

# **DESIGN AND ENGINEERING**

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# Module 4

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

# PROBLEM BASED LEARNING

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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 typically follow prescribed steps:

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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

WHERE is the PAIN ?

WHEN did it START ?

OTHER SYMPTOMS ?

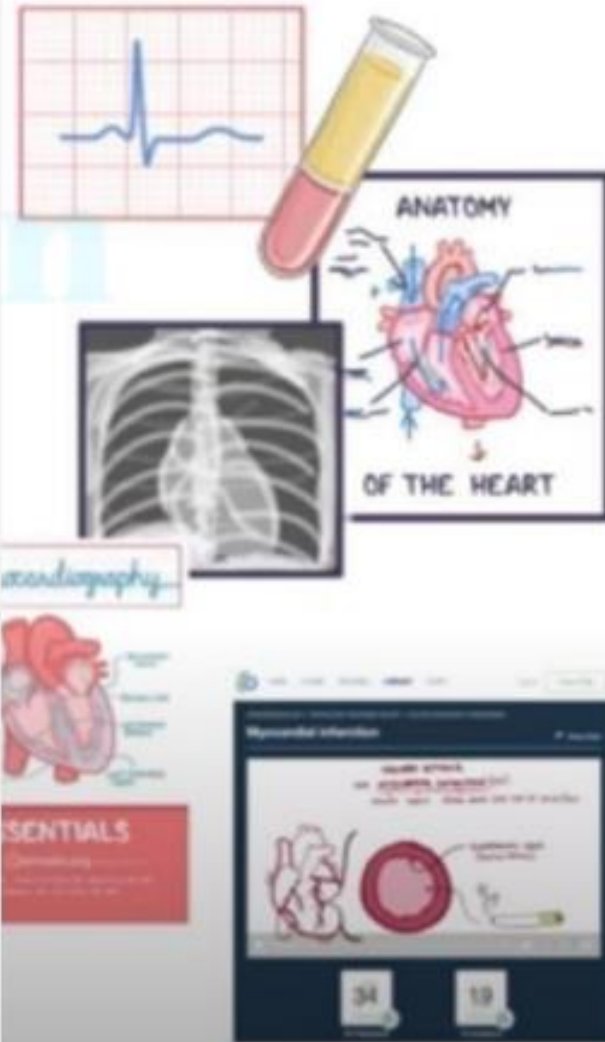
MEDICAL/ FAMILY  
HISTORY ?

OTHER PROBLEMS ?

72 yrs old MAN



CHEST



SCRIBE

- ~ WHITEBOARD
- ~ SHARED DOC
- ~ CONCEPT MAP



WHAT DO we KNOW ?

KNOWLEDGE GAPS ?

→ AT the END :

### Learning issues:

\* How does the heart pump blood ?

○

\* Why do heart attacks cause pain ?

○

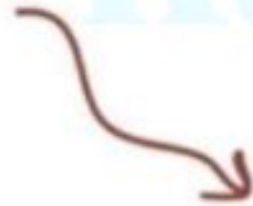


DIVIDE up &  
RESEARCH on  
their OWN



## BEFORE the NEXT CLASS :

STUDENT 1



STUDENT 2



STUDENT 3



### 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](http://www.osmosis.org/myocardial-infarction)

Textbook

STUDENT 4



STUDENT 5



STUDENT 6





APPLY NEW INFO to the CASE



DEEPER and RICHER  
UNDERSTANDING

MORE EASILY  
REMEMBERED !

# ACTIVE ENGAGE IN LEARNING

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

# PROJECT-BASED LEARNING

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- 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.

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## Involves

- Knowledge
- Critical thinking
- Collaboration
- Communication

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➤ 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.

<b>Differences</b>	
<b>Project Based Learning</b>	<b>Problem Based Learning</b>
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"



# MODULE 4

## 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 and Problem-based Learning in Design.

TABLE I  
DIFFERENCES BETWEEN PJBL AND PBL ACCORDING TO [20]

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

# Modular Design

- It is an approach in which a product is designed for assembling in module wise fashion.

