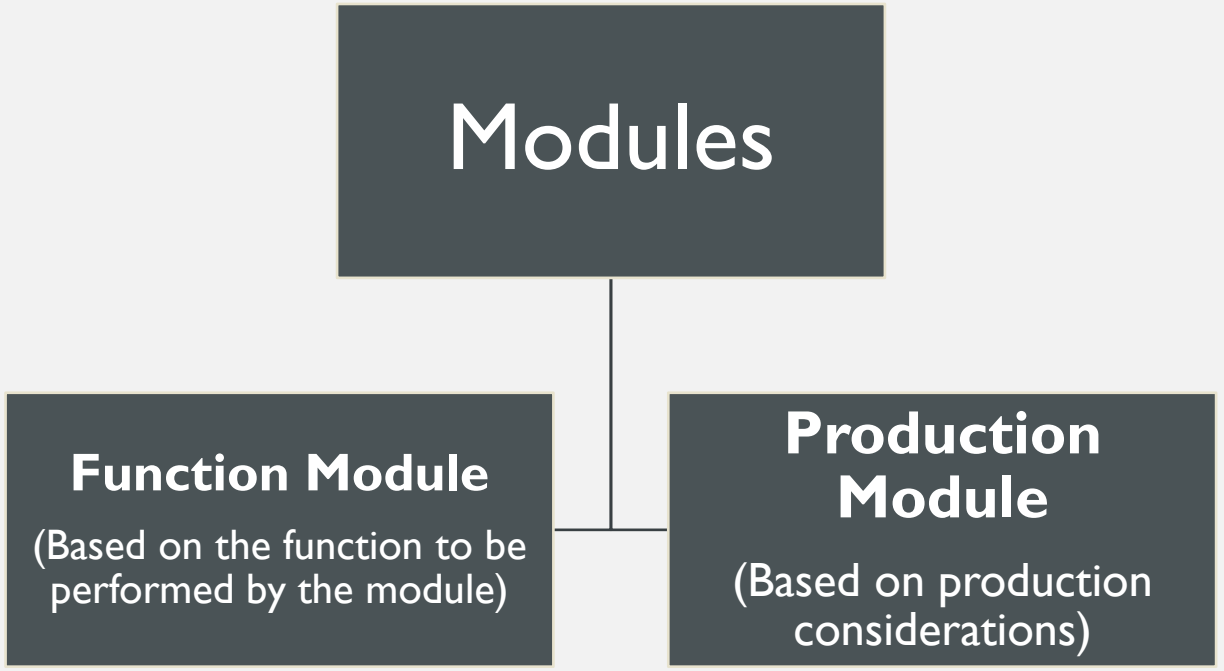
- Module' means separate elements
- Modular design is an approach in which a product is designed for assembling in module-wise fashion.
- Modular products are the artifacts that are composed of many modules
- These modules function together to get the overall function of the product.
- Modular products can be machines, assemblies and components that fulfill various overall functions through the combination of distinct building blocks or modules.
- In a modular product (or modular system), the overall function performed by the product is the results achieved through a combination of discrete units (modules).



MODULARIZATION

- Dividing a product into discrete units based on some criteria is called as modularization of a product.
- As we have seen, modular products or modular Systems are built up on separable or inseparable units called as modules.
- The basic idea behind modular design is to organize a complex system as a set of distinct component that can be developed independently and then assembled together to perform a function

