Design for Manufacturing

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5: Project Definition and Planning

- Concurrent engineering encourages involvement of engineers throughout the entire product life cycle.

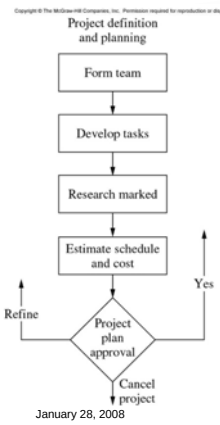


Fig. 5-1 Project definition and Planning

Courtesy: David Ullman – Mechanical Design Process, McGraw Hill, 2003

Project Definition

- New product Ideas come from
  - Marketing department
  - Engineers and Scientists
  - 2 to 10% of revenue is spent on R & D
  - Design and Refine

Project Definition

- Questions to be asked
  - 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

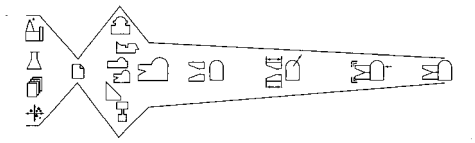
- Planning is the process used to develop a scheme for scheduling and committing the resources of time, money, and people.
- Planning results in a map showing how product design process activities are scheduled.
- Planning generates a procedure for developing needed information and distributing it to the correct people at the correct time.

Project planning

- The activity of planning results in a blueprint for a process.
- Most companies have a generic process (I.e., a master plan) that they customize for specific products.
- This master plan is called the product development process, product delivery process, new product development plan, or product realization plan.

Project planning

- Key feature of concurrent engineering is the emphasis on the continuous improvement of the both the product and the process of developing the product.
- The material is presented as follows:
  - ISO 9000
  - Background material
  - Steps for planning a design project
  - Examples of project plans



Planning	Concept Development	System-Level Design	Detail Design	Testing and Refinement	Production Ramp-Up
Marketing • Articulate market opportunity. • Define market segments.	• Collect customer needs. • Identify lead users. • Identify competitive products.	• Develop plan for product options and extended product family.	• Develop marketing plan.	• Develop promotion and launch materials. • Facilitate field testing.	• Place early production with key customers.
Design • Consider product platform and architecture. • Assess new technologies.	• Investigate feasibility of product concepts. • Develop industrial design concepts. • Build and test experimental prototypes.	• Generate alternative product architectures. • Define major sub-systems and interfaces. • Refine industrial design.	• Define part geometry. • Choose materials. • Assign tolerances. • Complete industrial design control documentation.	• Reliability testing. • Life testing. • Performance testing. • Obtain regulatory approvals. • Implement design changes.	• Evaluate early production output.

Manufacturing • Identify production constraints. • Set supply chain strategy.	• Estimate manufacturing cost. • Assess production feasibility.	• Identify suppliers for key components. • Perform make-buy analysis. • Define final assembly scheme.	• Define piece-part production processes. • Design tooling. • Define quality assurance processes. • Begin procurement of long-lead tooling.	• Facilitate supplier ramp-up. • Refine fabrication and assembly processes. • Train work force. • Refine quality assurance processes.	• Begin operation of entire production system.
Other Functions • Research: Demonstrate available technologies. • Finance: Provide planning goals. • General Management: Allocate project resources.	• Finance: Facilitate economic analysis. • Legal: Investigate patent issues.	• Finance: Facilitate make-buy analysis. • Service: Identify service issues.		• Sales: Develop sales plan.	

EXHIBIT 2–2

The generic product development process. Six phases are shown, including the tasks and responsibilities of the key functions of the organization for each phase.

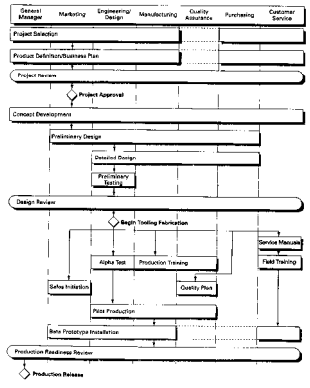


EXHIBIT 2–5

AMF Bowling's standard development process.

