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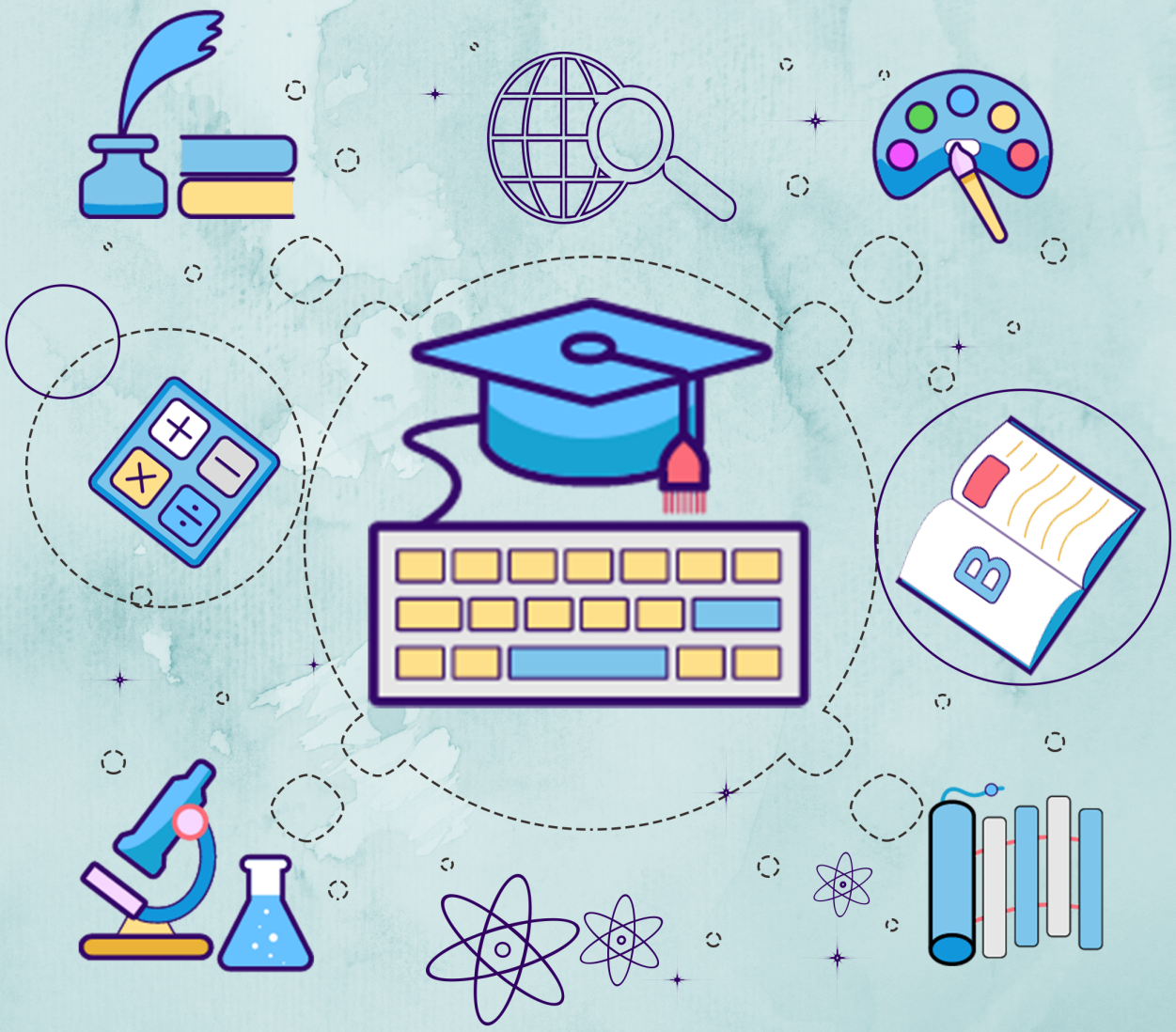

