Chemical Product Design

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PART III. The Product Development Process

How do you characterize a business entity?

- **Consider a business as a black box. . .**
  - Environmental niche
  - Structure
  - Inputs and outputs
  - What else?

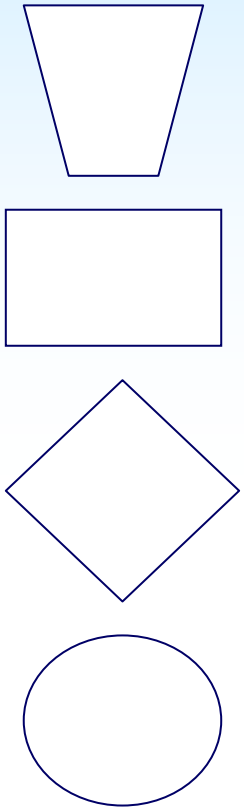
A Process

- What is a Process?
  - A set of actions with decision points which describe a flow of activities
- Why a Process?
  - Repetition allows for continuous learning
    - Don't need to reinvent the wheel
  - Improvement of a process, improves *all* products developed using that process
  - Can tell where you are
  - Can tell where you are going
  - Can tell how you are doing
  - Forces clear roles and responsibilities
    - for smooth handoffs avoiding "dropped balls", overlaps and misunderstandings
  - Is a common language, extensible to other domains
  - Can import ideas from other domains

What are some examples?

- Performing an experiment
- Synthesizing a new material
- Building a MEM device
- Writing a grant proposal
- Or. . .
- Waking up and arriving at work
- Writing bills at the end of the month
- Mowing the lawn
- Planning a vacation
- Getting an Art Center or Caltech degree

Process Mapping



Start, Stop

Action,

Decision

Continuation

A process has. . .

- A Beginning
- An end
- A Duration (C/T)
  - Entitlement
  - Theoretical
  - Actual

Sequential Actions (flow)

Decision Points

Quality

Performance

Efficiency

What Characterizes all processes?

- **Cycle time**
  - average time for products to be designed
- **Quality**
  - defects in process
- **Cost**
  - development cost per product in dollars, people
- **Performance**
  - Are products competitive?

Are these co-variant?

How would you measure these characteristics?

Three Fundamental Business Processes

1. Make/Market
    1. **To take an order**
    2. **To manufacture the product**
    3. **To ship the product**
    4. **To collect the payment for the product**
2. Design Develop
    1. **To conceive the product**
    2. **To design the product**
    3. **To transfer the product to steady-state manufacturing**
3. Strategic
    1. **To write and execute the strategic plan of the company**

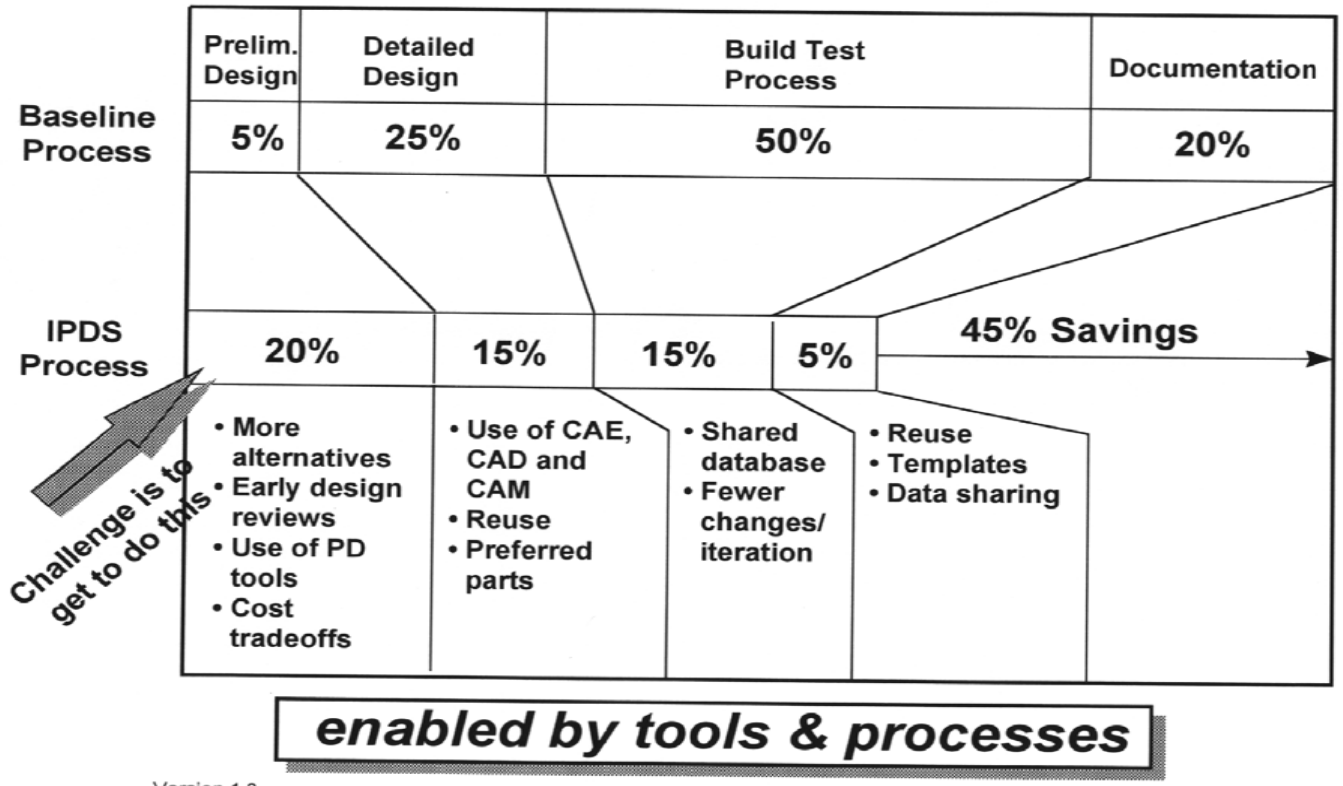
All business activity is contained in these processes or directly supports them

