



VM450 & VE450

Product Design Specification



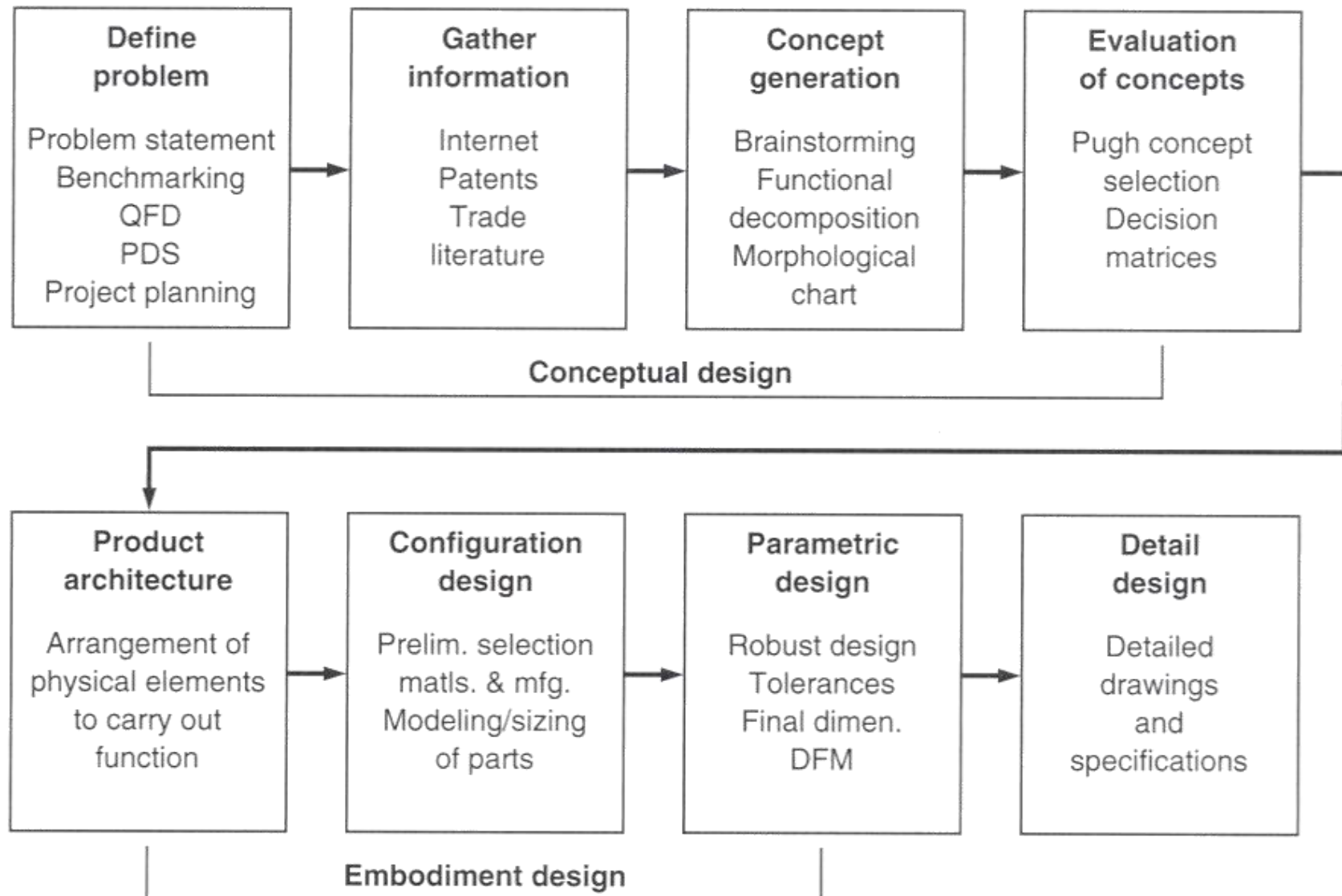
Outline



- What are Product Design Specifications?
- How to write Product Design Specifications?
- What role Product Design Specifications play in the product development process?



