SPC Tools and Visual Methods

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Perspectives

Designing a new product, process, service

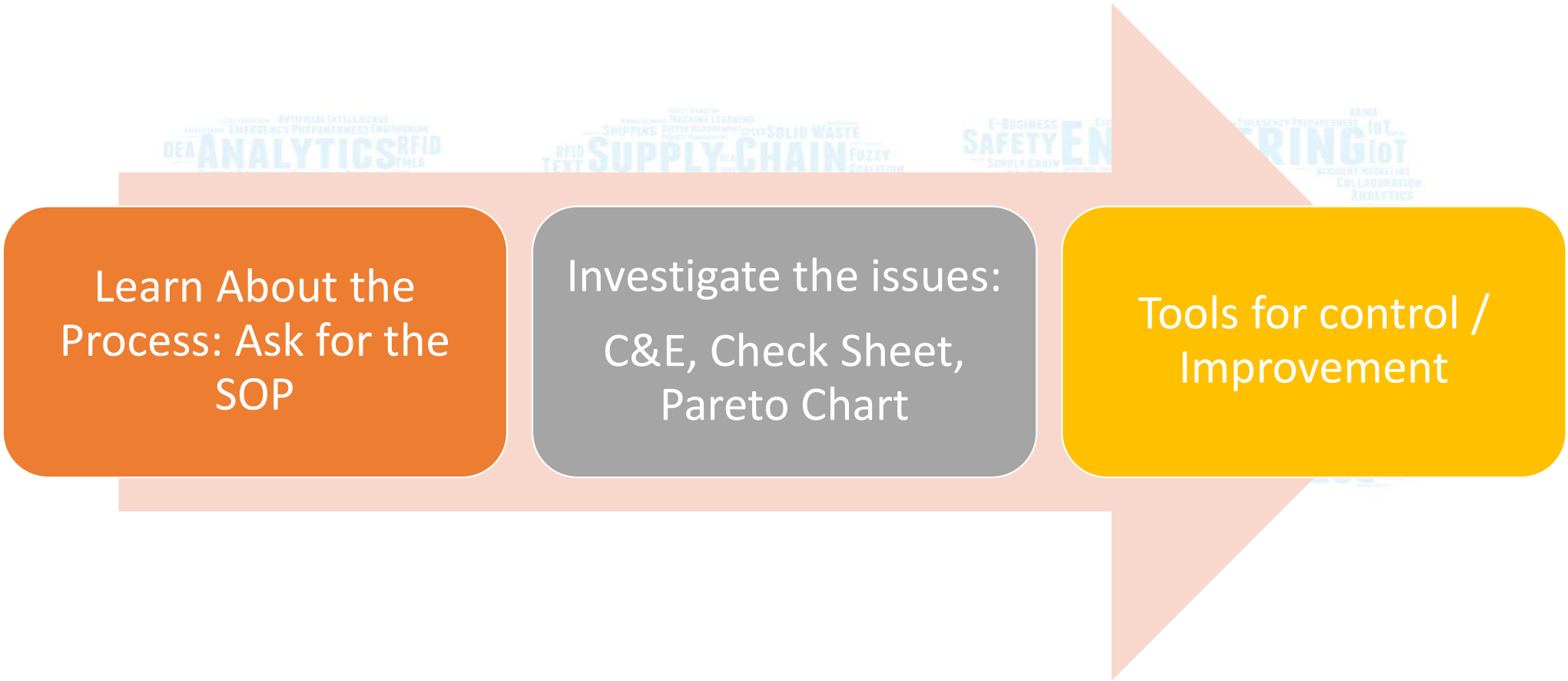
Maintaining prescribed quality

Improving an existing product, process, service

“What cannot be measured, cannot be managed”

-Peter Drucker (American consultant)

Outline


Learn About the Process: Ask for the SOP
Investigate the issues:
C&E, Check Sheet, Pareto Chart
Tools for control / Improvement

Magnificent Seven (Chapter 5, Montgomery)

1. Histogram or Stem and Leaf Plot
2. Check sheet
3. Pareto chart
4. Cause and effect diagram
5. Defect concentration diagram
6. Scatter diagram
7. Control chart

What is SPC/SQC?: ASQ (American Society for Quality)

- 7 Quality Control Tools (7-QC)
  1. Cause and Effect Diagram
  2. Check Sheet
  3. Control Chart
  4. Histogram
  5. Pareto chart
  6. Scatter plot
  7. Stratification

- 7 Supplemental Tools (7-SUPP)
  1. Data stratification
  2. Defect maps
  3. Event logs
  4. Process flowcharts
  5. Progress centres
  6. Randomization
  7. Sample size determination