ISO - 9000

- Quality Management System
- Company has a quality system that
  - Standardizes, organizes and controls operation
  - 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
  - Encourages improvement

Types of design projects

- Variation of an existing product
- Improvement of an existing product
- Development of a new product for single or small run
- Development of a new product for mass production

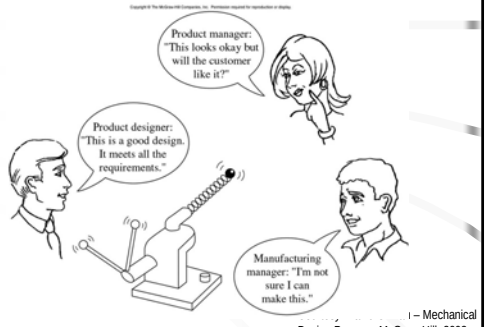
Members of Design Teams

- Large teams – many members, specialized functions
- Small teams – one individual may fill many roles

Members of Design Teams

- Product design engineer
- Product manager
- Manufacturing engineer
- Detailer
- Drafter
- Technician
- Materials specialist
- Quality control/assurance specialist
- Analyst
- Industrial engineer
- Assembly manager
- Vendor's or supplier's representatives

Fig. 5-2 The Design team at work



– Mechanical Design Process, McGraw Hill, 2003

Structure of Design Teams

- Functional organizations (13%)
  - Each project assigned to relevant functional area or group within a functional area
  - A functional area focuses on a single description
  - Boeing – Aerodynamics, Structures, Payload, Propulsion, etc.

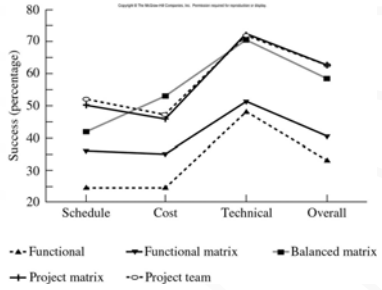
Structure of Design Teams

- Functional matrix (26%)
  - Project manager with limited authority is designated to coordinate the project across different functional areas or groups
- Balanced matrix (16%)
  - Project manager is assigned to oversee the project and shares with the functional managers the responsibility and authority for completing the project

Structure of Design Teams

- Project matrix (28%)
  - Project manager is assigned to oversee the project and has the primary responsibility for completing the project
- Project team (16%)
  - A project manager is put in charge of a project team composed of a core group of personnel from several functional areas or groups, assigned on a full-time basis

Fig. 5-3 Project success versus team structure



Courtesy: David Ullman – Mechanical Design Process, McGraw Hill, 2003

Planning for Deliverables

- Progress in a project can be measured by the deliverables such as
  - Drawings, prototypes, bill of materials, results of analysis, test results, and other information generated in the project
- Prototypes
  - Proof-of-concept
  - Proof-of-product
  - Proof-of-process
  - Proof-of-production

Planning for Deliverables

- Prototypes
  - Physical models
  - Rapid prototyping using CAD
  - Rapid tooling

Table 5.1 Types of models

	Medium		
Phase	Physical (form and function)	Analytical (mainly function)	Graphical (mainly form)
Concept	Proof-of-concept prototype	Back-of-the-envelope analysis	Sketches
↓	Proof-of-product prototype	Engineering science analysis	Layout drawings
Final product	Proof-of-process and proof-of-production prototypes	Finite element analysis; detailed simultation	Detail and assembly drawings; solid models

Five steps in Planning

- Project plan is a document that defines the tasks necessary to be completed during the design process
- For each task, the plan states the objectives, the personnel requirements, the time requirements, the schedule relative to other tasks, projects, and programs; and some times cost estimates.

Step 1: Identify the tasks

- Tasks needed to bring the problem from its current state to final product
- Activities that need to be performed in the process
- Tasks should be as clear as possible

Fig. 5-4 Gantt chart for BikeE suspension system project

Courtesy: David Ullman – Mechanical Design Process, McGraw Hill, 2003

Step 2: State objectives of each task

- The objective is to take some existing information about the product – the input – and through some activity refine it for output to other tasks.
- Each task objective must be
  - Defined as information to be refined or developed and communicated to others
  - Easily understood by all on the design team
  - Specific in terms of exactly what information is to be developed
  - Feasible within the resources available

Step 3: Estimate the resources needed to meet the objectives

- For each task it is necessary to identify who in the design team will be responsible for meeting the objectives, what percentage of their time will be required, and over what period of time they will be needed.
- Design takes time

Table 5.2 The time it takes to design

Task	Personnel/time
Design of elemental components and assemblies. All design work is routine or requires only simple modifications of an existing product.	One designer for one week
Design of elemental devices such as mechanical toys, locks, and scales, or complex single components. Most design work is routine or calls for limited original design.	One designer for one month
Design of complete machines and machine tools. Work involved is mainly routine, with some original design.	Two designers for four months
Design of high-performance products that may utilize new (proven) technologies. Work involves some original design and may require extensive analysis and testing.	Five designers for eight months

Step 3: Estimate the resources needed to meet the objectives

- Everything takes twice as long.
- Time estimation is very difficult and subject to error.
- Time allocation in phases
  - Project Planning – 3 to 5%
  - Specification definition – 10 to 15%
  - Conceptual design – 15 to 35%
  - Product development – 50 to 70%
  - Product support – 5 to 10%

Step 4: Sequence for the tasks

- The goal is to have each task accomplished before its result is needed.
- Identify predecessors (to be done before) and successors (to be done after).