Questions

- Which of these step takes the longest?
- Which should take the longest?
- Which costs the most?
- Where is it hardest to correct mistakes?

AlliedSignal

Cycle time compression.....



enabled by tools & processes

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Version 1.3

Center for Process Improvement - *Partner for Productivity*

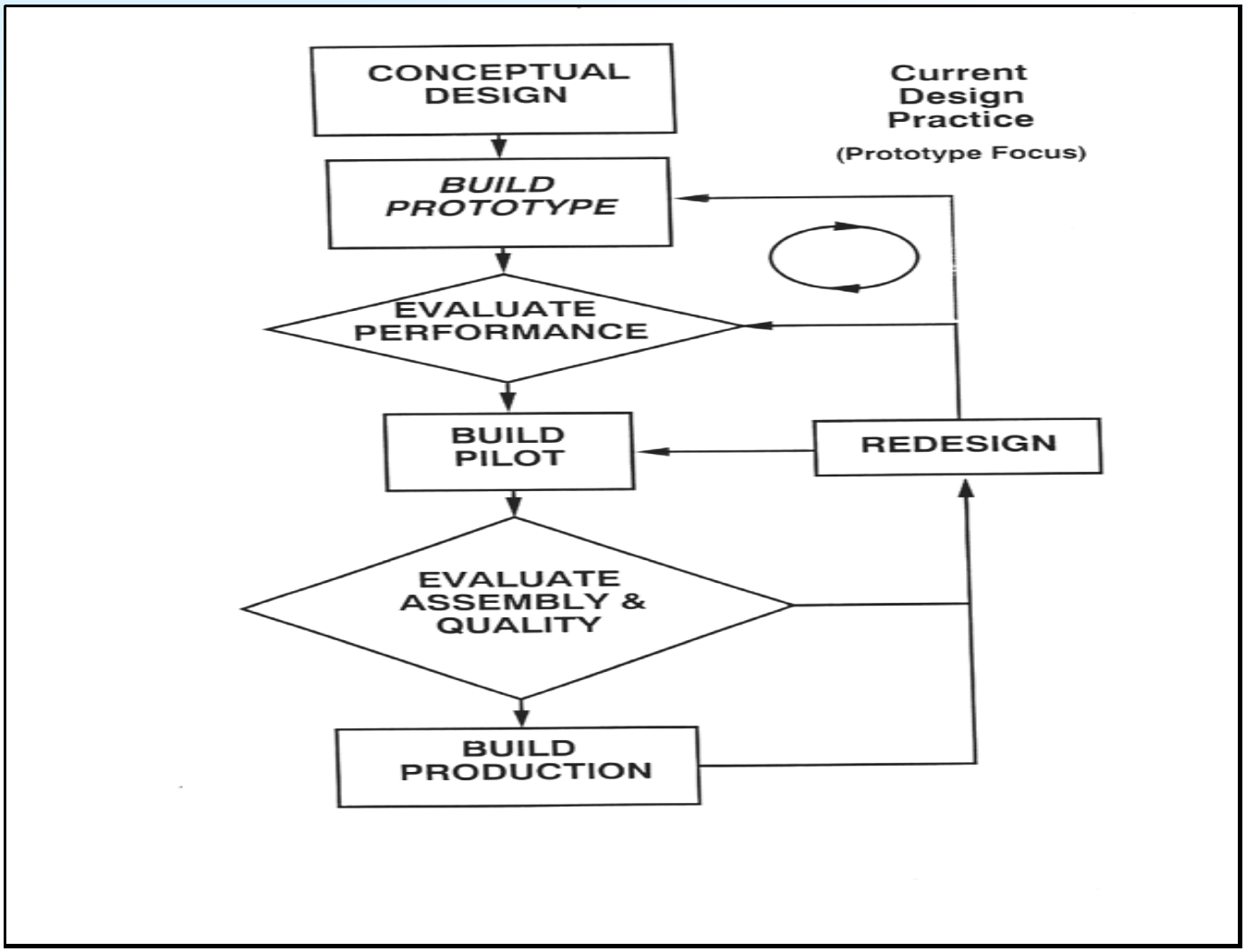
Phase Exit Reviews

- To put discipline in process, DFX tools must be used at their appropriate phase in the process
- Outside reviewers are employed to assure that the process is followed
- If the product is not ready, it can not go to the next phase

