DESIGN TO LIFE CYCLE COST

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- EARLY DESIGN
- REQUIREMENT DEFINITION AND CONCEPTUAL DESIGN
- TRADE-OFF ANALYSIS
- OPTIMIZATION USING COST AND UTILITY METRICS
- TRADE-OFF ANALYSIS MODELS AND PARAMETERS
- DESIGN TO COST
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PITFALLS IN REQUIREMENT DEFINITION

- Successfully translating customer needs into product level requirements is extremely difficult. There are several common pitfalls in this process.
- First - a specific solution (e.g., technology, resolution, bandwidth, or part types) is determined too early before conceptual design and trade-off studies have been performed.
- Second - product requirement must be extremely Innovative - many risks and ensure failure
- Third - requirements can be stated in general terms.
- Fourth - common temptation to accept customer, marketing, or a consultant's suggestions as the only and final input.

- Fifth - problem statement is continuously changing. This is called a "moving target."
- Sixth - product's requirements become too complex and detailed.
- Seventh - develop only one set of requirements for all customers.

CONCEPTUAL DESIGN PROCESS

- The conceptual design process

(1) identifies all design approaches (i.e., alternatives) that could meet the defined requirements,

(2) performs trade-off analyses to select the best design approach to be used and

(3) transforms the product requirements into lower level design requirements based on the selected approach.

- It begins when a new product is defined in the requirement definition process and continues until the final design approach has been identified.
- Requirements are allocated down to the lowest levels needed and documented during this process.
- This is the phase where the size of the design team will grow.

(1) Identify all design approach and alternatives

- The first step is to start identifying potential design solutions to be used in trade-off analyses.
- Many people are involved in this collaborative effort to insure all possible options are considered. Creativity and innovation must be encouraged not only for design but also manufacturing, logistics and other areas.
- Identifying alternatives are often performed in "brainstorming" sessions.
- Design is about anticipation. The team anticipates new technologies and styling trends to envision how they might be translated into a good-looking, useful, easy-to-use and desired products. The team also anticipates styling and social changes and identities new customer need and desires as a result of those changes

(2) Extensive Trade-off Analyses

- The next step of conceptual design consists of evaluating each of the identified design approaches.
- Examine alternative design approaches and different parameters with the purpose of optimizing the overall performance of the system and reducing technical risk. This includes both innovative and Traditional approaches.
- A trade study is a formal decision-making method that can be used to solve many complex problems.
- Trade studies (also called trade off studies or analyses) are used to rank user needs in order of importance, develop cost models, and identify realistic configurations that meet mission needs. That information then helps highlight producible, testable and maintainable configurations with quality, cost, and reliability at the required levels.

- Trade-off studies are directed at finding a proper balance between the many demands on a design. The trade-off studies should include all-important parameters such as cost, schedule, technical risk, reliability, producibility, quality, and supportability.
- Utility metrics can be also used to quantify the different alternatives. The steps in trade-off studies are to:

1. Form a cross-functional team. The team may be completely independent group, with augmentation by functional experts.
2. Encourage customer involvement and innovation.
3. Define the objectives of the trade study alternatives.
4. Determine the approach and resources required.
5. Evaluate and select the preferred alternative.
6. Validate the study results through testing and/or simulation.
7. Iterate more detailed trade studies throughout the design process.
8. Document the study and results.

(3) Developing and allocating Design Requirements

- Since these design requirements will provide the Performance baseline for each design team member they should be:

1. Easy to understand
2. Realistic
3. Detailed and measurable for the selected design approach.

- Important method of communication and provide the foundation for the design effort. It is used to develop program organization, funding, partnerships, and guidelines (including part selection, producibility, and reliability).
- Design goals and requirements should be sufficient in detail to:

- Communicate essential requirements to all the members of the design team including vendors.
- Permit complete technical control of the design process in all aspects of the program.
- Minimize loss of continuity resulting from personnel changes.
- Provide a quantified baseline for design trade-offs, design reviews and measurement of technical progress.
- Provide quantified testable requirements for test and evaluation.

➢ Design team must ensure that the stated requirements are reasonable and appropriate for the end user and within the limits of existing technology or that the technology could be developed.

