Build4 Scale
U.S. Department of Energy

Detailed Design Package

Module 2C Acceptable Quality Level

Motivation

Why is this module important?

- Most scale-up operations fail because of poor process design; it is critical that all the failure modes are identified and eliminated during the design and prototyping stages so nothing unexpected happens during scale-up
- Supplier quality can make a big difference for scale
- The amount of content from suppliers, in any product (with just a moderate number of components), can range from 50% to 70%
- Customer requirements may be very vague; you need a tool to translate those vague words to engineering specifications

Examples: Both the 2016 Takata Airbag recall and the 2009 Toyota Acceleration Pedal recall were due to supplier's product quality failure

Acceptable Quality Level

Motivation

Why is customer input important?

- Capturing the voice of the customer very early on is critical to product development because it will inform all the subsequent decisions, such as materials selection (Module 3B), process selection (Module 3C), and partnership selection (Module 5A)

Module Outline

- Learning objectives
- Introduction to quality functional deployment (QFD)
  - —A real world application of QFD (on a separate Excel file)
- Role of suppliers in quality management
  - —Supplier integration during design
  - —Supplier quality management checklist
- Process failure modes and effect analysis (PFMEA)
  - —What is PFMEA?
  - —How to conduct PFMEA

Learning Objectives

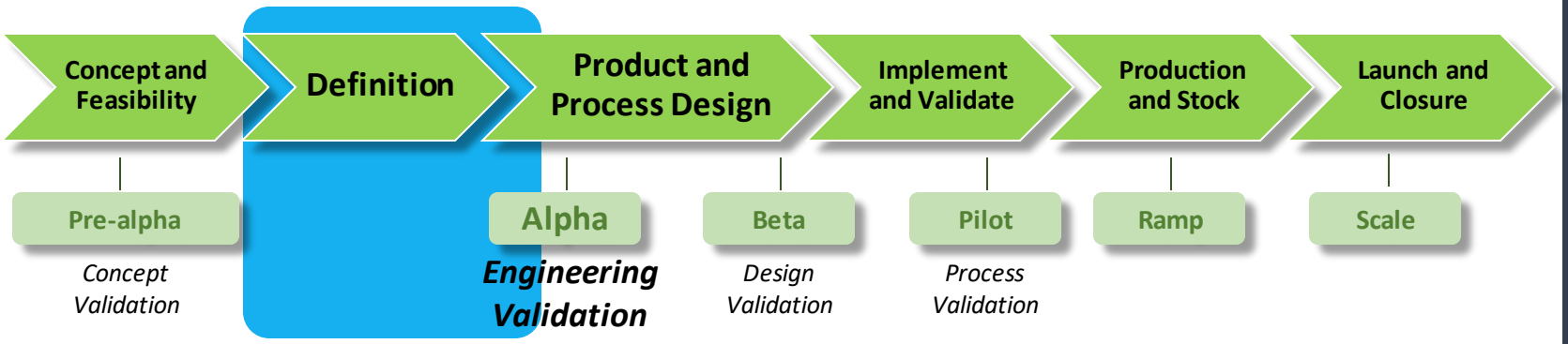
- LO1. Translate functional requirements into quality specifications
- LO2. Understand role of suppliers on necessary quality levels
- LO3. Construct process failure modes and effect analysis (PFMEA)

What This Module Addresses

- How does a company translate customer needs to a technical specifications by using a QFD analysis tool?
- What roles do suppliers play in managing quality?
- What are the benefits of supplier integration during design process?
- How to identify potential process failures before they occur?

QFD And PFMEA

Where does this fit into the development cycle?

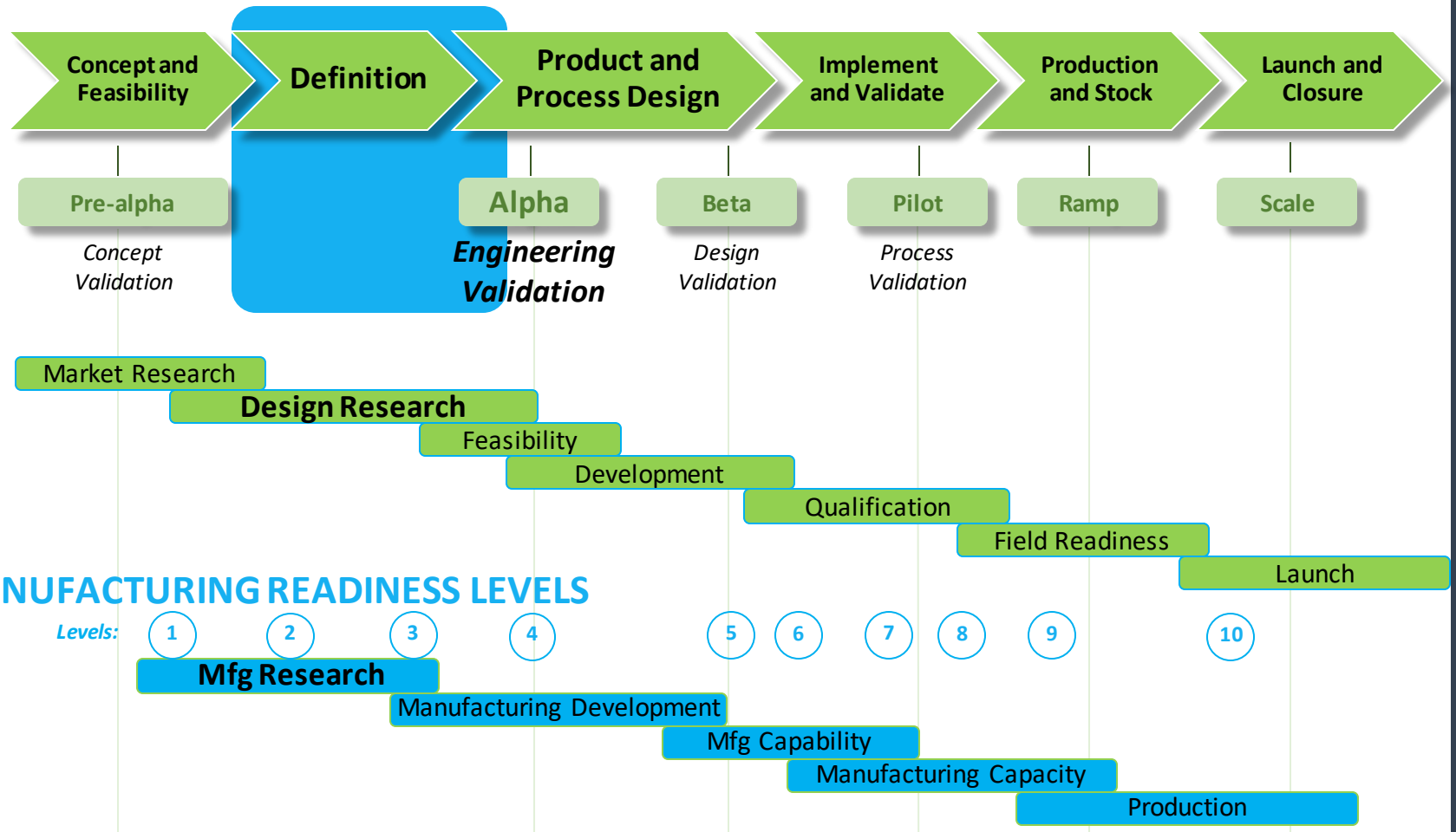


- Quality function deployment (QFD) is a tool to translate customer requirements into engineering specifications
- Clearly identifying the role of suppliers and integrating them early on during the product-development process can help you launch the product on time at lower costs
- Identifying the potential failure modes of your future manufacturing process at the definition stage can result in significant savings due to reduction in down time and defective products

Acceptable Quality Level

QFD And PFMEA

Where does this fit into the development cycle?



