Project Definition and Planning

- Concurrent engineering encourages involvement throughout the entire product life cycle from the project definition to product retirement.

- Project definition and planning is the first phase of the mechanical design process.
Project Definition

● Why developing new products?
  - To fill some market need
    • Mostly driven by the customer
  - To exploit a technological development
    • Driven by new technologies and what is learned during the design

● Project Definition:
  - the challenges of choosing from the many suggestions as to which products to spend time and money on to develop or refine
  - “Fuzzy front end” of dealing with vague design ideas

● Specific Questions in Project Definition Phase:
  - Is there a good potential return on investment (ROI)?
  - Does the new product or improvement fit the company image?
  - Does it fit the distribution channels?
  - Is there sufficient production capacity in-house or with known vendors?
  - What will the project cost?
Project Planning

- Planning is like trying to measure the smile of the Cheshire cat; you are trying to quantify something that isn’t there.

- Planning is the process used to develop a scheme for scheduling and committing the resources of time, money, and people.
  - Producing a map showing how product design process activities are scheduled.
  - The whole activities of specification definition, conceptual design, and product development must be scheduled and have resources committed to them
  - Planning generates a procedure for developing needed information and distributing it to the correct people at the correct time.
  - Important information: product requirements, concept sketches, system functional diagrams, component drawings, assembly drawings, material selections, and any other representation of decisions made during the development of the product.

- Typical Master Plan (a generic process) of a Company for Specific Products:
  - A blueprint for a process:
    - product development process; delivery process; new product development plan; or product realization plan, etc.

- We will refer to this generic process as the product development process (PDP).
ISO-9000

- A quality management system of the International Standard Organization
  - First issued in 1987 and now adopted by over 150 countries
  - Over 350,000 companies worldwide and 8500 U.S. companies have the ISO-9000 certification

- ISO-9000 registration means that the company has a quality system that:
  - Standardizes, organizes, and controls operations.
  - Provides for consistent dissemination of information.
  - Improves various aspects of the business-based use of statistical data and analysis.
  - Enhances customer responsiveness to products and services.
  - Encourage improvement.

- To receive certification,
  - One should develop a process that describes how to develop products, handle product problems, and interact with customers and vendors.
    - Required written procedures that:
      - Describe how most work in the organization gets carried out (i.e., the design of new products, the manufacture of products, and the retirement of products).
      - Control distribution and reissue of documents.
      - Design and implement a corrective and protective action system to prevent problems from recurring.
  - Evaluation of the effectiveness of the process by an accredited external auditor
  - Certification expires in 3 years and audits at 6-month intervals to maintain the currency of the certificate.

- ISO-9000 requires a company to have a documented development process on which the plan for a particular product can be based.
Background for Developing a Design Project Plan

- A plan tells how a project will be initiated, organized, coordinated, and monitored, e.g., managerial activities.
  - All team members are a part of these activities in the concurrent engineering.

- Types of Design Projects:
  - Variation of existing product:
    - Little change (little dimension change, etc.); takes little engineering
  - Improvement of existing product:
    - Redesign of some features of an existing product due to:
      - Customers request;
      - no longer supply of materials or components from the vendor;
      - needed improvement in manufacturing; or
      - New technology or new understanding of an existing technology
  - Development of a new product for a single or small run:
  - Development of a new product for mass production:

- Members of the Design Team:
  - Product design engineer:
  - Product manager (product marketing engineer):
  - Manufacturing engineer; Detailer; Drafter; Technician; Materials specialist; QC/QA specialist; Analyst; Industrial engineer; Assembly manager; Vendor’s or supplier’s representatives

- Structure of Design Teams:
  - Functional Organization (13 %)
  - Functional Matrix (26 %)
  - Balanced Matrix (16 %)
  - Project Matrix (28 %)
  - Project Team (16 %)
  - Organize the talent around the project whenever possible.
    - Structures focus on the project are more successful than those built around the functional areas in the company.
Planning for Deliverables

● Deliverables:
  – All models of the product, such as drawings, prototypes, bills of materials, analysis results, test results, and other representations of the information generated in the project
  – Measure of the progress in design project

● Models vs. Prototypes:
  – Models are analytical and/or physical representations of design information.
  – Prototypes are physical models. Solid models in CAD can replace the physical models these days.

