GENERAL INNOVATION TOOLS

- Benchmarking
- Brainstorming
- Business Process Reengineering
- Change Management
- Technology Audit
- Technology Forecast
- Value Analyses

PRODUCT INNOVATION TOOLS

- Design for X
- Quality Function Deployment

MANAGERIAL INNOVATION TOOLS

- Failure Mode and Effect Analysis
- Peer Evaluation
- Team Building
- ISO 9000
- Total Productive Maintenance

PROCESS INNOVATION TOOLS

- Design for Manufacture and Assembly
- Lean Thinking
- Continuous Improvement
- Concurrent Engineering
- Just In Time

General Innovation Tools

BENCHMARKING

Benchmarking is the process of improving performance by continuously identifying, understanding, and adapting outstanding practices and processes found inside and outside an organization (company, public organization, University, College, etc.).

Benchmarking of business is usually done with top performing companies in other industry sectors. This is feasible because many business processes are essentially the same from sector to sector.

BRAINSTORMING

Brainstorming is an idea-generating method widely used by teams for identifying problems, alternative solutions to problems, or opportunities for improvement. This method originated in 1941 by Alex F. Osborne, when his search for creative ideas resulted in an unstructured group process of interactive "brain-storming" that generated more and better ideas than individuals could produce working independently.

The term Brainstorming has become a commonly used word in the English language as a generic term for creative thinking. It is actually done naturally and doesn't necessarily require planning. The more alternatives you generate, the better chance you have of uncovering the best solution.

REENGINEERING

"Reengineering is the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance such as cost, quality, service, and speed." ..... (Hammer & Champy, 1993).

CHANGE MANAGEMENT

Change management is the process of aligning an organization's people and culture with systems changes, business strategy, and organizational structure. An active change management plan builds understanding and commitment to changes associated with an implementation of any type (e.g., reengineering, information technology, or strategic initiatives); aligns key organizational elements (structure, roles, skills, etc.) to support the desired change; and enables continuous performance improvement to sustain the change.

Specific techniques useful at the different change management process steps.

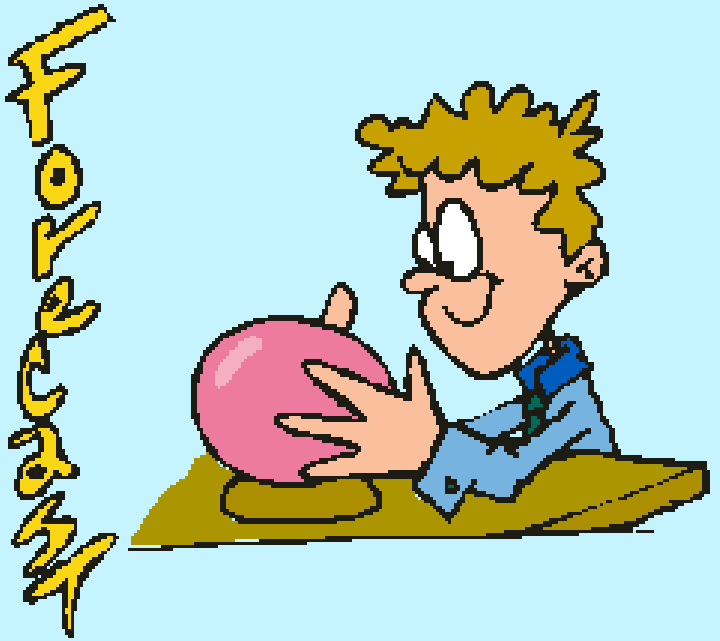
CHANGE MANAGEMENT STEP	**SPECIFIC TECHNIQUE**
Making time	time management techniques
Preparing a vision statement	SWOT analysis
Identify what factors will hinder change	force field analysis
Selling the change	internal marketing techniques
Developing a plan	strategic planning techniques
Learning	
Monitoring effectiveness	

TECHNOLOGY AUDIT

The Technology Audit is a method for identifying through a short interview-visit to a company, the major company requirements, needs, weaknesses and strengths on both human resources and infrastructure. The Technology Audit is a technique that enables the auditor to determine and identify in a very short meeting session, the management's view of how the company performs as well as strong indications of what the company really needs. The Technology Audit technique examines concurrently the External and Internal environment of the company and identifies the human resources relation to company's performance.

TECHNOLOGY FORECAST

Technology forecast includes "all efforts to project technological capabilities and to predict the invention and spread of technological innovations". A technological forecast actually includes four elements: the time of the forecast or the future date when the forecast is to be realized, the technology being forecasted, the characteristics of the technology or the functional capabilities of the technology, and a statement about probability.



VALUE ANALYSIS

Value Analysis can be defined as a process of systematic review that is applied to existing product designs in order to compare the function of the product required by a customer to meet their requirements at the lowest cost consistent with the specified performance and reliability needed.

Product Innovation Tools

DESIGN FOR X

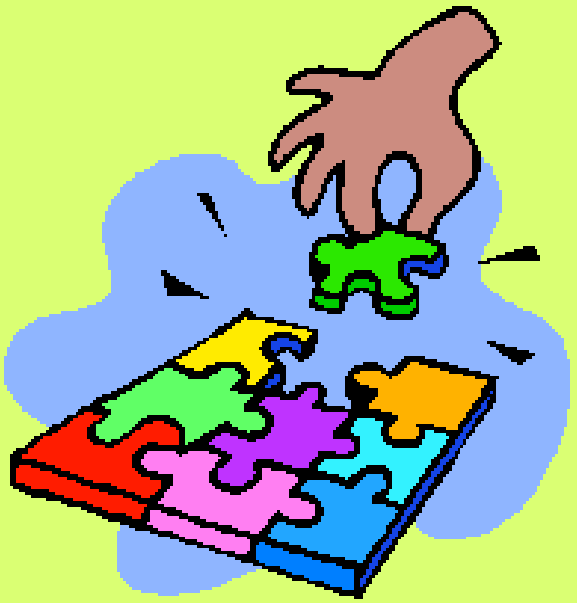
Design for X (DFX) is one of the most effective approaches to implementing Concurrent Engineering. It focuses on a limited number, say 7 ± 2, of vital elements at a time (Miller, 1956). This allows available resources to be put into best use.