Product Development Process





Product Development Process



- PDP (Product Development Process) is triggered in response to
 - * to fulfill an unmet need or
 - * to better fulfill an existing need
- Problem Identification
 - * True problem identification can be elusive
 - * New needs are recognized and established as the design process moves forward
 - * Solution neutral statement of need is preferred

Problem Identification Matters



As proposed by the project sponsor



As specified in the project request



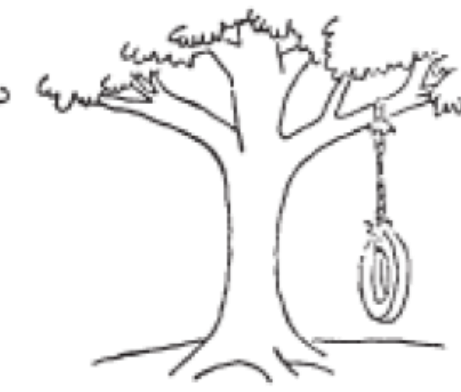
As designed by the senior designer



As produced by manufacturing



As installed at the user's site



What the user wanted

FIGURE 1.4

Note how the design depends on the viewpoint of the individual who defines the problem.



Critical Definitions



- Form

- ✧ The physical description of an artifact as it is observed from the outside itself.

- Behavior

- ✧ The interaction of an artifact in its use environment. This environment includes the physical surroundings, the users in control or contact with the artifact, and the effects of all other persons or artifacts in the surrounding environment

- Function

- ✧ Intended behaviors of an artifact



Critical Definitions



- Design parameter

- ✧ Parameters are a set of physical properties whose values determine the form and behavior of a design.
- ✧ Parameters include the features of a design that can be set by designers and the values used to describe the performance of a design.

- Design variable

- ✧ A design variable is a parameter over which the design team has a choice. For example, the gear ratio for the RPM reduction from the rotating spindle of an electric motor can be a variable.



Critical Definitions



- Customer Requirements

- ✧ Descriptions in everyday terms of what an end-user would like in the way they experience a product. CRs can be a mix of design parameters and performance parameters.

- Engineering Characteristics

- ✧ Descriptions of a design solution or it's performance in part or in whole
- ✧ Usually quantitative but they can be a class variable such as the color
- ✧ Most ECs are part of the specifications of a design solution



Critical Definitions



- Constraints give boundaries for design parameters or performance parameters.
-
- Different types of constraints include:
 - * Constraints can identify a threshold for some maximum or minimum value of a design variable or a performance measure
 - * Constraints can give a range of values.
 - * Constraints can set a parameter's value



Critical Definitions



- Constraints are limits on design freedom given by a variety of sources
 - * Design sponsor
 - * Standards Association
 - * Technical feasibility
 - * Design team can recognize a constraint emerging because of design decisions already made (e.g., motor size if motor must be used from an existing product line)



Steps in Defining Problem



- Understand customer needs
- Develop customer requirements
- Establish engineering characteristics
- Write product design specifications



Understand Customer Needs



- Identify the customer
 - * Customer is the one who writes the check, while user is not always the buyer
 - * Underlying need
 - ✧ *Competitors*
 - ✧ *Unmet yet?*
 - * How need is being met currently
 - * Use environment
 - * All modes of use



Find Customer Requirements



- Personal Experience
- Ethnographic Studies
- Customer Interviews
- Complaints or Warranty Information
- Benchmark of competing products or current means



Customer Requirements



- Basic CR's (Customer Requirements)
 - * *Expected behavior or standard features*
 - * *Mostly include spoken requirements*
- Unspoken CR's (Customer Requirements)
 - * *Can be so basic as to be taken for granted*
 - * *Can be too technical to be articulated by average user*
 - * *Identify from implicit sources, such as ethnographic ones, etc.*



Engineering Characteristics



- Engineering statement of customer requirements
 - * Customers want rugged laptop carrying case
 - * What will be the engineering characteristics?
- Engineering Characteristics (ECs)
 - * Descriptions or performance of a design in part or in whole
 - * Usually quantitative but they can be a class variable such as color
 - * Most ECs are part of the specifications of a design
 - * A design team may decide that an EC should be treated as a constraint for all alternatives
 - * Solution neutral



Product Design Specifications (PDS)