Quality Functional Deployment

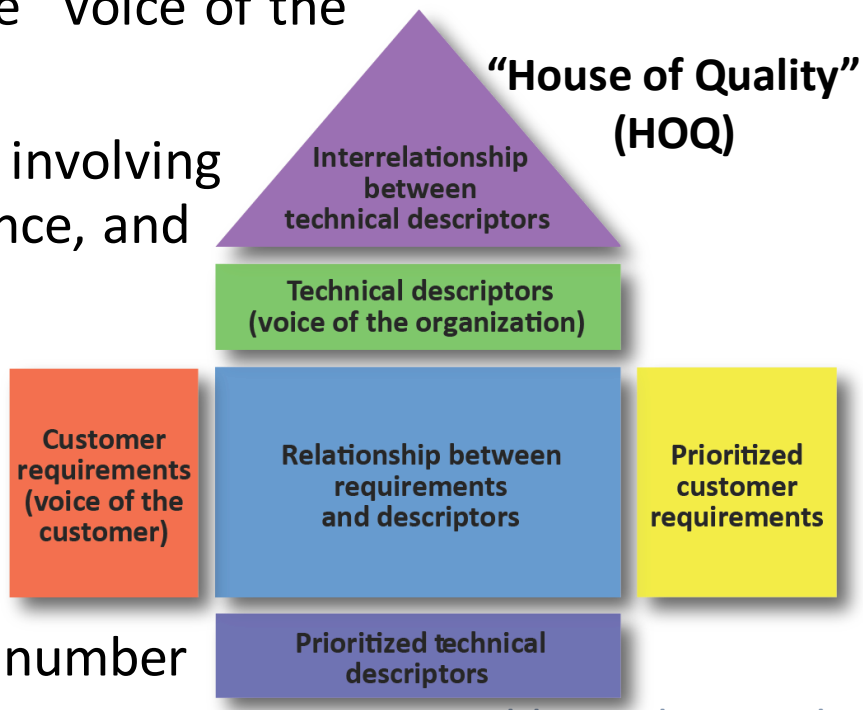
Basics

- Quality functional deployment (QFD) is a quality-planning tool originally developed in Japan in the 1960s, but is now widely used in many manufacturing and service companies in the U.S. and around the world
- It is a powerful tool for translating customer requirements into engineering specifications
- It consists of multiple steps that are organized in the form of relationship matrices, also known as house of quality (HOQ)

QFD/House Of Quality

Overview

- It requires significant time and commitment from top management
- Focuses on meeting or exceeding customer needs by using their actual statements (i.e., the "Voice of the customer")
- It is multi-functional teamwork involving marketing, design, quality, finance, and manufacturing personnel
- It uses a comprehensive matrix called "House of Quality" or HOQ for documenting and analyzing the information
- Depending upon the need, the number of matrices in a QFD analysis can vary



Acceptable Quality Level

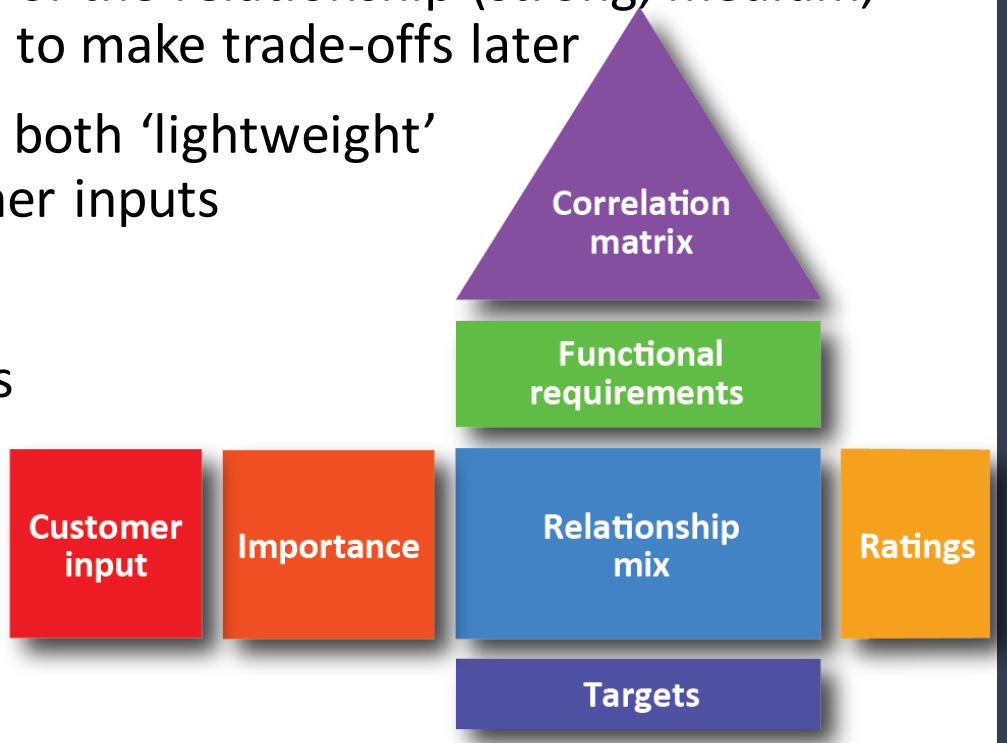
House Of Quality

Relationship matrix

- Displays relationship between customer inputs and functional requirements
- Usually indicates strength of the relationship (strong, medium, weak), which can be used to make trade-offs later

Example: Mass might affect both 'lightweight' and 'easy to handle' customer inputs

- Targets:
- First step is to assign units
- Define target ranges
- Define ideal value or direction of the current value



Acceptable Quality Level

House Of Quality

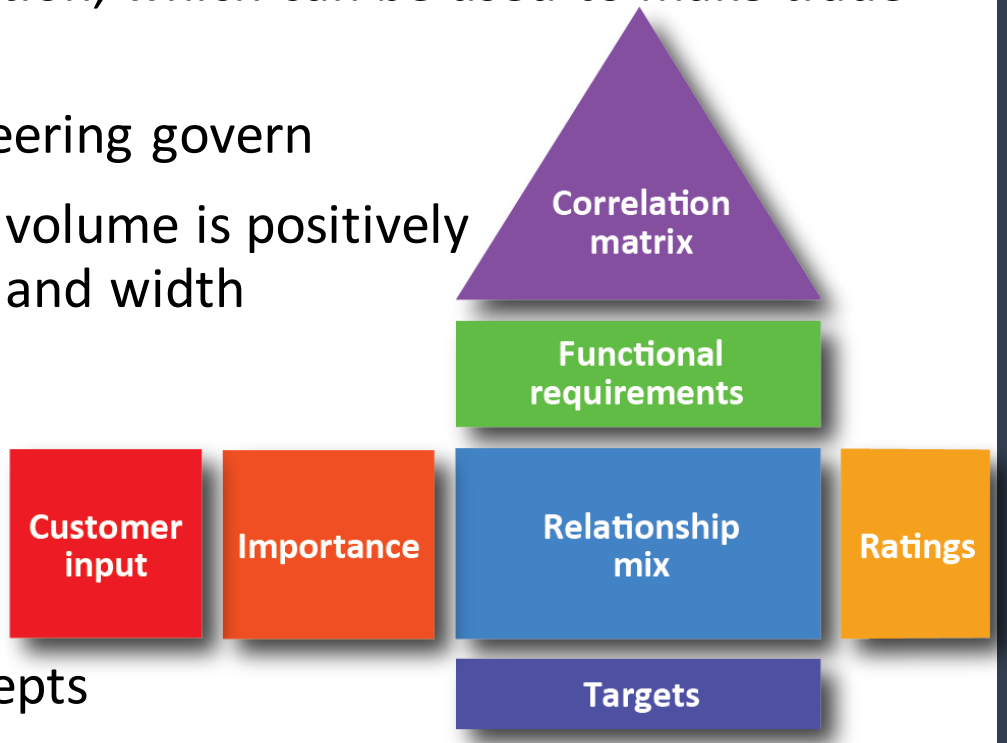
Correlation matrix

- Displays relationship among functional requirements (correlation matrix)
- Shows strength of correlation, which can be used to make trade-offs later
- Where physics and engineering govern

Example: automotive cabin volume is positively correlated with wheel base and width

Ratings:

- Used to rate competitive products
- Can also be used to evaluate alternative concepts



Quality Functional Deployment

Step-by-step

1. Customer requirements
2. Regulatory requirements
3. Customer importance ratings
4. Customer rating of competition
5. Identify technical descriptors
6. Identify direction of improvement

Quality Functional Deployment

Step-by-step (cont.)

