Unit II

Murphology of design, divergent, transformation and convergent phases of product design, identification of need, Analysis of need. Design criteria; functional, aesthetics, ergonomics, form, shape, size, colour.

Mental blocks, Removal blocs, Ideation techniques, Creativity, Check list.

Morphology of Design

Phase I:	feasibility study
Phase II:	Embodiment Design
Phase III:	Detail Design
Phase IV:	Planning for Production
Phase V:	Planning for Distribution
Phase VI:	Planning for Use
Phase VII:	Planning for Retirement of the Product

Phase I: Feasibility study

- The producer has to undertake the detailed feasibility investigation which comprising two feasibility studies:
- i) The Technical Feasibility Study
- ii) The Economic Feasibility Study

- Technical Feasibility

- Technical Feasibility Study covers the following aspects:
- Location of the project
- Lay-out of the Plant
- Size of the Plant
- Factory construction
- Manufacturing process / Technology
- Process Design
- Product Design
- Scale of Operation
- Infrastructural facilities

Economic Feasibility

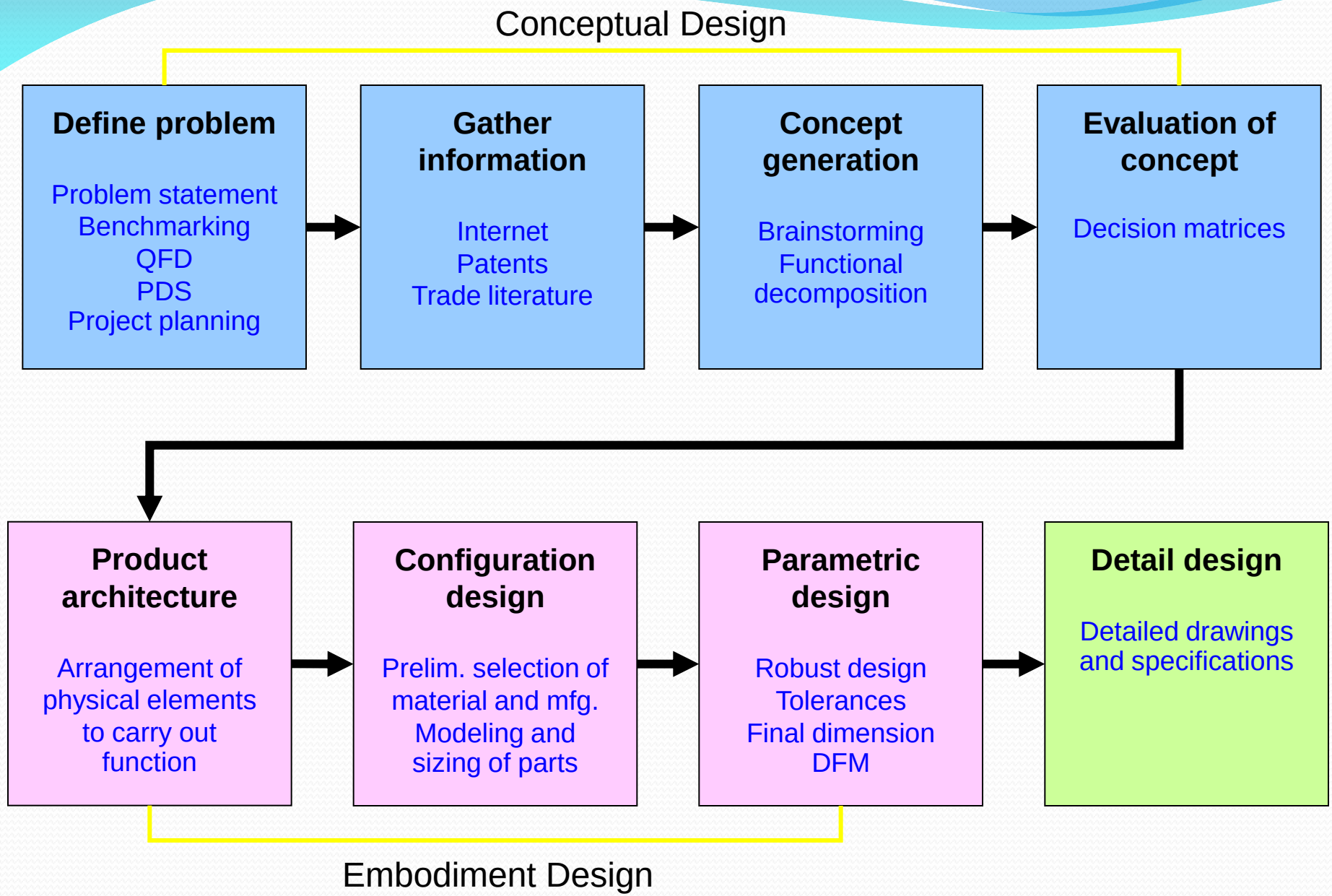
- The prime objective of setting up a project is to derive a fair return on the investment.
- Economic Feasibility Study, therefore, concerns itself with matching of economic resources with the physical requirements of a project and determining the viability of investment therein.