IMPORTANT DEFINITIONS

TRADE-OFF STUDIES

- Design trade-off studies examine alternative design approaches and different parameters with the purpose of optimizing the overall performance of the system and reducing technical risk.

COST

- Cost is the most useful and popular measure for trade-off studies due to its universal nature and its flexibility as a measure. Cost is a flexible measure since almost any design parameter can be converted to a cost measure.

DESIGN TO COST (DTC)

- Design to Cost (DTC) is a cost analysis technique aimed at reducing or minimizing a product's price or cost, which results in increased sales volume.

LIFE CYCLE COST

- Life cycle cost (LCC) is **a cost analysis discipline that develops a** model of the total cost for development, operation, maintenance and disposal of a product over its full life to be used in design trade-off studies.

BEST PRACTICES FOR TRADE-OFF ANALYSIS

- Systematic decision making process that addresses all possible impacts of various design decisions.
  - Design improvements are identified and implemented through an action-oriented approach.
  - Models are accurate and based on a realistic assessment of user needs, market requirements, product performance, manufacturing capabilities, prototypes, logistics, and other factors.
  - Parameters used in the model are up-to-date, accurate.
- Design to Cost aggressively lowers product costs in order to increase sales and profit.
- Life Cycle Cost models are used for in-depth trade-off studies of design, manufacturing, operation, maintenance, logistics, environmental, and warranty parameters to improve the design.

SYSTEMATIC TRADE-OFF ANALYSIS PROCESS

➢ Analysis is a technique for gathering additional information in order to make better design decisions for improving the design.

➢ All analyses need to address the possible impacts of their results on other areas/disciplines in product development. This includes all aspects of a product at the appropriate level of detail. The steps of a successful trade-off analysis procedure at one company are to develop:

- Clear problem statement
- Identification of requirements that must be achieved
- Ground rules and assumptions
- Decision criteria
- Schedule
- Potential solutions and screening matrix
- Comprehensive array of feasible alternatives
- Comparisons of alternatives using decision criteria
- Technical recommendation of trade study leader

TRADE-OFF ANALYSIS MODELS AND PARAMETERS

- Models provide information to the design team. The quality of the model and its parameters determines the quality of the information provided.
- Models and their parameters need to be accurate, up to date and based on a realistic assessment of user needs, market requirements, product performance, manufacturing and support capabilities, prototypes, logistics, and other factors.
- Good models provide quality information that reduces technical risk and are cost effective, accurate, and timely. The best model depends on the application and the resources and time available.

DESIGN TO COST

- A technique aimed at reducing or minimizing a product's price or cost, which results in increasing sales volume. This analysis focuses on the need to reduce a product's purchase price.
- Reduction of product cost is accomplished through a rigorous approach of identifying and implementing cost reducing design and manufacturing improvements.
- There are three steps in developing an effective DTC program:
  1. Determine critical product price goals or targets using market elasticity research for various levels of sales.
  2. Establish realistic product cost goals based on projected sales volumes and learning curve improvements in design and manufacturing that accomplish the established product price goals.
  3. Reduce costs to meet these cost goals through an action-oriented approach using trade-off studies.

DESIGN TO LIFE CYCLE COST

- Life cycle cost (LCC) is a discipline that develops a model of the total cost for acquisition, operation, maintenance and disposal of a product over its full life to use in design trade-off studies.
- The model is used for analytical trade-off studies, identifying overall cost of a product and predicting future costs of maintenance, logistics, and warranties.
- A major decision to be made when using cost metrics is the types of costs to include, length of time for the study, and the cost of money i.e. inflation in the study.
- An effective effort requires a realistic LCC model, valid input data, extensive design trade-off studies, and the implementation of design improvements identified in the trade-off analyses. The limitations of the model are as important as its strengths.

There are three steps in developing effective life cycle cost models for design trade-offs.

1. Develop cost models that accurately describe the costs associated with a product.
    a. Define parameters and collect data
    b. Develop LCC model (parametric or accounting)
    c. Perform baseline analysis using the model
2. Perform verification analyses, trade-off analyses and identify cost drivers.
    a. Vary LCC model inputs and iteratively evaluate its effects to
    b. Perform trade-off analyses
    c. Identify design improvements
3. Reduce costs to meet these goals through an action oriented approach using design trade-off studies.
    a. Implement improvements

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Thank you