7. Construct relationship matrix between customer inputs and technical descriptors
8. Assess organizational difficulty
9. Conduct engagement assessment considering technical difficulty
10. Set target values for technical descriptors
11. Construct correlation matrix among the technical descriptors

To go through these steps, download the Excel file "Module 3E_QFD.xlsx" provided in the resource library

Quality Functional Deployment

Exercise

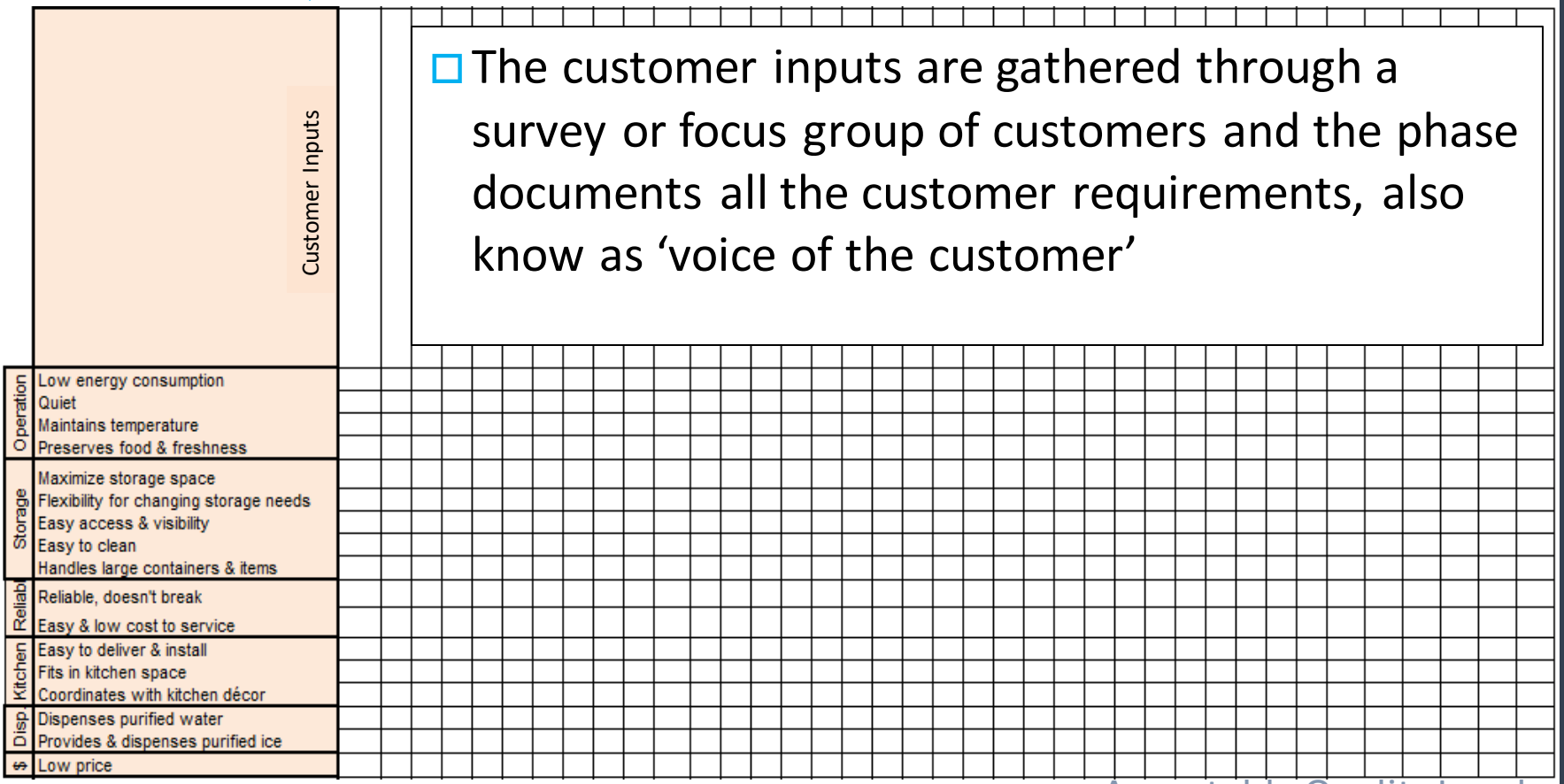
Translating voice of the customer to improve the design of a refrigerator

Source: Google Image

Quality Functional Deployment

Step 1 – Gather customer requirements

Enlarged on next page and printable from library



- The customer inputs are gathered through a survey or focus group of customers and the phase documents all the customer requirements, also know as 'voice of the customer'

Acceptable Quality Level

Quality Functional Deployment

Step 1 – Gather customer requirements (cont.)

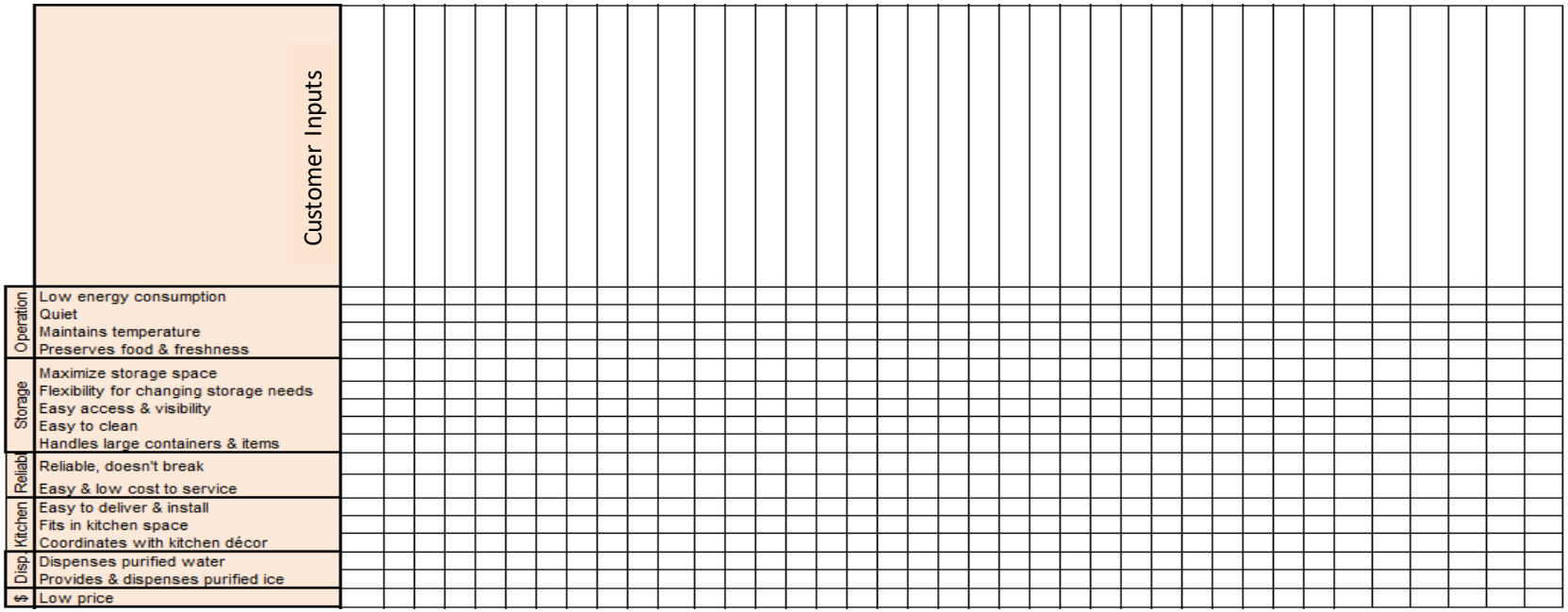
Operations	Low energy consumption Quiet Maintains temperature Preserves food & freshness
Storage	Maximize storage space Flexibility for changing storage needs Easy access & visibility Easy to clean Handles large containers & items
Reliability	Reliable, doesn't break Easy & low cost to service
Kitchen	Easy to deliver & install First in kitchen space Coordinates with kitchen décor
Dispense	Dispenses purified water Provides & dispenses purified ice
$	Low price

Acceptable Quality Level

Quality Functional Deployment

Step 2 – List regulatory requirements

- In this case, since there are no regulatory requirements, we can skip this step and go directly to Step 3
- However, if there are any regulator requirements, they will be listed in the "customer inputs" column



