EPFL School of Engineering

Continuous Improvement (CIP)

Module 3 – Process

Quality Improvement

Amin Kaboli

Week 7, Session 1&2, April 4th, 2025

Course Framework

Change Plan
Strategic plan

Continuous Improvement (ME-498)

Module 1
Introduction

Feb 23rd

CIP Foundations
CIP case studies

Module 2
People

March-May

Managing Change
Emotional Intelligence
Managing Oneself
Connection & Bonding
Effective Change Comm.
Managing Conflict

Module 3
Process

March-May

Capacity Planning
Constraint Management
Managing waiting lines
Quality Planning
Quality Control
Quality Improvement
Process selection
Facility Layout
Lean Management

Module 4
Technology

March-May

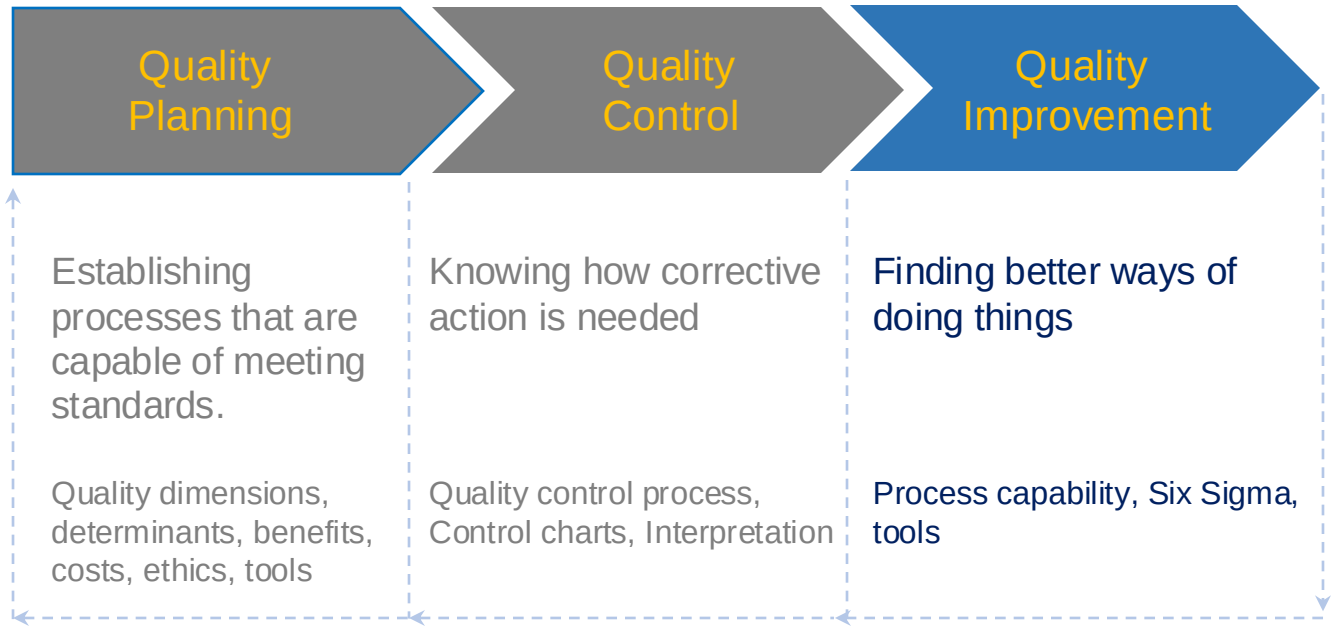
AI for CIP
Data Analytics, ML&AI
Digital Ecosystems
Best case practices

Final

May 31st

Final presentation & solid understanding of the course

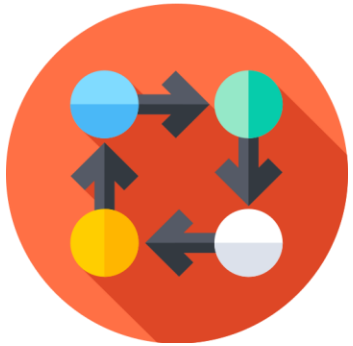
Quality Management – Trilogy



Quality Control – Questions

Q1. What is Quality Control?, why is it important?

Q2. What are the main questions in inspection?



Q3. What are the main steps of effective control process?

Q4. How control charts are used to monitor a process?