Graphical and Visual Tools

- Standard Operating Procedure — Learn about the process, also new SOP once the change is implemented
- Check Sheet
- Cause and Effect Diagram (Fishbone diagram)
- Pareto Charts

  } Identify the problems, and the extent of causes

- Quality Function Deployment — Voice of Customer to Design of Product, Process
- Value Stream Mapping — Efficiency of Process

Chapter 5, SQC by D.C. Montogomery

Standard Operating Procedure (SOP)

- A step by step guide compiled by an organization to help workers carry out complex routine operations (Wikipedia)
- SOPs aim to achieve efficiency, quality output and uniformity of performance while reducing miscommunication and failure to comply with industry regulations.
- It should follow 4 C's, Clear, Complete, Concise, Courteous and Correct.
- SOP helps smoothing the transition process from one worker to another.
- The sections may include (but not limited to):
  - Purpose/ Objective
  - Scope
  - Responsibilities
  - Accountability
  - Procedure

https://www.pharmaguideline.com/p/sop-for-quality-control.html

Check Sheet

- When to use?
  - When data can be observed and collected repeatedly
  - When collecting data on the frequency of patterns, problems, defects, issues
  - Production process
- How to use?
  - Decide what problems are observed. Define the problems
  - Decide the duration and length of data collection
  - Design a form, so that data can be recorded simply, by putting check marks, ‘X’s or numbers
  - Test for a short trial period and then implement in appropriate situations

https://asq.org/quality-resources/check-sheet

Example of Check Sheet

Project Name: Mechanical Issues of Trucks
Name of Data Recorder: SPC Students
Location: KGP
Data Collection Dates: 21-07-2019 - 28-07-2019

Defect Types/ Event Occurrence	Dates							TOTAL
	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	
Battery down	5	6	7	25	3	2	22	70
Oil Leakage	1	2	3	7	8	9	10	40
Overheating of Radiator	12	34	16	18	2	4	8	94
AC dysfunctional	3	12	19	4	6	8	20	72

Source: asq.org

Telephone Interruptions

Reason	Day					
	Mon	Tues	Wed	Thurs	Fri	Total
Wrong number	𝍸	II	I	𝍸	𝍸 II	20
Info request	II	II	II	II	II	10
Boss	𝍸	II	𝍸 II	I	IIII	19
Total	12	6	10	8	13	49

Check Sheet Example

Example of Check Sheet

CHECK SHEET
DEFECT DATA FOR 2002–2003 YTD

Part No.: TAX-41
Location: Bellevue
Study Date: 6/5/03
Analyst: TCB

	2002												2003					
Defect	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	Total
Parts damaged		1		3	1	2		1		10	3		2	2	7	2		34
Machining problems			3	3				1	8		3		8	3				29
Supplied parts rusted			1	1		2	9											13
Masking insufficient		3	6	4	3	1												17
Misaligned weld	2																	2
Processing out of order	2															2		4
Wrong part issued		1						2										3
Unfinished fairing			3															3
Adhesive failure				1							1		2			1	1	6
Powdery alodine					1													1
Paint out of limits						1								1				2
Paint damaged by etching			1															1
Film on parts						3		1	1									5
Primer cans damaged								1										1
Voids in casting									1	1								2
Delaminated composite										2								2
Incorrect dimensions											13	7	13	1		1	1	36
Improper test procedure										1								1
Salt-spray failure													4			2		4
TOTAL	4	5	14	12	5	9	9	6	10	14	20	7	29	7	7	6	2	166