Phase II: Conceptual (preliminary) Design

- Identification of customer needs
- Problem definition
- Gathering information
- Conceptualization
- scope selection
- Refinement of the PDS

Phase II: Embodiment Design

- Product architecture
- Configuration design of parts and components
- Parametric design of parts and components


Conceptual Design
Define problem
Problem statement
Benchmarking
QFD
PDS
Project planning
Gather information
Internet
Patents
Trade literature
Concept generation
Brainstorming
Functional decomposition
Evaluation of concept
Decision matrices
Product architecture
Arrangement of physical elements to carry out function
Configuration design
Prelim. selection of material and mfg.
Modeling and sizing of parts
Parametric design
Robust design
Tolerances
Final dimension
DFM
Detail design
Detailed drawings and specifications
Embodiment Design

Phase IV: Planning for Manufacture

1. Designing specialized tools and fixtures
2. Specifying the production plant that will be used
3. Planning the work schedules and inventory control
4. Planning the quality assurance system
5. Establishing the standard time and labor costs for each operation
6. Establishing the system of information flow necessary to control the manufacturing operation

Phase V: Planning for Distribution

- Designing the packaging of product
- Planning of warehousing of product
- Planning for promotional activity
- Designing the product for condition arising in distribution.

Phase VI: Planning for Use

- Design for reliability
- Design for safety
- Design for maintenance
- Design for ease in use
- Design for aesthetic feature
- Design for operational economy
- Design for adequate duration for service

Phase VII: Planning for Retirement of the Product

- Design to reduce the rate of obsolescence by taking into account the anticipated effect of technology development
- Design physical life to match anticipated service life.
- Testing of serviced part in laboraty for design perpose.

Need Identification

Types of Design Project

- Variation of an existing product
- Improvement of an existing product
- Development of a new product for a low-volume production run
- Development of a new product for mass production
- One-of-a-kind design