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KTU S4 CSE NOTES

DESIGN AND ENGINEERING (EST 200)

Module 5

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Module 5: Design & Engineering

Background

- **Design for manufacturing (DFM)** is design based on minimizing the costs of production and/or the time to market for a product, while maintaining an appropriate level of quality.
- DFM begins with the formation of the design team.
- In commercial settings, design teams committed to DFM tend to be multidisciplinary, and they include engineers, manufacturing managers, logistics specialists, cost accountants, and marketing and sales professionals. Each brings particular interests and experience to a design project,
- but all must move beyond their primary expertise to focus on the project itself.
- A basic methodology for DFM consists of six steps:
    - Estimate the manufacturing costs for a given design alternative;
    - Reduce the costs of components;
    - Reduce the costs of assembly;
    - Reduce the costs of supporting production;
    - Consider the effects of DFM on other objectives; and
    - If the results are not acceptable, revise the design once again.
- **Design for Assembly (DFA)**: Assembly refers to the way in which the various parts, components, and subsystems are joined, attached, or otherwise grouped together to form the final product.
    - Handles parts or components (i.e., retrieves and positions them appropriately relative to each other)
    - Inserts (or mates or combines) the parts into a finished subsystem or system.
- **DESIGN FOR USE**
    - **Reliability**
    - To an engineer, reliability is defined as "the probability that an item will perform its function under stated conditions of use and maintenance for a stated measure of a variate
    - we can properly measure the reliability of a component or system only under the assumption that it has been or will be used under some specified conditions.
    - the appropriate measure of use of the design, called the variate, may be something other than time.
    - **Maintainability**
    - Maintainability can be defined as "the probability that a failed component or system will be restored or repaired to a specific condition within a period of time when maintenance is performed within prescribed procedures."

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- Designing for maintainability requires that the designer take an active role in setting goals for maintenance, such as times to repair, and in determining the specifications for maintenance and repair activities in order to realize these goals.
- This can take a number of forms, including:
  - selecting parts that are easily accessed and repaired;
  - providing redundancy so that systems can be operated while maintenance continues;
  - specifying preventive or predictive maintenance procedures; and
  - indicating the number and type of spare parts that should be held in inventories in order to reduce downtime when systems fail.

- **DESIGN FOR SUSTAINABILITY**
  - **Environmental Life-Cycle Assessments**
  - Life-cycle assessment is a tool that was developed to help product designers understand, analyse, and document the full range of environmental effects of design, manufacturing, transport, sale, use, and disposal of products.
  - LCA has three essential steps:
    - Inventory analysis lists all inputs (raw materials and energy) and outputs (products, wastes, and energy), as well as any intermediate outputs.
    - Impact analysis lists all of the effects on the environment of each item identified in the inventory analysis, and quantifying or qualitatively describing the consequences (e.g., adverse health effects, impacts on ecosystems, or resource depletion).
    - Improvement analysis lists, measures, and evaluates the needs and opportunities to address adverse effects found in the first two steps.

ENGINEERING ECONOMICS IN DESIGN

Labor, Materials, and Overhead Costs

- Costs are often broken up into the categories of labor, material, and overhead costs.
- **Labor**: costs include payments to the employees who build the designed device, as well as to support personnel who perform necessary but often invisible tasks such as taking and filling orders, packaging, and shipping the device.
- Labor costs also include a variety of indirect costs that are less evident because they are generally not paid directly to employees.
- These indirect costs are sometimes called fringe benefits and include health and life insurance, retirement benefits, employers' contributions to Social Security, and other mandated payroll taxes
- a simple starting point for estimating costs is to keep good records or the activities needed to build our design's prototype.
- **Materials** include those items and inputs directly used in building the device, along with intermediate materials and inventories that are consumed in the manufacturing process.
- A key tool for estimating the materials cost of an artifact is the bill of materials (BOM), the list of all of the parts in our design, including the quantities of each part required for complete assembly
- The BOM is particularly useful since it is usually developed directly from the assembly drawings, and so it reflects our final design intentions.