Check sheet to record defects in a tank used in aerospace Application

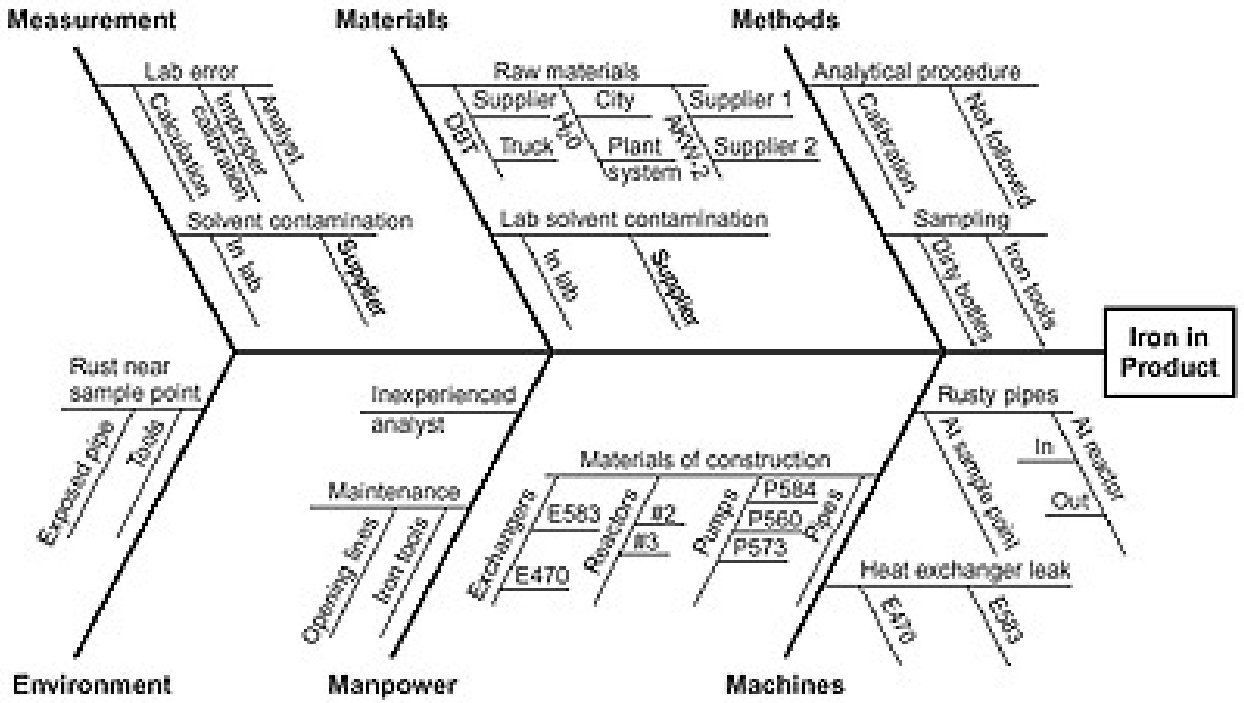
Source: Montgomery, SQC

Cause and Effect Diagram (Fishbone Diagram)

- When to use?
  - To identify possible causes of a problem
  - When the problem is too complicated to be resolved by experts in specific fields
- How to use?
  - Agree on a problem statement
  - Brainstorm major categories of causes of the problem. The generic categories are
    - Methods
    - Machines
    - Manpower
    - Materials
    - Measurement
    - Environment
  - Write the causes as branches of the main problem
  - Ask “why” for each of the major causes, then write subcauses as the branches of the main causes. Generate deeper levels of causes.

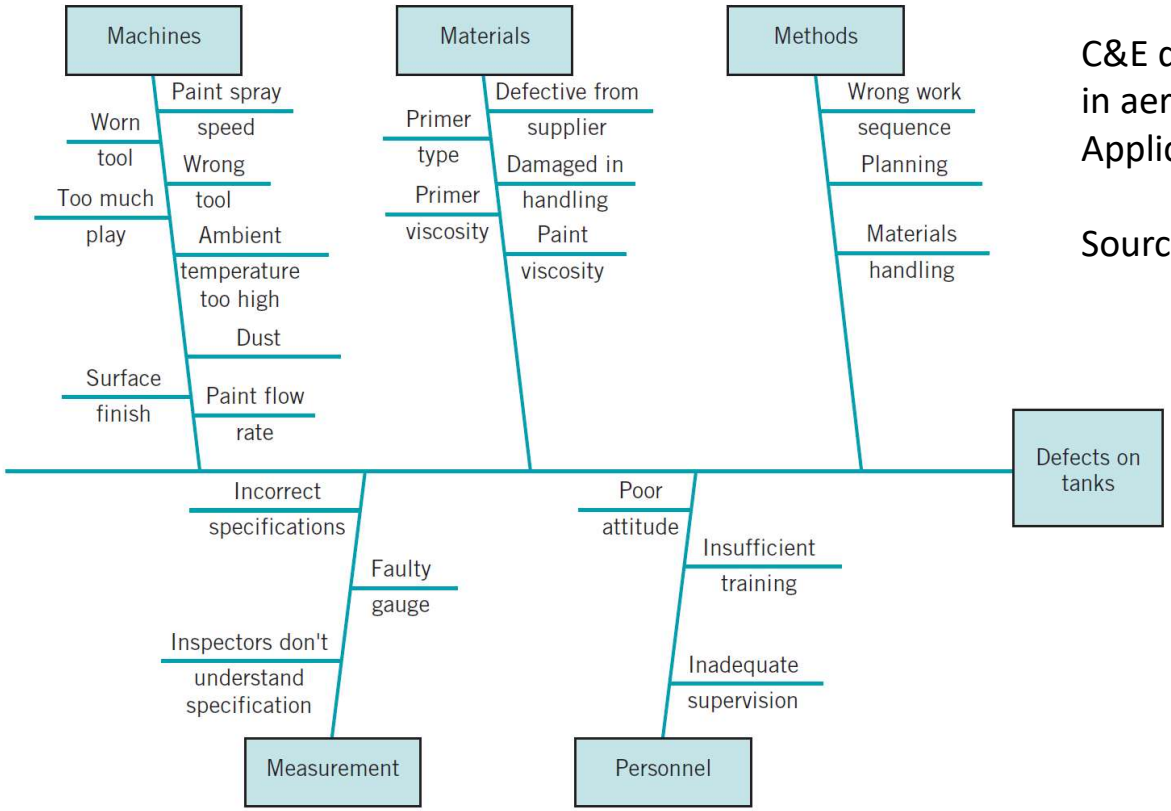
https://asq.org/quality-resources/fishbone
https://www.juran.com/blog/the-ultimate-guide-to-cause-and-effect-diagrams/