## Advantages

- Minimizing cost
- Design of a single part is easier as designer can concentrate only in one section
- A part of module can be updated
- Replacement of a part become cheaper
- Shorten the design cycle



# 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).

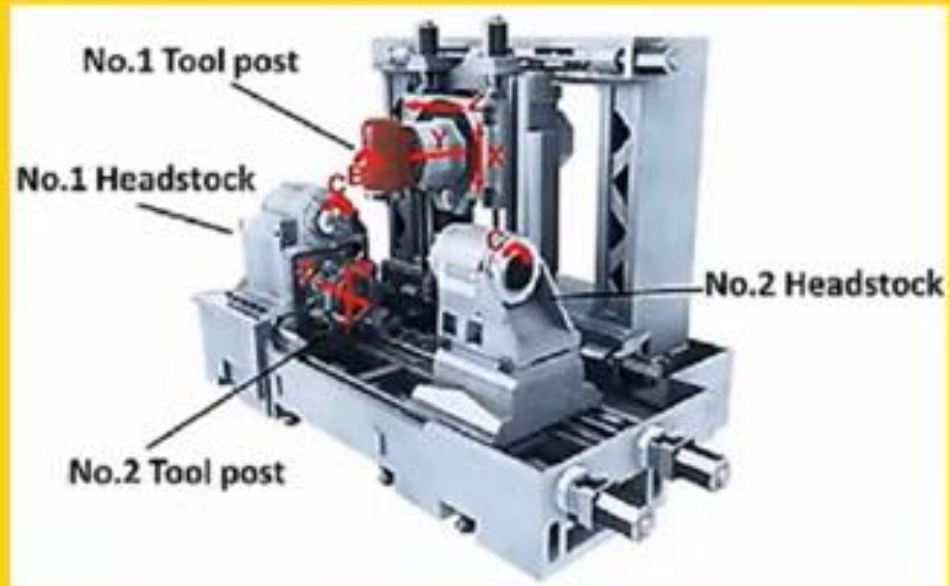
# MODULARIZATION

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- 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