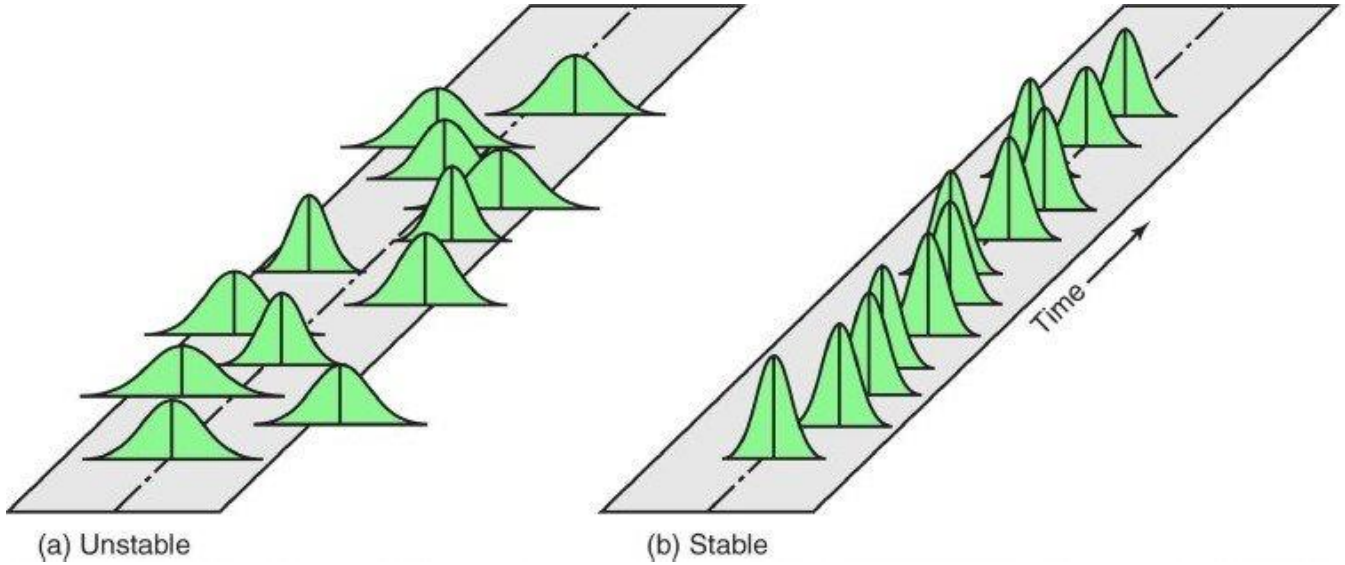
Q5. How do you interpret the control chart?

Q6. What is process capability?

Question 1:

What is Process Capability?

Process Capability – Definition & Necessity



Definition: The inherent variability of process output relative to the variation allowed by the design specifications.

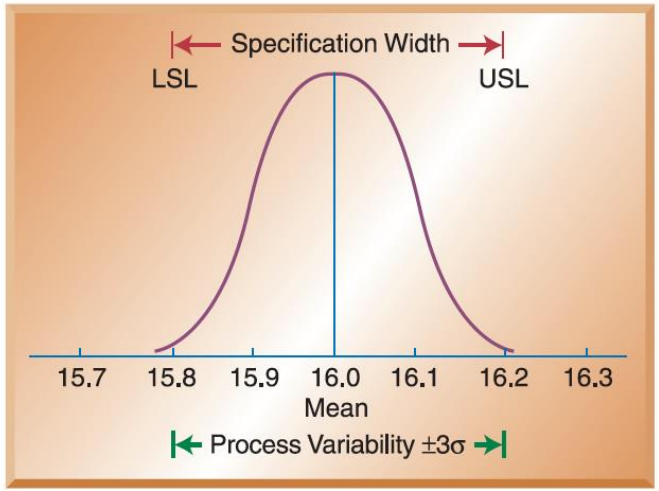
Why? An indicator that a process is capable to produce/serve within an acceptable range.

Question 2:

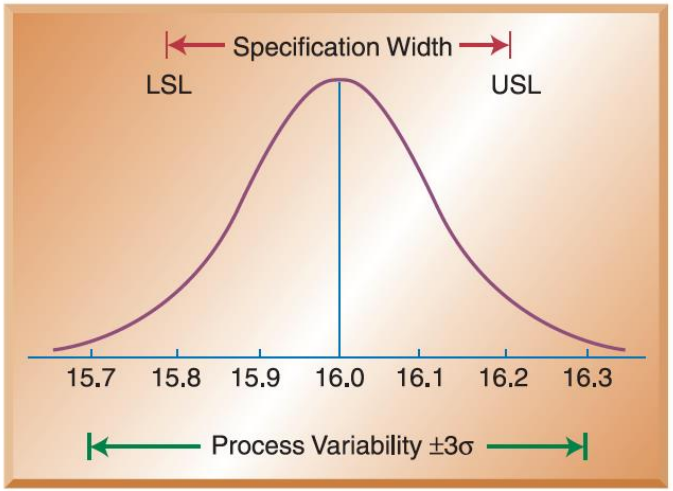
How to ensure a process is capable?