„X“ - examples

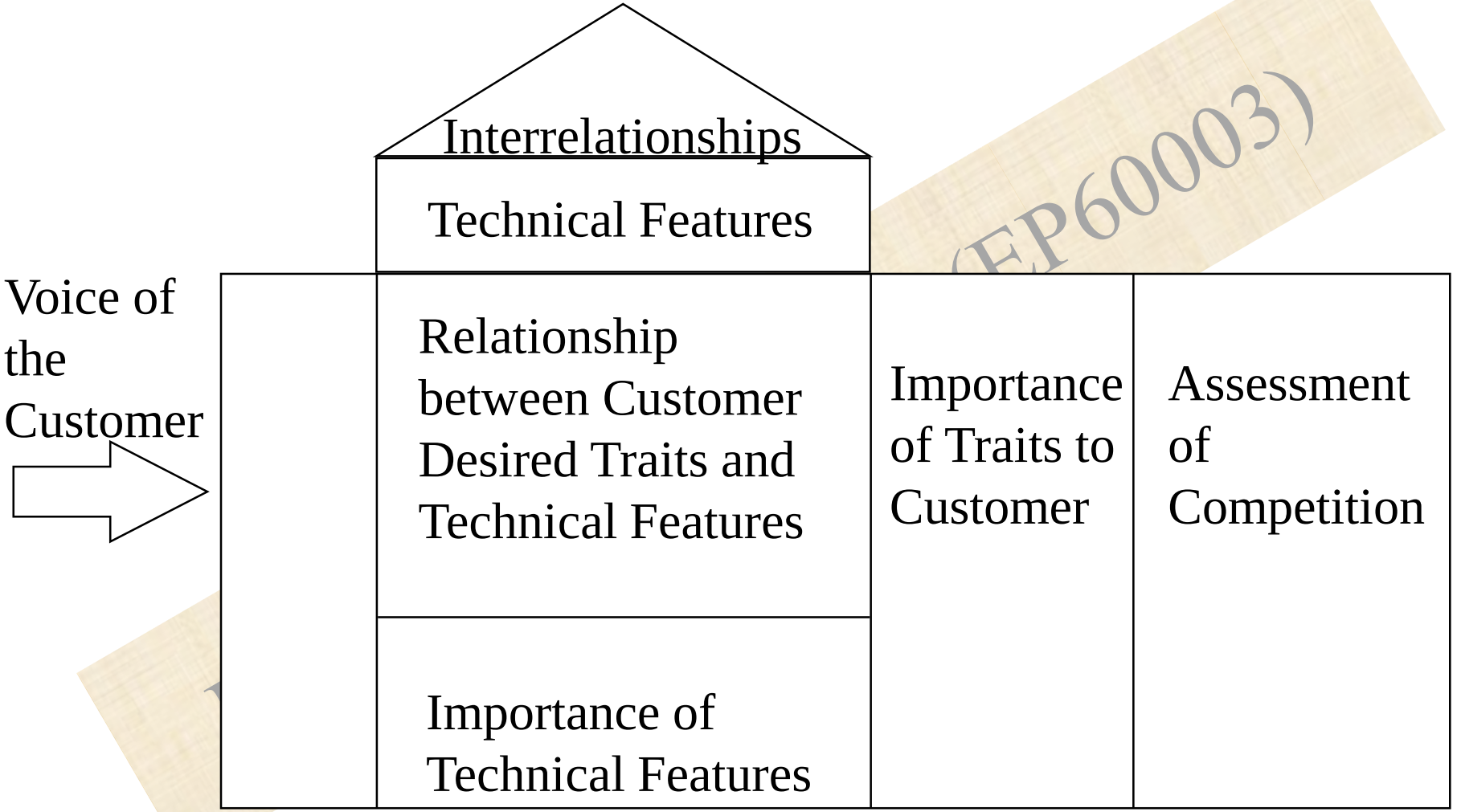
Design for Manufacturing and Assembly (DFMA)	**Design for Environment (DFE)**
Design for Dimensional Control (DDC)	**Design for Inspectability (DFI)**
Design for Storability (DFS)	**Design for Reliability (DFR)**
Design for Electromagnetic Compatibility (DFEC)	**Design for Disassembly (DFD)**

QUALITY FUNCTION DEPLOYMENT

We can define Quality Function Deployment as converting the consumers' demands into "quality characteristics" and developing a design quality for the finished product by systematically deploying the relationships between the demands and the characteristics, starting with the quality of each functional component and extending the deployment to the quality of each part and process. The overall quality of the product will be formed through this network of relationships.



House of Quality



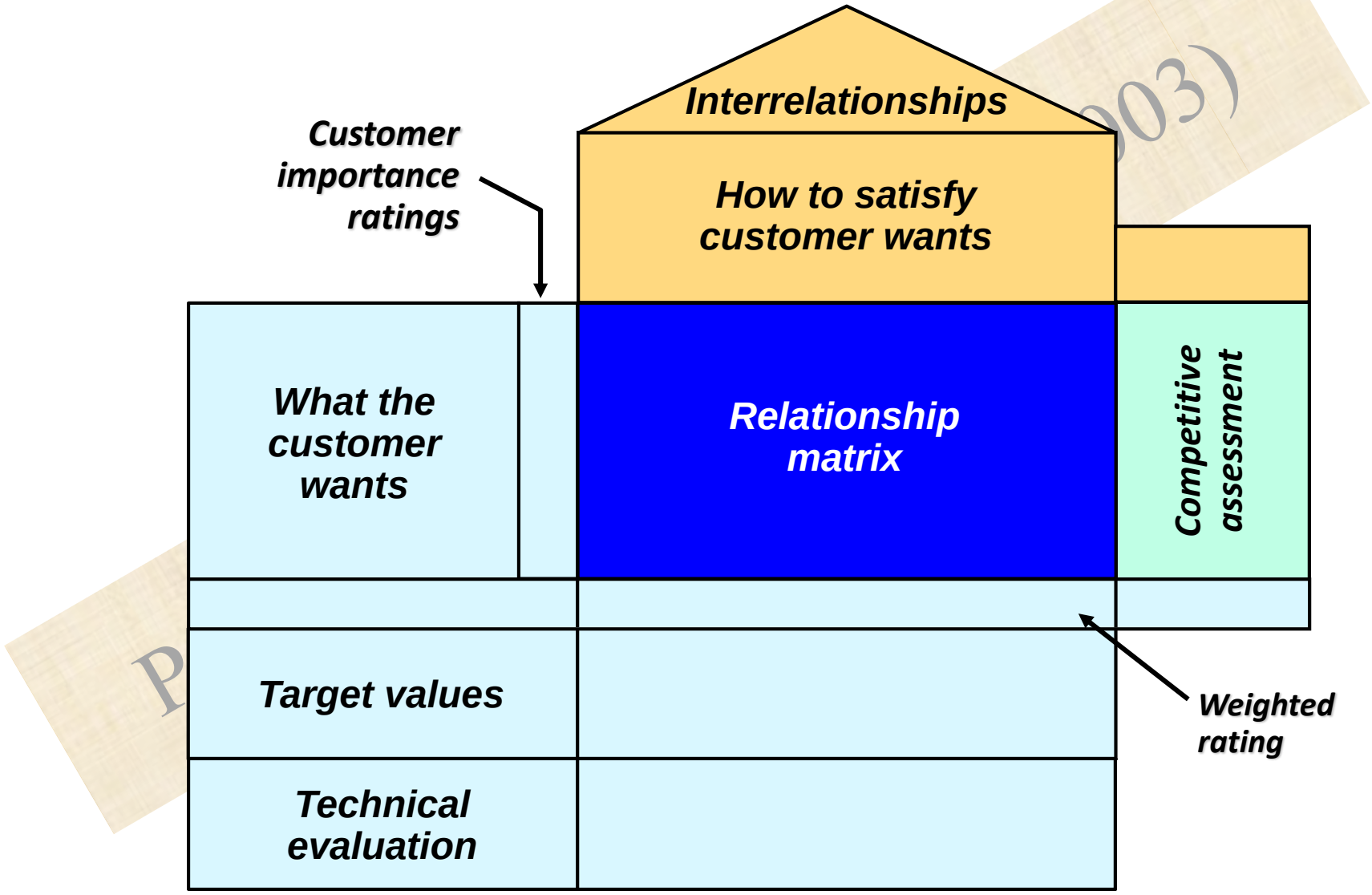
House of Quality:
Steps for Generation

1. Identify Customer Attributes
2. Identify Supporting Technical Characteristics
3. Correlate Customer Attributes with Supporting Technical Features
4. Assign Priorities to Customer Requirements and Technical Features
5. Evaluate Competitors' Stances and Products
6. Identify Technical Characteristics to Deploy in the Final Product Design