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## MODULAR DESIGN

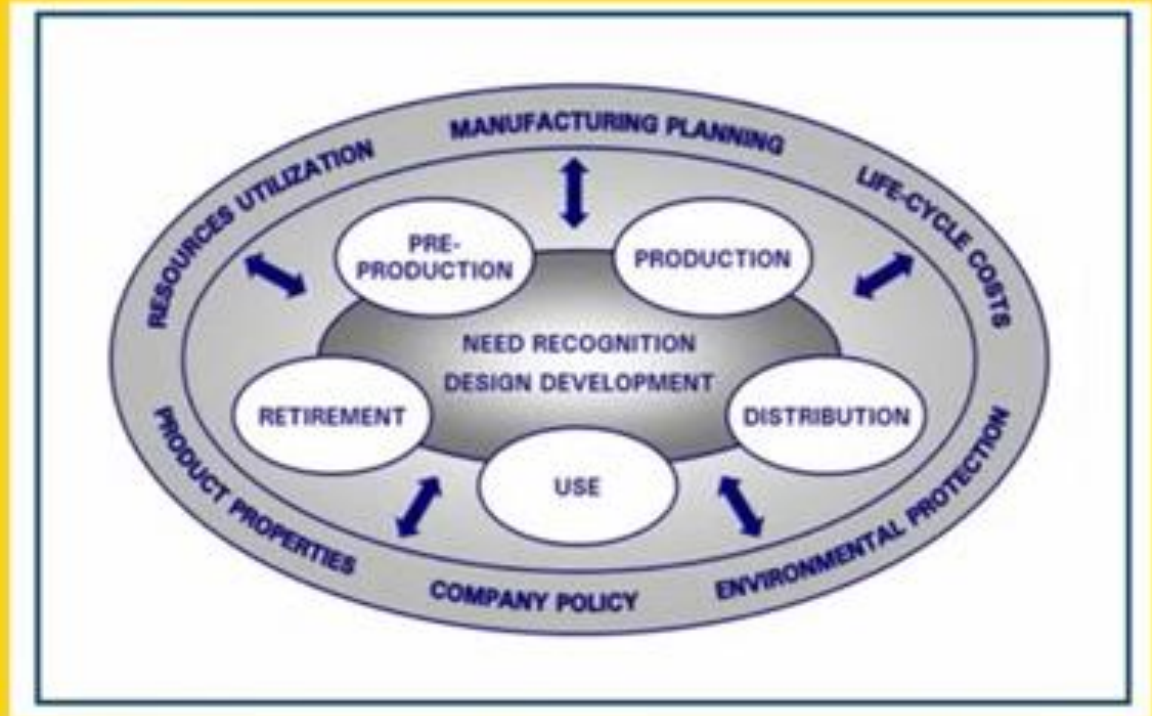




# MODULE 4

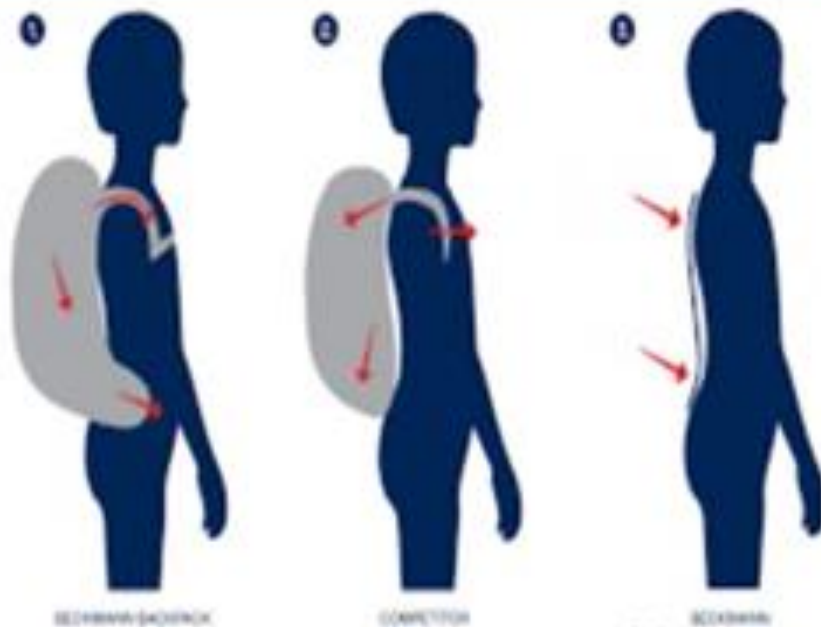
## LIFE CYCLE DESIGN

- Development
- Production
- Distribution
- Use
- Maintenance
- Disposal
- Recovery



# Ergonomics in Design

- Focus on human comfort and decreased fatigue through product design
- that is during the design phase, all aspects of discomfort while using the product are identified. Then analyze the causes of discomfort and appropriate solution will be incorporated in product design.
- Ergonomic design applied to an office chair will focus on how much it is comfortable for a person who sit on it during office work
- **Advantages:**
  - Health issues can be solved
  - Reduce medical expenditure
  - Increase saving because of productive , sustainable and effective work environment



BECKENHÖHE (BECKENBUCKEL)

CORREKTION

BECKENHÖHE

The 3-Way-Adjustment Support System helps to keep the backpack close to the body & holds against the back straps

## Das ergobag Ergonomiekonzept

1. Stabilisierende Air-Profilkissen
2. Breiter Beckengurt mit geschützten Beckenflüssen
3. Höhenverstellbarer Brustgurt
4. Stufenlose Rückenabgabeneinstellung
5. Atmungsaktives Rückenpolster
6. Innovativer Tunnelzug mit Kompressionseffekt zum Heranbringen des Gewichts an den Rücken



Design  
Innovativ! Günstig!