Process Capability – Quality Improvement

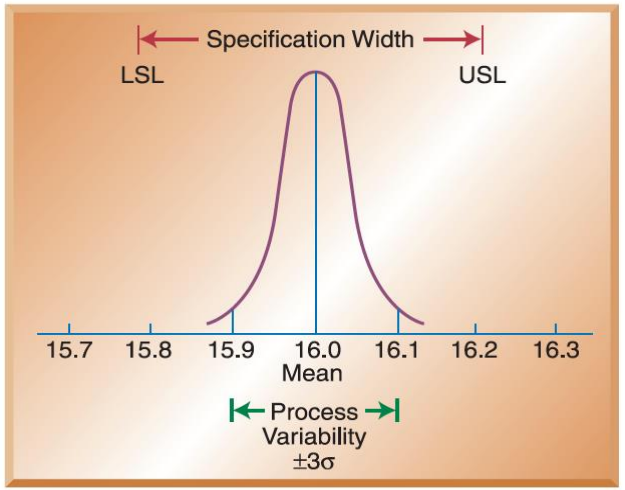
$$C_p = \frac{\text{specification width}}{\text{process width}} = \frac{\text{USL} - \text{LSL}}{6\sigma}$$



(a) Process variability meets specification width



(b) Process variability outside specification width



(c) Process variability within specification width

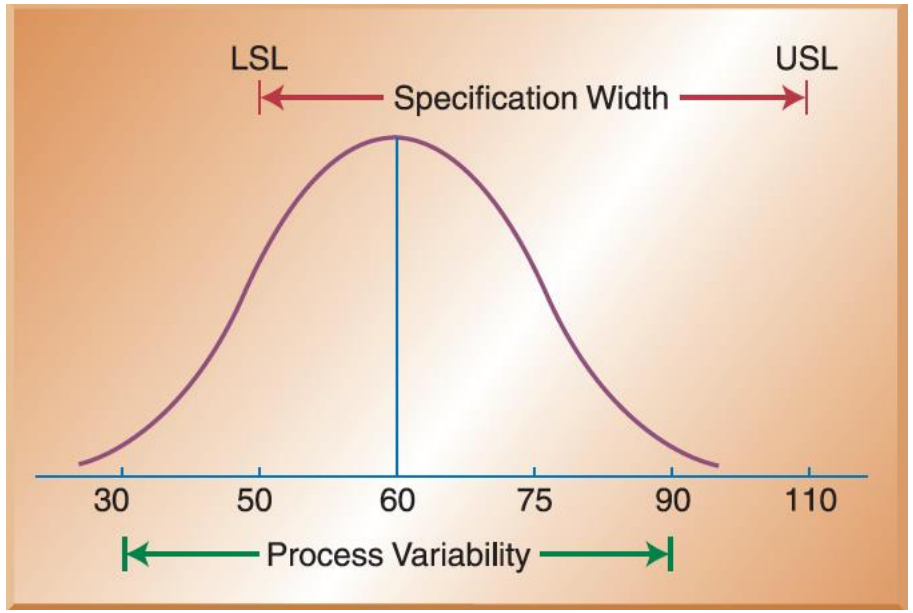
PPM: parts per million 100% - 99.74% = 0.26 which for a million parts will be 2600

