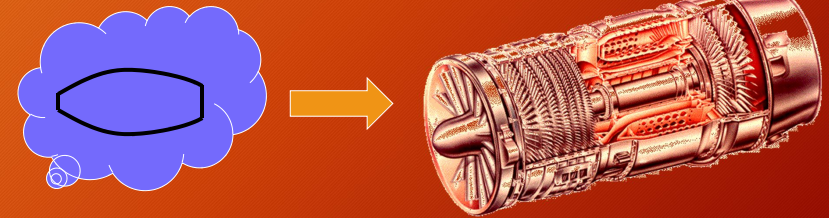


Product Design

Lecture 4: Development of new product

The Process of Design

- Designing is the process of making many decisions that converts an abstract concept into a hardware reality.



Concept

Product

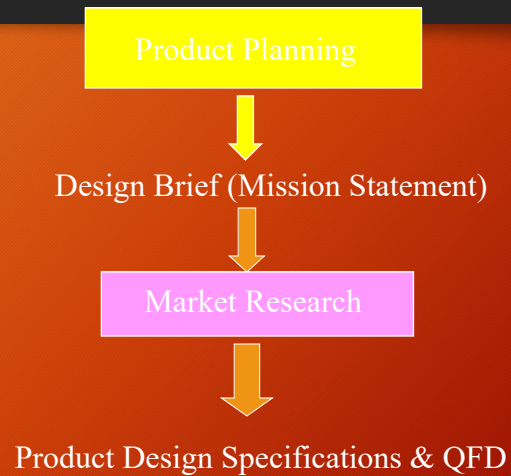
7-Step Design Process

1. Problem definition (PDS)
2. External Search (Research)
3. Internal Search (Brainstorming)
4. Evaluation and Selection
5. Detail Design (Engineering)
6. Prototyping
7. Documentation

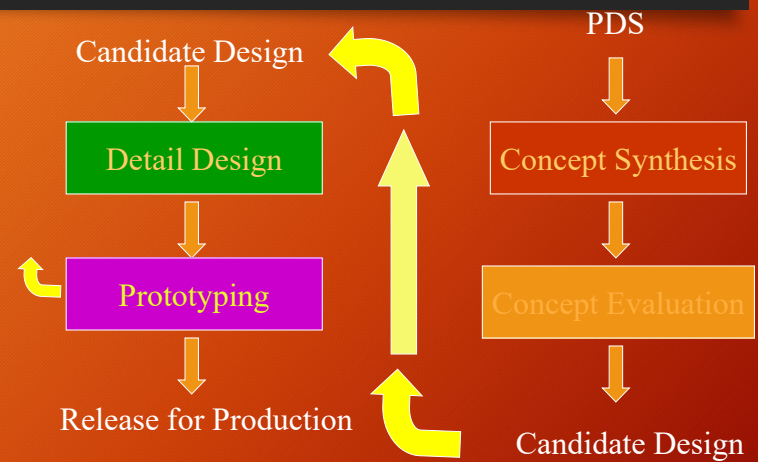
Design Process

- Top-level problem definition is called PDS (*Product Design Specifications*)
- Problem definitions at lower levels derive from PDS:
 - Sub-system design specifications.
 - Component design specifications.
 - Feature design specifications.