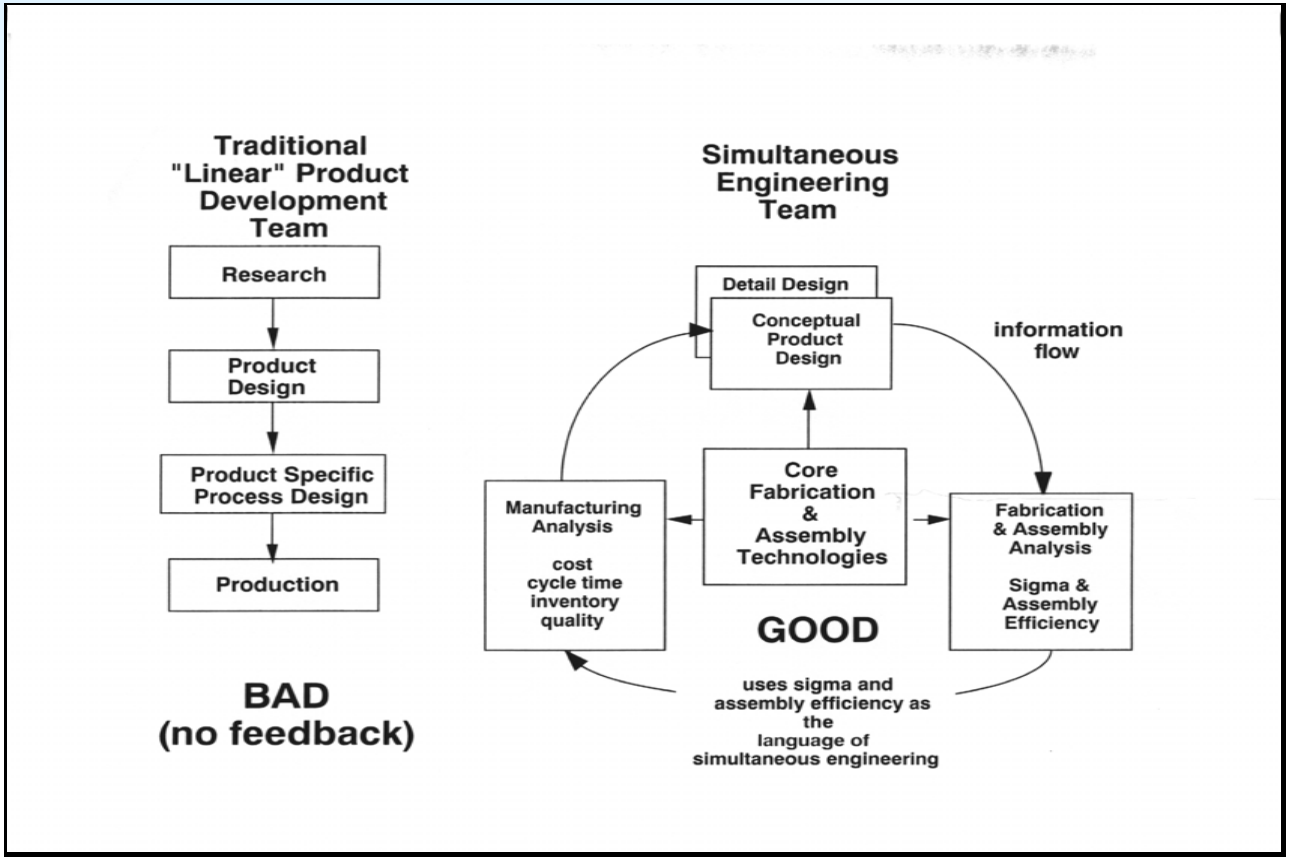
Concurrent Engineering

- Design/Build Team
- Early Problem discovery
- Early Decision making
- Cross Functional team optimized designs