- PDS defines the functional and non-functional characteristics of the product being designed
 - ✧ *What the system will be capable of doing*
 - ✧ *How the system will be deployed and used during the life cycle*
 - ✧ *What regulations will affect the design, use, and disposal of the system, etc.*
- Statements in PDS should be **solution neutral**
- PDS is evolutionary and can be changed during the design process



PDS Template



- Product Identification
- Market Identification
- Key project deadlines
- Physical description
- Financial requirements
- Life Cycle Targets
- Social, political, and legal requirements
- Manufacturing/fabrication specifications



PDS Example



Product Title:

Drywall Taping System

Purpose:

To dispense joint compound and tape simultaneously to fill gaps between adjacent drywall sheets.

Benefits:

- Reduce the number of separate operations to apply the tape coat
- Reduce the time it takes to complete the tape coat
- Simplify the application of the tape coat

Competitors:

- Brand/company A
- Brand/company B

Customers/Market:

- Primary customers: professional drywall companies
- Secondary customers: homeowners and tool rental centers

Need:

Brand A is a relatively inexpensive tool (\$150), which speeds up operation, but does not provide the customer with the level of performance they have requested. Brand B is a more complete tool, but it is costly (\$1650 plus accessories). Hence, there is a need to satisfy customer requirements with a reasonably priced tool.

Quantity:

Production will be 12,000 units in the first year, and 20,000 units for the following two years.

Product Cost:

- Retail: < \$500
- Company's selling price: < \$200

Magrab, Edward B. *Integrated product and process design and development : the product realization process.* pp. 103-107.

formance:

- Tape inside corners.
- Tape joints in any orientation.
- Tape joints without leaking joint compound.
- Taped joints will require no additional smoothing.
- Tape will not break prematurely.
- Compound will flow evenly across tape/wall.
- Will work with both paper and fiberglass tape, with tapes whose widths vary from 1.75 - 2.25 inches (44.5 - 57 mm) and whose thickness vary from 0.005-0.007 inches (0.13 - 0.18 mm).
- Work with thick or thin viscosity compounds.
- Dispense tape at the rate of 6 inches/second (150 mm/second). [See Section 6.1]
- Dispense the joint compound at the rate of 2 in³/second (32 cm³/second). [See end of Section 6.1]

Time Scale:

- In the marketplace by December, 1997.
- Components and raw materials must have lead times of less than one month.

Size:

- Small enough to be easily transported by one person.
- Hand held part of device will be smaller than 29×12×16 inches (74×30×41cm).

Manufacturing Facilities and Processes:

- No new manufacturing facilities will be required.
- Manufacturing operations per component to be minimized.
- No components to require expensive or time consuming operations.

Shipping:

- Will be shock, vibration and weather resistant for shipping by any means: vibration environment from 4-33 Hz at 0.06 inch (1.5 mm) amplitude; shock environment simulated with an 8 foot (2.4 m) drop test. Insensitive to temperature and humidity.
- Will be packaged in a rectangular cardboard box that can be stacked to 8 ft (2.5 m).



PDS Example (Cont.)



Installation:

Product will be shipped assembled.

Aesthetics:

Product will have a durable finish.

Colors will be green and black.

Product will convey ruggedness.

Weight:

Hand held portion will weigh less than 5 pounds (2.3 kg) empty.

Will weigh less than 20 pounds (9 kg) when fully loaded with joint compound and tape if joint compound carried on body or placed on floor; otherwise unit will weigh less than 15 pounds (7 kg).

Maintenance:

All fasteners will be standard.

All components subject to wear to be inexpensively and easily replaceable with standard tools and no special skills.

Design will be modular for easy repair and cleaning.

Joint compound removed after each day's work.

No or very few lubrication points.

Packaging:

Will not require special handling during shipment.

Container will have the name, function, critical performance specifications and picture of the product on the outside.

Must stack safely up to 8 feet (2.4 m).

Reliability:

Will withstand repeated subsection to shipping and testing conditions without affecting performance.

Components will have a service life of more than 5 years.

Tape severing device will last for at least 10,000 tape separations.

Shelf Life:

Shelf life greater than 5 years.