Cause and Effect Diagram Example



Source: asq.org

Cause and Effect Diagram Example



C&E diagram to identigy defects in a tank used in aerospace Application

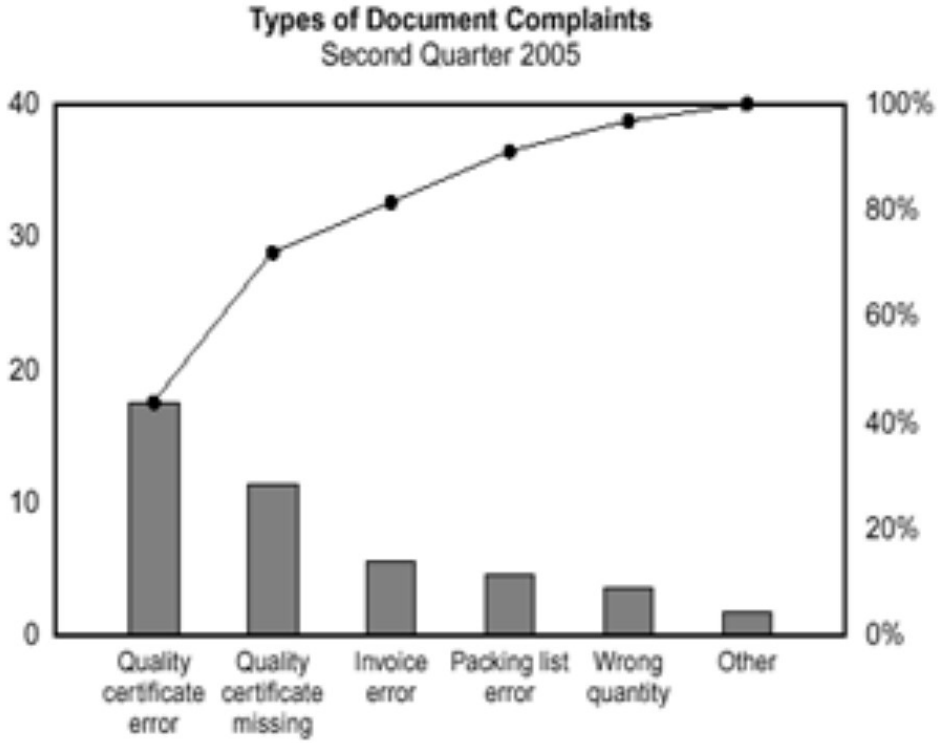
Source: Montgomery, SQC

Pareto Chart

- When to use?
  - To analyse frequency of problems or causes of a problem
  - When there are multiple problems in a process and you want to focus on important few
  - Communicating distribution of problem/causes
- How to use?
  - Collect data on number of occurrences of problems/causes
  - Order the data in descending order of frequencies
  - Create a bar chart with the frequency (or percentages) on y-axis, problem category labels on x-axis
  - From the top of the highest bar, draw a line diagram using cumulative frequency of problem categories