Assignment 1 – Quality Improvement

Please download the problem set from Moodle

Exercise 1 – Process Capability *Cp*

Process Capability – Not Centered



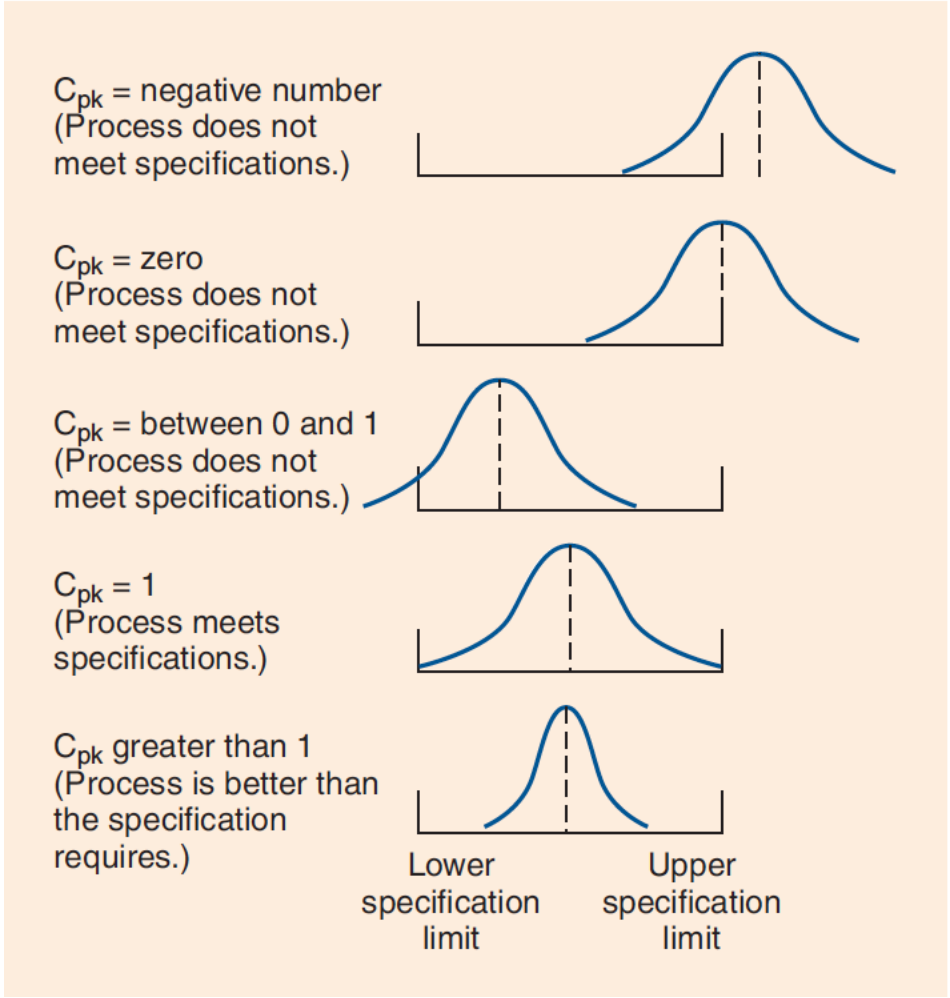
$$C_{pk} = \min\left(\frac{\text{USL} - \mu}{3\sigma}, \frac{\mu - \text{LSL}}{3\sigma}\right)$$

where μ = the mean of the process
σ = the standard deviation of the process

Meanings of C_{pk} Measures

C_{pk} = Less than 0

C_{pk} = Larger than 1



Source: Heizer, J., Render, B., Munson, C., & Sachan, A. (2017). Operations Management: Sustainability and Supply Chain Management, 12/e. Pearson Education.

Assignment 2 – Quality Improvement

Please download the problem set from Moodle

Exercise 2 – Process Capability *Cpk*

Question 3:

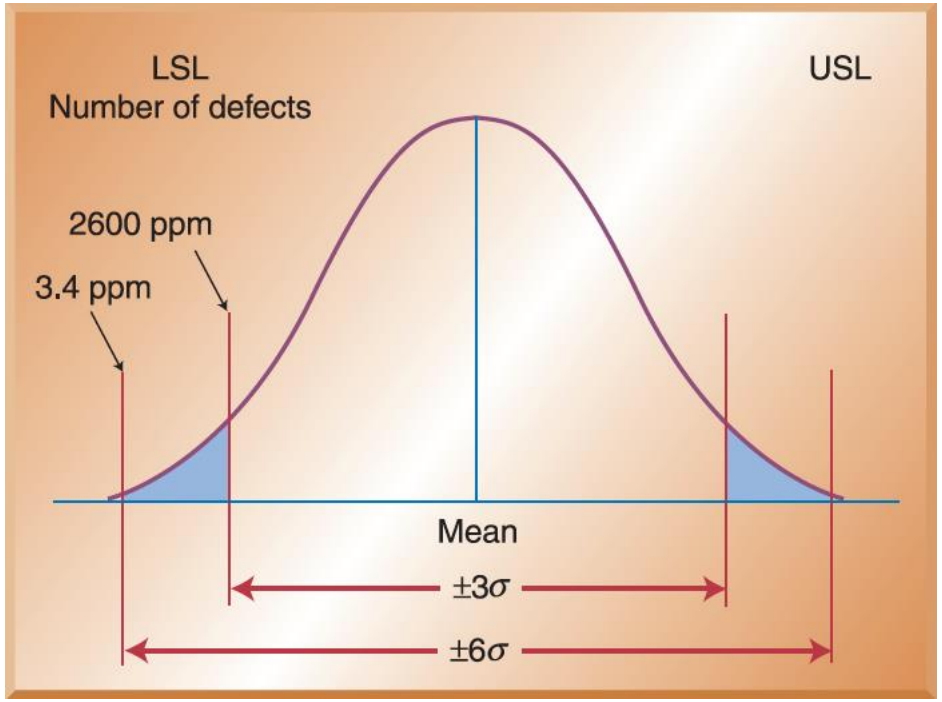
How to improve quality?