Acceptable Quality Level

Quality Functional Deployment

Step 3 – Provide customer importance ratings

- On a scale from 1-5, customers then rate the importance of each requirement
- This number will be used later in the relationship matrix

	Customer Inputs	Priority
Operation	Low energy consumption	4
	Quiet	1
	Maintains temperature	3
	Preserves food & freshness	3
Storage	Maximize storage space	5
	Flexibility for changing storage needs	3
	Easy access & visibility	4
	Easy to clean	2
	Handles large containers & items	4
Reliabl	Reliable, doesn't break	5
	Easy & low cost to service	3
Kitchen	Easy to deliver & install	1
	Fits in kitchen space	5
	Coordinates with kitchen décor	4
Disp	Dispenses purified water	3
	Provides & dispenses purified ice	3
$	Low price	3

Acceptable Quality Level

Quality Functional Deployment

Step 4 – Gather customer rating of competition

- Customers are asked to rate the product/service in relation to the competition
- Additional room can be added for sales opportunities, goals for continuous improvement, customer complaints, etc

	Customer Inputs	Priority	Your Company (U)	Maytag-M	Whirlpool (W)	GE (G)	Frigidaire (F)	Amana (A)
Operation	Low energy consumption	4	2	3	5	3	3	4
	Quiet	1	5	3	4	4	3	3
	Maintains temperature	3	5	3	3	3	2	2
	Preserves food & freshness	3	5	3	4	3	3	3
Storage	Maximize storage space	5	1	3	5	3	4	4
	Flexibility for changing storage needs	3	2	5	3	3	3	1
	Easy access & visibility	4	1	5	4	4	3	3
	Easy to clean	2	5	2	2	2	2	2
	Handles large containers & items	4	1	4	3	3	4	3
Reliab	Reliable, doesn't break	5	5	1	3	3	4	3
	Easy & low cost to service	3	1	3	4	4	5	2
Kitchen	Easy to deliver & install	1	5	2	2	2	2	2
	Fits in kitchen space	5	2	1	5	5	1	4
	Coordinates with kitchen décor	4	2	3	5	5	3	3
Disp.	Dispenses purified water	3	2	3	4	5	3	3
	Provides & dispenses purified ice	3	3	3	5	4	3	3
$	Low price	3	4	2	3	3	5	5

Acceptable Quality Level

Quality Functional Deployment

Step 5 – Identify technical descriptors

Enlarged on next page and printable from library

	Customer Inputs	Priority	Compressor energy efficiency rating	Insulation Efficiency	Noise measurement-front	Refrig.temp.range (on/off cycle)	Refrig. temp. variation	Refrig. cooling speed (from 30°C to 5°C)	Freezer.temp.range (on/off cycle)	Freezer.temp.variation	Freezer cooling speed (from 30°C to -15°C)	Volume efficiency (total/usable)	% Shelf & tray area adjustable	Drawer/shelf pull force	# of visibility features	Dis-arry & re-assy time for cleaning	% of features rated easy to clean	Freezer width	Refrigerator shelf depth & width	Freezer shelf height	Door tray depth	Warranty period (years)	Water filter replacement time & cost	10 years service contract cost	Time to disassb & reassb door	Refrigerator depth	Stainless & trim panel option prices	Focus group rating - appearance	Water temperature	Water filter indicator & life	Ice produced daily	Manufacturing cost	No. of adjustable temp. drawers	Your Company (U)	Maytag-M	Whirlpool (W)	GE (G)	Frigidaire (F)	Amana (A)
Operation	Low energy consumption	4																															2	3	5	3	3	4
	Quiet	1																															5	3	4	4	3	3
	Maintains temperature	3																															5	3	3	3	2	2
	Preserves food & freshness	3																															5	3	4	3	3	3
Storage	Maximize storage space	5																															1	3	5	3	4	4
	Flexibility for changing storage needs	3																															2	5	3	3	3	1
	Easy access & visibility	4																															1	5	4	4	3	3
	Easy to clean	2																															5	2	2	2	2	2
	Handles large containers & items	4																															1	4	3	3	4	3
Reliab	Reliable, doesn't break	5																															5	1	3	3	4	3
	Easy & low cost to service	3																															1	3	4	4	5	2
Kitchen	Easy to deliver & install	1																															5	2	2	2	2	2
	Fits in kitchen space	5																															2	1	5	5	1	4
	Coordinates with kitchen décor	4																															2	3	5	5	3	3
Disp.	Dispenses purified water	3																															2	3	4	5	3	3
	Provides & dispenses purified ice	3																															3	3	5	4	3	3
$	Low price	3																															4	2	3	3	5	5

- Engineers are asked to come up with appropriate technical descriptors for customers requirements; 'voice of the engineer'
- Technical descriptors are attributes about the product or service that can be measured and benchmarked against the competition

Acceptable Quality Level

Quality Functional Deployment

Step 5 – Identify technical descriptors (cont.)

Customer Inputs		
Priority		
Compressor energy efficiency rating	Freezer width	Your Company (U)
Insulation Efficiency	Refrigerator shelf depth & width	Maytag-M
Noise measurement-front	Freezer shelf height	Whirlpool (W)
Refrig.temp.range (on/off cycle)	Door tray depth	GE (G)
Refrig. temp. variation	Warranty period (years)	Frigidaire (F)
Refrig. cooling speed (from 30°C to 5°C)	Water filter replacement time & cost	Amana (A)
Freezer.temp.range (on/off cycle)	10 years service contract cost	
Freezer.temp.variation	Time to disassb & reassb door	
Freezer cooling speed (from 30°C to -15°C)	Refrigerator depth	
Volume efficiency (total/usable)	Stainless & trim panel option prices	
% Shelf & tray area adjustable	Focus group rating - appearance	
Drawer/shelf pull force	Water temperature	
# of visibility features	Water filter indicator & life	
Dis-arry & re-assy time for cleaning	Ice produced daily	
% of features rated easy to clean	Manufacturing cost	
Freezer width	No. of adjustable temp. drawers	

Acceptable Quality Level

Quality Functional Deployment

Step 6 – Identify direction of improvement

	Customer Inputs	Priority	Goal	↑ Compressor energy efficiency rating	↓ Insulation Efficiency	↓ Noise measurement-front	↓ Refrig.temp.range (on/off cycle)	↓ Refrig. temp. variation	↓ Refrig. cooling speed (from 30°C to 5°C)	↓ Freezer temp.range (on/off cycle)	↓ Freezer.temp.variation	↓ Freezer cooling speed (from 30°C to -15°C)	↑ Volume efficiency (total/usable)	↑ % Shelf & tray area adjustable	↓ Drawer/shelf pull force	↑ # of visibility features	↓ Dis-arry & re-assy time for cleaning	↑ % of features rated easy to clean	↑ Freezer width	↑ Refrigerator shelf depth & width	↑ Freezer shelf height	○ Door tray depth	↑ Warranty period (years)	↓ Water filter replacement time & cost	↓ 10 years service contract cost	↓ Time to disassb & reassb door	○ Refrigerator depth	↓ Stainless & trim panel option prices	↑ Focus group rating - appearance	↓ Water temperature	↑ Water filter indicator & life	↑ Ice produced daily	↓ Manufacturing cost	↑ No. of adjustable temp. drawers	Your Company (U)	Maytag-M	Whirlpool (W)	GE (G)	Frigidaire (F)	Amana (A)
Operation	Low energy consumption	4																																	2	3	5	3	3	4
	Quiet	1																																	5	3	4	4	3	3
	Maintains temperature	3																																	5	3	3	3	2	2
	Preserves food & freshness	3																																	5	3	4	3	3	3
Storage	Maximize storage space	5																																	1	3	5	3	4	4
	Flexibility for changing storage needs	3																																	2	5	3	3	3	1
	Easy access & visibility	4																																	1	5	4	4	3	3
	Easy to clean	2																																	5	2	2	2	2	2
	Handles large containers & items	4																																	1	4	3	3	4	3
Reliab	Reliable, doesn't break	5																																	5	1	3	3	4	3
	Easy & low cost to service	3																																	1	3	4	4	5	2
Kitchen	Easy to deliver & install	1																																	5	2	2	2	2	2
	Fits in kitchen space	5																																	2	1	5	5	1	4
	Coordinates with kitchen décor	4																																	2	3	5	5	3	3
Disp.	Dispenses purified water	3																																	2	3	4	5	3	3
	Provides & dispenses purified ice	3																																	3	3	5	4	3	3
$	Low price	3																																	4	2	3	3	5	5