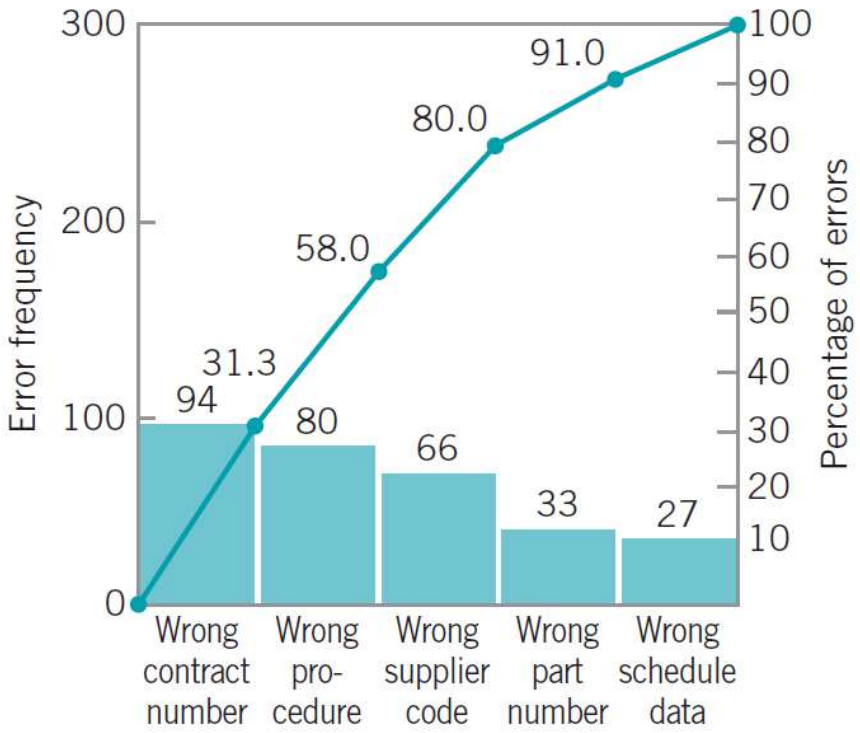
https://asq.org/quality-resources/pareto

Pareto Chart Example



Source: asq.org

Pareto Chart Example



C&E diagram to identigy defects in a tank used in aerospace
Application

Source: Montgomery, SQC

Defect Concentration Diagram

- Picture of a unit showing all the relevant views and the associated defects.
- Defects are color coded – helps identifying the source of the defect

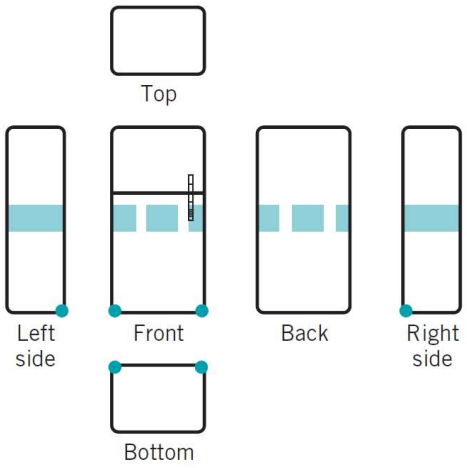


FIGURE 5.20 Surface-finish defects on a refrigerator.

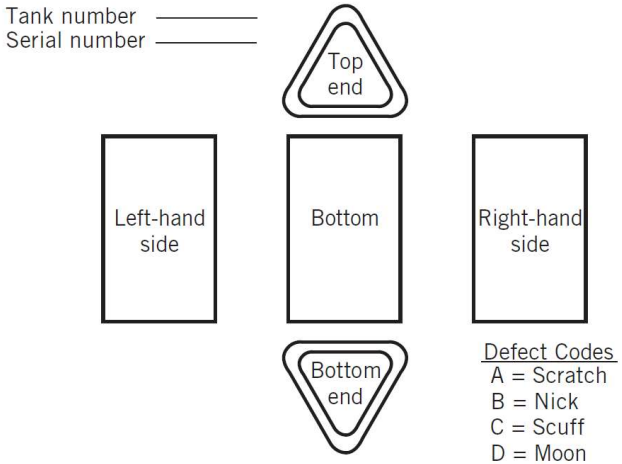
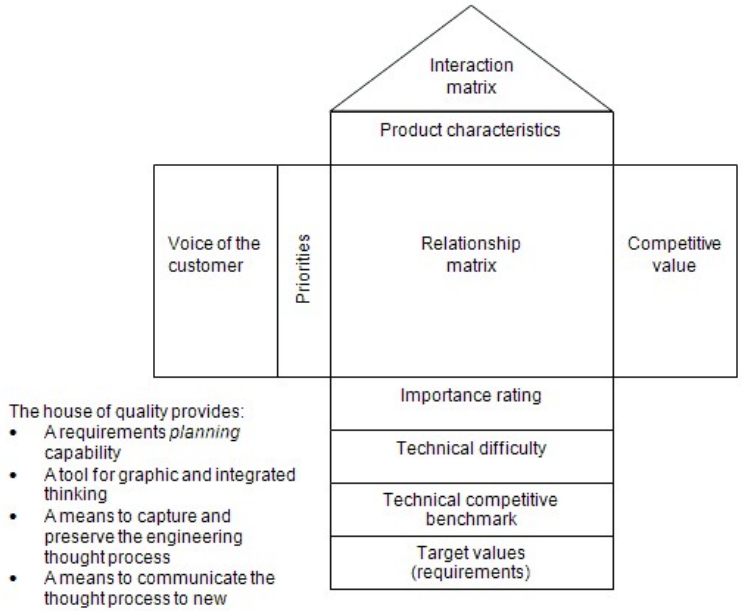


FIGURE 5.21 Defect concentration diagram for the tank.