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- Materials costs can often be reduced significantly by using commercial off-the-shelf materials rather than making our own.
- This is because outside vendors have the machinery and expertise to make very large numbers of parts for a lot of customers.
- The costs incurred by a manufacturer that cannot be directly assigned to a single product are termed **overhead**.
- Estimating the costs of producing a design requires careful consultation with clients or their suppliers.
- In practice, each engineering discipline has its own approaches to cost estimating that are captured by general guidelines

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(Q1) Examine the changes in the design of a foot wear with constraints of 1) production methods, 2) life span requirement, 3) reliability issues and 4) environmental factors. Use hand sketches and give proper rationalization for the changes in design.

Solution

Design of a foot wear

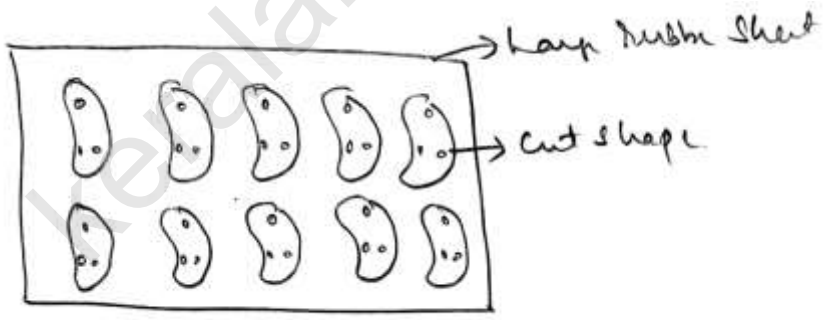
A design of foot wear is simple. We have to consider certain simple things while we are designing with the given constraints

Let us discuss each

Constraints of production method

Since we are designing a rubber foot wear we can have a good rubber material for foot wear with long lasting life

- Foot wear is produced in bulk so we need large amount of production materials
- So, to reduce the cost we can use large sheets of rubber material and cut the foot wear from that using machines
- The other works like stitching or combining parts of the foot wear are being done with workers so labours are required to do those jobs
- For stitching we can use good quality nylons



Constraints of life span requirements

- By considering life span requirement of a foot wear it is difficult to consider the return of the product and recycling. So me must make the product with a bio degradable material. The best option for that is good quality rubber

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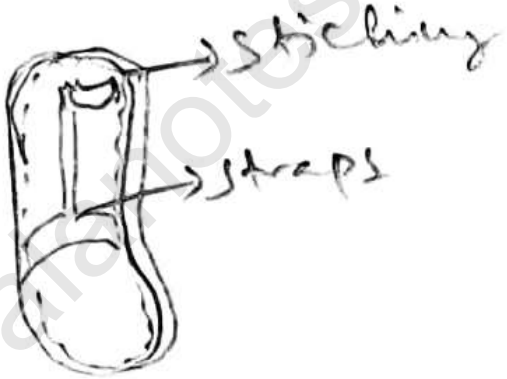
- Another problem may be manufacturing defects or manmade error, We can provide a service for the foot wear around 1-2 year for that
- On the life span another issue is using the foot wear at the time of rainy seasons. By using the rubber product for the manufacturing, we can solve that issue
- To get the old product back and recycle. we can give some discounts for the old product for new purchases. By giving that way we can make sure the return of the product after the use and done for the recycling purpose

Constraints of reliability

- One of the main reliability issues is long life of the foot wear on all seasons. This constrains can be resolved using the good footwear material rubber
- Another constrains is breaking the straps. This can be reduced by strong materials at the end and also by stitching the joints of the foot wear after the instalment of the strap
- Wear and tear at the corners of the foot wear can be also reduced by stitching around the corners of the foot wear with good nylon.
- Another constrain is wear the bottom side of the foot wear while at the long use. To inclreas the life of the foot wear we can use strong and bendable quality rubber material at the bottom of the foot wear as souls of the foot wear