# MODULE 4

## ERGONOMICS IN DESIGN



# Aesthetics in design

- 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
- It is an important aspects for its business merit and acceptability
- **Eg:** A beautiful person, A good food, A nice perfume



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## AESTHETICS IN DESIGN



# Application of Biomimicry

- Borrows nature's blueprints, recipes, processes and ecosystem strategies
- Then come up with design principles to solve our own problems

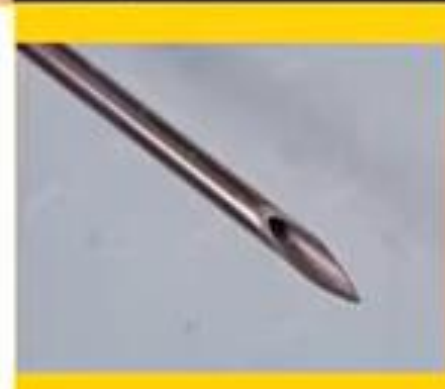
## Example

- Aero plane – from Birds
- Syringe- from Mosquitoes
- AC – Termite inspired



# MODULE 4

## BIO-MIMICRY IN DESIGN



### Termite-Inspired Air Conditioning



Eastgate (Harare, Zimbabwe) uses only 10 percent of the energy of a conventional building its size, **saved 3.5 million in air conditioning costs** in five years, and has rents that are 20% lower than a newer building next door.



# Value Engineering

- Value engineering is used to solve problems, identifying and eliminate unwanted cost and improve function and quality.
- Systematic method of improving the value of a product that a project produces.
- It is used to analyze a service, system or product to determine the best way to manage the important functions while reducing the cost.