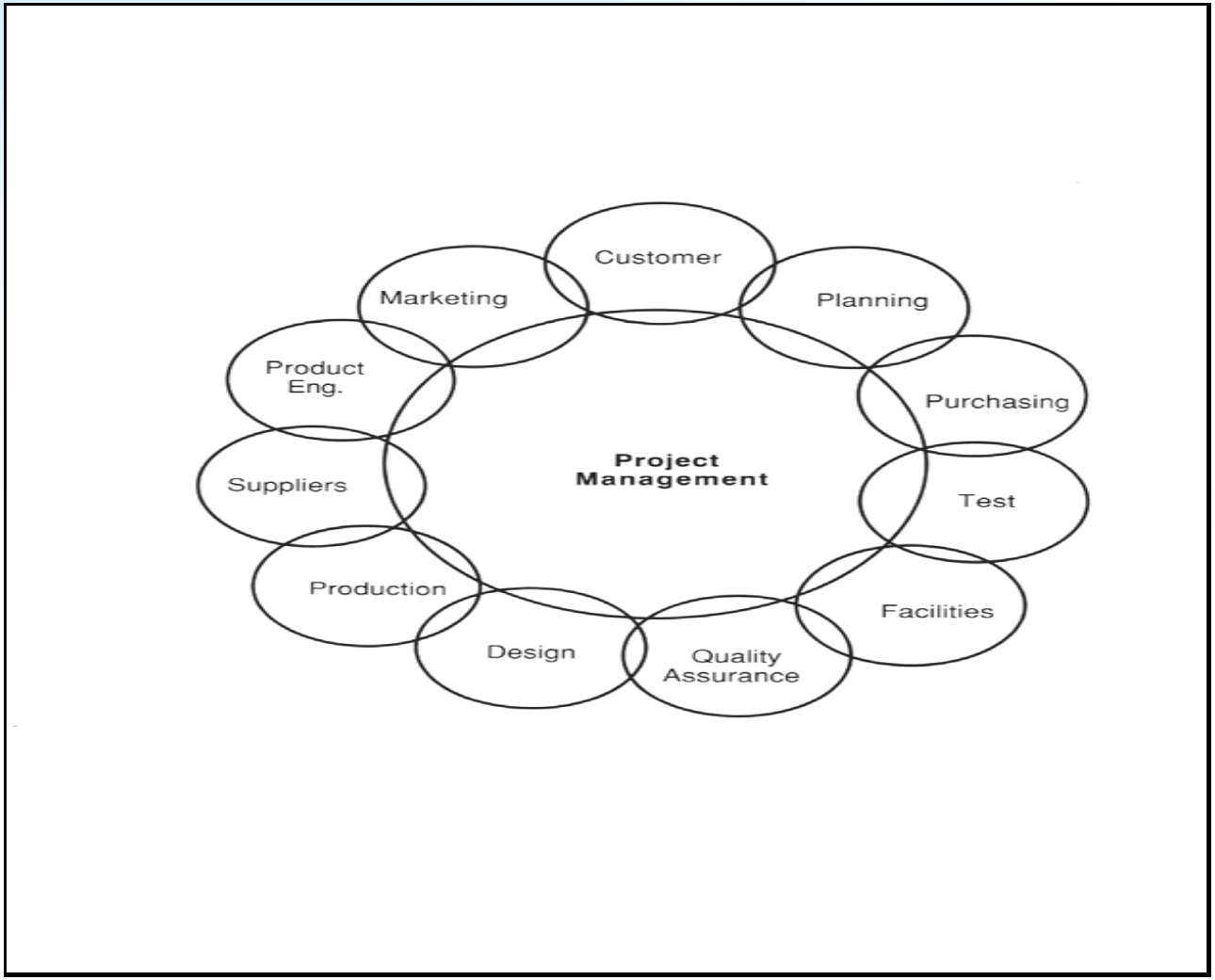
Old Way


CONCEPTUAL DESIGN
Current Design Practice
(Prototype Focus)
BUILD PROTOTYPE
EVALUATE PERFORMANCE
BUILD PILOT
REDESIGN
EVALUATE ASSEMBLY & QUALITY
BUILD PRODUCTION

Linear to Concurrent



Cross Functional Teams



Product Metrics

- Quality
  - **How well the product satisfies specifications**
  - **Measured in DPU**
- Cost
  - **Meets specs**
  - **Competitive**
  - **Profitable**
- Speed
  - **How long did the product take to get to market?**
- Performance
  - **Did the product perform to specifications**
  - **Were specs sufficiently aggressive?**

Manufacturing Process

- Quality
  - **Yield, redo rate (First pass yield)**
  - **Product DPU (Defects per Unit)**
- Cost
  - **per unit**
  - **standard parts use (inventory)**
  - **capital avoidance**
- Speed
  - **Cycle Time (Order Entry to Delivery)**
- Performance
  - **Productivity**
  - **Management of Variation**
  - **fill rate**
- Capacity
  - **Max Product per unit time**

Product Development Process Metrics

Cycle time

- **Average time for products to be designed**
- **Do products consistently get to market on time?**

Quality

- **defects in process**
- **First pass success**
- **Manufacturing hiccoughs due to design**
- **Measured in DPU**