- The technical team determines the direction of movement for each technical descriptor whether or not a technical specification is greater the better (upward arrow), smaller the better (downward arrow), or has to be a specific value (a circle)

Acceptable Quality Level

Quality Functional Deployment

Step 7 – Construct relationship matrix between customer inputs and technical descriptors

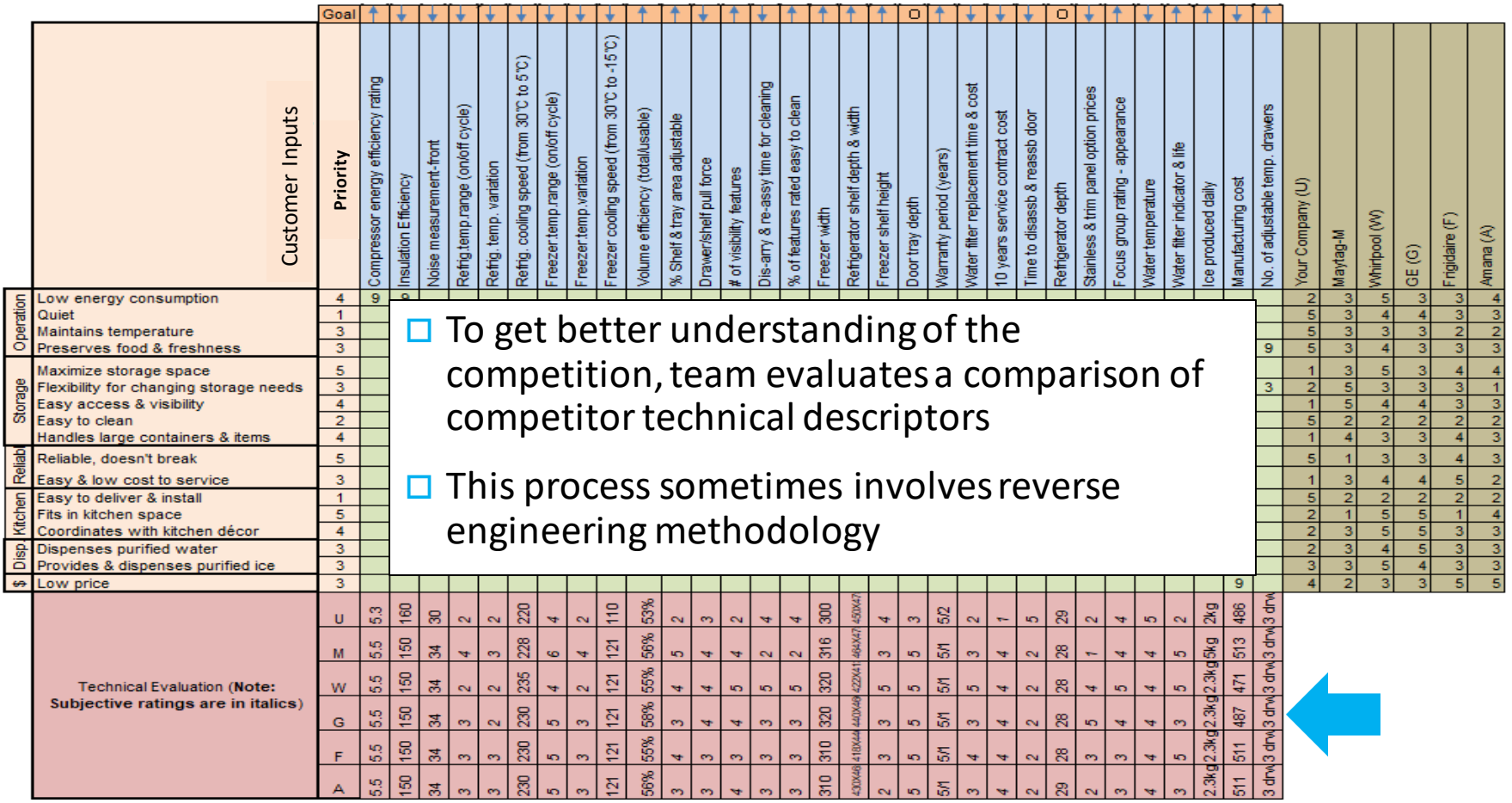
- The team determines the relationship between customer needs and the company's ability to meet those needs
- Relationship can either be weak (1), moderate (3), or strong (9)

	Customer Inputs	Priority	Compressor energy efficiency rating	Ins	Nc	Re	Re	Re	Fr	Fr	Fr	Vo	%	Dr	# c	Dis	%	Fr	Re	Fr	Do	Wa	Wa	10	Tir	Re	Sta	Fo	Wa	Wa	Ice	Ma	No. of adjustable temp. drawers	Your Company (U)	Maytag-M	Whirlpool (W)	GE (G)	Frigidaire (F)	Amana (A)
	Goal		↑	↓	↓	↓	↓	↓	↓	↓	↓	↑	↑	↓	↑	↓	↑	↑	↑	↑	O	↑	↓	↓	↓	O	↓	↑	↓	↑	↑	↓	↑							
Operation	Low energy consumption	4	9	9																														2	3	5	3	3	4
	Quiet	1			9																													5	3	4	4	3	3
	Maintains temperature	3		1		3	3	3	3	3	3																							5	3	3	3	2	2
	Preserves food & freshness	3		1		9	9	9	9	9	9																						9	5	3	4	3	3	3
Storage	Maximize storage space	5		3								9						3	3	3														1	3	5	3	4	4
	Flexibility for changing storage needs	3										3	9	1		3																	3	2	5	3	3	3	1
	Easy access & visibility	4											1	9	9	3		1	1	1														1	5	4	4	3	3
	Easy to clean	2										3				9	9																	5	2	2	2	2	2
	Handles large containers & items	4																9	9	9	9													1	4	3	3	4	3
Reliab	Reliable, doesn't break	5																				9												5	1	3	3	4	3
	Easy & low cost to service	3																				9	9	9	1									1	3	4	4	5	2
Kitchen	Easy to deliver & install	1																							9	3								5	2	2	2	2	2
	Fits in kitchen space	5		3								5														9								2	1	5	5	1	4
	Coordinates with kitchen décor	4																								3	9	9						2	3	5	5	3	3
Disp.	Dispenses purified water	3				1																3							9	9				2	3	4	5	3	3
	Provides & dispenses purified ice	3							1													3							9	9	9			3	3	5	4	3	3
$	Low price	3																														9		4	2	3	3	5	5