Patents:

Product must not infringe on the following patents [Descriptions of U.S. patents can be accessed on the world wide web at <http://patents.cnidr.org/access/> access. Html or at <http://patent.womplex.ibm.com/>.]:

5,279,700	1994	Automated Wall Board Taping Apparatus and Process
5,279,684	1994	Wall Board Taping Process
5,242,495	1993	Combined Joint Compound Bucket and Tape Dispenser
5,230,608	1993	Positive Feed System for Wallboard Tape Applicators
5,169,449	1992	Apparatus for Applying Joint Compound to Corner Beads
5,137,752	1992	Gypsum Wallboard Taping System
5,114,527	1992	Drywall Tape Applying Tool
5,079,042	1992	Drywall Joint Finishing System
5,013,389	1991	Wallboard Taping Apparatus
4,996,941	1991	Gypsum Wallboard Taping System
4,757,783	1988	Container-to-Tape Dispenser for Drywall Joint Compound
4,452,663	1984	Wallboard Taping Apparatus

Magrab, Edward B. Integrated product and process design and development : the product realization process. pp. 103-107.



PDS Example (Cont.)



Disposal and Recycling:

Product will not contain any environmentally hazardous materials.
Easily disassembled for component recycling and reuse.

Political, Social and Legal:

Will conform to all applicable OSHA standards. [OSHA regulations and standards can be accessed on the world wide web at <http://www.osha-slc.gov/>.]
Product names and slogans will be inoffensive to people of all races, creeds, and gender.

Product Environment:

Product must operate properly in the following environment:
Temperatures between 40 and 120 °F (4 and 50 °C)
Atmospheric pressure from sea level to 7,000 ft (2.1 km)
Relative humidity to 100%
Concentration of solid or liquid particulate smaller than 500 µm.

Testing:

All components will be purchased from suppliers with ISO 9000 certification.
Vibration and shock testing as described in Shipping above, and thermal testing as described in Product Environment above.

Safety:

All sharp edges, with the exception of the smoothing device, electrical, hot and moving parts will be shielded to prevent contact with the operator.
Product will be well balanced and ergonomically designed to facilitate safe operation.

Documentation:

A user's manual, maintenance manual and guarantee will accompany product.
All testing will be documented by the company or by outside agency performing the test.
Customer will be asked to complete a questionnaire to determine whether the product meets his/her expectations.

Life Span:

Product will be modular to allow component upgrades as they become available.
Minimum operational life of 5 years.

Materials:

All materials will not corrode.
Materials must be well suited to company's manufacturing methods.