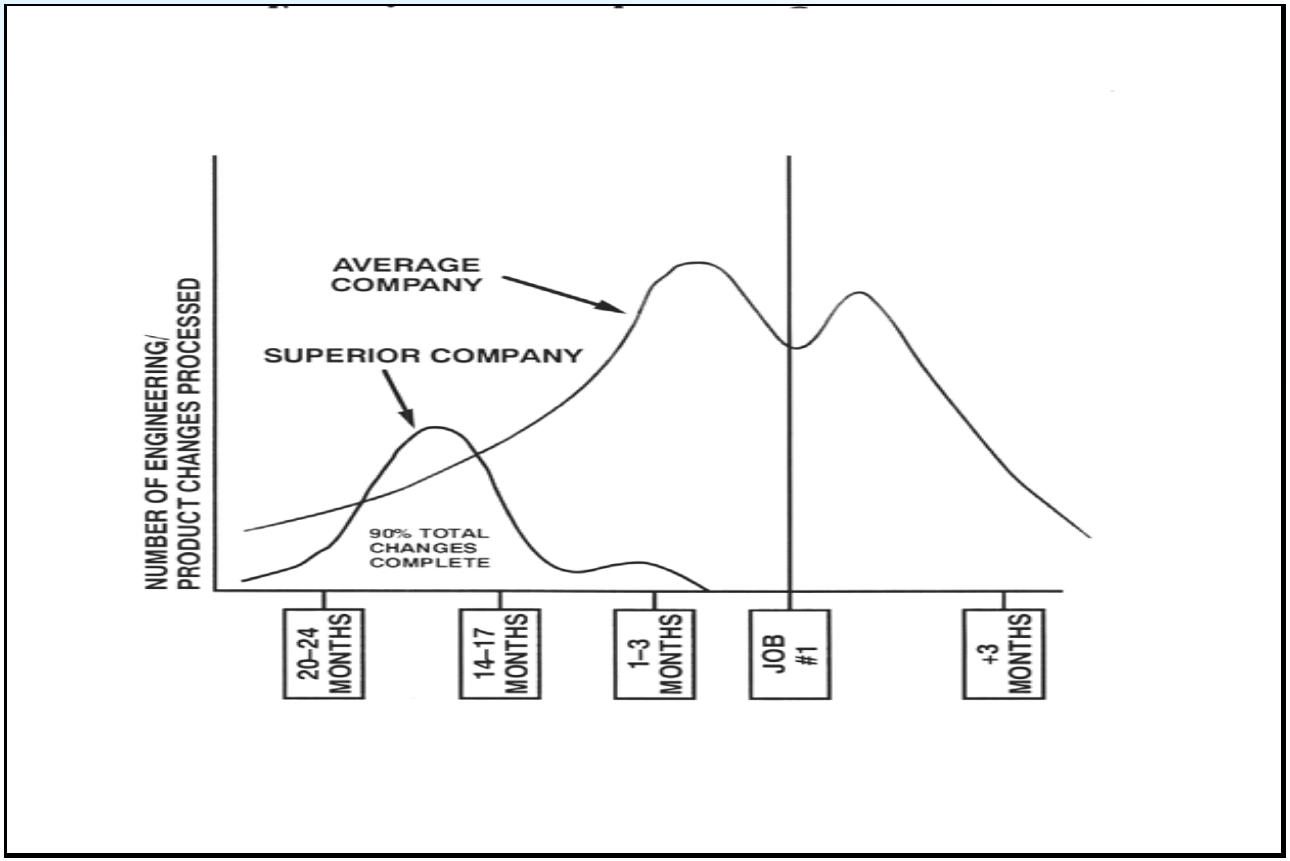
Cost

- **Development cost per product in dollars, people**

Performance

- **Use of Resource V Plan**
- **Competitive Development Costs**
- **Did the products perform to specifications?**

Superior Vs Average Company



Who has the most influence on the cost of the Product?

- Design Engineering
- Marketing
- The Factory
- Materiel
- ?

How do you improve process?

- **Map the process**
  - Use all people who touch process
  - Do from the viewpoint of design
- **Look for “white spaces”**
- **Look for distance traveled**
- **Look for “re-dos”**
- **Look for “scrap”**
- **Look at robustness**
- **Look at predictability**
- **Make sure DFX methodology is employed**
- **Concentrate on Cycle time and quality of process- other attributes follow**

DFX

A good product development process is characterized by the inclusion of anticipatory team-driven tasks which will

- **Avoid downstream surprises**
- **Cause the product to meet specifications**
  - **Performance**
  - **Quality**
  - **Cost**
  - **Time to market**

Design For “X” (DFX) cont.

- Quality
  - **Minimization of “Cost of Poor Quality”**
- Reliability
- Serviceability
- Adaptability to variability in materials and manufacturing conditions
- Adaptability to various use conditions

Design For “X” (DFX) cont.

- Societal Constraints
  - **Compliance with Regulatory Agencies**
  - **All other Legal constraints (International?)**
  - **Intellectual property protection**
  - **Industry Standards**
- Environmental
  - **Pollution and toxicity**
  - **Safety of use and manufacture**
  - **Disassembly**
  - **Recycling and disposal**
  - **Reuse/remanufacture**
- Ethical issues
  - **Product**
  - **Process**

Strategic

- Adheres to Company's Strategy
- Positioned to beat competition