MODULARIZATION



MODULAR DESIGN PROCESS

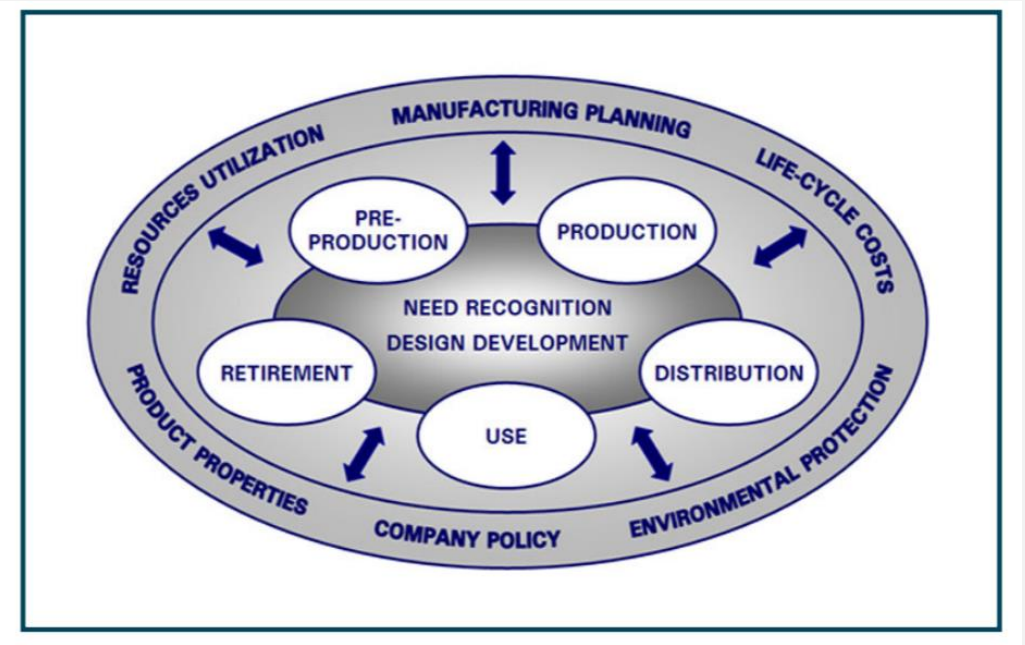
- We give importance to designing of module rather than the product as a whole
- Stage 1 : clarify the task
- Stage 2 : establish function structure
- Stage 3 : searching for solution principles and concept varients
- Stage 4 : selecting and evaluating
- Stage 5 : Preparing design and dimensioned layouts
- Stage 6 : Preparing production document

ADVANTAGES OF MODULAR DESIGN

- Minimizing cost
- Design of a singe part is easier as designer can concentrate only in one section
- Module can be separately improved without affecting the entire product
- A part of module can be updated
- Replacement of a parts becomes cheaper
- Shorten the design cycle
- Improves reliability and quality

LIFE CYCLE DESIGN

- The application of the life cycle concept to the design phase of the product development process is known as Life Cycle Design (LCD)
- a design intervention which takes into consideration all the phases of a product's life cycle
  - Development
  - Production
  - Distribution
  - Use
  - Maintenance
  - Disposal
  - Recovery



LIFE CYCLE DESIGN

- As a design approach, Life Cycle Design is characterized by three main aspects:
  - the perspective broadened to include the entire life cycle;
  - the assumption that the most effective interventions are those made in the first phases of design;
  - the simultaneity of the operations of analysis and synthesis on the various aspects of the design problem.
- Main phases of a product's life cycle
  - Recognition and design development
  - Pre-production
  - Production
  - Distribution
  - Use
  - Retirement,

LIFE CYCLE DESIGN

- The selection of design alternatives must be guided by considering the main factors of product success (design targets), in relation to all the phases of the life cycle:
  - Resources utilization
  - Manufacturing planning
  - Life cycle cost
  - Product properties (ease of production, functionality, safety, quality, reliability, aesthetics)
  - Company policies
  - Environmental protection.

ERGONOMICS IN DESIGN

- The word derived from Greek, '*ergon*' means work and '*nomos*' means laws
- Ergonomics is basically the science of analyzing work and then designing items (tools, equipment, products) and methods to most appropriately fit the capabilities of the user.
- Ergonomics design approach focuses on human comfort and decreased fatigue through product design.
- Means, during the design phase of a product, all the aspects of the product that can cause discomfort while using that product are identified. Then, analyzes the causes of the discomfort and appropriate solutions will be incorporated in the product design

