EST 200 : DESIGN AND ENGINEERING MODULE 5

Manu Prasad
Asst. Professor, Dept. of ECE
AWH Engineering College, Kozhikode 08
Email : manuprasad@awhengg.org

SYLLABUS

- Expediency, Economics and Environment in Design Engineering:-Design for Production, Use, and Sustainability. Engineering Economics in Design. Design Rights. Ethics in Design

DESIGN FOR PRODUCTION, USE, AND SUSTAINABILITY

- **Concurrent engineering** : a multidisciplinary design team works simultaneously and in parallel to design a product, a manufacturing approach, a distribution scheme, user support, maintenance, and ultimately disposal.

DESIGN FOR PRODUCTION

- **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.

DESIGN FOR MANUFACTURING (DFM)

- 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 MANUFACTURING (DFM)

- keep in mind when doing DFM.
  - consulting with experts on manufacturing can often reveal manufacturing techniques that will (or will not) work with your design
  - production costs can usually be reduced by using commercially available inputs rather than custom parts
  - DFM must always be done with the client's objectives in mind

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.

DESIGN FOR USE

- **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."
  - 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

- The American Society of Mechanical Engineers (ASME) stipulates that "Engineers shall consider environmental impact in the performance of their duties."
- Environmental Issues and Design
  - We can often characterize the environmental implications of a design in terms of the effects on air quality, water quality, energy consumption, and waste generation.
  - Air quality almost immediately springs to mind when we list environmental concerns related to design.
  - Environmentally conscious engineers should also concern themselves with issues of water quality and water consumption

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

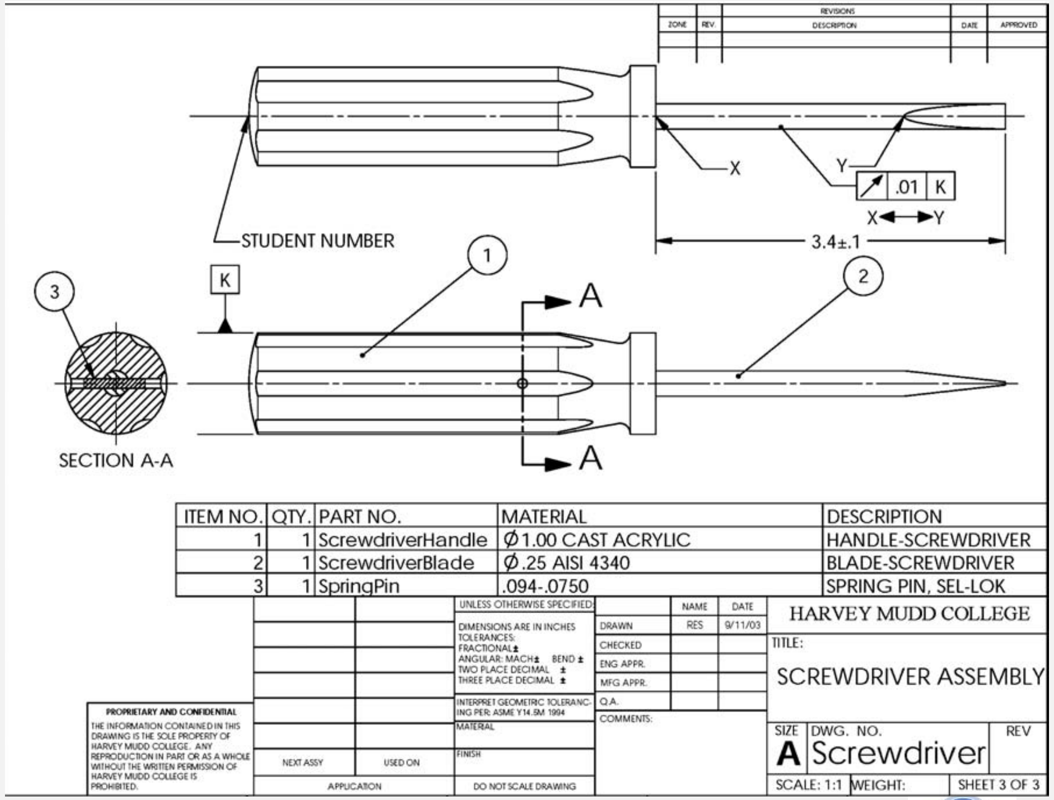
- COST ESTIMATION: HOWMUCH DOES THIS PARTICULAR DESIGN COST?
  - In practice, cost estimation is a complex business that requires skill and experience. However, there are several ways that we can break out the cost structure of a device that we are designing.
  - The simplest, conceptually, is to estimate labor, materials, and overhead costs.