Constraints of the environmental factors

- The product like foot wear the environmental factors are mainly use of the product at the time of rainy season. As we discussed before, making of the product with good quality factors can be extend the life time of the foot wear

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- Due to govt. orders the product used for the making of foot wear must be bio degradable. We already mentioned that in the previous steps
- Since we are also considered the recycling steps and initiation for the products. It will help more in the environmental factors.
- We must also follow the govt. rules for the machine used in the manufacturing factory. Or we can import the product from other merchandises which will solve the other pollution problems and cost.

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(Q2) Describe the how to estimate the cost of a particular design using ANY of the following: i) a website, ii) the layout of a plant, iii) the elevation of a building, iv) an electrical or electronic system or device and v) a car. Show how economics will influence the engineering designs. Use hand sketches to support your arguments.

Solutions

From the above question let us consider the cost estimation of a website creation and maintenance. I am estimating the cost of a shopping website design. Mainly for a product design there are three costs 1) labour cost , 2) material cost and 3) overhead cost. Let us discuss each

Labour cost

- The labour cost of the website creation is mainly for the website designers and programmers. For the creation of the established shopping website fully we need minimum 10 to 15 designers, programmers and supporting engineers
- The estimated time for the full functioning of the website may take around 5- 8 months
- We need to pay the salary for the workers at that time period. Let us take nearly 15000 per month one person. Then the total salary for a month will be **15*15000 = 225000**.
- That amount should provide for the estimated time period of 8 months. Which will cost **8*225000 = 18,00,000 rs**
- After the website creation we can provide support and annual maintenance of the website afterwards. This may cost 3-5 worker's salary and other benefits. The salary may cost **5*15000 = 75000 rs**. Tis cost will continue as long as the website is functioning.
- The other works like marketing and social media marketing can be done by 2 workers. The salary for them may cost **2*10000 =200000 rs**
- We can also reduce the cost by hiring a website creation outsourcing company for to do the jobs, which will reduce the employee salary and other expences

Material cost

- The main material cost for the website creation is computer expense. At the tine of the website creation above mentioned workers need 10 – 15 computer sets for the website design and developing. So for a single computer set will cost nearly **30000** per system. So the total cost will be **15*30000= 450000**.
- Also, must have servers/ cloud storage for the smooth functioning and controlling of the website which will cost **100000** per server
- If we chose the cloud storage then we must pay yearly rent for the cloud servers
- There must be an office for the functioning of the website we can have own building or rented building. The cost will be depending on the option
- The initial cost of this will be high for a starting company. We can also reduce this cost by outsourcing the work with another firm
- The other cost will be website domain cost which will be nearly **3000/year** which is a mandatory cost in each year
- Another mandatory cost is website hosting which nearly cost **2000/year**
- Some of the costs can be reduced by outsourcing the works to another firms.

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Overhead costs

- Over head cost are the cost happening after the cost estimation. There will be always overflow of the cost estimation after the establishment and while the functioning of the website. We must consider those options also. Some of the overhead cost is mentioned below
    - Some cases we might need to develop an app for the website to use it in mobile phones. This may cost additional
    - Some cased to improve the traffic and working of the website we might need additional certificate for website like sst certificate.
    - Additional publicity cost will be there for reaching the website to more people. This can be done by social media advertising, additional discounts for the products. These steps can cost extra
    - If the website got hit then we might nee some additional office staffs
    - We can also use some delivery staffs for the fast delivery of the products. These will come under the labour cost afterwards
    - Due to some issues there may be a chance to extend the website completing time period. This can cause the additional cost of the employee salary.

These are the preliminary costs estimation for the shopping websites. In spite of the above points there is a possibility that additional unexpected cost can also be happen. So we need to be prepared for those additional cost estimation before starting the work

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