Methods for Managing Customer Needs

Goal of this lecture

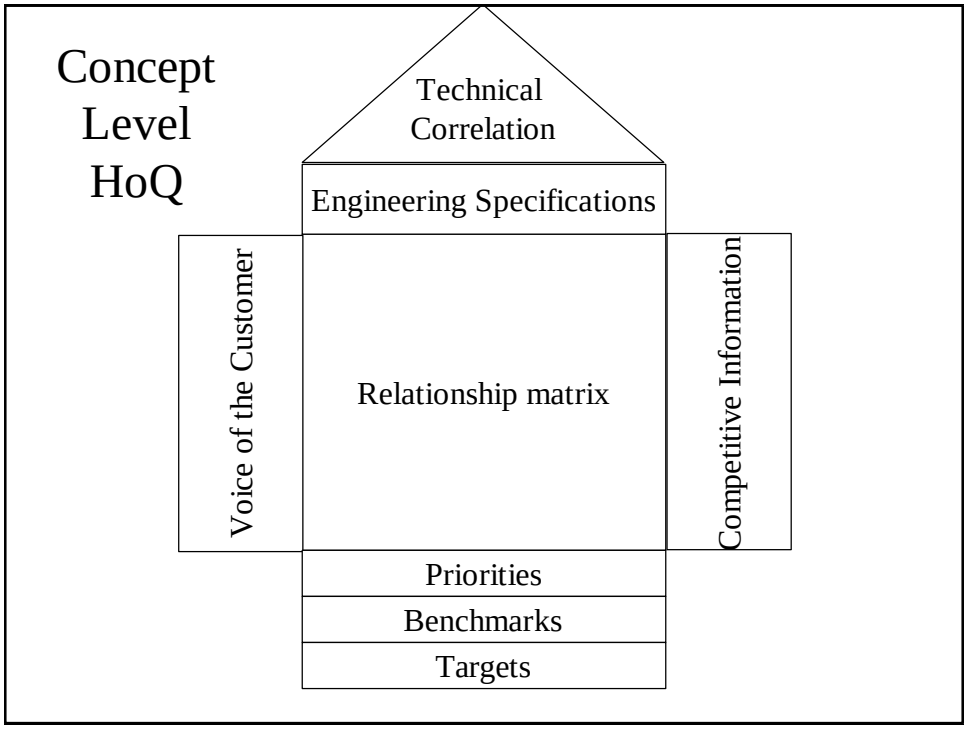
- Introduce you to three tools
  - HoQ
  - FMEA
  - Requirements flowdown
- Understand the uses/problems of each
- Assignment
  - Need to perform FMEA, HoQ and requirements flowdown on your product
  - Need to identify with these tools the key risks

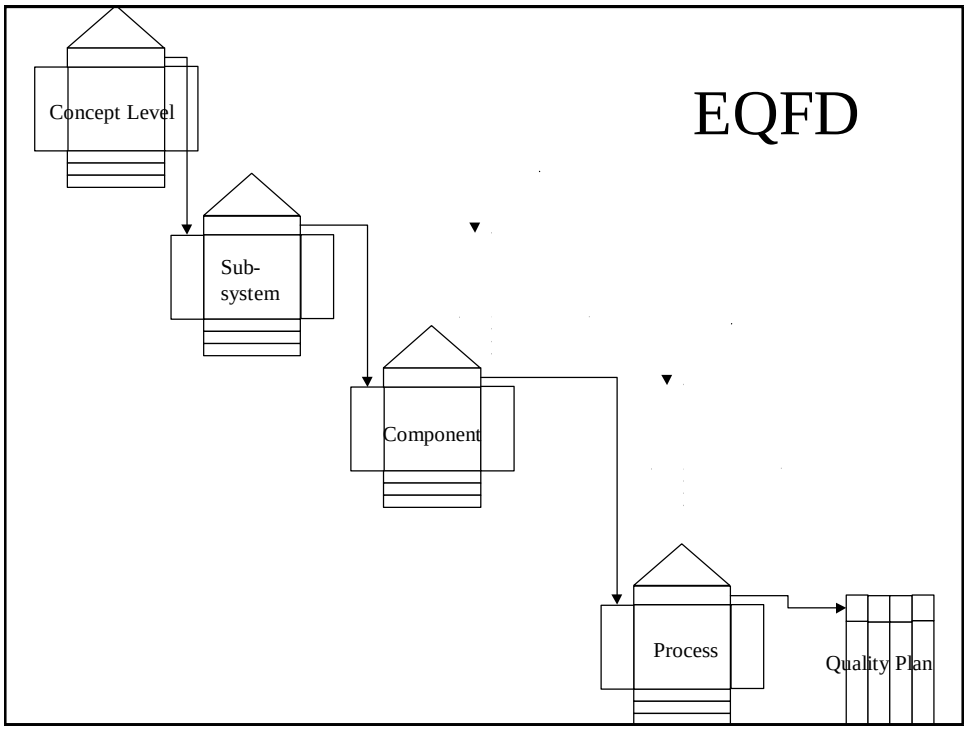
Wide variety of tools that

- Highlight problems
- Highlight tradeoffs
- Used to facilitate discussion
- Create “to-do” lists or responsibility lists
- To organize and systematically manage critical issues