Quality Function Deployment

- ☑ Identify customer wants
- ☑ Identify how the good/service will satisfy customer wants
- ☑ Relate customer wants to product hows
- ☑ Identify relationships between the firm's hows
- ☑ Develop importance ratings
- ☑ Evaluate competing products
- ☑ Compare performance to desirable technical attributes

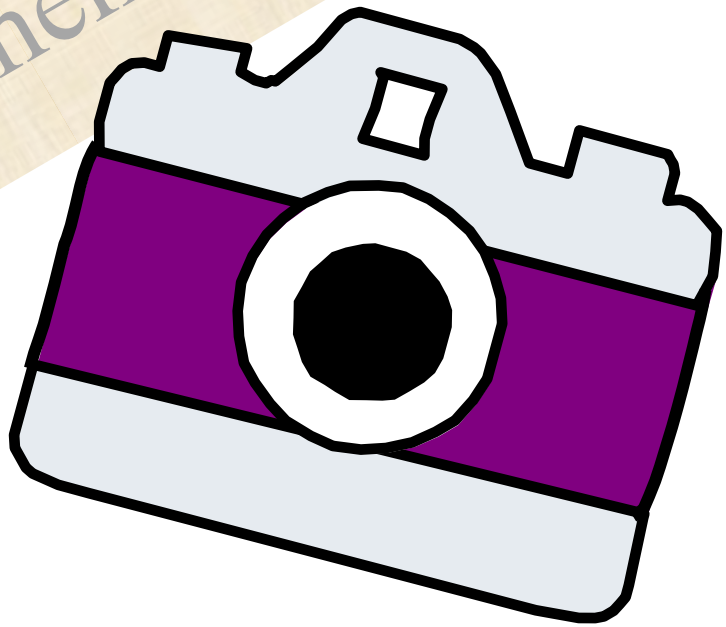
QFD House of Quality



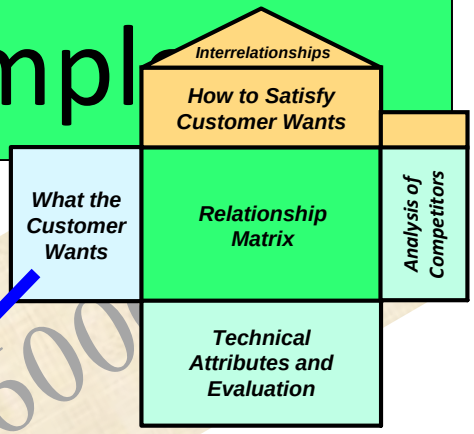
House of Quality Example

Your team has been charged with designing a new camera for Great Cameras, Inc.

The first action is to construct a House of Quality



House of Quality Exampl

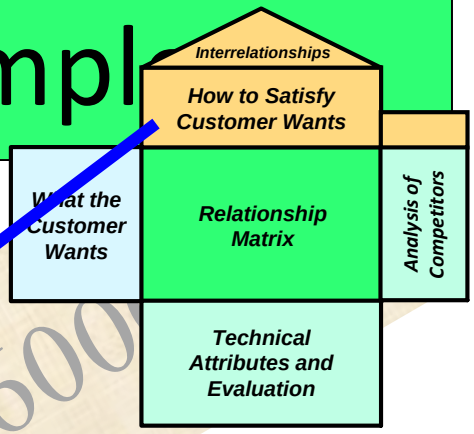


What the customer wants

Customer importance rating (5 = highest)

Lightweight	***3***
Easy to use	***4***
Reliable	***5***
Easy to hold steady	***2***
Color correction	***1***

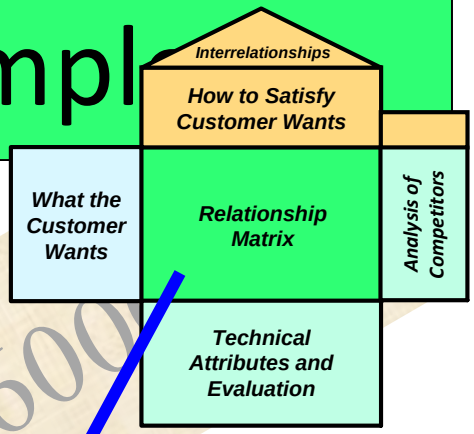
House of Quality Exampl



- Low electricity requirements
- Aluminum components
- Auto focus
- Auto exposure
- Paint pallet
- Ergonomic design