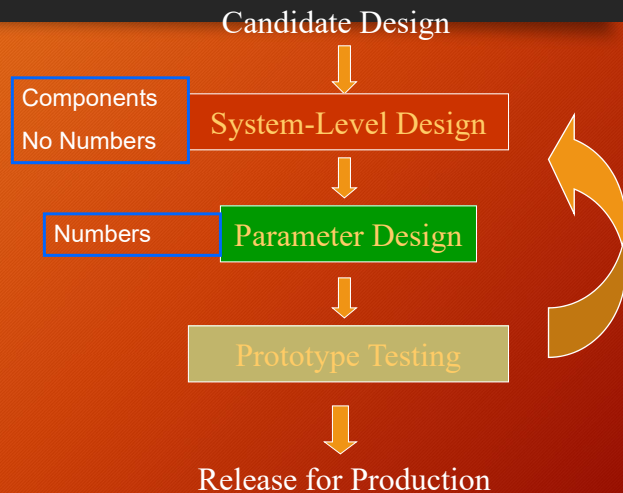
Product Development Process



Product Development Process

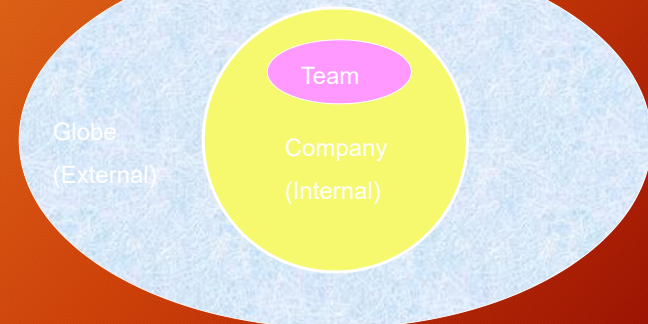


Detail Design

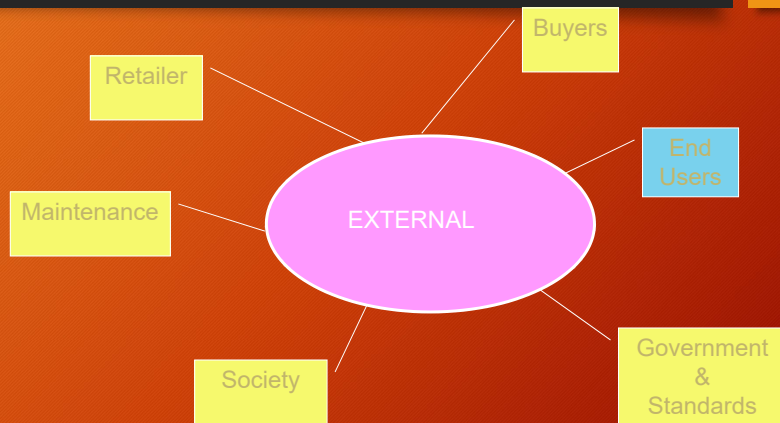


Customers

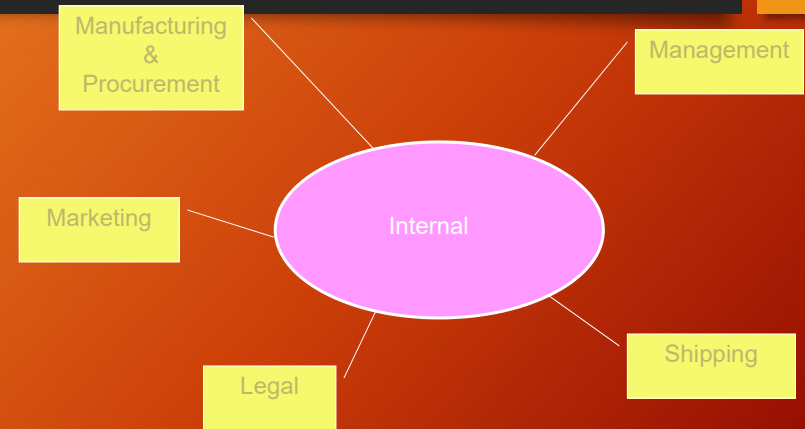
- People who are affected by the product



External Customers



Internal Customers



What Do They Want?

- End Users
 - Performance & Functionality
 - Affordability
 - Ease of use including ergonomics
 - Reliability and Long life
 - Versatility
 - Safety
 - Low maintenance and easy assembly
 - Esthetics

External Customers

- Buying managers
 - Low Cost/Performance
 - Safety
 - Ruggedness (abuse resistance)
 - Ergonomics
 - Long warranties
 - Reliable with Low downtime
 - Low operating cost
- Retailers
 - Small and attractive packaging
 - Long shelf life
 - Low cost/performance and Exciting features

External Customers

- Maintenance
 - Ease of maintenance
- Government / Standards / Society
 - Conformance to laws and regulations
 - Promotion of public health and safety
 - Protection of environment
 - Solution to chronic problems in society
 - Traffic
 - Energy
 - Noise
 - Drugs, abuse and other crimes
 - Diversity / Social tolerance / Security

Internal Customers

- Management
 - Make a big profit
 - On time delivery
 - Low failure risk
 - Documentation
 - Process: Conformance to company product development process

Internal Customers

- Marketing
 - Attractive features to target buyers
 - Low production cost
 - Esthetics
 - Attractive packaging
 - On time delivery
 - Long Warrantees
- Manufacturing
 - Manufacturability using standard methods and schedules.
 - Conformance to company documentation formats.
 - Use of products from preferred vendors.

Internal Customers

- Legal
 - No patent infringements
 - Safety
 - All required safety warnings and labels
 - Designed protection against reasonable abuse
 - Codes and regulations
- Shipping and Packaging
 - Ease of user assembly
 - Small packaged size
 - Ability of locking or fixing sensitive components
 - Resistance against damage due to dropping, vibrations, moisture, heat, and cold.

| | Performance | cost | Ease of use | Reliability | Safety |
|-----------|-------------|-------|-------------|-------------|--------|
| Users | ***** | ***** | ***** | ***** | ***** |
| Buyers | **** | ***** | ** | ***** | ***** |
| Retailers | *** | *** | *** | ** | ** |
| Govrnmnt | | | | | ***** |
| Mangmnt | ** | **** | ** | ** | *** |
| Marketng | **** | ***** | *** | **** | *** |

Purpose of a product specification

- **Documentation** is useful on all stages of the production process, on the suppliers and producer sides as well as on the buying company side which can use this document as a quality standard required at the delivery.
- In some industries such as in the food industry, the number of protocols and documents required during the production process can quickly skyrocket to guarantee food safety and a higher food quality. To meet this goal and standard, the food product and raw material specifications sheets primarily inform about the ingredients of each product and its condition of production.

Documentation process for the product specification

- The buying company asks for specifications to its suppliers or producers and accepts the products meeting the quality standards. Each specification document generally has a resubmission date after which the data must be checked and updated by the producer or the supplier.
- Some companies request further informations to meet the company specific needed data. A specific template will generally be provided to the supplier in order to get the exact information needed.