Three tools

- House of Quality (HoQ)
- Failure modes and effects analysis (FMEA)
- Requirements flowdown


Concept Level HoQ
Technical Correlation
Engineering Specifications
Voice of the Customer
Relationship matrix
Competitive Information
Priorities
Benchmarks
Targets


EQFD
Concept Level
Sub-system
Component
Process
Quality Plan

HOQ

Benefits

- Captures relationships
- Traceable
- Competitive information included

Problems

- Time consuming
- EQFD almost never done
- Difficult to see linkages and system interfaces
- Mixing problems
  - •nominal
  - •variation

Failure Modes and Effects Analysis

- Tool to
  - – identify failure
  - – assess failure
  - – identify actions to mitigate risk of failure
    - redesign
    - special control
- It is a living document that should be
  - – started in the beginning of the design
  - – followed through to production

FMEA

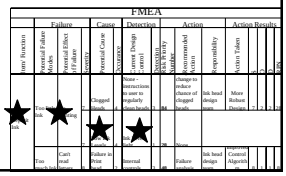
IPPD 2/17/00 HoQ and FMEA

FMEA																
	Failure			Cause		Detection		Action			Action Results					
Item/ Function	Potential Failure Modes	Potential Effect of Failure	Severity	Potential Cause	Occurrence	Current Design Control	Detection	Risk Priority Number	Recommended Action	Responsibility	Action Taken	S	O	D	RPN
Deposit Ink	Too little Ink	No printing	7	Clogged Heads	4	None - instructions to user to regularly clean heads	3	**84**	design change to reduce chance of clogged heads	Ink head design team	More Robust Design	7	2	2	28
			7	Low Ink Levels	4	Ink Level light	1	**28**	None						
	Too much Ink	Can't read letters	8	Failure in Print head	2	Internal controls	3	**48**	Failure analysis	Ink head design team	Improved Control Algorithm	8	1	1	8

Text in FMEA

IPPD 2/17/00 HoQ and FMEA

- List all functions
- Use a cross functional team to to identify
  - potential failure mode for each function
  - effect of that failure mode
  - cause of failure mode
  - current design controls (redundancy, error checking, testing)



Severity	Occurrence	Detection
10 - Hazardous Effect	10 - Almost Certain (> 1 in 2)	10 - Almost impossible - no known method to detect
9 - Serious Effect	9 - Very high (1 in 3)	9 - Remote (unreliable)
8 - Extreme Effect	8 - High (1 in 8)	8 - very slight
7 - Major Effect	7 - Moderately High (1 in 20)	7 - Slight
6 - Significant Effect	6 - Medium (1 in 80)	6 - Low
5 - Moderate Effect	5 - Low (1 in 400)	5 - Medium
4 - Minor Effect	4 -Slight (1 in 2,000)	4 -Moderately high
3 - Slight Effect	3 -Very Slight (1 in 15,000)	3 -High
2 - Very Slight Effect	2 - Remote (1 in 150,000)	2 - Very High
1 - No Effect	1 - Almost Never (<1 in 1,500,000)	1 - Almost Certain

Example for Auto Industry:

S6 - Customer experience discomfort. Vehicle Performance degraded but operable and safe. Partial loss of System function, but operable

Severity, Occurrence and Detection

IPPD 2/17/00 HoQ and FMEA

- Numbers are
  - product specific
  - product stage specific (i.e., early in design vs. production)
- Meaning should be
  - agreed on by the Cross functional team
  - consistently used

Risk Priority Number

- RPN = Severity * Occurrence * Detection
- Rank order according to RPN
- No physical meaning to RPN.
- Used to "bucket problems"
- Don't spend a lot of time worrying about what a measure of "42" means

Meaning of RPN

- Severity High, Occurrence High, Detection Low (i.e., can be detected)
  - Although the problem is of high risk it can easily be detected
- Severity Medium, Occurrence High, Detection High (i.e., can not be detected)
  - Large chance of a problem but can not be detected so it needs extra action

Debate on RPN

- Two failure modes may have the same RPN
  - S - 10, O - 1, D - 2 (RPN = 20)
  - S - 1 , O - 5, D - 4
- Which one deserves more attention
  - Typically, anything that has a failure mode of 10 is automatically addressed