- Investment required
- Product and technology platforms

Design For “X” (DFX) cont.

- Sales and marketing (Customer alignment)
  - **Meets Customers’ needs**
  - **Design to Cost to allow Target pricing**
  - **Time to market**
  - **Product Price/Volume/Feature mix**
  - **Packaging and Labels**
  - **Advertising strategy, plan and literature**
  - **Catalogues**

Design For “X” (DFX) cont.

- **User-Friendliness**
  - **–Ergonomics**
  - **–Aesthetics**
  - **–Instructions and training**

Design For “X” (DFX) cont.

- Manufacturing and Producability
  - **Make/buy**
  - **Supplier alignment**
  - **Integration of new manufacturing into previous manufacturing process with minimum disruption and capitalization costs**
  - **Maximum responsiveness to surges (and declines!) in demand**
  - **Ease of Assembly/Manufacturability /Modularity**
  - **Parts minimization**
  - **Testability**
  - **Inspectability**
  - **Standardization**

Design For “X” (DFX) cont.

- After market Support and Servicing
  - **Training of factory personnel, sales force, customers. Manuals and Documentation**
  - **Maintainability**
  - **Spare Parts availability**
  - **Customer assembly**
  - **Logistics**
  - **Upgradability**
  - **Shelf life and Storage**
  - **Installability**
  - **Warranties**

A Word on Technology

Science $\neq$ Engineering

- **Can the Technology be manufactured with known manufacturing processes?**
- **Are the critical parameters that control the new Technology's functions identified?**
- **Are the safe operating ranges known?**
- **Have the failure modes been evaluated?**
- **Have the life cycle effects been evaluated?**
- **Are the environmental effects known?**

If yes, engineering. If no, science

A Product Delivery Process with Science