How to Satisfy Customer Wants

House of Quality Exampl

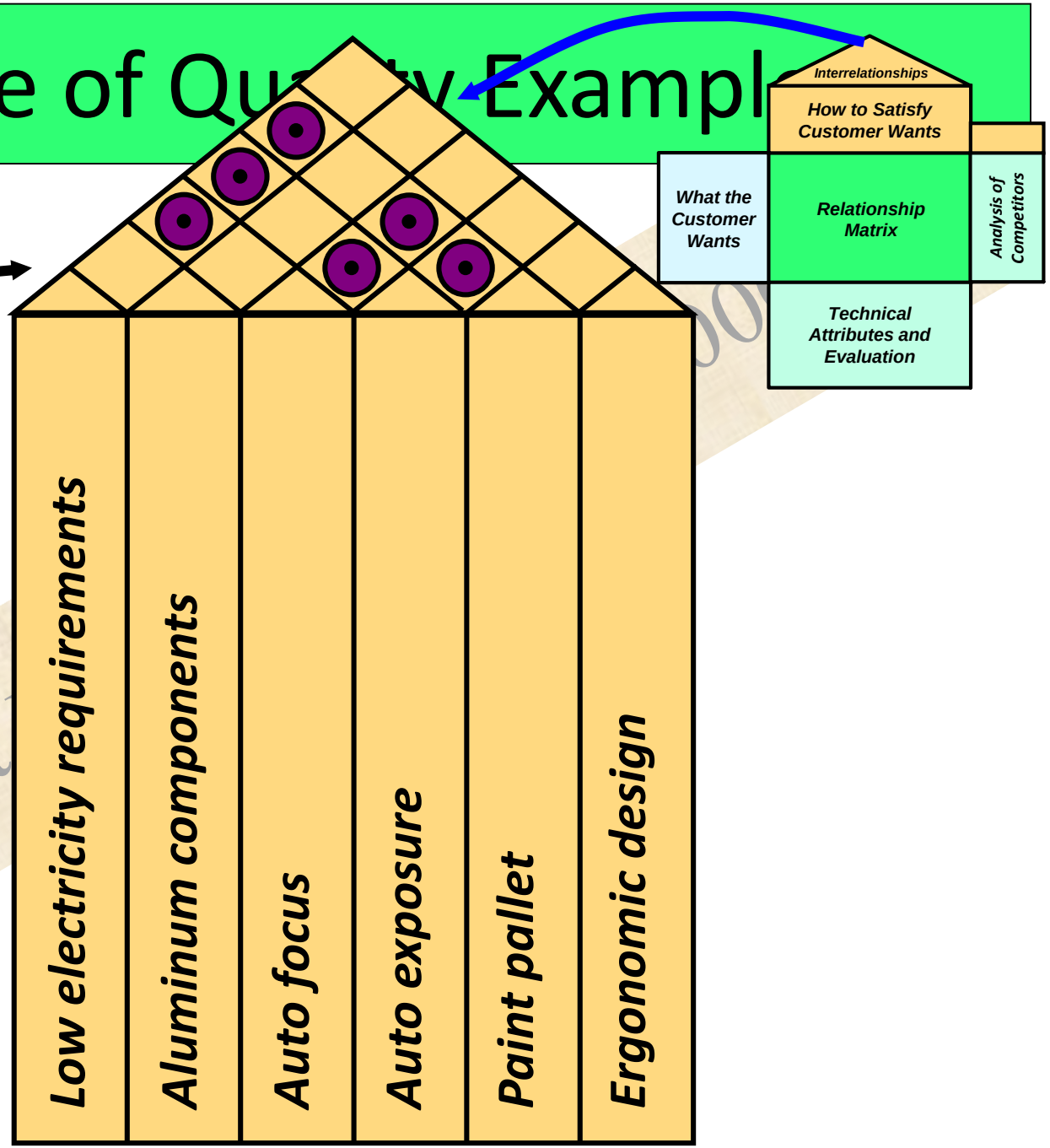


- ***High relationship***
- ***Medium relationship***
- ***Low relationship***

Lightweight	***3***	•	●				•
Easy to use	***4***	•		●	●	●	●
Reliable	***5***	●		●	●	●	
Easy to hold steady	***2***						◉
Color corrections	***1***					◉	

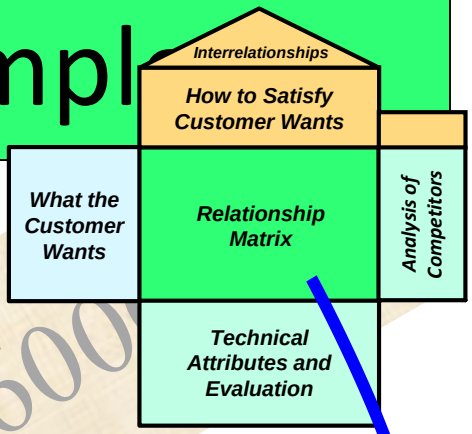
Relationship matrix

House of Quality Example



Relationships between the things we can do

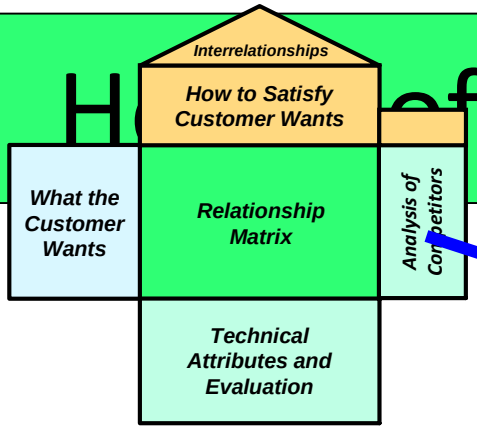
House of Quality Exampl



Lightweight	3	•	◉				•
Easy to use	4	•		◉	◉	◉	◉
Reliable	5	◉		◉	◉	◉	
Easy to hold steady	2						◎
Color corrections	1					◎	
Our importance ratings		22	9	27	27	32	25

Weighted rating

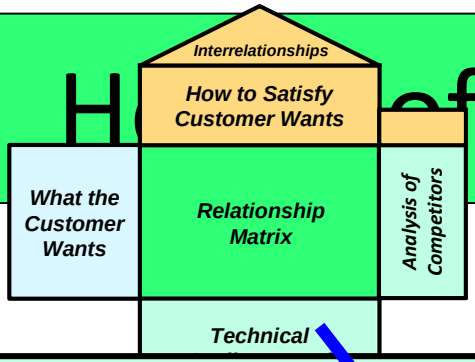
House of Quality Example



How well do competing products meet customer wants

				Company A	Company B
Lightweight	3	•	•	G	P
Easy to use	4	•	●	G	P
Reliable	5	●		F	G
Easy to hold steady	2			G	P
Color corrections	1			P	P
Our importance ratings		22	5		

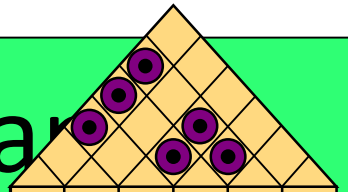
H[illegible]f Quality Example



Target values (Technical attributes)		***0.5 A***	***75%***	***2' to ∞***	***2 circuits***	***Failure 1 per 10,000***	***Panel ranking***
Technical evaluation	***Company A***	**0.7**	**60%**	***yes***	**1**	***ok***	***G***
	Company B	**0.6**	**50%**	***yes***	**2**	***ok***	***F***
	Us	**0.5**	**75%**	***yes***	**2**	***ok***	***G***

House of Quality Exa

Completed House of Quality



		Low electricity requirements	Aluminum components	Auto focus	Auto exposure	Paint pallet	Ergonomic design	Company A	Company B
Lightweight	3	•	●				•	G	P
Easy to use	4	•		●	●	●	●	G	P
Reliable	5	●		●	●	●		F	G
Easy to hold steady	2						◉	G	P
Color correction	1					◉		P	P
Our importance ratings		22	9	27	27	32	25		
Target values (Technical attributes)		0.5 A	75%	2' to ∞	2 circuits	Failure 1 per 10,000	Panel ranking		
Technical evaluation	Company A	0.7	60%	yes	1	ok	G		
	Company B	0.6	50%	yes	2	ok	F		
	Us	0.5	75%	yes	2	ok	G		

House of Quality Sequence

Deploying resources through the organization in response to customer requirements