Effective Quality Control – Steps

- **Step 1: Define** (what is to be controlled)?
- **Step 2: Measure** (How measurement will be accomplished?)
- **Step 3: Compare** (What level of quality being sough?)
- **Step 4: Evaluate** (What is out of control? How is the variability?)
- **Step 5: Correct** (How corrective actions must be taken?)
- **Step 6: Monitor** (How do you monitor results and ensure corrective actions were effective?)

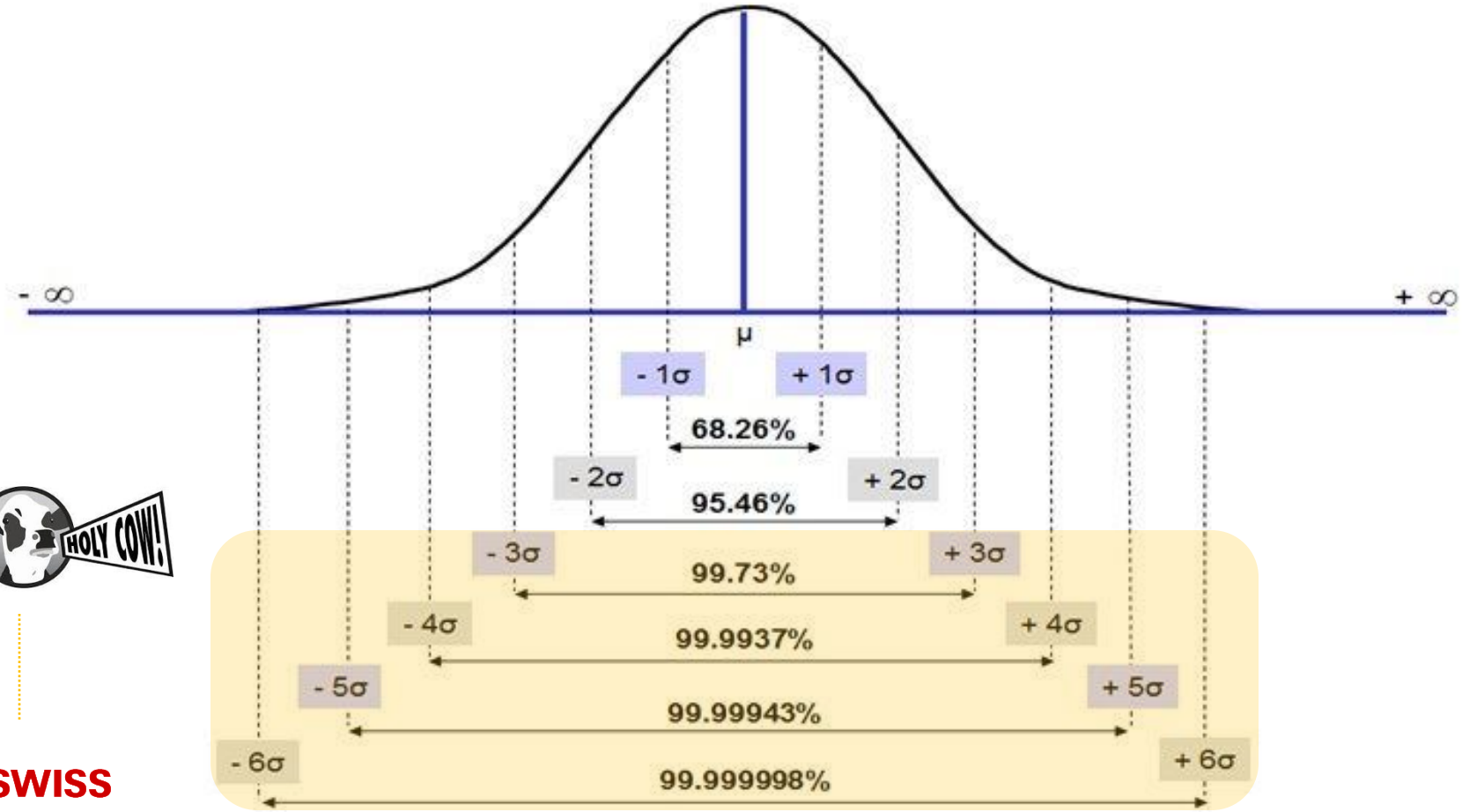
What is Six Sigma?