ERGONOMICS IN DESIGN

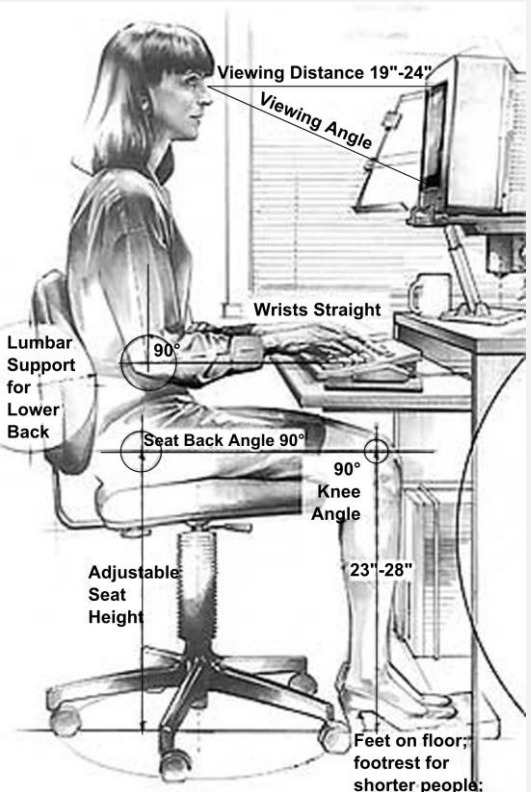
- Ergonomic design applied to an office chair will focus on how much it is comfortable for a Person who sits on it during office work.
- A chair ergonomically designed for dining purpose and a chair meant for relaxed sitting at beach will be different.
- It is, because, the kind of comfort and function to be provided by the chairs in these situations are different

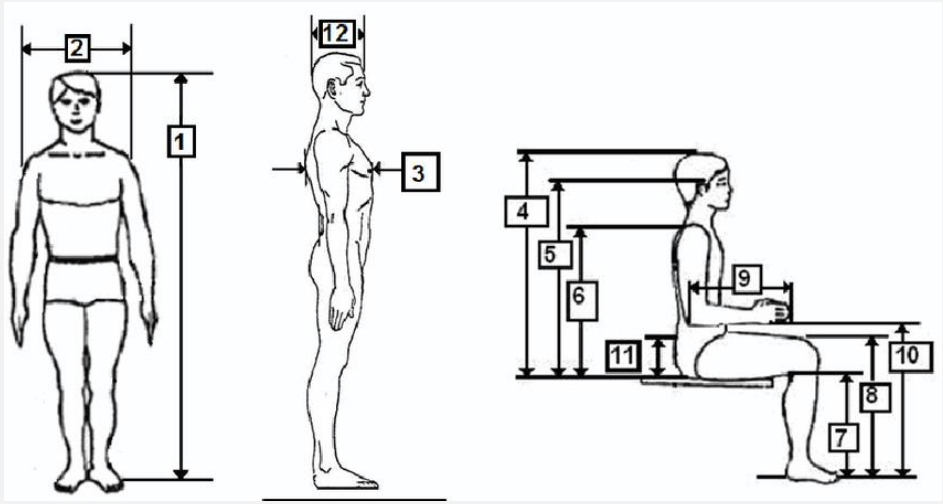
FACTORS CONSIDERED IN ERGONOMICS DESIGN

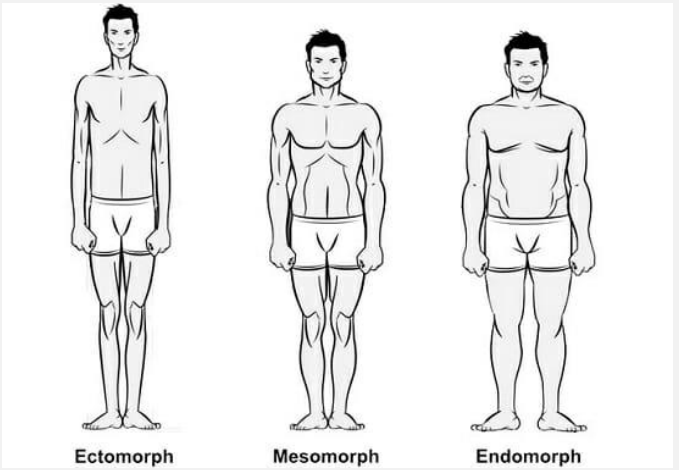
- To develop an ergonomic design (for a product or system), the designer will have to consider and analyse anthropometric data (dimensions of human body), posture of working while using the product, kind of movements and kind of workspace.
- ultimately, ergonomic design involves every aspect of user-product interaction, for the comfortable utilization of a product.