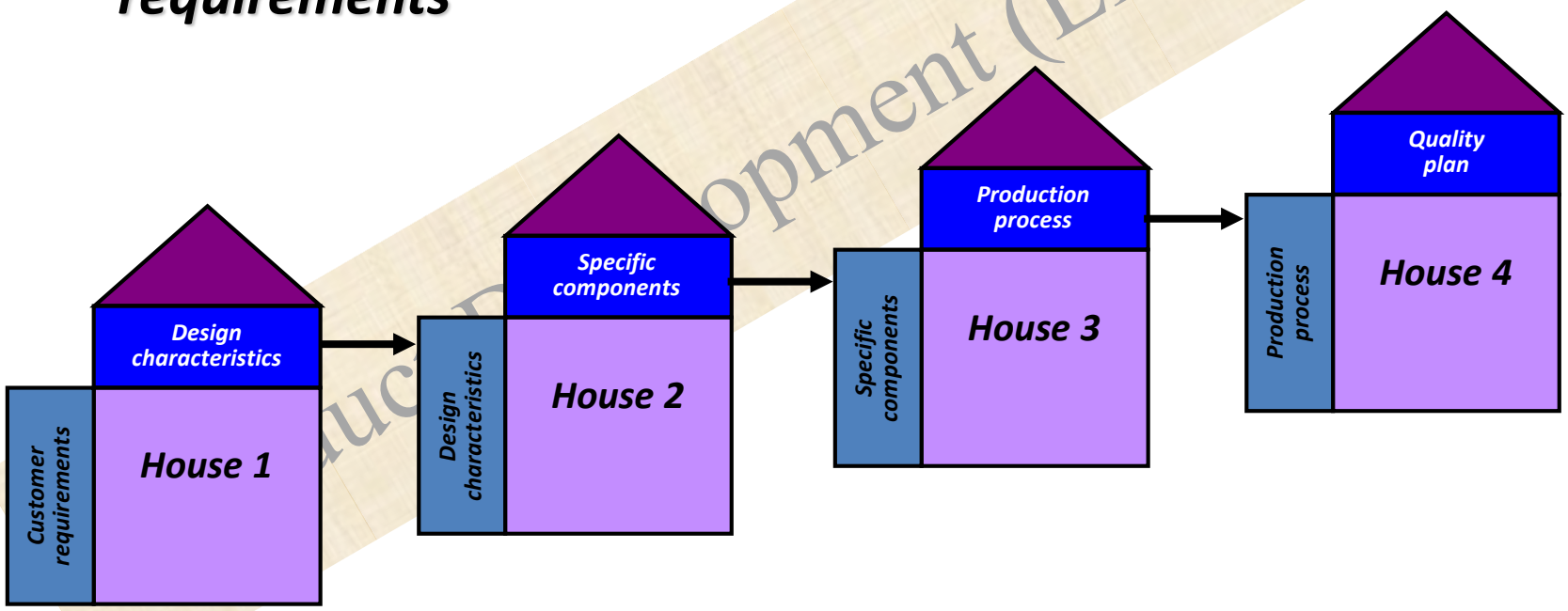
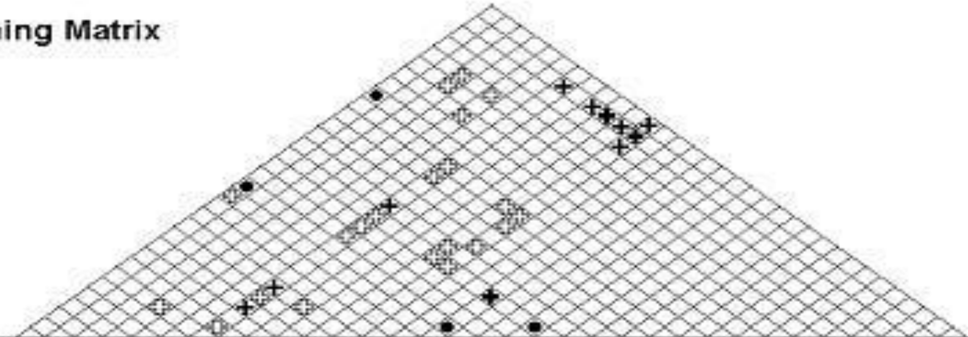


Figure 5.4

Product Planning Matrix



Interactions:
- ✚ Strong Negative
- ⊕ Moderate Negative
- ● Strong Positive
- ○ Moderate Positive

	Customer Needs	Priority	No loose parts during joint operation	Joint override time	Operator force/torque limit (normal conditions)	No stat. damage at max force/torque limit	Minimum joint activation force / torque	Operator lifting force	Target cost	Variation in structural / dynamic parameters	Deflection limit under 4g load	Guide thimble stresses	Adaptor plate stress
	Goal		O	↓	O	O	O	↓	↓	↓	↓	↓	↓
	Area		Joint Features						$	Design			
Jt. Feat.	Override capability / joint margin	2		5							3	5	5
Jt. Feat.	Visually verify locked joints	4											
Jt. Feat.	Allow assembly repair	3											
Repair	Simple tooling	4	3		5			5					
Repair	Fast repair	5	3	1	1		3	3					
Compat.	Compatible with system components	3				1						3	1
Compat.	Compatible with site tooling	3											
Compat.	Compatible interface to other assys	3								3	3	3	1
Rg.	Meet regulatory limits	3								5	6	3	3
Rel.	Joint reliability during operation	3					5						
Rel.	Joint reliability during repair	5	5		1	5	1					1	
$	Minimum price increase	5							5				
Technical Evaluation		5	[illegible]				[illegible]	[illegible]		R			
		4			[illegible]				R	QD	[illegible]	[illegible]	[illegible]
		3		[illegible]		QF			S	SF			
		2			R	R			QD				
		1	R			DS		R	F				
Target Value			Zero	4 hrs. per nozzle	Torque=16 ft-lbs / 32 lbs	X torque / Y force	36 in-oz / X lbs	40 lbs	80% + (MAT Alloy + entry costs (per kit))	Less than 6%	0.04 in.	X psi	X psi
Technical Difficulty (1-Low, 5-High)			3	1	1	2	3	1	5	2	2	2	2
Importance Rating			65	18	34	33	47	43	75	24	30	43	25
Normalized Importance Rating			4	1	2	2	3	3	5	2	2	3	2

	Customer Needs	Priority	Joint component stresses	Use of MFRD approved material	Set-up & teardown time	Joint lock verification time	Maximum removal / installation time	RCCA / TPD functional gauging drag	Flow (cooling) through annulus	Protrusion above adapter plate	Guide thimble mis-location from true ctr.	Joint internal diameter	Top plate width (Char. "S")
	Goal		↓	O	↓	↓	↓	↓	↑	↓	↓	↑	O
	Area		Design		Time			Compatibility					
Jt. Feat.	Override capability / joint margin	2	5										
Jt. Feat.	Visually verify locked joints	4				5							
Jt. Feat.	Allow assembly repair	3											
Repair	Simple tooling	4			5					1			
Repair	Fast repair	5				3	6			3	1		
Compat.	Compatible with system components	3						5	3	5	5	5	
Compat.	Compatible with site tooling	3											5
Compat.	Compatible interface to other assys	3											
Rg.	Meet regulatory limits	3	3	3				3	3				1
Rel.	Joint reliability during operation	3	1	5									
Rel.	Joint reliability during repair	5	3	3							1		
$	Minimum price increase	5			3		1						
Technical Evaluation		5				R	Q		[illegible]	[illegible]	R		
		4	[illegible]	[illegible]	QF		T	[illegible]			QD	[illegible]	[illegible]
		3				QD	DS						
		2									SF		
		1			R	SF	R		D	0			
Target Value			ASME Stress limits	Yes / No	4 hrs. total (2 hrs. each)	10 mins. per nozzle	60 mins. total	16 lbs max (RCCA) / 40 lbs max (TP)	(Lat area > annular area)	0.15 in.	0.01 in.	0.552 in.	0.988 in.
Technical Difficulty (1-Low, 5-High)			5	1	1	4	3	1	3	2	4	1	1
Importance Rating			41	45	65	43	53	24	18	42	29	15	18
Normalized Importance Rating			3	3	4	3	4	2	1	3	2	1	1