- A high level of quality associated with approximately 3-4 defective parts per million.



PPM defective for +/-3 sigma vs +/-6 Sigma quality (not to scale)

Successful & Sustainable Operations



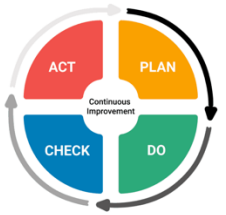
Successful & Sustainable Operations

Sigma	Defects Per Million Operations (DPMO)	Percentage of Successful Operations
1	691’462	30.9%
2	308’538	69.1%
3	66’807	93.3%
4	6’210	99.4%
5	233	99.98%
6	3.4	99.99966%

SWISS

Correct – How corrective actions must be taken?

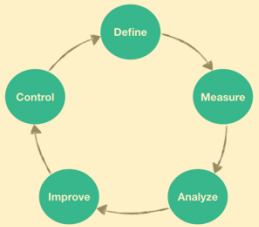
Quality Problem Solving – Systematic Process Improvement



PDCA cycle

Basic steps of problem solving

Process improvement



DMAIC

Sources:
The Second Figure from Donna Summers, Quality, 2nd ed., p. 67. Copyright © 2000 Prentice Hall, Inc. Reprinted by permission of Pearson Education, Inc., Upper Saddle River, NJ.
William J. Stevenson, Operations Management, Page 388-392, McMcGraw-Hill Education, 12th edition, 2015.

Systematic Idea Generation

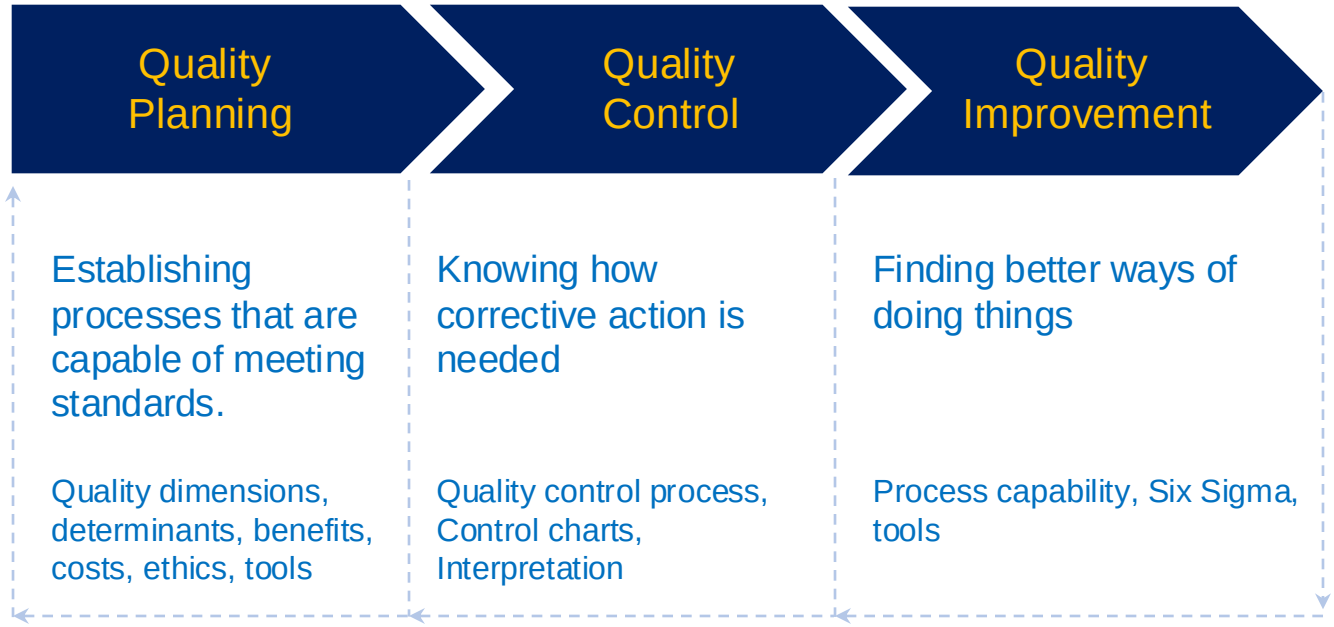
Brainstorming

Quality circles

Benchmarking

Design Thinking

Quality Management – Trilogy



Assignment 7 – Tasks of Quality Improvement

5 min

Understand and evaluate your case study's manufacturing/service process capability and offer recommendations as needed.

