

## CONCEPTUAL DESIGN AND TRADE OFF ANALYSIS

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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
- ❖ DESIGN TO LIFE CYCLE COST
- ❖ DESIGN FOR WARRANTIES

# IMPORTANT DEFINITIONS

## REQUIREMENT DEFINITION

- An evolutionary process of **identifying, defining, and documenting specific customer needs** to develop product requirements for a new product, system, or process.
- It focuses on “what needs to be done” and is the **first phase in product development** but sometimes requires updating as changes occur in the market and technology.
- This activity focuses on “**what is needed**” to be successful **not on “how to” design the product.**

## CONCEPTUAL DESIGN

- A systematic analytical process used to
  - 1) identify several **design approaches** (i.e., alternatives) that could meet the defined product requirements,
  - 2) perform trade-off analyses to **select the best design approach** to be used, and

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

➤ It focuses on “**how to get it done**” and begins when a need for a new product is defined and continues until a detailed design approach has been selected that can successfully meet all requirements.

➤ In addition, it determines detailed design goals and requirements, allocates them to the lowest levels needed and then finalizes them during this phase.

## **BEST PRACTICES FOR EARLY DESIGN REQUIREMENT DEFINITION PROCESS**

- (i) Customer needs analysis
- (ii) Product use and user profiles
- (iii) Technological capability forecasts
- (iv) Benchmarking and company compatibility
- (v) Prototyping, virtual reality and house of quality

## CONCEPTUAL DESIGN PROCESS

- (i) Collaborative multidisciplinary process
- (ii) Identify all possible design alternatives
- (iii) Extensive trade-off studies
- (iv) Design requirements
- (v) Documentation

## CUSTOMER NEEDS ANALYSIS

- ❖ Interviews of customers
- ❖ Design partnerships or alliances
- ❖ Computer databases and data mining
- ❖ Consultants or experts
- ❖ Brainstorming sessions
- ❖ Personal and company experience
- ❖ Published information
- ❖ Market and competitor benchmark analysis
- ❖ Prototyping and virtual reality
- ❖ House of quality or Quality Function Deployment

# PRODUCT USE AND USER PROFILES

- Product use and user profiles **document on a time scale, all the functions that a product and the user must perform**, including the various environments that the system will encounter.
- Profiles provide the operational, maintenance, and environmental baseline for the definition of design requirements.
- **Profile methods** include:
  - 1. Scenarios and use cases:** step-by-step descriptions of how the product will be used for a particular application or task.
  - 2. Task analysis and user profile** - design technique that evaluates specific task requirements for an operator with respect to an operator's capabilities. **Breaks down major tasks into detailed descriptions.** The level of details and requirements for each task will progressively become more detailed as the design process progresses. The **level of details** varies from project to project but can include: **Expertise And Training, Tools And Equipment, Goals, Feedback, Resources, Expected Outcomes, Decisions** etc.

**3. Network diagrams**-used to graphically show the interrelationships and sequential flow of how the product will be used and supported. Traditional structured analyses may also be used to identify process flows, events and conditions, and entities in legacy system documentation.

**4. Product use, mission or environmental profiles** - These profiles should include both environmental and functional conditions. An environmental profile shows on a time scale the significant environmental parameters, including their levels and duration that are expected to occur during the life of the product. It defines the total envelope of environments in which the product must perform, including conditions of storage, handling, transportation, and operational use.



# BENCHMARKING AND COMPANY CAPABILITY ANALYSIS

➤ Processes for **studying a company's capabilities and measuring the company's products, services, and practices against the competition or those companies recognized as leaders.** The purpose is to **determine product requirements and identifying innovative ideas.** It is the systematic process of identifying the "best" practices in industry, setting product and manufacturing goals based on results of what the competition has achieved or will achieve in the future and identifying the best vendors.

➤ **Importance of Bench marking** for several reasons:

- Better awareness of customer needs, preferences and values
- Better knowledge of each company's strengths and weaknesses
- Better awareness of competitor's product, manufacturing processes, vendors used, etc.
- Identify successful product requirements (e.g., performance, quality, availability, price, service, reliability, support)
- Identify the best vendors and suppliers to use in the design.

➤ Five key steps to benchmarking are:

1. **Analyze** all aspects of the **competition** and other **successful companies**.
2. Determine where your **company stands** relative to competitors and leaders on key features, parameters, and processes both on today's products and on predictions of future products.
3. **Establish "Best in Class" product features and parameters**.
4. Set product, manufacturing, and supportability **requirements**.
5. Implement a practice of "**innovative imitation**" (i.e., improve on the best ideas and methods that were identified).

## **PROTOTYPING AND VIRTUAL REALITY**

➤ Use hardware and software conceptual prototypes to **study customer responses to new products and to identify areas for improvements** for both requirement definition and conceptual design. The basic philosophy behind the use of prototyping is to provide a **communications platform for studying consumer needs** and refining product use scenarios and task analysis.

➤ Prototyping helps the design team by encouraging the consideration of as many product development issues as possible during the early phases and identifying potential problems. The steps in prototyping are:

1. Produce prototypes that provide the reviewer a realistic view or feel of the proposed design.
2. Develop as many prototypes as economically possible.
3. Continuously produce prototypes throughout the product development process.
4. Show the prototypes to everyone.

## HOUSE OF QUALITY

➤ House of Quality or Quality Function Deployment (QFD) is both a requirement definition and conceptual design tool that systematically documents customer needs, benchmarks competitors, and other aspects and then transforms this information into design requirements. QFD is a complex process that requires considerable effort.

➤ The steps in QFD are:

1. Determine and **rank customer attributes**, i.e. what does the customer want? Which attributes are most important?
2. **Document customer perceptions** of how well different products meet these attributes. Which products do the customers like for each of the attributes?
3. **Determine “measurable” design characteristics/parameters** and rate their relationship to the customer attributes.
4. Determine **objective requirements and measures** (goals) for the design characteristics.



# References

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A large, faded logo of Galgotias University is centered in the background. It features a circular emblem with three curved, overlapping bands in shades of yellow, blue, and red, creating a sense of motion or a stylized 'G'.

**Thank you**

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