ANTHROPOMETRY

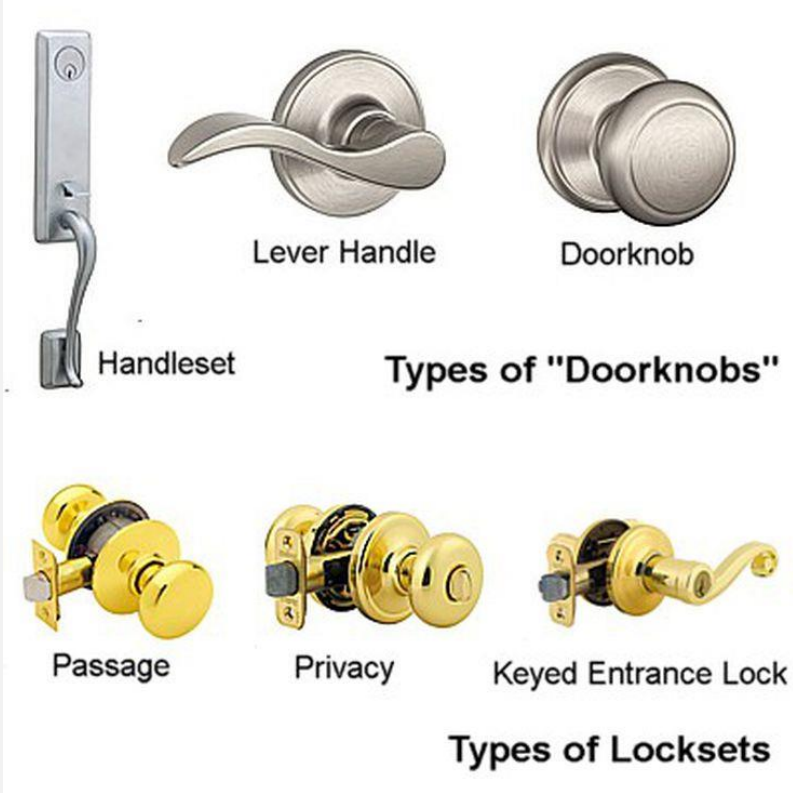
- Anthropometry is the science that measures the range of body sizes in a population.
- While designing products, it is very important for a designer to remember that people come in many sizes and shape.
- The anthropometric data vary considerably between human races.
- Age and occupation of the user is also relevant in anthropometric study.
- Working posture is another important factor to be considered in ergonomic design. Posture can be standing, sitting, reaching, moving and combinations of any of these (such as sitting and moving, standing and reaching, etc.).







UNIVERSAL DESIGN CONCEPT



- The designer must recognize the special needs of different users, including the individuals with disabilities.
- The disability can be temporary or permanent.
- Few examples for disabilities include broken bones, sprained joints, pregnancy, handicap, differently able, aging, etc.
- Universal design is an approach in ergonomics design, which considers all people; common and special people; who are potential users of a product.

ADVANTAGES OF ERGONOMIC DESIGN

- Proper consideration of ergonomic design can bring lots of advantages in working environment
  - health issues can be solved
  - Increase savings because of productive, sustainable and effective work environment
  - Reduce medical expenditure

EXERCISE

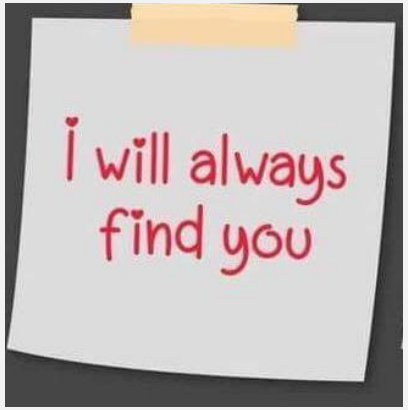
- Ergonomically design a vegetable knife for your kitchen, consider gripping material, shape, safety and placement of knife

AESTHETICS IN DESIGN

- The word 'aesthetics' is derived from the Greek word 'aesthetikos' meaning sensory perception.
- Aesthetics is the feel that a human being perceives.
- When a person perceives a sense of pleasure through any of the senses while using a product, then we can say that the product is aesthetically appealing.
- Example: a beautiful person, a good food, nice perfume

AESTHETICS IN ENGINEERING

- Products are intentionally designed to generate a defined perception in potential customers
- Aesthetics of a product (that is how a customer feels about a product) is a very important aspect for its business merit and acceptability.
- This feel (or perception) enables the customer to distinguish and choose a product from similar products.
- Few examples for demarcation of percept ions are; hot and cold, smooth and rough, soft and hard, heavy and light, dark and bright, sweet and sour, loud and quiet, sharp and dull, spacious and congested, etc.. customers generally combine few of these feels (or attributes) and arrive at conclusion of a product as reliable, enjoyable and precise.