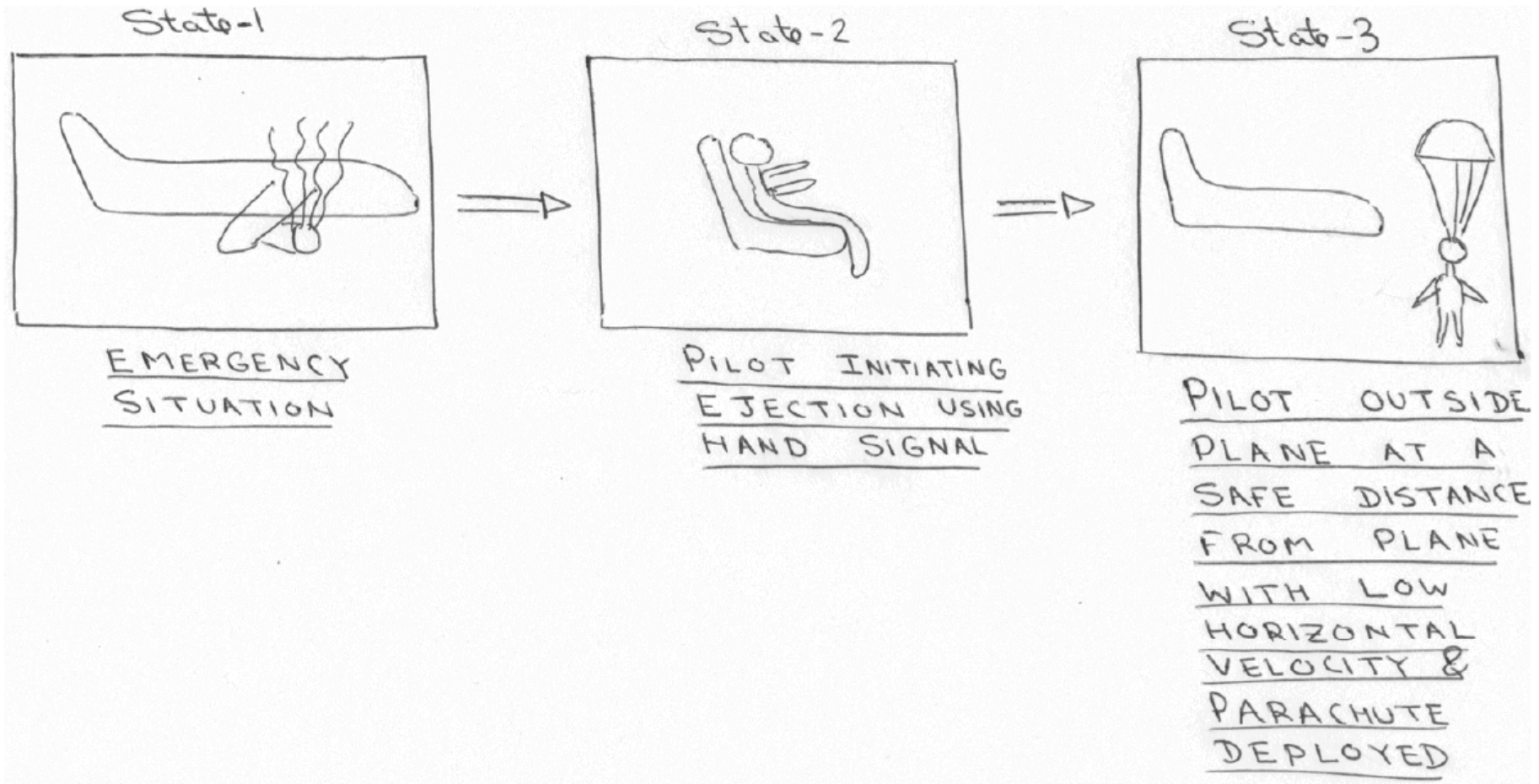
Ergonomics:

Product must be comfortable to use for long periods.
Single operator.
Two-handed use.

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Develop PDS for Air Crew Ejection System

- Mission Statement: Safely Eject Aircrew from Aircraft in Event of Aircraft Failure





Important Requirement Categories



- Function
- Testing
- Manufacturing
- Warehousing
- Shipping
- Disposal



Important Constraints



- Response time
- Velocity
- Target Weight
- Altitude at Which the Parachute will be Deployed
- Safe Distance from Aircraft