Reflect, share and collect ideas of your group members and answer the following question in your work;

- Is the process that you studied in Assignment 4 and 5, capable? How do you measure it?
- What is the level of successful and sustainable operations for your case study?
- What is your proposal for quality improvement? what other quality tools (other than what you already explained earlier) can be in use to enhance the quality of your case?
- How would you structure your project based on DIMAC steps?

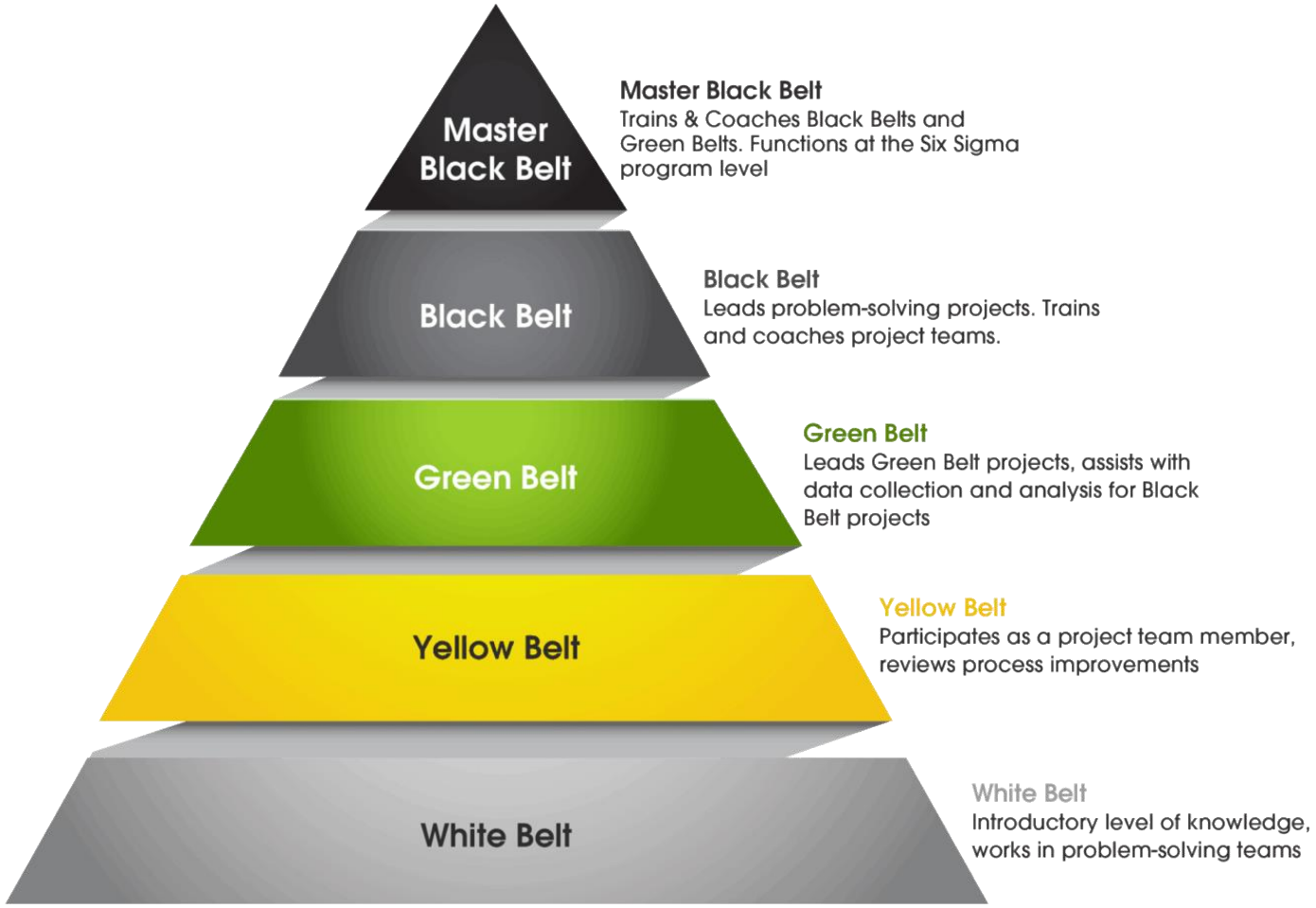
Note 1: Refer to page 390-392 of your book chapter, Management of Quality.