● 4 Purposes of Prototypes:
  – Proof-of-concept:
    • Developing function of the product to compare with the goals
    • Learning tool
  – Proof-of-product:
    • Refine the components and assemblies
    • Geometry, materials and manufacturing processes are as important as functions
    • Rapid prototyping and CAD models have greatly improved the time and cost efficiency in building prototypes.
  – Proof-of-process:
    • Verify both the geometry and manufacturing process.
    • Exact materials and manufacturing processes are used to build sample for functional testing.
  – Proof-of-production
    • Verify the entire production product.
    • The result of preproduction run.
## Types of Models

<table>
<thead>
<tr>
<th>Phase</th>
<th>Physical (Form and Function)</th>
<th>Analytical (mainly Function)</th>
<th>Graphical (mainly Form)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concept</td>
<td>Proof-of-concept prototype</td>
<td>Back-of-the envelope analysis</td>
<td>Sketches</td>
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<td>Proof-of-product prototype</td>
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<td>Layout drawings</td>
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<td></td>
<td>Proof-of-process and proof-of-production prototype</td>
<td>Finite element analysis; detailed simulation</td>
<td>Detail and assembly drawings; solid models</td>
</tr>
<tr>
<td>Final Product</td>
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An important decision in planning the project:
How many models and prototypes should be scheduled in the design process?

Because of cost effectiveness, there is a strong move toward replacing physical prototypes with computer models. But not always right.

Be sure to set realistic goals for the time required and the information learned.
Five Steps in Planning

- **Step 1: Identify the Tasks**
  - Tasks in terms of the activities that need to be performed (generate concepts).
  - Make the tasks as specific as possible.

- **Step 2: State the Objective for Each Task**
  - Each task must be characterized by a clearly stated objective.
    - The results of the tasks (or activities) should be the stated objectives.
  - Task objectives should be:
    - Defined as information to be refined or developed and communicated to others.
    - Easily understood by all in the design team.
    - Specific in terms of exactly what information is to be developed. If concepts are required, then tell how many are sufficient.
    - Feasible, given the personnel, equipment, and time available.

- **Step 3: Estimate the Personnel, Time, and Other Resources Needed to meet the Objectives**

- **Step 4: Develop a sequence for the tasks**

- **Step 5: Estimate the Product Development Costs**
Step 3: Estimate the Personnel, Time, and Other Resources Needed to Meet the Objective

- **Necessary Identification for each Task:**
  - Who on the design team will be responsible for meeting the objectives?
  - What percentage of their time will be required?
  - Over what period of time they will be needed?

- **Time (in hours) = A x PC x D^{0.85}**
  - **A** = a constant based on past projects
    - **A** = 30 for a small company with good communication
    - **A** = 150 for a large company with average communication
  - **PC** = product complexity based on function
    \[ PC = \sum j \times F_j \text{ (} j \text{ = the level in the functional diagram; } F_j \text{ = the number of functions at that level)} \]
  - **D** = project difficulty
    - **D** = 1, not too difficult; **D** = 2, difficult; **D** = 3, extremely difficult

- **Time estimation = (o + 4m + p)/6**
  - **O** = optimistic estimate; **m** = most-likely estimate; **p** = pessimistic estimate

- **Time Distribution across the Phases of the Design Process**
  - Project Planning (3 – 5 %); Specifications Definition (10 – 15 %); Conceptual Design (15 – 35 %); Product Development (50 – 70 %); Product Support (5 – 10 %)
Step 4: Develop a Sequence for the Tasks

- The goal is to have each task accomplished before its result is needed and to make use of all of the personnel, all of the time.
  - For each task, it is essential to identify its predecessors and successors.
  - Tasks are often interdependent – two tasks need decisions from each other in order to be completed.
    - Sequential vs. Parallel tasks

- Bar Chart (or Gantt Chart) – best way to develop a schedule

- Design Structure Matrix (DSM)
  - Useful tool for to help sequence the tasks
  - Showing the relationship (or inter-dependence) among tasks (example: see page 104)
Step 5: Estimate the Product Development Cost

- The planning document can serve as a basis for estimating the cost of designing the new product in terms of:
  - Personnel cost
  - Resources (supplies and equipment)

Team Project:
- Planning must be done and written in the PDF.
- Read examples in pages from 105 – 109 for planning.
- Gantt chart or DSM should be good entries.