How to develop a comprehensive PDS



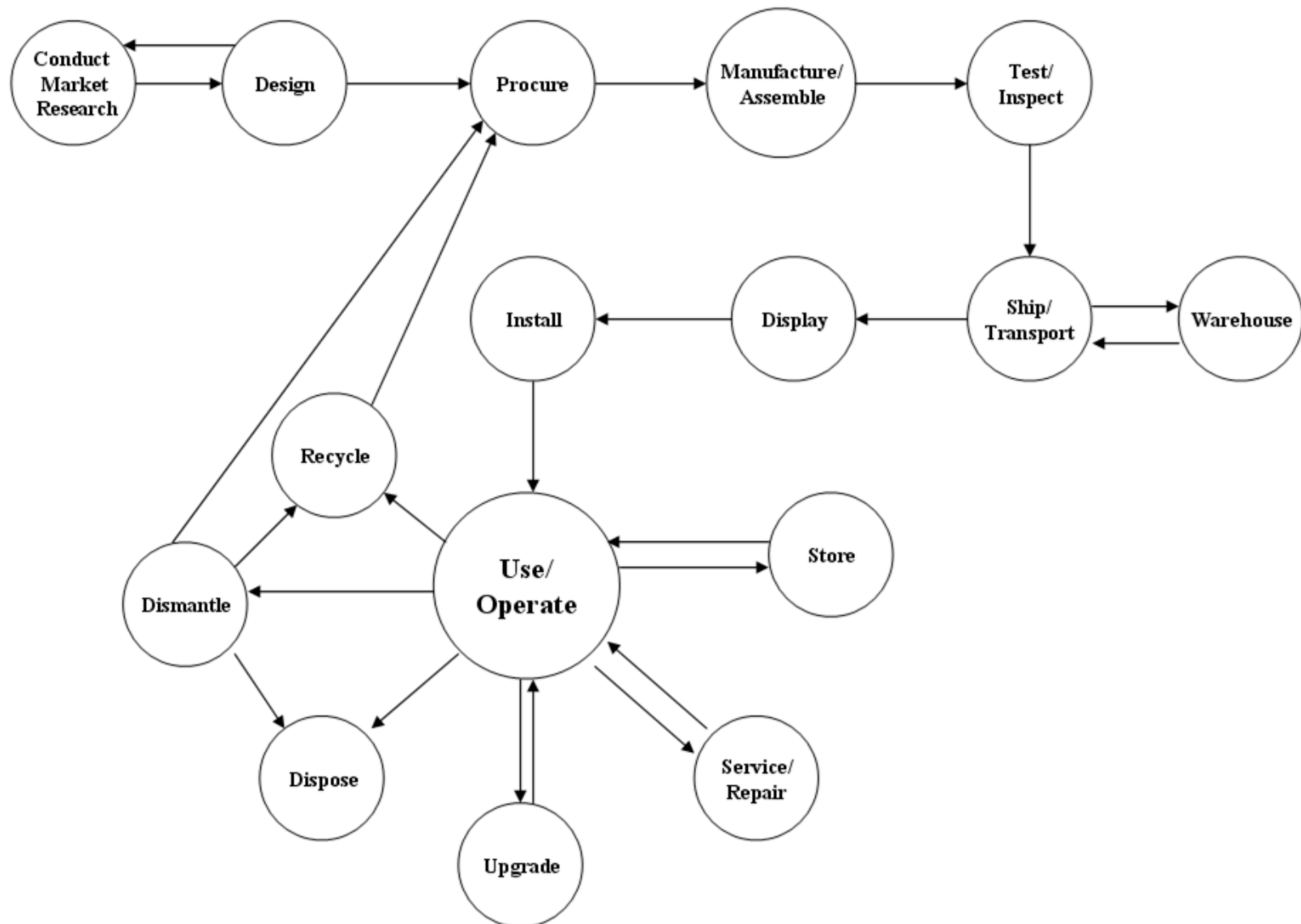
- Systems engineering community has developed detailed guidelines for requirements engineering
- Tools (DOORS and SLATE) are also available for managing requirements
 - ✧ Revisions
 - ✧ Decomposition
 - ✧ Notifications

IBM Rational® DOORS®, a family of requirements definition and requirements management solutions, improves quality by optimizing communication and collaboration and by promoting compliance and verification. <http://www-01.ibm.com/software/awdtools/doors/productline/>

SLATE (System Level Automation Tool for Engineers) is computer-aided engineering groupware for system designers. SLATE accelerates the design process by managing the entire design life cycle, from pre-proposal and proposal through implementation.

http://www.mathworks.com/products/connections/product_detail/product_35447.html

Possible Product States





Possible Product States



- Identify the applicable product states and capture the requirements for each product state
- IP Based requirements
 - ✧ Don't infringe on patent XYZ
- Time requirements
 - ✧ Need to launch product by Dec 21st, 2020
- Legal requirements
 - ✧ Comply with OSHA standards, comply with EPA standards, attach warning label on product
- Financial Requirements
 - ✧ Budget will not exceed 6000 RMB



Value of a Good PDS



- Ensures that all features of the final design are really needed (not over designed)
- Ensures that no requirements are skipped (high quality)
- Provides design rationale (facilitate design improvements)



Select Specifications



- Need to account for customer requirements and preferences
- Need to account for competitors
- Need to account for core competencies of the organization



Summary



- Overview of Product Design Specifications
- Tips for Writing Comprehensive Product Design Specifications
- Role of Product Design Specifications in the product development process