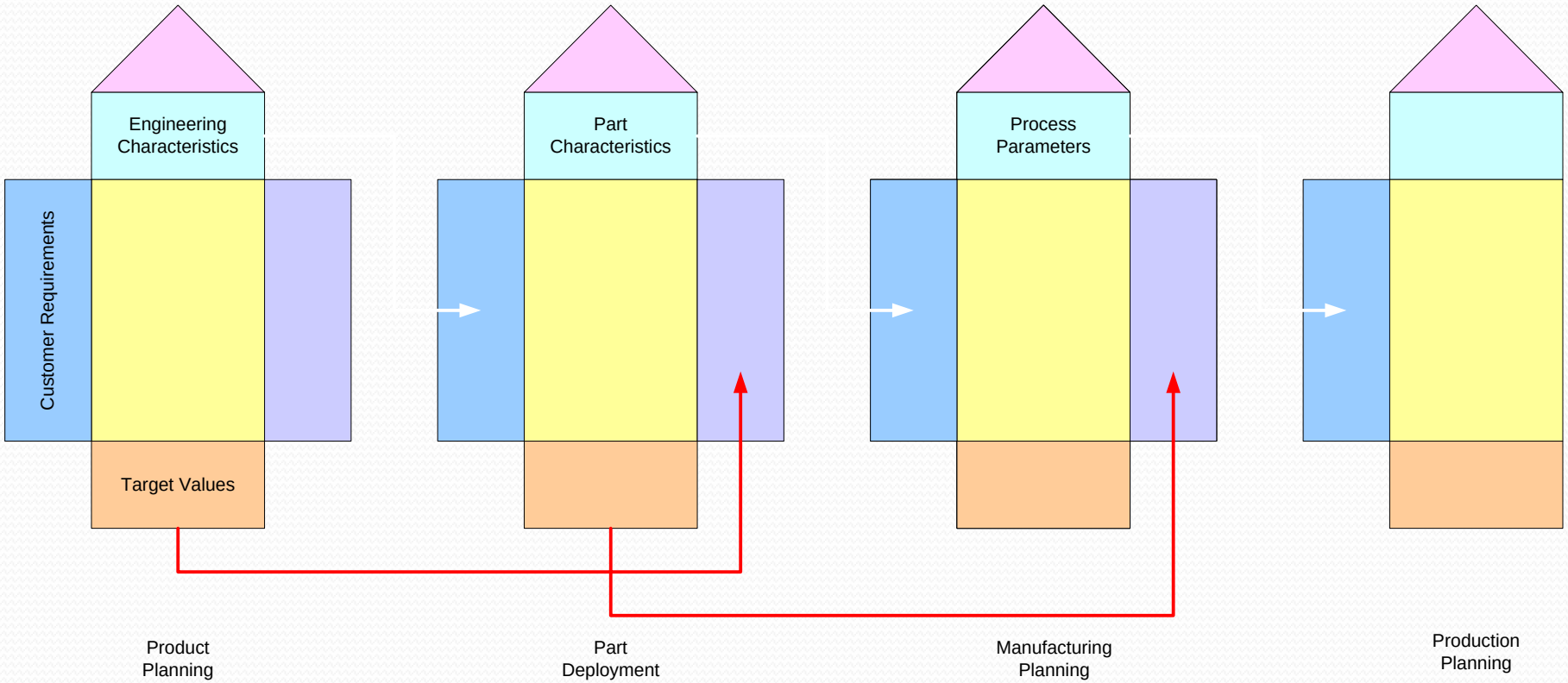
How to Gathering Information from Customer