	Customer Needs	Priority	Variation in delta P	QD collet-to-insert clearance	No moveable tooling parts	Tooling stresses acceptable	Joint operation cycle test	Qualified-joint operation w/in force/torque limits	Thermal cycle test-operation w/in force/torque limit	In-operation loose parts simulation/analysis	Locked joint damage force	Inactive joints	Joint lateral impact resistance
	Goal		↓	↑	O	O	↑	↑	↑	O	↑	↑	↑
	Area		Compatibility	Op Tooling			Robust						
Jt. Feat.	Override capability / joint margin	2										5	
Jt. Feat.	Visually verify locked joints	4											
Jt. Feat.	Allow assembly repair	3		5									
Repair	Simple tooling	4		1	5	5							
Repair	Fast repair	5		3	3			1					
Compat.	Compatible with system components	3											
Compat.	Compatible with site tooling	3											
Compat.	Compatible interface to other assys	3	3										
Rg.	Meet regulatory limits	3											
Rel.	Joint reliability during operation	3					1			5			
Rel.	Joint reliability during repair	5		1	3	1	5	5	5		3	3	5
$	Minimum price increase	5											
Technical Evaluation		5	R							R			
		4	Q	R	QDF	[illegible]	SR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	QF
		3	[illegible]	Q	S		[illegible]				S		SD
		2		DS		R					R		
		1		F	R								R
Target Value			Less than 6% change	Zero on nominal stackup	Zero	0.5X material yield strength	100 cycles	Equiv. to 1200 EFPD	X Cycles	Zero	30 lbs	2 joints (different quadrants)	Survive 2g impact
Technical Difficulty (1-Low, 5-High)			2	5	1	1	2	1	2	5	2	2	1
Importance Rating			9	48	61	28	34	38	30	18	18	28	30
Normalized Importance Rating			1	3	4	2	2	3	2	1	1	2	2

Customer Needs	Competitive Evaluation (1-Low, 5-High): 1	2	3	4	5	Sales Points	Improvement Ratio (ORTN)
Override capability / joint margin			[illegible]			1	1
Visually verify locked joints	FS		QD		R	1	1
Allow assembly repair	FW	SD	Q	R		1	1
Simple tooling		R		[illegible]		1	1
Fast repair	R	SD	F	Q		1.5	1
Compatible with system components			SD	SF	R	1	1
Compatible with site tooling					[illegible]	1	1
Compatible interface to other assys					[illegible]	1	1
Meet regulatory limits			S	DF	RQ	1	1
Joint reliability during operation				[illegible]		1.2	1
Joint reliability during repair	R		[illegible]			1.2	1
Minimum price increase	F	QD	B	R		1.5	2

Evaluation Key:
R-RTN
Q-ORTN
D-Customer Design
F-Competitor A
S-Competitor B

Examples of Quality Characteristics

Products

Performance	Serviceability	Reliable
Reasonable Price	Ease of Use	Maintainability
Durability	Simplicity of Design	Aesthetics
Available	Safe	Ease of Disposal

Examples of Quality Characteristics

Service

Responsiveness	Credibility	Available
Reliable	Safe	Security
Competence	Understand the Customer	Accuracy
Completeness	Timeliness	Communication

DRIVERS OF QUALITY

1. Customers:

Quality is established with a focus on satisfying or exceeding the requirements, expectations, needs, and preferences of customers.

2. Products / Services

Conformance to requirements and zero defect concepts have roots in producing a product / service that meets stated or documented requirements.

3. Employee Satisfaction

This concept is that an organization takes care of employee's needs so that they can be free to worry only about the customer.

4. Organizational Focus

Some organizations tend to focus on total organizational quality while others are quite successful at using a segmented approach to implementing quality.

APQP

A structured method of defining & establishing the steps necessary to assure that a product satisfies the customer

Benefits of APQP

- To direct resources to satisfy the customer
- To promote early identification of required changes
- To avoid late changes
- To provide a quality product on time at the lowest cost

METHODS OF QUALITY IMPLEMENTATION

1. **Quality of design versus quality of conformance**

The organization's values, goals, mission, policies, and practices reinforce designing into the product or service rather than inspecting it in. Emphasis is placed on doing the right things right the first time. Conformance is the norm.

METHODS OF QUALITY IMPLEMENTATION

2. Quality planning, control, and improvement

The focus of this dimension is for organizations to continually improve their products, services, processes, and practices with an emphasis on reducing variation and reducing cycle time. Quality management tools, including cost of quality, process management approaches, and measurement techniques are implemented.

METHODS OF QUALITY IMPLEMENTATION

3. Little q and Big Q

Organizations focusing on quality control and inspection activities (little q) will fail to be fully effective they must transform their thinking to quality across organization (Big Q)