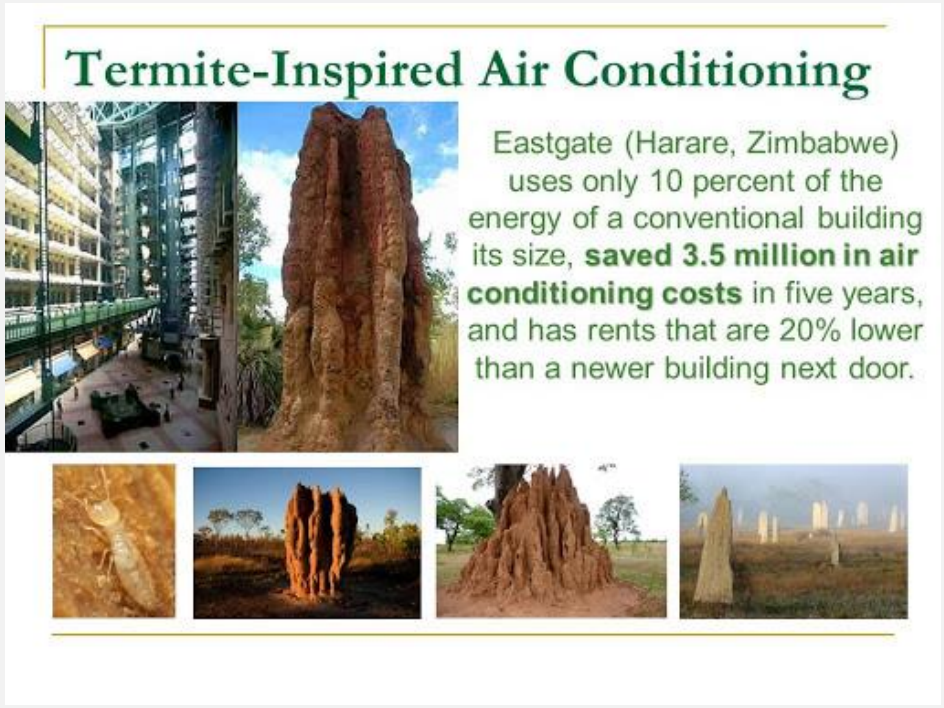


AESTHETICS IN DESIGN

- The customer may not know why a product is aesthetically appealing for them. it an be appealing because the designer has incorporated some specific attributes the design in order to create such a feel in the customer.

BIO-MIMICRY IN DESIGN

- "**Biomimicry** borrows nature's blueprints, recipes, processes, and ecosystem strategies and then comes up with **design** principles to solve our own problems



VALUE OF ENGINEERING(VE)

- Technique for improving the value of the product, project and process
- The term value defined as the ratio of function to cost

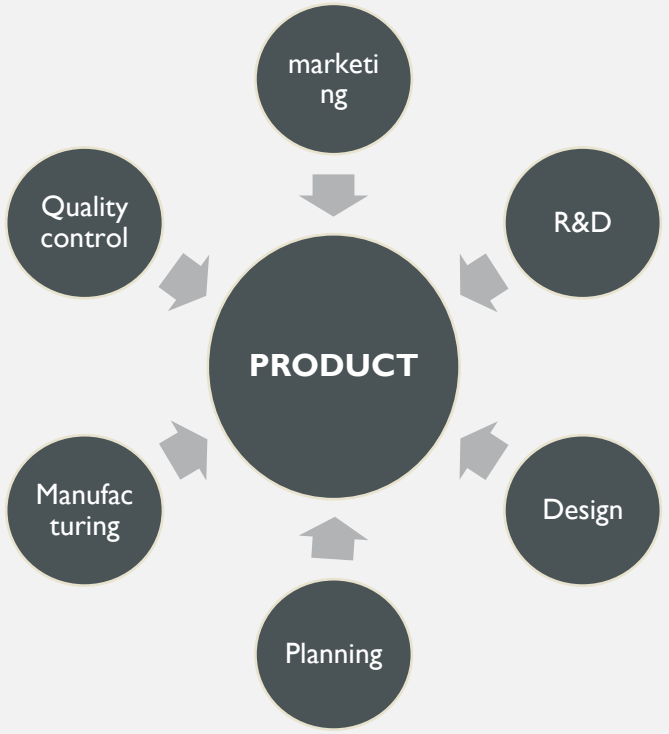
$$\text{Value} = \frac{function}{cost}$$