- Interview with customer
- Focus group
- Customer surveys
- Customer complaints

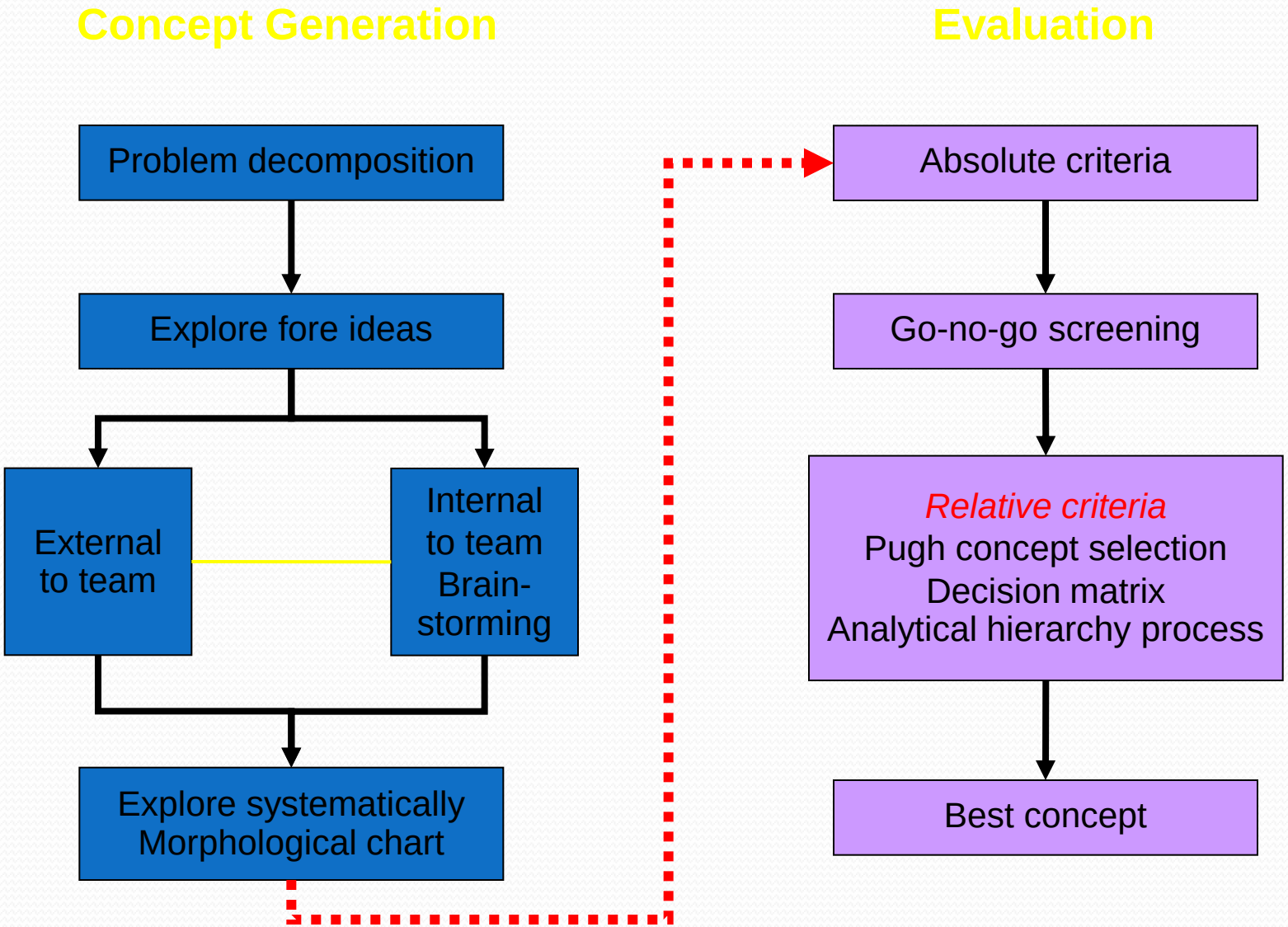
Levels of Customer Requirements

- Expecters: *the basic attribute that one would expect to see in the product*
- Spokens: *the specific features that the customers say they want in the product*
- Unspokens: *the product attributes the customer does not generally talk about, but are nevertheless are important to him or her*
- Exciters or delighters: *the features that make the product unique and distinguish it from the competition*

From customer requirement to production planning

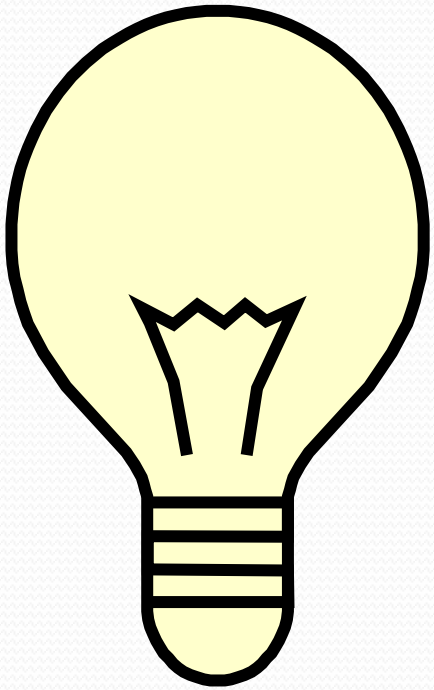


Concept Generation and Evaluation


Concept Generation
Evaluation
Problem decomposition
Explore fore ideas
External to team
Internal to team Brain-storming
Explore systematically Morphological chart
Absolute criteria
Go-no-go screening
Relative criteria
Pugh concept selection
Decision matrix
Analytical hierarchy process
Best concept