METHODS OF QUALITY IMPLEMENTATION

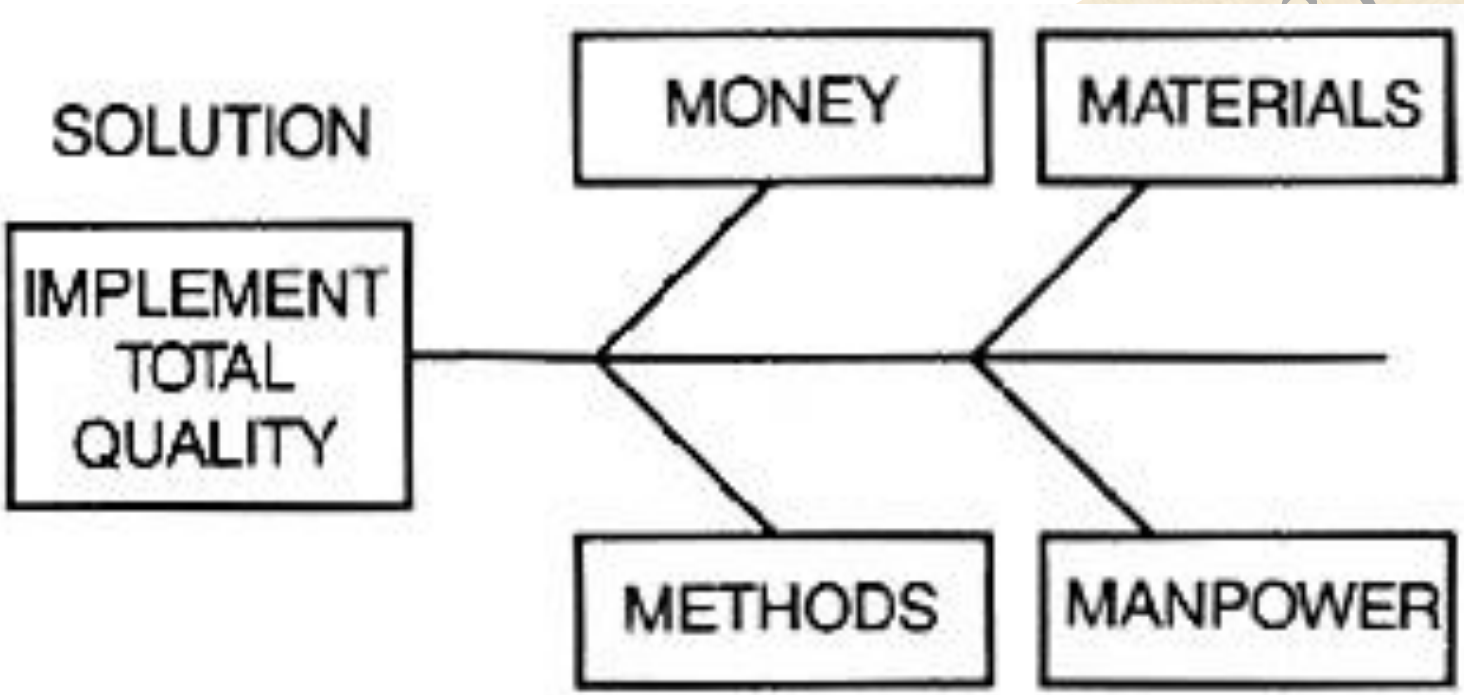
4. Quality is strategic

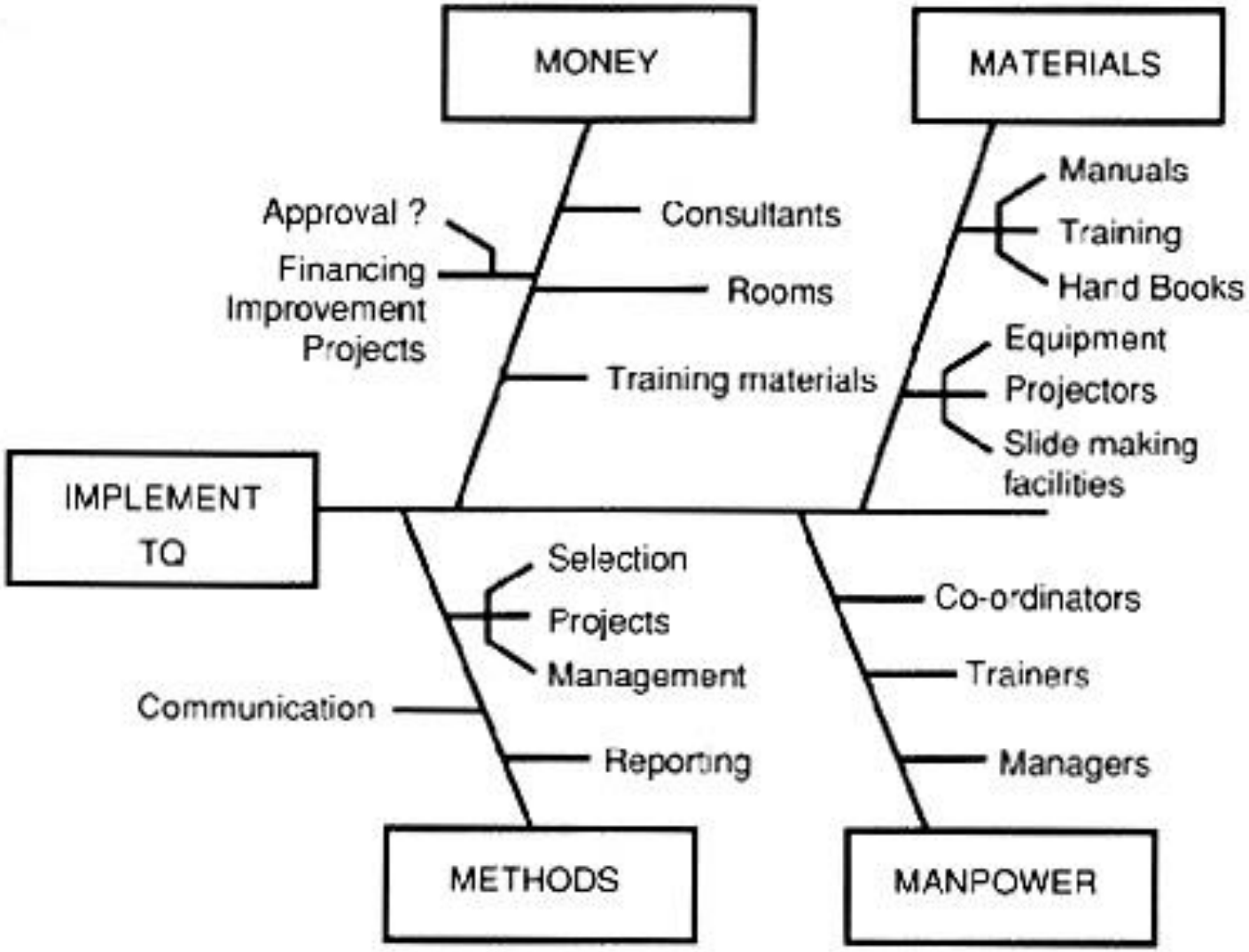
Quality, or the absence of it, has a strategic impact on the organization. Consumers buy certain products and request services based on their knowledge and perception of the organization and what it provides. Few buyers knowingly buy poor quality. Accumulated experiences and perceptions of customers ultimately make or break an organization.

Managerial Innovation Tools

FAILURE MODE AND EFFECT ANALYSIS (FMEA)

Failure Mode and Effect Analysis (FMEA) is a powerful, quality assurance discipline used to identify and minimise the effects of potential problems in product or process designs. The technique was formalised by NASA in mid-1960's, and first used by Ford North America in 1972, and is now used by GMH (Aust) and Ford (Aust).


SOLUTION
IMPLEMENT TOTAL QUALITY
MONEY
MATERIALS
METHODS
MANPOWER


MONEY
MATERIALS
Approval ?
Financing
Improvement
Projects
Consultants
Rooms
Training materials
Manuals
Training
Hard Books
Equipment
Projectors
Slide making
facilities
IMPLEMENT
TQ
Selection
Projects
Management
Communication
Reporting
Co-ordinators
Trainers
Managers
METHODS
MANPOWER

The 6 Ms (used in manufacturing industry)

- Machine (technology)
- Method (process)
- Material (Includes Raw Material, Consumables and Information.)
- Man Power (physical work)/Mind Power (brain work): Kaizens, Suggestions
- Measurement (Inspection)
- Milieu/Mother Nature (Environment)

Two more Ms have been included later:

- Management/Money Power
- Maintenance

The 7 Ps (used in marketing industry)

- Product=Service
- Price
- Place
- Promotion
- People/personnel
- Process
- Physical Evidence

The 5 Ss (used in service industry)

- Surroundings
- Suppliers
- Systems
- Skills
- Safety

Questions to be asked while building a Fishbone Diagram

1. Man/Operator

- Was the document properly interpreted?
- Was the information properly circulated to all the functions?
- Did the recipient understand the information?
- Was the proper training to perform the task administered to the person?
- Was too much judgment required to perform the task?
- Were guidelines for judgment available?
- Did the environment influence the actions of the individual?
- Are there distractions in the workplace?
- Is fatigue a contributing factor?
- Is his work efficiency acceptable?
- Is he responsible/accountable?
- Is he qualified?
- Is he experienced?
- Is he medically fit and healthy?
- How much experience does the individual have in performing this task?
- Can he carry out the operation without error?