Quality Function Deployment (House of Quality)

- A tool“To satisfy or even delight the customers, QFD is an essential tool” – ASQ
- Focused on “voice of the customer”

Source: asq.org



The house of quality provides:

- A requirements *planning* capability
- A tool for graphic and integrated thinking
- A means to capture and preserve the engineering thought process
- A means to communicate the thought process to new members of the QFD team
- A means to inform management regarding inconsistencies between requirements, risks, and needs of the customer

https://www.edrawsoft.com/template/pdf/qfd.pdf

QFD

- Tool to design quality product incorporating customer needs
- Evaluates competitors on two perspectives: customers' and technical
- QFD cuts down on time that would otherwise be spent on product redesign
- QFD is also used to create training programs, hire new employees, establish supplier development criteria and improve service
- Needs a cross-functional team for data collection and analysis

QFD

EXHIBIT II

Japanese automaker with QFD made fewer changes than U.S. company without QFD

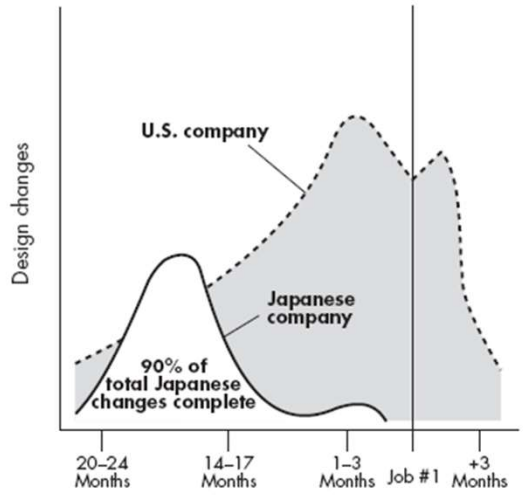
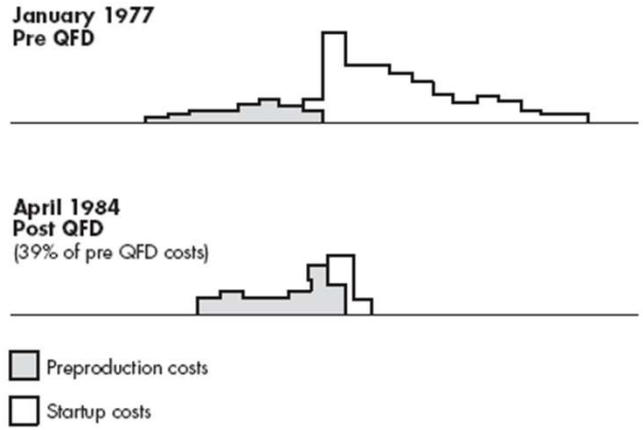


EXHIBIT I

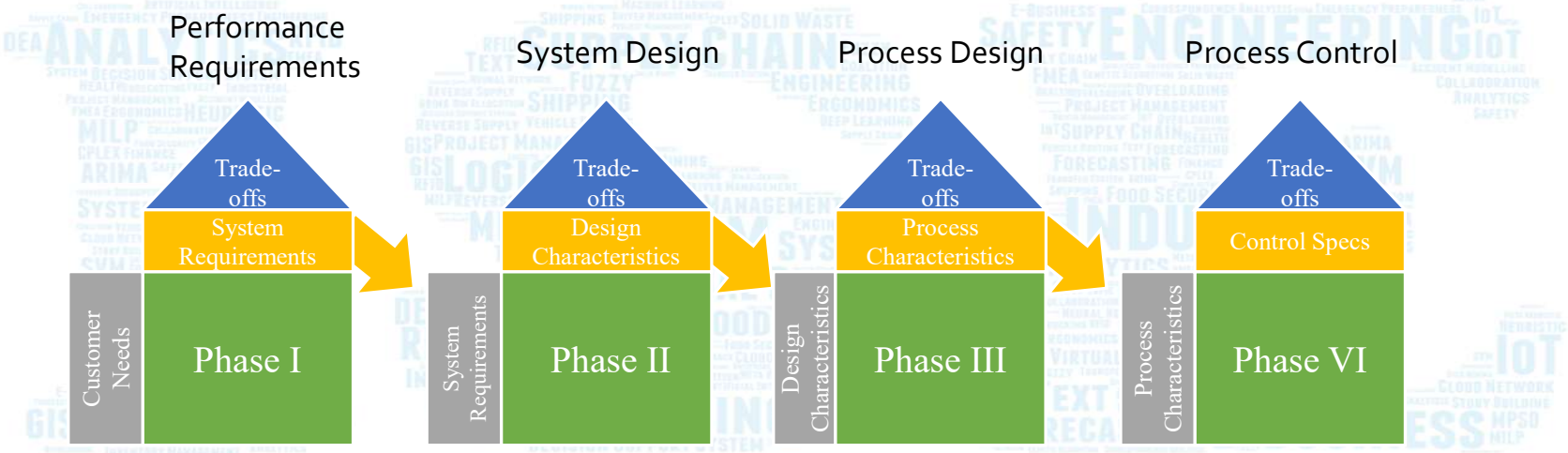
Startup and preproduction costs at Toyota Auto Body before and after QFD