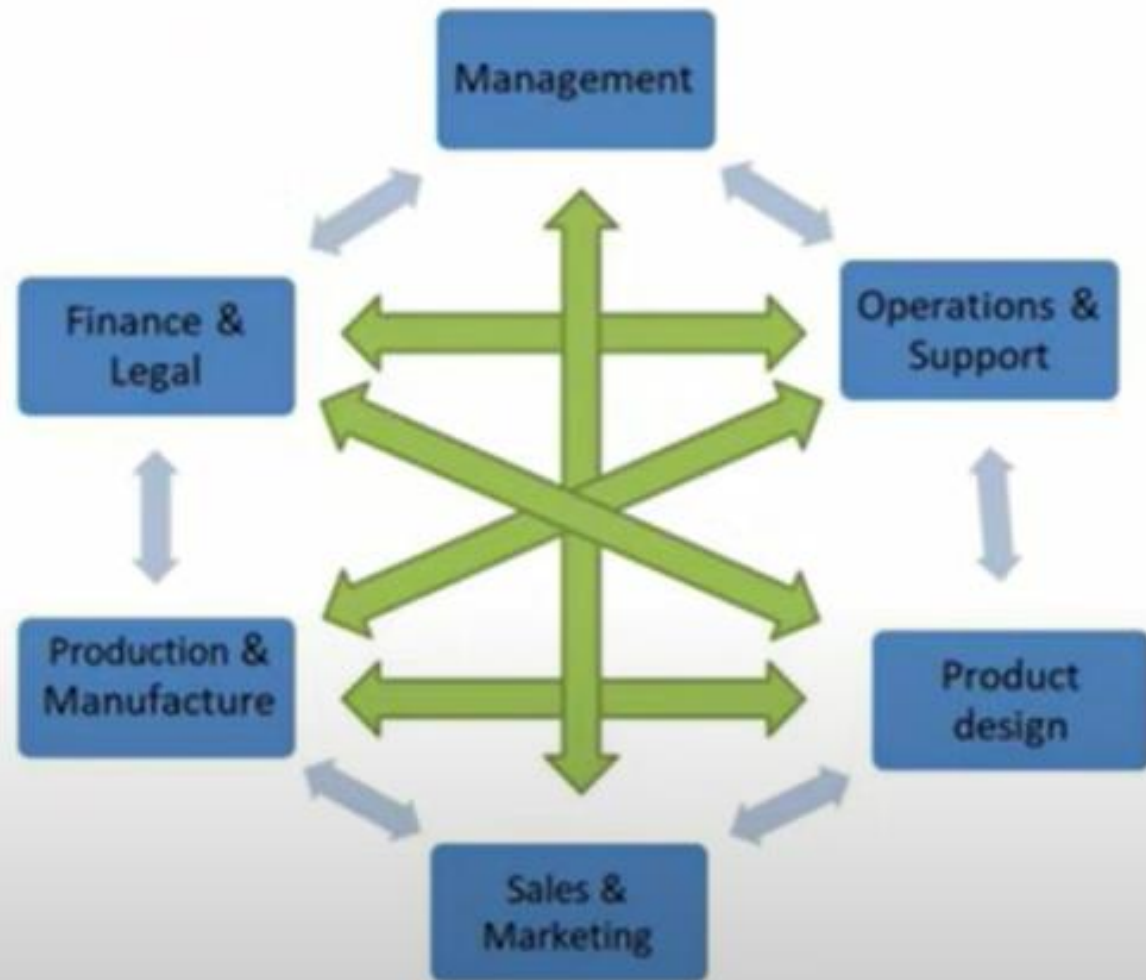


# Concurrent Engineering

- It is an approach in product design process in which people from various functional areas work together simultaneously to develop a product.

## Advantages:

- Reduce design time
- Reduce manufacturing cost
- Every person has a feel of belongingness to the product





# Reverse Engineering in Design

- It is an approach in which an existing product is analyzed and another product is developed in light of the analysis.
- It help the designer to identify weak side of the design
- Product that analyzed can be own product of the producer or product from a competetor.

In reverse engineering, a product is dissected or dis-assembled to find out in detail how a part works and why it is 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

# MODULE 4

# PREVIOUS YEAR

# QUESTIONS

KTU June 2023 – PART B

## Module 4

- 17 What is meant by modular design? Apply the modular design concept to design a bicycle. (14)
- 18 What is the importance of project-based learning and problem-based learning? (14)  
Use project based learning method to design a modern city for the year 2030.

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### **Module 4**

- 17 Design a nature inspired solar lamp for the students residing in urban areas. These students do not have proper availability of electricity and cannot afford highly priced products. Illustrate your design with sketches. (14)
- 18 Apply modular engineering to a conventional bicycle and design a bicycle which can used in different terrains. Illustrate the design using sketches. (14)

## Module 4

- 17 A class room has to be designed in such a way that it should support the faculty (14)  
for taking both online and offline mode class in the same room. Prepare a bill of  
material and draw a neat sketch showing the seating arrangement, cable layout,  
projector and smartboard position, podium, camera and the teacher position.  
aesthetic, ergonomics and convenience must be considered.
- 18 (a) Write the significance of life cycle design? (4)  
(b) Apply the ergonomic design concepts to design a knife for various purposes. (10)  
Illustrate each design with a neat sketch?



## **Module 4**

- 17 Show the development of a nature-inspired design for a fashionable umbrella (14)  
based on a banana leaf. Use hand sketches to support your arguments.
- 18 Develop some design modification for sports utility bag, to improve its (14)  
functionalities as well as product value. Sketch the design.

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## **Module 4**

- 7 Illustrate modular design approach for designing of desktop computer
- 8 Demonstrate the concept of ergonomics through design of a table lamp

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## **Module 4**

- 17 Apply value engineering to a pen, and design a lightweight pen torch. Illustrate the solution using sketches. (14)
- 18 Design waste bins to be kept at bus stops for waste collection enabling source separation. The bin should be theft-resistant and protect the contents of the bin from external weather conditions. Design the bins with ergonomic consideration for waste collection workers. Sketch the design using hand drawings. (14)

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1. Describe the use of value engineering in the design process. (3)
  2. How does intelligence in nature inspire engineering design
  3. Explain the role of Prototyping in evaluating a Design.
  4. Explain the importance of project-based learning in design engineering.
  5. Discuss the role of life cycle design approach in design decisions.
  6. Relate how designs are inspired from nature. (3)

7. How the life cycle design approach influences design decisions
8. Illustrate advantages of reverse engineering in design
9. Explain bio mimicry in design with an example
10. Examine how engineering students can learn design engineering through projects.
11. Distinguish how aesthetics and ergonomics change engineering designs
12. Why prototyping is important in the design process
13. Explain life cycle design.
14. Describe how aesthetics is important in design process