2. Machines

- Was the correct tool/tooling used?
- Does it meet production requirements?
- Does it meet process capabilities?
- Are files saved with the correct extension to the correct location?
- Is the equipment affected by the environment?
- Is the equipment being properly maintained (i.e., daily/weekly/monthly preventative maintenance schedule)
- Does the software or hardware need to be updated?
- Does the equipment or software have the features to support our needs/usage?
- Was the machine properly maintained?
- Was the machine properly programmed?
- Is the tooling/fixturing adequate for the job?
- Does the machine have an adequate guard?
- Was the equipment used within its capabilities and limitations?
- Are all controls including emergency stop button clearly labeled and/or color-coded or size differentiated?
- Is the equipment the right application for the given job?

3. Measurement

- Does the gauge have a valid calibration date?
- Was the proper gauge used to measure the part, process, chemical, compound, etc.?
- Was a gauge capability study ever performed?
- Do measurements vary significantly from operator to operator?
- Do operators have a tough time using the prescribed gauge?
- Is the gauge fixturing adequate?
- Does the gauge have proper measurement resolution?
- Did the environment influence the measurements taken?

4. **Material** (Includes Raw Material, Consumables and Information)

- Is all needed information available and accurate?
- Can information be verified or cross-checked?
- Has any information changed recently / do we have a way of keeping the information up to date?
- What happens if we don't have all of the information we need?
- Is a Material Safety Data Sheet (MSDS) readily available?
- Was the material properly tested?
- Was the material substituted?
- Is the supplier's process defined and controlled?
- Was the raw material defective?
- was the raw material the wrong type for the job?
- Were quality requirements adequate for the part's function?
- Was the material contaminated?
- Was the material handled properly (stored, dispensed, used & disposed)?

5. Method

- Was the canister, barrel, etc. labeled properly?
- Were the workers trained properly in the procedure?
- Was the testing performed statistically significant?
- Was data tested for true root cause?
- How many “if necessary” and “approximately” phrases are found in this process?
- Was this a process generated by an Integrated Product Development (IPD) Team?
- Did the IPD Team employ Design for Environmental (DFE) principles?
- Has a capability study ever been performed for this process?
- Is the process under Statistical Process Control (SPC)?
- Are the work instructions clearly written?
- Are mistake-proofing devices/techniques employed?
- Are the work instructions complete?
- Is the work standard upgraded and to current revision?
- Is the tooling adequately designed and controlled?
- Is handling/packaging adequately specified?
- Was the process changed?
- Was the design changed?
- Are the lighting and ventilation adequate?
- Was a process Failure Modes Effects Analysis (FMEA) ever performed?
- Was adequate sampling done?
- Are features of the process critical to safety clearly spelled out to the Operator?

6. Management

- Is management involvement seen?
- Inattention to task
- Task hazards not guarded properly
- Other (horseplay, inattention....)
- Stress demands
- Lack of Process
- Training or education lacking
- Poor employee involvement
- Poor recognition of hazard
- Previously identified hazards were not eliminated

PEER EVALUATION

Teams have specific goals—Team members have learned that team goals cannot be accomplished unless everyone participates and works together—and Teams have developed a shared strategy which allows them to evaluate their progress. The evaluation of this progress for each one separately is actually what **Peer Evaluation** is.

TEAM BUILDING

A team is a group of people working towards a common goal. Team Building is the process of enabling that group of people to reach their goal. It is therefore a management issue, and the most effective form of team building is that undertaken as a form of management consultancy, rather than as pure training (though there is a role for training within a program of team building).

Together

Everyone

Accomplishes

More

ISO 9000

In 1987 ISO published the first five international models on quality assurance, known as the ISO 9000 Standards. In their announcements at the time, they described the new standards as 'the refinement of all the most practical and generally applicable principles of quality systems and the culmination of agreement between the world's most advanced authorities of these standards as the basis of a new era of quality management.'

ISO14000

refers to procedures for ensuring sustainable and environmentally friendly operations

EIA – Environmental Impact Assessment

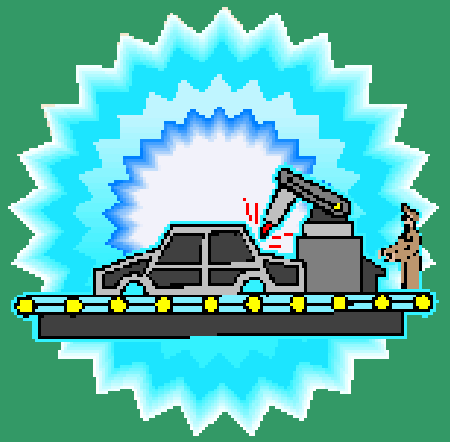
TOTAL PRODUCTIVE MAINTENANCE

Total Productive Maintenance (TPM) is a Company Strategy for equipment and process improvement. An important part of TPM is that the equipment users become and actively contribute to improvement actions. This is known as Autonomous Maintenance, and involves the equipment users taking time to clean, inspect and carry out basic maintenance on their equipment.

Process Innovation Tools

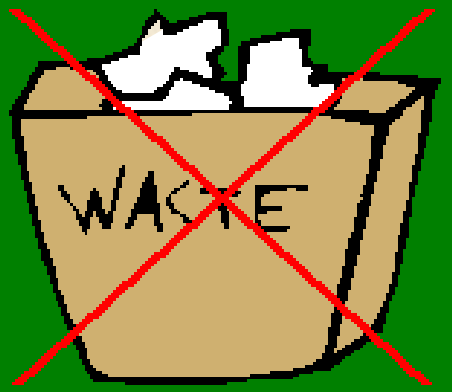
DESIGN FOR MANUFACTURING AND ASSEMBLY (DFMA)

Design for Manufacturing and Assembly (DFMA) is a Design for X Tool (DFX). It is a systematic procedure that aims to help companies make the fullest use of the manufacturing processes that exist and keep the number of parts in an assembly to the minimum. It achieves this by enabling the analysis of design ideas. It is not a design system, and any innovation must come from the design team, but it does provide quantification to help decision – making at the early stages of design.



LEAN THINKING

Fortunately, there is a powerful antidote to muda: Lean Thinking. It provides a way to specify value, line up value-creating actions in the best sequence, conduct these activities without interruption whenever someone requests them, and perform them more and more effectively. In short, lean thinking is lean because it provides a way to do more and more with less and less – less human effort, less equipment, less time, and less space – while coming closer and closer to providing customers with exactly what they want.



CONTINUOUS IMPROVEMENT

Continuous Improvement (CI) is a philosophy that approaches the production process as a "work-in-progress" situation. This means that even if things are going really good, there are still places that can be improved. The company has to always strive to better their processes, which in turn will help them to cut costs, and to improve productivity.

CONCURRENT ENGINEERING

Concurrent Engineering (CE) is the parallel performance of market research, design, development, and production planning. It is the combination of efforts and disciplines, brought together within a multifunctional team. Basically, with the CE in place, various company teams use real-time feedback in their planning and execution. The effect is threefold:

1. Compressed product development cycles
2. Better system integration, design for manufacturability, and customer satisfaction
3. Lower overall development and production costs

PRODUCT QUALITY PLANNING TIME CHART