Acceptable Quality Level

Quality Functional Deployment

Step 8 – Assess organizational difficulty

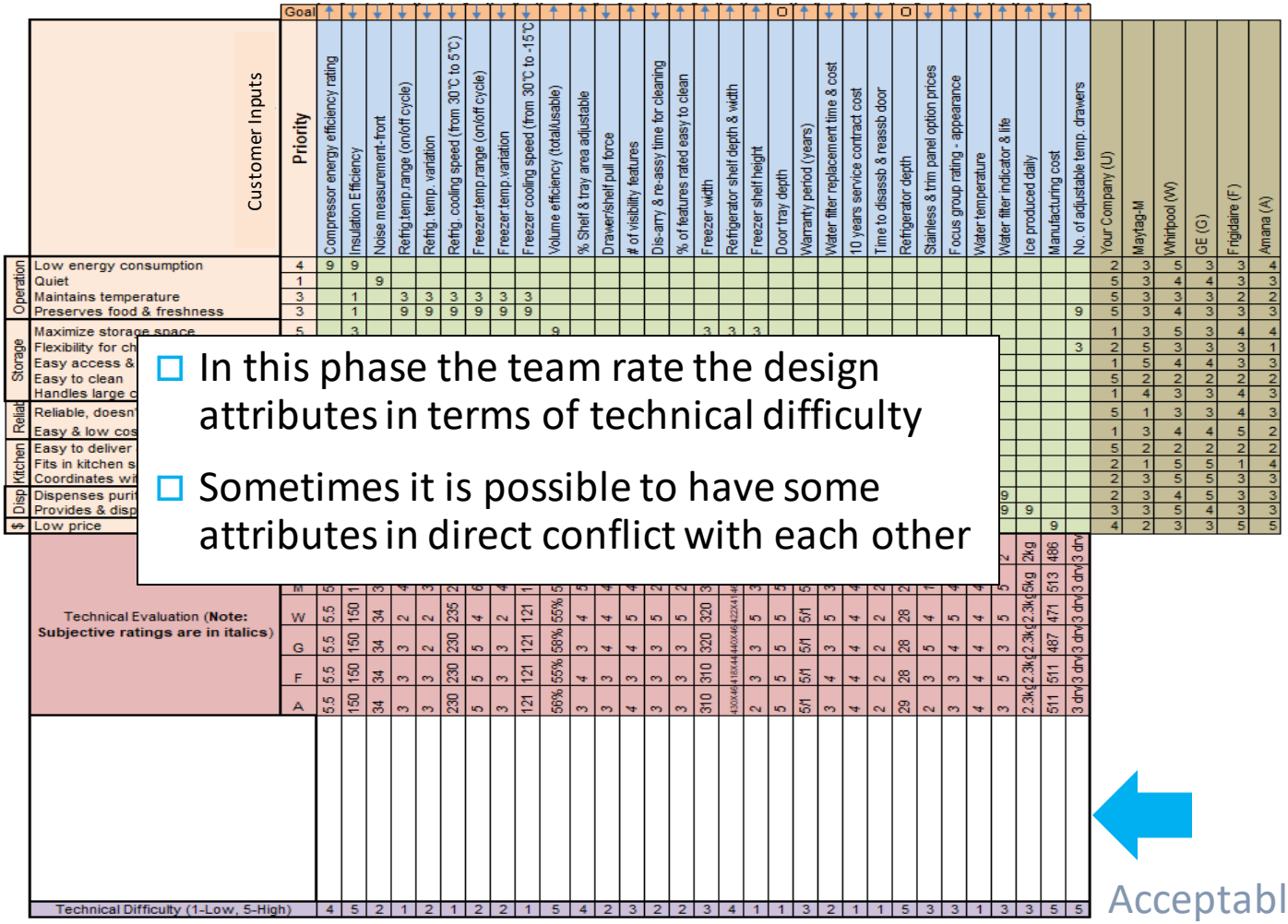


- To get better understanding of the competition, team evaluates a comparison of competitor technical descriptors
- This process sometimes involves reverse engineering methodology

Acceptable Quality Level

Quality Functional Deployment

Step 9 – Conduct engagement assessment considering technical difficulty

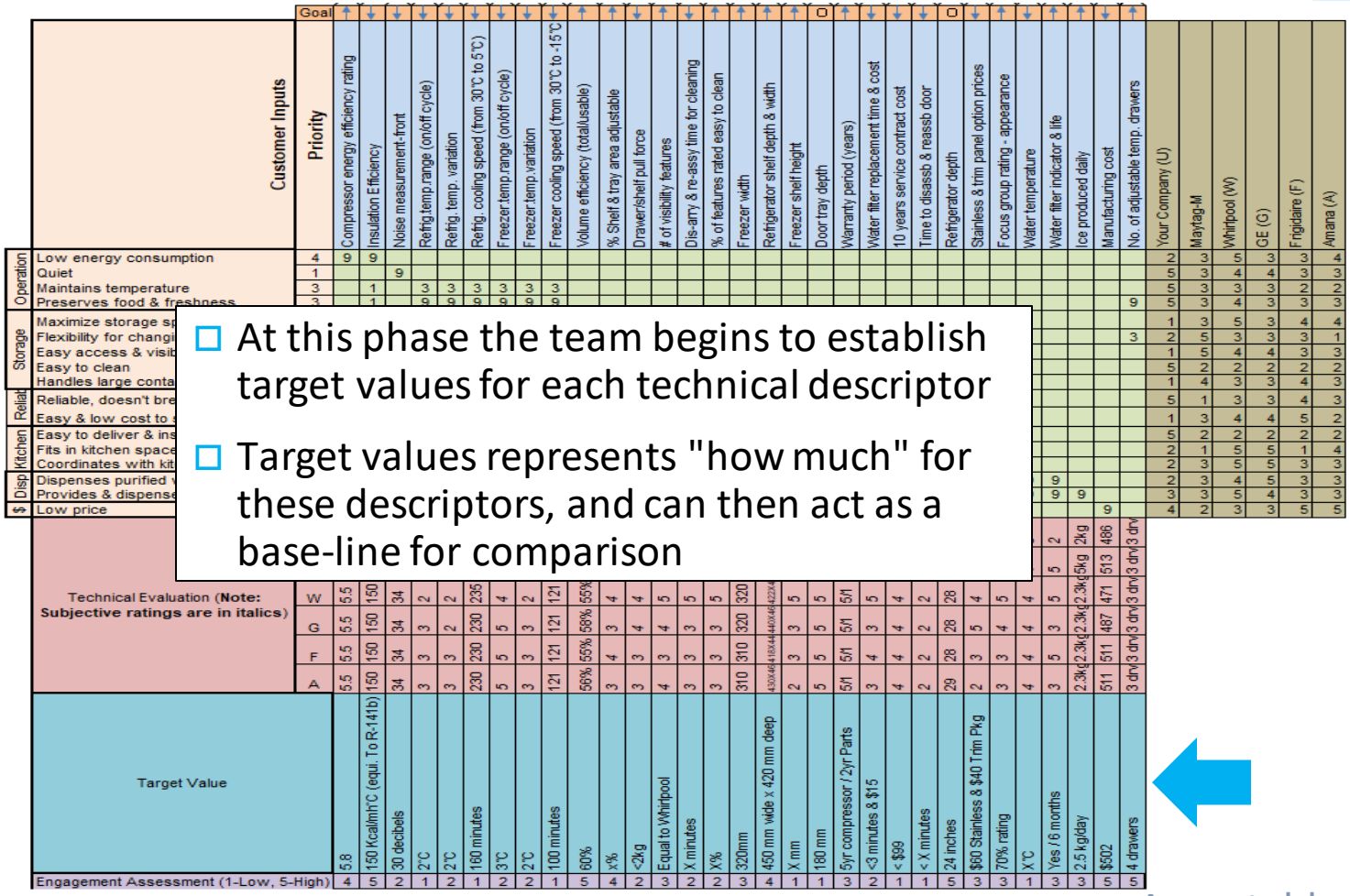


- In this phase the team rate the design attributes in terms of technical difficulty
- Sometimes it is possible to have some attributes in direct conflict with each other

Acceptable Quality Level

Quality Functional Deployment

Step 10 – Set target values for technical descriptors



- At this phase the team begins to establish target values for each technical descriptor
- Target values represents "how much" for these descriptors, and can then act as a base-line for comparison