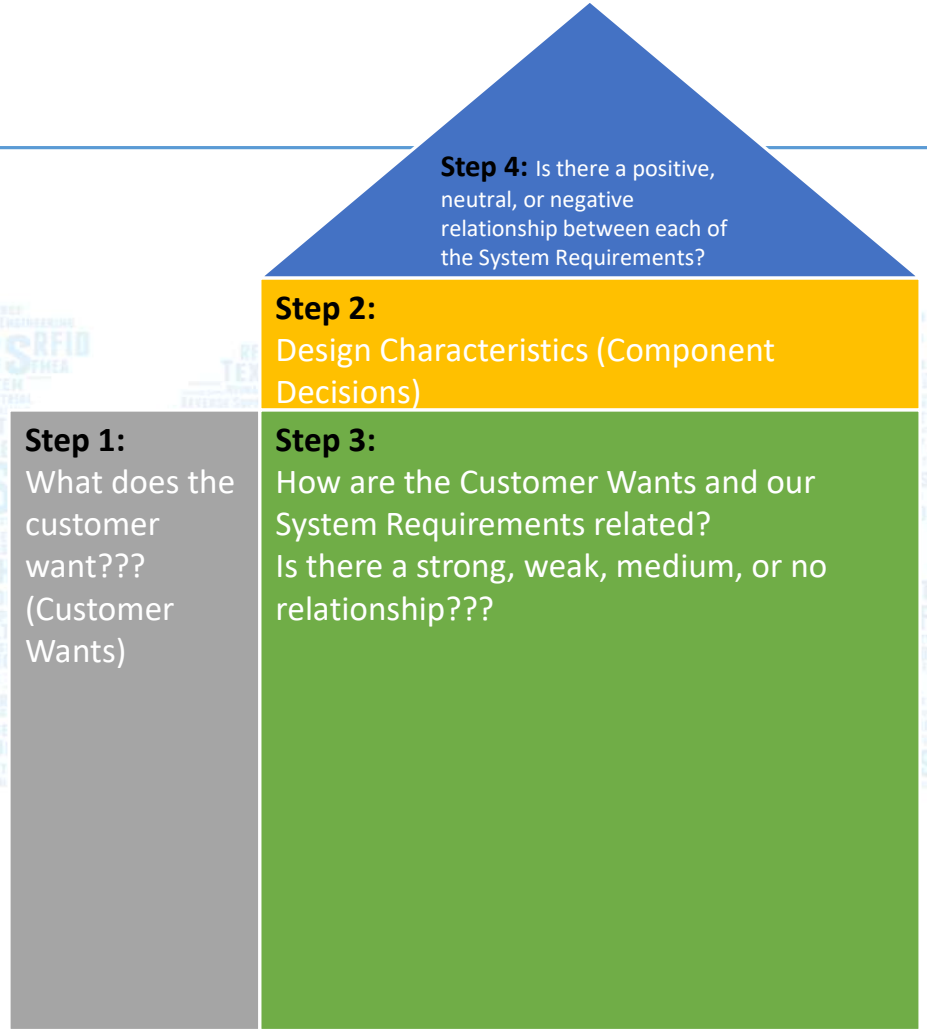


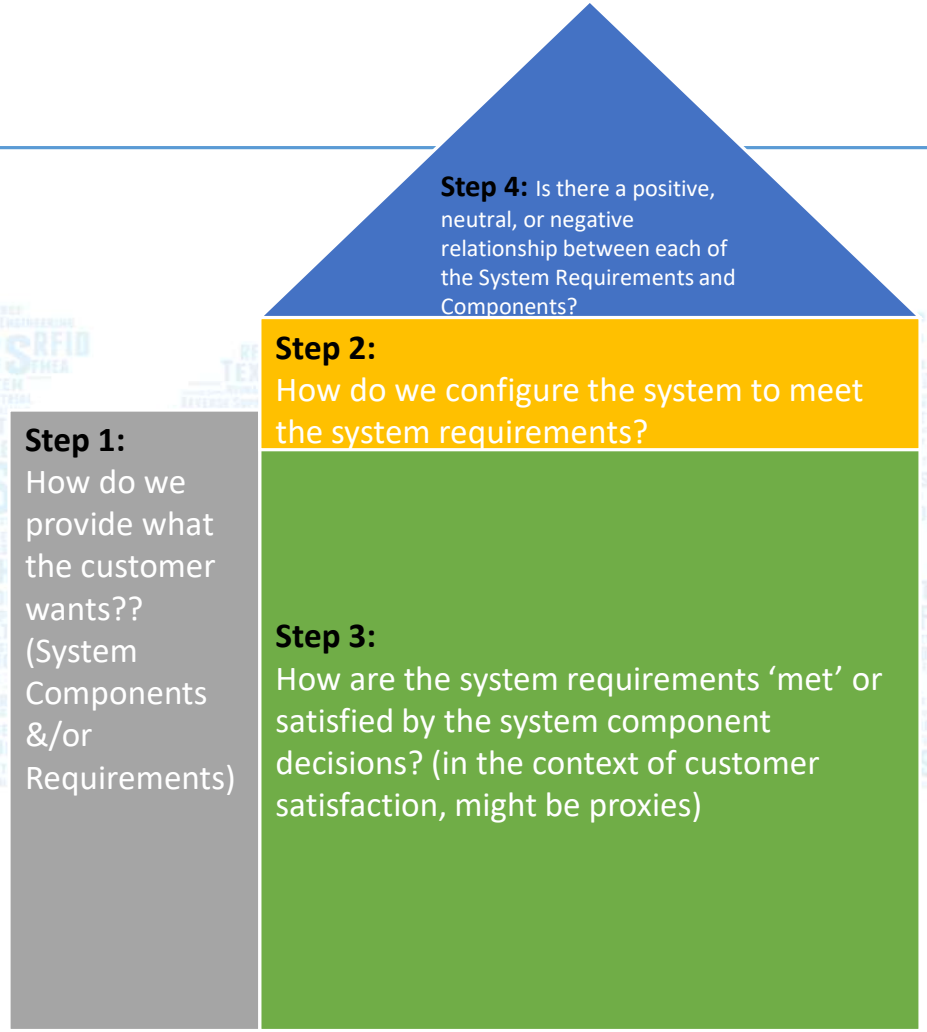
Source for Exhibits I and II: Lawrence P. Sullivan, "Quality Function Deployment," *Quality Progress,* June 1986, p. 39. © 1986 American Society for Quality Control. Reprinted by permission.

Quality Function Deployment

Four Phases of Quality Function Deployment




Step 4: Is there a positive, neutral, or negative relationship between each of the System Requirements?
Step 2:
Design Characteristics (Component Decisions)
Step 1:
What does the customer want??? (Customer Wants)
Step 3:
How are the Customer Wants and our System Requirements related?
Is there a strong, weak, medium, or no relationship???


Step 4: Is there a positive, neutral, or negative relationship between each of the System Requirements and Components?
Step 2:
How do we configure the system to meet the system requirements?
Step 1:
How do we provide what the customer wants?? (System Components &/or Requirements)
Step 3:
How are the system requirements 'met' or satisfied by the system component decisions? (in the context of customer satisfaction, might be proxies)

Lean Management

- “Value” is something for which your customer is willing to pay. These are called value-adding activities.
- Everything else falls under the category of “waste”
- Taichi Ohno, architect of Toyota production system conceived this idea of lean, and devoted his career in eliminating waste from production process.
- 7 types of waste: Transport, Inventory, Motion , Waiting, Overproduction, Over-processing, Defects
- Pure Waste: Any activity that does not bring value and damages efficiency
- Necessary Waste: Activities that our customer does not want to pay for, but is necessary to provide value for the end product

https://kanbanize.com/lean-management/value-waste/what-is-value-lean/

Value Stream Mapping

- What is VSM?
  - Representation of the flow of material and information from supplier to customer through your organization.
  - It enables you to see where the delays are in the process, if there is bottleneck, excessive inventory or other restraints.
  - You create your current state map and work towards producing your ideal state map.

http://leanmanufacturingtools.org/wp-content/uploads/2012/05/Value-stream-map1.gif