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.

LABOR, MATERIALS, AND OVERHEAD COSTS

- **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.
- 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.



LABOR, MATERIALS, AND OVERHEAD COSTS

- 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

THE COST OF DESIGN AND THE COST OF THE DESIGNED DEVICE

- There is an important distinction between the cost of designing, prototyping, and testing a product and the cost of the product after manufacturing and distribution.
- while costing is an important element in the profitability of a design, it is generally not a key factor in the pricing of the artifact.
- costs are an important element in the profit equation. Revenues, on the other hand, are determined by the price charged for an item multiplied by the number of items sold.
- For most profit maximizing firms, prices are not set on the basis of costs, but rather in terms of what the market is willing to pay.
- the responsibilities of marketing professionals on a design team usually include identifying design attributes that make consumers willing to pay a high price for a new product design.

DESIGN RIGHTS

- What is a design right?
  - If you have created a new design, it's worthwhile considering registering it to effectively prevent others from copying or exploiting your design. A registered design is an excellent and cost-effective tool to protect your rights against copying and counterfeiting.
- A design registration means you can register the look of your product. It gives you an exclusive right to your design for a limited time
- Designs can be registered to protect the look of your whole product, a part of your product, or even just a small detail. Your product might be something functional, like a mobile phone, a drill, or a toothbrush, or something more decorative like a vase or a piece of jewellery.

DESIGN RIGHTS

- You can also protect graphical symbols, logos, computer icons, user interface graphics, even typefaces with a registered design.
- The design must be new and have individual character over prior design registrations in order to be registered

ETHICS IN DESIGN

- To design means to accept responsibility for creating designs: designers are influenced by the society in which they work, and designed products influence society. That is why we must consider ethics and ethical behavior in our examination of how engineers design things.

ETHICS: UNDERSTANDING OBLIGATIONS

- Words like ethics, morals, obligations, and duty are used in a variety of ways in everyday life, including seemingly contradictory or unclear ones
- **Ethics**
  - **1:** the discipline dealing with what is good and bad and with moral duty and obligation
  - **2a:** a set of moral principles or values
  - **2b:** a theory or system of moral values c: the principles of conduct governing an individual or group
- **moral**
  - **1 a:** of or relating to principles of right or wrong in behavior
  - **1 b:** expressing or teaching a conception of right behavior
- These definitions define ethics as a set of guiding principles or a system that people can use to help them behave well.

CODES OF ETHICS: WHATARE OUR PROFESSIONAL OBLIGATIONS?

- The professional societies also undertook other kinds of activities, including promulgating design standards, and providing forums for reporting research and innovations in practice.
- The professional engineering societies continue to play a leading role in setting ethical standards for designers and engineers.
- These ethical standards clearly speak to the various and often conflicting obligations that an engineer must meet.
- The societies also provide mechanisms for helping engineers resolve conflicting obligations, and, when asked, they provide the means for investigating and evaluating ethical behavior.
- Most professional engineering societies have published codes of ethics.

CODES OF ETHICS: WHATARE OUR PROFESSIONAL OBLIGATIONS?

- There are some points to make regarding the professional societies and their codes.
  - the differences in the codes reflect different styles of engineering practice in the various disciplines much more than differences in their views of the importance of ethics.
  - the professional societies, notwithstanding their promulgation of codes of ethics, have not always been seen as active and visible protectors of whistleblowers and other professionals who raise concerns about specific engineering or design instances.
  - the codes of ethics we have described are not necessarily the same as those in all parts of the world.

ETHICS: ALWAYS A PART OF ENGINEERING PRACTICE

- Ultimately, ethics is intensely personal
- There is no way to predict when a serious conflict of obligations and loyalties will arise in our individual lives.
- Nor can we know the specific personal and professional circumstances within which such conflicts will be embedded.
- Nor, unfortunately, is there a single answer to many of the questions posed.
- If faced with a daunting conflict, we can only hope that we are prepared by our upbringing, our maturity, and our ability to think and reflect about the issues that we have briefly raised

SAMPLE QUESTIONS

- 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.
- 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.

REFERENCES

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