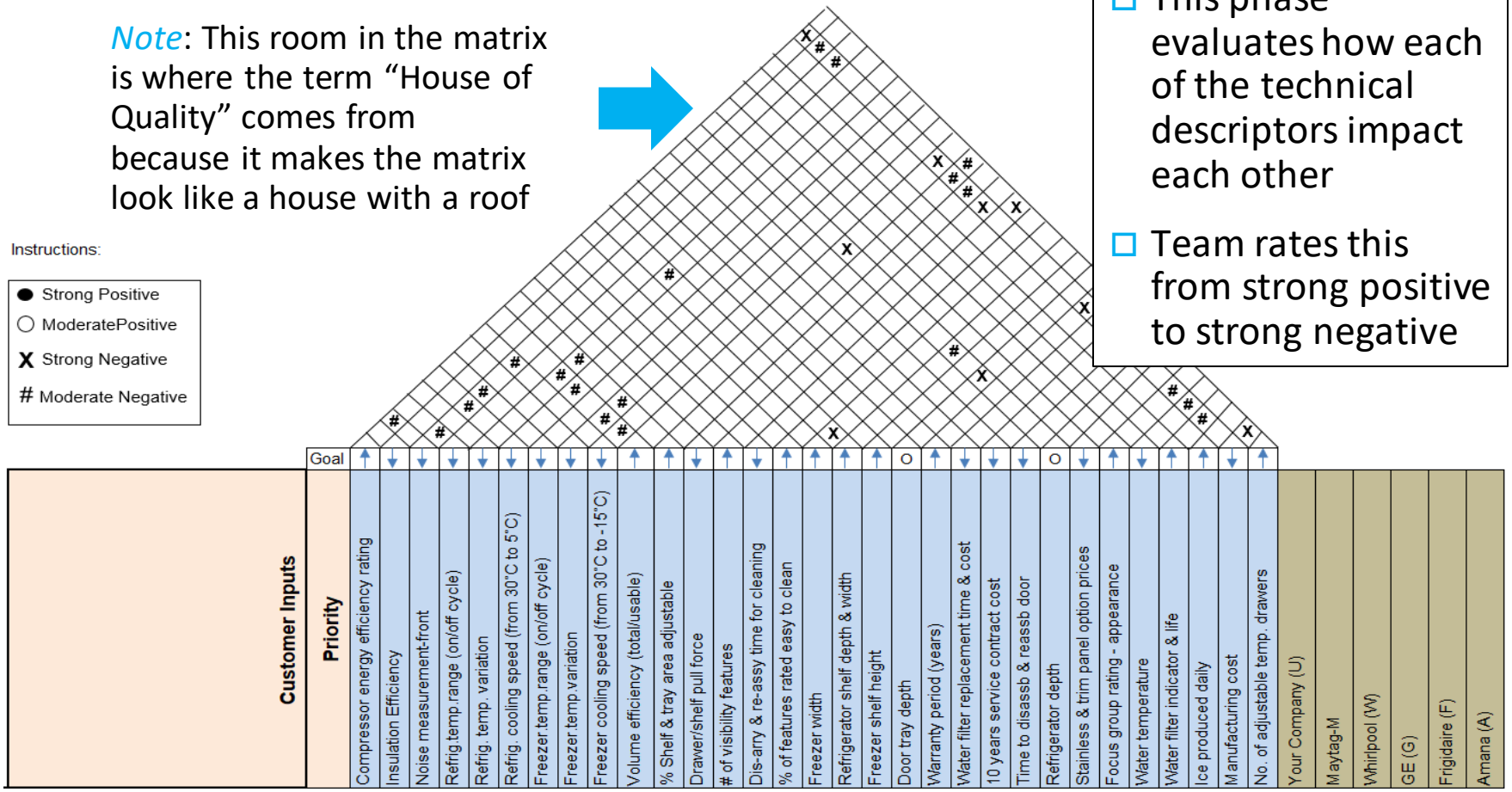
Acceptable Quality Level

Quality Functional Deployment

Step 11 – Construct correlation matrix among the technical descriptors

Note: This room in the matrix is where the term "House of Quality" comes from because it makes the matrix look like a house with a roof

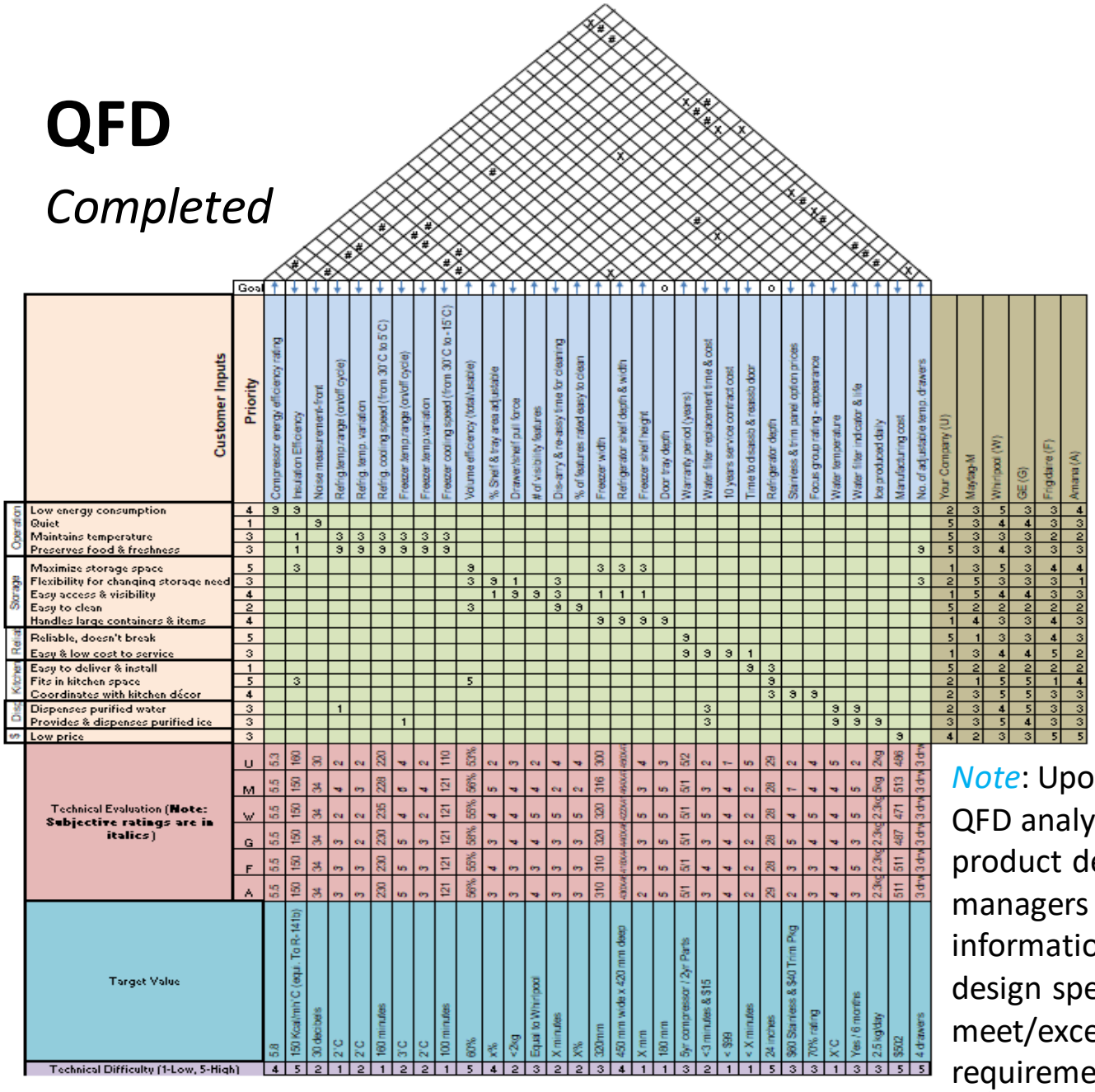
- This phase evaluates how each of the technical descriptors impact each other
- Team rates this from strong positive to strong negative



