EE 4BI5 Fall 2006

PRODUCT SPECIFICATIONS

I What are Specifications?

- Precise description of what the product has to do
- Target specifications are established early before technical, cost or time constraints are fully considered
- Result of identifying and determining customer needs

II Establishing Target Specifications

- Prepare the list of metrics (measurables) that define the specifications
- Should be complete
- Should be dependent, not independent variables
- Metrics should be practical
- Should include the popular criteria for comparison in the market place
- Collect competitive benchmarking Information
- Set ideal and marginally acceptable Target Values for each metric
- Reflect on the results and the process

SETTING THE FINAL SPECIFICATION

I Develop Technical Model of the Product

- Determine the technical feasibility of the product. Is the concept do-able using current technology available
- Build or design prototypes to evaluate each concept and determine the specifications that can be achieved using that concept.
- Computer simulation or analytic evaluation. Software such as EM field calculations, SPICE, CAD etc. can be used to determine whether specifications can be met by a concept without expensive building. However this usually only gives you ideal results and real achievable results tend to be less satisfactory.
- Several independent models representing different subsystems are better than one inclusive model. In other words break the product down into subsystems and work with each subsystem.

  NB The models developed can only relate to a specific design concept. Therefore you will need a separate model for each design concept.

II Develop Cost model of the Product

- Goal is to determine whether product can be produced at the target cost
- i.e. Manufacturing cost + distribution cost + a reasonable profit will still give a competitive consumer price. In the case of a large production run such as thousands for several years development costs have very little impact on target cost. However when the product run is small and development costs, especially

for a complex product, are high, these costs must be factored into the consumer price

- The first estimate of costs can be a bill of materials with each item cost determined from the purchase price or cost of manufacturing. Assembly costs can be added as these are determined
- The bill of materials can also be used as a cost performance indicator for different design concepts or target specifications

It must be remembered that where target specifications are a result of interpreting customer needs, final specifications, including generating technical and cost models are iterative processes followed while in the concept generation, concept selection stages of the development process.

III Refine the Specifications, making Trade-offs where Necessary

- Use the technical and cost models to develop final specifications. Each concept will have its models and sets of specifications. At this time trade-offs may have to be made between costs and achieving target specifications or between sets of conflicting specifications.
- Use competitive maps – plotting cost and value for specific metrics of your product and for the competition's products.

IV Flow Down the Specifications as Appropriate

- For complex products you need overall specifications
- The overall specifications are then applied to each subsystem as required. In other words the specifications for each subsystem must be consolidated to give the overall specifications

V Reflect on Results and Process

- Is the product a winner?
- How uncertain or approximate are the technical or cost models?
- Is the concept best for the target market or best meets another market segment? For example, although a less stringent set of target specifications had been established, the new concept allows us to achieve a much more exacting set of specifications. This could mean shifting from a consumer market to a professional or business market.
- Can better modeling approaches be adopted?

CONCEPT GENERATION

A product concept is an approximate description of the technology working principles and the form of the product

I Clarify the Problem

- Understand the problem fully

- Decompose a complex problem into simpler sub problems, i.e. from a single block in a flow diagram create sub blocks each relating to a function (3 to 10 sub functions for a major block). No detailed implementation is yet suggested.
- Focus on the critical sub problems first.

II Search Externally

- Find existing solutions to both overall problem and sub problems. Search in related fields
- Some sub problems may have conventional solution while others will require novel solutions
- Sources include journal or textbook literature, WEB, experts, descriptions of similar products.

III Search Internally

- Use expertise of group members
- Use course notes and texts including previous assignments, etc

IV Explore Systematically

- Concept classification tree (overall concepts followed by subconcepts)
- Eliminate less promising branches
- Identify which concepts require more work
- Identify whether concepts can be combined for a better solution
- Manage exploration sensibly (set time limit and resource limit)

CONCEPT SELECTION

Once all reasonable concepts have been explored, the final product concept must be chosen

I Structured Approach

- Use a hierarchical approach
- Are resources available or can be acquired in a reasonable time?
- Are there any technical uncertainties (even if the concept is very novel and exciting are there unknowns associated)?
- What are the relative dollar costs for each concept?
- How does each concept match the capabilities of the team members?
- What are the associated time requirements for each concept?
- How well does each concept satisfy the ideal specifications?

II Rating and Ranking Concepts

- Determine your rating criteria for each concept and determine a number for each criterion
- Give an overall ranking for each concept by multiplying each criterion value by a weighting factor and summing the results

Selecting Final Concept(s)

- Ranking for student projects can be based on the weighted sum of purchase costs of subcomponents, implementation time, and overall design implications.
- Before rejecting concepts determine if best features of competing concepts can be combined.
- Determine if considered concept(s) can be improved.
- Select concepts in order of priority. Selection of one concept may influence selection of concept for a lower priority subcomponent.
- Before selecting final concept(s) consider all implications of selection.
- Before ordering parts or starting detailed design reflect on your decisions.

Concept Testing

In industry prior to the detailed design and testing of final prototypes, it is a common practice to conduct a market survey to determine the acceptability of the final concept selection. The target market is established and presentations are made using a variety of marketing techniques including literature (with graphics including sketches) of proposed product, seminar presentations to selected high profile groups, video including Web based presentations. Detailed customer responses are solicited to (i) determine if proposed product is a winner and (ii) determine if concept(s) meet customer needs. In our case that won't be necessary since I am your customer. This process is necessary in real life before company resources are poured into detailed design (for manufacturing) and setting up a manufacturing facility to produce a prototype(s) or even the final product. A very specific example is the solicitation by armed forces weapons procurement agency for concept presentations followed by limited funding for designing and building several prototypes. These are then evaluated prior to final granting of the contract.

Industrial Design

The primary mission of industrial design is to design the aspects of a product that relate to the user: aesthetics and ergonomics. How does it look and how easy is it to use (how much mental energy or physical energy is required by the operator). Industrial design will be required for some of your projects. For example, attractive and easy to view and use computer interface windows or displays will determine whether your product will be a winner in the market place. This area of engineering design is not to be underestimated for importance in the overall design process.

Design for Manufacturing

If you are required to manufacture your proposed design in quantity, design for manufacturing is aimed at reducing manufacturing costs while simultaneously improving (or at least not inappropriately compromising) product quality, development time and development cost. In our context, it is minimizing the cost of your bill of materials. In software development, this is not a consideration. However for all projects maintainability is an important consideration.

Prototyping
Defined as an approximation of the product along one or more lines of interest. This is the process you will be engaged in from now until the project is completed.

- Prototypes can be usefully classified along two dimensions: (1) the degree to which they are physical as opposed to analytical and (2) the degree to which they comprehensive as focused.
- Prototypes are used for learning, communication, integration and milestones. Physical prototypes are usually best for communication, and comprehensive prototypes are best for integration and milestones.
- Analytical prototypes are generally more flexible than physical prototypes. Physical prototypes are required to detect unanticipated phenomena. A prototype may reduce the risk of costly iterations, expedite other development steps, or restructure task dependencies.
- 3D computer modeling, circuit simulators, high level language packages, and free form fabrication technologies have reduced the relative cost and time to create prototypes.
- A four-step method for planning a protype is:

  1. define the purpose of the prototype
  2. Establish the level of approximation
  3. Outline an experimental plan
  4. Create a schedule for procurement, construction, and test

- Milestone prototypes are defined in the product development plan. The number of such prototypes and their timing is one of the key elements of the overall development plan