Table 13.2 VE study of Printed Circuit Board

Product description	Printed circuit board (PCB) for a temperature controller in a home appliance.
Reason for VE Study	The appliance is losing market share to new domestic and foreign competitors, due to higher cost of appliance.
Analysis of PCB (Original Concept)	PCB mounted with 10 components takes 8 manufacturing steps in assembly process. Excessive waiting and moving time during assembly.
VE alternative concepts	Analysis of component cost led to alternatives for its procurement. Analysis of assembly process led to revised layout of assembly line.
Advantages	Component prices reduced to a small degree. Assembly time reduced to large degree.
Disadvantages	Plant layout had to be changed to reduce moving and waiting time.
Results	Cost of components reduced. Net cost of manufacturing reduced. Competitive pricing for the appliance achieved. Company achieves the goal of market share and turned profitable.

CONCURRENT ENGINEERING

- It is an approach in product design process in which people from various functional areas works together simultaneously to develop a product.
- Since people from various fields are working simultaneously for the development, this kind of engineering is also known as Simultaneous Engineering or Parallel Engineering.
- This approach is adopted to improve the efficiency of product design and reduce the product development cycle time.

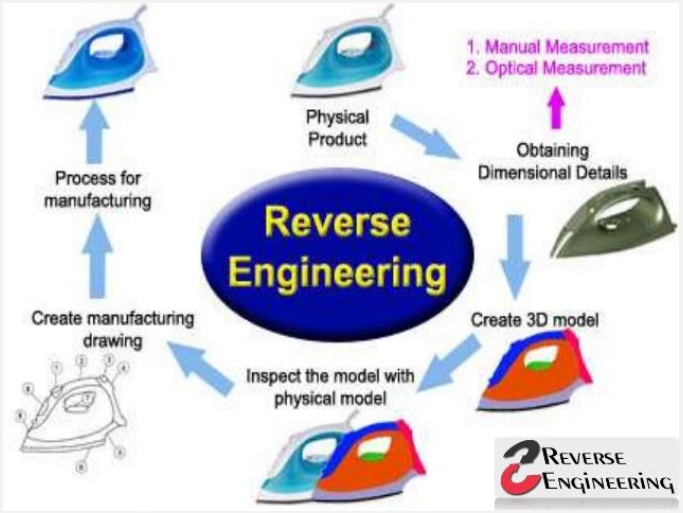


ADVANTAGES OF CE

- Reduce design time
- Reduce manufacturing
- Reduce cost for design changes
- Ensure correct data and information transfer between various sections
- Simultaneous thinking leads to amazing innovations
- Every person has feel of belongingness to the product

REVERSE ENGINEERING

- Reverse Engineering is an approach in which an existing product is analyzed and another product is developed in light of the analysis.
- The product that is analyzed can be own product of the producer or a product from a competitor.
- In reverse engineering, a product is dissected or dis-assembled to find out in detail how a part works an why is it used. This information obtained by this process can then be applied to solve own design problem or develop a new product.
- Reverse Engineering is essentially a functional decomposition process in the reverse direction.
- an existing product is analyzed into subsystems, which are further analyzed into deep to ultimately establish the product concept
- This analysis will help the designer to identify weak side of the design



ACTIVITY

- Objective : To purpose a new design for screw driver based on reverse engineering method
- Design requirement : conventionally for different screws different heads are available. Present requirement is to develop a screw driver that can handle any screws without changing the heads. You can change the designs as per your wish

REFERENCES

- Basics of product development DESIGN AND ENGINEERING by Dr. Sadiq A
- https://youtu.be/XbH7-Qa9xaU