Acceptable Quality Level

QFD

Completed



	Customer Inputs	Priority	Compressor energy efficiency rating	Insulation Efficiency	Noise measurement-front	Refrig temp range (on/off cycle)	Refrig. temp. variation	Refrig. cooling speed (from 30 C to 5 C)	Freezer temp range (on/off cycle)	Freezer temp variation	Freezer cooling speed (from 30 C to -15 C)	Volume efficiency (total/usable)	% Shelf & tray area adjustable	Drawer/shelf pull force	# of visibility features	Dis-assy & re-assy time for cleaning	% of features rated easy to clean	Freezer width	Refrigerator shelf depth & width	Freezer shelf height	Door tray depth	Warranty period (years)	Water filter replacement time & cost	10 years service contract cost	Time to dispose & reinstall door	Refrigerator depth	Stainless & trim panel option prices	Focus group rating - appearance	Water temperature	Water filter indicator & life	Ice produced daily	Manufacturing cost	No. of adjustable temp. drawers	Your Company (U)	Maytag-M	Whirlpool (W)	GE (G)	Frigidaire (F)	Amana (A)
		Goal	↑	↓	↓	↓	↑	↑	↑	↓	↑	↓	↑	↑	↑	↑	↑	↑	↑	↑	↑	o	↑	↓	↓	o	↑	↓	↑	↓	↑	↓	↑						
Operation	Low energy consumption	4	9	9																													2	3	5	3	3	4
	Quiet	1			9																												5	3	4	4	3	3
	Maintains temperature	3		1		3	3	3	3	3	3																						5	3	3	3	2	2
	Preserves food & freshness	3		1		3	3	3	3	3	3																					9	5	3	4	3	3	3
Storage	Maximize storage space	5		3								9						3	3	3													1	3	5	3	4	4
	Flexibility for changing storage need	3										3	9	1		3																9	2	5	3	3	3	1
	Easy access & visibility	4											1	3	9	3		1	1	1													1	5	4	4	3	3
	Easy to clean	2										3				9	9																5	2	2	2	2	2
	Handles large containers & items	4																9	9	9	9												1	4	3	3	4	3
Reliab	Reliable, doesn't break	5																				9											5	1	3	3	4	3
	Easy & low cost to service	3																				9	9	9	1								1	3	4	4	5	2
Kitchen	Easy to deliver & install	1																							9	3							5	2	2	2	2	2
	Fits in kitchen space	5		3								9														9							2	1	5	5	1	4
	Coordinates with kitchen décor	4																								3	9	9					2	3	5	5	3	3
Disp	Dispenses purified water	3				1																3							9	9			2	3	4	5	3	3
	Provides & dispenses purified ice	3							1													3							9	9	9		3	3	5	4	3	3
$	Low price	3																														9	4	2	3	3	5	5
	Technical Evaluation (**Note: Subjective ratings are in italics**)	U	5.3	160	30	2	2	220	4	2	110	53%	2	3	2	4	3	300	4304	4304	4304	3	502	2	1	5	29	2	5	2	2kg	486	3 drw						
		M	5.5	150	34	4	3	228	6	4	121	56%	5	4	3	2	4	316	4552	4552	4552	3	511	3	4	2	28	1	4	5	5kg	513	3 drw						
		W	5.5	150	34	2	2	235	4	2	121	58%	4	4	5	2	2	320	4552	4552	4552	5	511	5	4	2	28	4	5	4	2.3kg	471	3 drw						
		G	5.5	150	34	3	2	230	5	3	121	58%	3	4	3	2	3	320	4304	4304	4304	3	511	4	4	2	28	5	4	4	2.3kg	487	3 drw						
		F	5.5	150	34	3	3	230	5	3	121	55%	4	3	3	3	3	310	4304	4304	4304	3	511	4	4	2	28	3	5	4	2.3kg	511	3 drw						
		A	5.5	150	34	3	3	230	5	3	121	56%	3	4	3	2	3	310	4304	4304	4304	5	511	3	4	2	29	2	3	5	2.3kg	511	3 drw						
	Target Value		5.8	150 Kcal/min C (equ. To R-141b)	30 decibels	2 C	2 C	160 minutes	3 C	2 C	100 minutes	60%	x%	<2kg	Equal to Whirlpool	X minutes	X%	320mm	450 mm wide x 420 mm deep	X mm	180 mm	5yr compressor / 2yr Parts	<3 minutes & $15	< $99	< X minutes	24 inches	360 Stainless & $40 Trim Pkg	70% rating	X C	Yes / 6 months	2.5 kg/day	$502	4 drawers						
	Technical Difficulty (1-Low, 5-High)		4	5	2	1	2	1	2	2	1	5	4	2	3	2	3	3	4	1	1	3	2	1	1	5	3	3	1	3	3	5						

Note: Upon completion of QFD analysis, engineers and product development managers can use this information to improve their design specifications to meet/exceed the customer requirements

Acceptable Quality Level

Product-Development Process

Integrating suppliers

- Every firm depends on its suppliers for parts and services to fulfill its production/technology/expertise requirements
- Involving suppliers early in the design process can minimize expensive engineering changes and extended lead times
- By including the suppliers in the quality assurance plan during design, an original equipment manufacturer (OEM) can leverage its design capability to gain a competitive advantage
- Integrating suppliers will also improve the suppliers' understanding of the overall assembly process and the quality requirements of the final product, thereby enabling them to better manage their component quality (e.g., tolerance stacking, tolerance allocation)

Supplier Quality Checklist

Checklist – Sample questions

- Does the supplier measure its quality performance?
- Does the supplier have quality performance goals? What is current defects rate in parts per million? Is it acceptable?
- Does the supplier have a documented continuous quality improvement process with prior quality data?
- Does the supplier follow a preventive approach or only depend on inspection?
- Does the supplier have a formal and documented sustainable quality management program including training programs for its employees?

Supplier Quality Checklist

Checklist – Sample questions (cont.)

- Can the supplier demonstrate if its process is in control? What tools are used to demonstrate control?
- What is the supplier's current process capability index (Cpk) for a desired process?
- Is the supplier ISO9001 (or similar standards applicable to its sector) certified?
- Is the supplier implementing any quality assurance program with its own suppliers?
- Has the supplier used any Lean Six Sigma quality improvement practices in the past?

PFMEA

What it is and when to use it

- Process failure modes and effects analysis (PFMEA) is a step-by-step approach for identifying all potential failure modes in a manufacturing or assembly process
- PFMEA is recommended when a process is being designed for a new product, or being redesigned after quality improvement
  - It should be done periodically throughout the lifecycle of a process for analyzing potential failures due to changes in the process over time
- It ranks the 'severity' level, 'occurrence' probability, and 'detectability' probability of every possible failure mode in a process

PFMEA

What it is and when to use it (cont.)

- A risk priority number (RPN) is calculated for each failure mode by multiplying the three factors on the pervious slide by one another (severity, occurrence, and detectability)
- The RPN number is used to prioritize the reliability-improvement decisions

Note: This module only introduces the concept of FMEA, which can be applied to evaluate the reliability of both design and manufacturing process

See Module 3E for an FMEA example

How To Conduct PFMEA

- Assemble a cross-functional team (design, manufacturing, quality, supplier, sales, and marketing)
- Identify the scope of PFMEA; such as process functions and boundaries, customer requirements, and product or parts to analyze
- For each process function, identify all the ways failure can occur
- Determine the severity of each effect (severity is usually rated on a scale of 1 to 10, where 1 is insignificant and 10 is fatal or catastrophic)

How To Conduct PFMEA

(cont.)

- For each failure mode, determine all of the potential root causes
- For each cause, determine the occurrence rating (O).
  - —This rating estimates the probability of failure occurring for that reason during the lifetime of your scope
  - —Occurrence is usually rated on a scale of 1–10, where 1 is extremely unlikely and 10 is inevitable
- For each cause, identify current process controls: these are tests, procedures, or mechanisms that you now have in place to keep failures from reaching the customer

How To Conduct PFMEA

(cont.)

- For each control, determine the detection rating (D)
  - —This rating estimates how well the controls can detect either their cause or their failure mode after they have occurred, but before the customer is affected
  - —Detection is usually rated on a scale of 1 to 10, where 1 means the control is absolutely certain to detect the problem and 10 means the control is certain not to detect the problem (or no control exists)
  - —On the PFMEA table, list the detection rating for each cause

How To Conduct PFMEA

(cont.)

- Calculate the risk priority number (RPN) =

  Severity (S) × Occurrence (O) × Detectability (D)

- Calculate the criticality = S × O
  - —These numbers provide guidance for ranking potential failures in the order they should be addressed
- Identify recommended actions
  - —These actions may be design or process changes to lower severity or occurrence
  - —They may be additional controls to improve detection
  - —Identify the key person for the actions and target-completion dates

Resources

- Otto, K. and Wood, K., 2001—Product Design: Techniques in Reverse Engineering and New Product Development, Prentice Hall
- Julie K. Spoerre, 1998—Quality Function Deployment as a Tool for Integrated Product and Process Design (in Concurrent Design of Products, Manufacturing Processes and Systems edited by Ben Wang, Vol 3. Chapter 3, Gordon and Breach Science Publisher
- Dominick, C., 2012. A 12-point Supplier Quality Checklist, Next level Purchasing https://www.nextlevelpurchasing.com/resources/supplier-quality-management.pdf

List Of Acronyms

- MRL – Manufacturing Readiness Level
- QFD – Quality Function Deployment
- FMEA – Failure Mode Effect Analysis
- DFMEA – Design Failure Mode Effect Analysis
- PFMEA – Process Failure Mode Effect Analysis
- OEM – Original Equipment Manufacturer
- RPN – Risk Priority Number