Creativity

- Develop a creative attitude
- Unlock your imagination
- Be persistent
- Develop an open mind
- Suspend your judgment
- Set problem boundary



Vertical and lateral thinking

Vertical thinking	Lateral thinking
▪ Only one correct solution	▪ Many possible solutions
▪ Analytical process	▪ Nonjudgmental
▪ Movement is made in a sequential, rule-based manner	▪ Movement is made in a more random pattern
▪ If a positive decision cannot be made at a step, progress stop	▪ If a positive decision cannot be made at a step, thinking jump
▪ Follow most likely decision path	▪ Follows all paths
▪ Deals only with reality as science know it today	▪ Can create its own reality
▪ Classification and label are rigid	▪ Reclassifies objects to generate ideas

Invention

- Invention is something novel and useful, being the result of creative thought.
- Classified into 7 categories
  1. The simple or multiple combination
  2. Labor-saving concept
  3. Direct solution to a problem
  4. Adaptation of an old principle to an old problem to achieve a new result
  5. Application of a new principle to an old problem
  6. Application of a new principle to a new use
  7. Serendipity

Psychological View of Problem Solving

- Four-stage model
  - ***Preparation***: The element of the problem are examined and their relations are studied.
  - ***Incubation***: You "sleep on the problem."
  - ***Inspiration***: A solution or a path toward the solution suddenly emerges.
  - ***Verification***: The inspired solution is checked against the desired result.

Creativity Methods

Mental Block

- Perceptual blocks
  - Stereotyping
  - Information overload
  - Limiting the problem unnecessarily
- Cultural blocks
- Environmental blocks
- Emotional blocks
  - Fear of risk taking
  - Unease with chaos
  - Adopting a judgmental attitude
  - Unable or unwilling to incubate
- Intellectual blocks

Brainstorming

- Four fundamental brainstorming principles
  1. Criticism is not allowed.
  2. Ideas brought forth should be picked up by other people present.
  3. Participants should divulge all ideas entering their minds without any constraint.
  4. A key objective is to provide as many ideas as possible within a relatively short time.

Stimulation of ideas

- *Combination:* What new ideas can arise from combining proposes and functions?
- *Substitution:* What else? Who else? What other place? What other time?
- *Modification:* What to add? What to subtract? Change color, material, motion, shape?
- *Elimination:* Is it necessary?
- *Reverse:* What would happen if we move it backward? Turn it upside down? Inside out?
- *Other use:* Is there a new way to use it?

7 corollaries are derived from the 2 axioms mentioned before

Corollary 1:	*Decoupling of a coupled design* Decouple or separate parts or aspects of a solution if FRs are coupled or become interdependent in the proposed design.
Corollary 2:	*Minimize FRs* Minimize the number of FRs and constraints.
Corollary 3:	*Integration of physical parts* Integrate design features in a single physical part if FRs can be independently satisfied in the proposed solution.
Corollary 4:	*Use of standardization* Use standardized or interchangeable parts if the use of these parts is consistent with the FRs and constraints.
Corollary 5:	*Use of symmetry* Use symmetric shapes and/or arrangement if they are consistent with the FRs and constraints. Symmetrical parts require less information to manufacture and to orient in assembly.
Corollary 6:	*Largest tolerance* Specify the largest allowable tolerance in stating FRs.
Corollary 7:	*Uncoupled design with less information* Seek an uncoupled design that requires less information than coupled designs in satisfying a set of FRs.