Fig. 5-4 Gantt chart for BikeE suspension system project

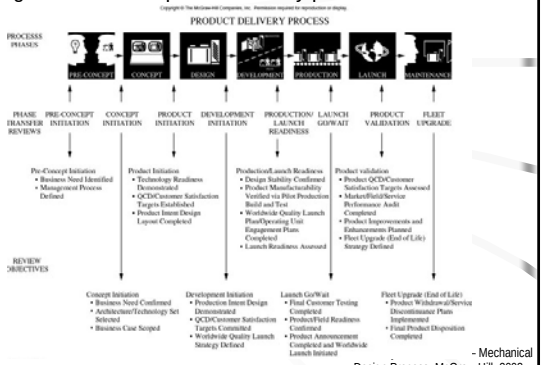
Courtesy: David Ullman – Mechanical Design Process, McGraw Hill, 2003

		A	B	C	D	E	F	G
Generate specifications	A	A						
Generate two concepts	B	X	B					
Develop test plan	C	X		C				
Test the concepts	D		X	X	D			
Design production parts	E	X	X		X	E	X	X
Design plastic injection mold	F	X				X	F	X
Design assembly tooling	G					X	X	G

Estimate the product development cost

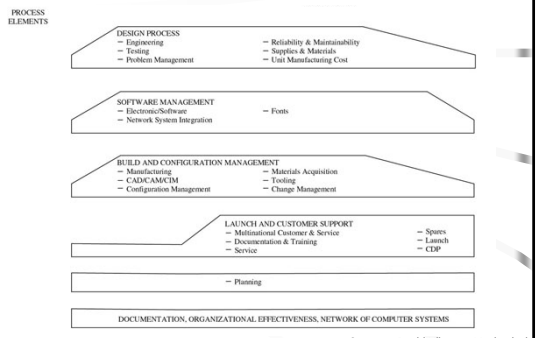
Design plan for Xerox

Fig. 5-5 The Xerox product delivery process



- Mechanical Design Process, McGraw Hill, 2003

Fig. 5-5 The Xerox product delivery process



Courtesy: David Ullman – Mechanical Design Process, McGraw Hill, 2003

Table 5.3 Details of Xerox's plan

Xerox phase	Phase in this text (Fig. 4.1)
Preconcept (33)	Project definition Project planning Specification development
Concept (43)	Conceptual design
Design (37) Development (61) Production planning (23) Launch (24)	Product design
Maintenance (10)	Product support

Table 5.4 Xerox sample C25: issue initial system requirements specification/system operation description

Description	The system requirements specification functionally describes the system and subsystem operation from a user's perspective, as well as describing the electrical, hardware, and software that underlies the functionality.
Purpose	Purpose is to ensure that the product requirements are understood and internalized by the design teams to enable the development of the initial prototype (P1).
Supplier	Engineering
Customer	Program Management, Marketing, Production Planner, Customer and Service Education, Support Groups, Manufacturing
Output	System requirement specification 1. System functional description a. System overview b. Features and functions c. System operation d. System faults and diagnosis 2. Subsystem function a. Input module description b. Copy handling module description c. Xerographic description d. Optics module description e. Fuser module description f. User interface description 3. Terminology and index

Design Plan – BikeE Rear Suspension

- Identified tasks are
  - Generate engineering specifications
  - Design two concepts
  - Develop prototype P1
  - Test P1 prototype
  - Select one concept
  - Develop prototype P2
  - Field test P2 prototype
  - Generate product documentation
  - Produce production plan
  - Produce marketing plan
  - Establish QC procedure
  - Write patent application

Summary

- Planning is like trying to measure the smile of the Cheshire cat, you are working with something that is not there.
- Planning is easier than doing, but much less fun.
- Plan to fail early and fail often.

Summary

- A task that only describes an activity is done when you complete the activity not when you have useful results.
- Everything takes twice as long.
- Never is often better than late. (Sidney Love, Planning and Creating Successful Engineered Designs, 1980.)

Questions and Comments