Product Design Specification

- **Elements of PDS**
 - **Performance (User)**
 - Speed,
 - Capacity,
 - Power,
 - Accuracy,
 - etc.

Elements of PDS

- **Environment:** *(User)*
 - Temperature range, humidity, dust and dirt, etc.
- **Life in service:** *(User)*
 - 10 years, 5000 cycles, etc.
- **Maintenance:** *(User)*
 - What is the market policy, what customers accept
- **Target production cost:** *(User)*
 - Cost of comparable products and company policy.
- **Shipping:**
 - Package sizes
 - Damage resistance

Elements of PDS

- **Quantity** *(Manufacturing)*
 - Determined by market analysis.
- **Manufacturing facility** *(Manufacturing)*
 - Is the design constrained by existing facility?
 - Are parts to be contracted and assembled in-house?
 - Does the company policy dictate certain facilities?

Element of PDS

- **Size and shape** *(Marketing)*
- **Weight** *(Marketing)*
 - What is the desired weight?
 - Should handles or lifting points be provided?
 - Should it be modular for better handling?
- **Aesthetics** *(Marketing, User)*
 - Color, shape, form, texture, finish.
 - Market research.

Elements of PDS

- **Materials** *(Marketing, Codes, Regulations)*
 - Left to designers unless company guidelines or regulations restrict certain materials (asbestos, lead).
- **Product life span** *(Marketing, Manufacturing)*
 - Life of a product as a marketable entity. Several months or several years?
- **Laws, Codes, and standards** *(Government)*
- **Ergonomics** *(User)*

Elements of PDS

- **Quality and reliability** (*Marketing*)
 - Company policy regarding warranties
 - Competitors warranty policies
- **Testing** (*Marketing, QA*)
 - What tests would be performed to verify performance
 - Standard tests
- **Shelf life (storage)** - *Retail*
 - Possibility of rust, decay, deterioration
- **Processes** (*company guidelines*)
 - Use of certain standards (GD&T for example)
 - Use of certain procedures
- **Time-scales (deadlines)** - *Management*
 - Whole design project, milestones

Elements of PDS

- **Safety** (*User, Government, Legal*)
 - What safety requirements are mandated by government
 - Professional society's codes and standards
 - Need for warning labels
 - Likely degrees of abuse or misinterpretation of operating procedures
- **Company constraints** (*Management*)
 - Compatibility with other products
- **Documentation** (*Management - Legal*)
 - A product design must include a full formal documentation per company guidelines.
 - Safety, Operation, and Service documents.
 - Etc.

Elements of PDS

- **Legal** (*Lawyers*)
 - What product liability law suits are associated with similar products and why.
 - **Note the legal terms:**
 - “defect of specification”
 - “defect of design”
 - “defect of manufacture”
 - Relevant patents
- **Installation** (*installers*)
 - Many products must interface with other products or be assembled with other products.
- **Disposal** (*Society*)
 - Should any parts be recyclable?
 - bio-degradable?

Wording of the PDS Document

- **Format of most statements in PDS:**
 - *The device must*
 - *The device is to*
 - *The device is desired to*
- **Avoid mixing requirements.**
 - One sentence per requirement.
- **Cast PDS statements in a positive format**

PDS is a Dynamic Document

- A design statement usually begins as a vague statement
 - The device is to be easy to use
 - The device is to be safe
 - The device is to be inexpensive
 - The device is to be rugged and reliable
 - The device is to be portable

Engineering Verification Testing (EVT)

- is a specific product verification test performed
- on prototypes to verify the design meets desired product specifications and performance. EVT consists of basic functional tests, parametric measurements and specification verification.

Quick Design Verification Tests (Q-DVT)

- for a fast, first look that helps uncover high impact design weaknesses early in the product development cycle. The Q-DVT is especially useful in rapid prototyping or quick response products for which EVT or DVT is not feasible. Q-DVT is a reliability risk assessment tool that can locate weaknesses and recommend potential changes to improve the product. Q-DVT includes an operational temperature test, an operational vibration test, and an Electro-Static Discharge (ESD) test. These tests together reduce the field failure rates and incidence of "non-repeatable" or "no trouble found" problems.

Design Verification Testing (DVT)

- After prototyping, the product is moved to the next phase of the design cycle: Design Refinement. Engineers revise and improve the design to meet performance and design requirements and specifications. Design Verification Testing (DVT) is specific product verification tests performed to deliver objective, comprehensive testing verifying the following:
- All products specifications
 - Interface standards
 - OEM requirements
 - Diagnostic commands

DVT areas of testing:

- Functional Testing (including usability)
- Performance Testing
- Environmental Testing
- Product Reliability Testing
- Product Regulatory Compliance Testing

Process (or Pilot) Verification Testing (PVT):

- When the product moves to production phase, the Process (or Pilot) Verification Test (PVT) is used. The PVT is a subset of the Design Verification Test (DVT) performed on pre-production or production units. The purpose is to verify the design has been correctly implemented into production.