Actions

- This is the important part of the FMEA
- Change design to reduce
  - Severity (redundancy)
  - Occurrence (change in design, or processes)
  - Detection (improve ability to identify the problem before it becomes critical)
- Assign a person or a team to the problem
- Follow up and assess the action with a new RPN number

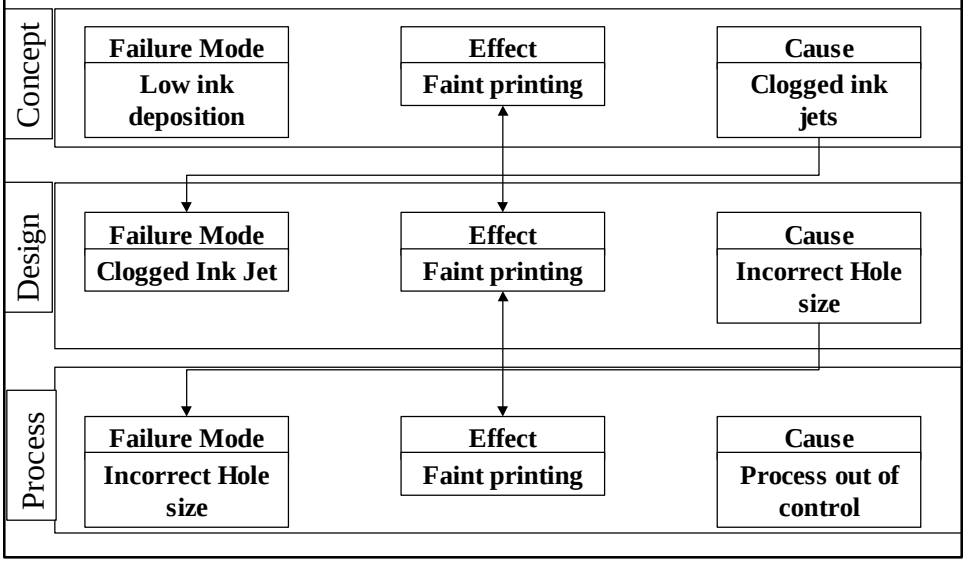
FMEA Levels

IPPD 2/17/00 HoQ and FMEA

- FMEA - 1 (Concept)
  - Failures in the concept (inability to achieve performance)
  - Detection
    - ability to find the failures (i.e., use of historical data, early models, etc.)
- FMEA - 2 (Design)
  - Failures in current design (performance)
  - Detection
    - highlighting failures during the detail design phase (i.e., crash simulations)
- FMEA - 3 (Process)
  - Failures in production process
  - Detection
    - finding the errors in the production line (i.e., SPC, inspection)

Relationships

IPPD 2/17/00 HoQ and FMEA



Uses

IPPD 2/17/00 HoQ and FMEA

- Concept
  - Identify where the *concept* can be changed to prevent failure
- Design
  - Identify where *design* can be optimized to reduce the chance of failure
- Process
  - Identify where the *process* can be optimized to reduce the chance of failure

	Failures			Cause		Detection		
Item	Potential Failure Mode	Effect	Severity	Casue	Occurance	Design control	Detection	RPN

FMEA

Benefits	Problems
Systematic way to manage failures Comprehensive Prioritizes	Based on qualitative assessment Unwieldy Hard to trace through levels Not always followed up

Requirements flowdown

- A product is made up of many possible sub-systems.
- Typically products designed by multiple teams
- Integrating these sub-systems requires
  - Systems engineers
  - Clear requirements for each sub-system

System Engineering

- Creates a set of specifications for each
- Entitled “requirements flowdown”
- Several types of flowdowns
  - Functional
  - Budget
  - Interface

Functional flowdown

- Performance of the system is a function of the parameters of two or more subsystems
- Print quality = f(speed of paper handling, skew of paper, wrinkling of the paper, image imprint quality)
- Need to understand system function and allocate the “variables” to the sub systems

Budgets

- There is often a limited commodity in a product
  - Temperature
  - Power
  - Variation
  - Volume
- Each sub-system gets allocated a budget that they must meet or exceed
- System engineer's role is to allocate and reallocate

Interfaces

- To ensure the final product works, the interface standards must be set
- Holes, plugs, shapes, communication protocol
- These need to be set, managed, and adhered to.

Take your product

- Generate the start of a “concept failure” FMEA

Problems with all tools

- Done as a box-checking
- Done but not followed up
- Done but not maintained
- Done but with the wrong people

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Next Thursday (no class tues)

- Case: Toyota Motor Corporation: Target Costing System,
- Reading
  - Cooper: Target Costing and Value Engineering.
  - Nagle The Strategy and Tactics of Pricing.
- What is target costing and how can it be used?
- How did Toyota use it?
- What type of products make target costing difficult?
- How does product architecture effect the ability to execute target costing?
- How is target costing done on a new product?