Note 2: We don't expect you to re-write or re-present a full-length project, rather a short description of your project, less than half a page, based on DIMAC steps.

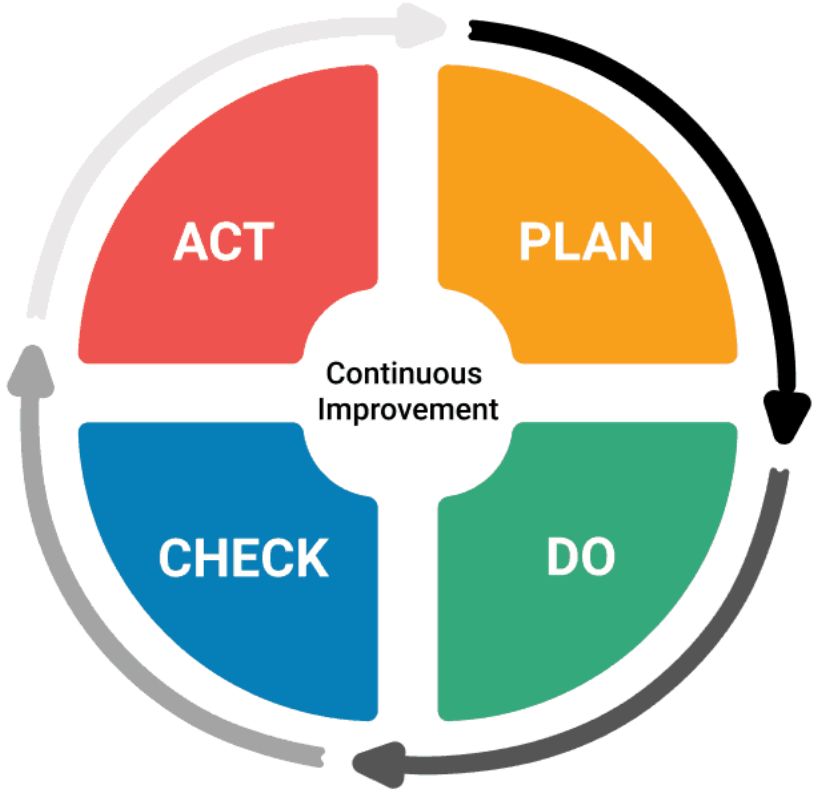
Reminder:

Quality tools?

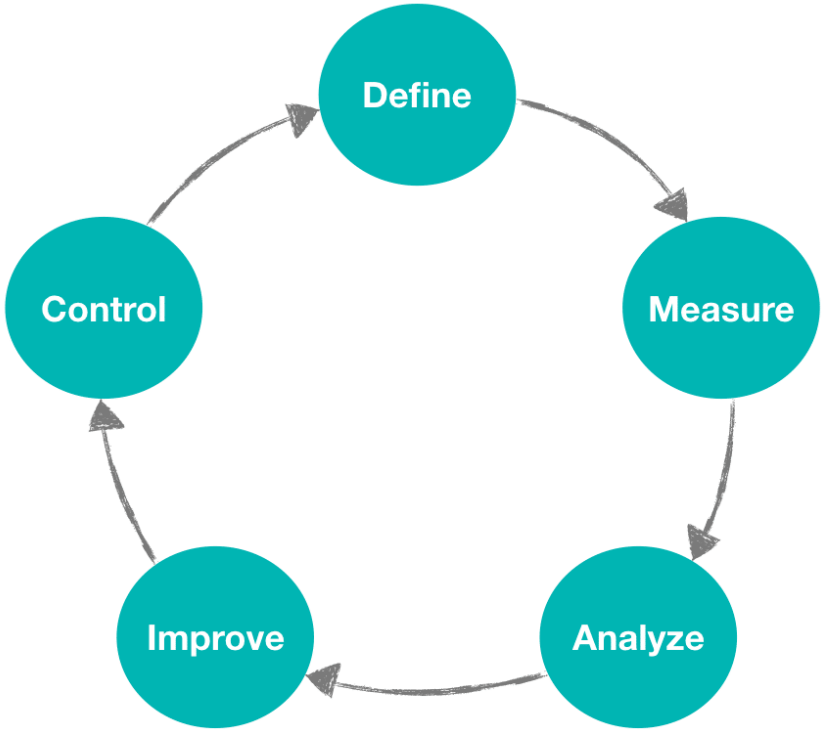
Six Sigma Mastery Level



Reminder: Problem Solving – PDCA & DMAIC



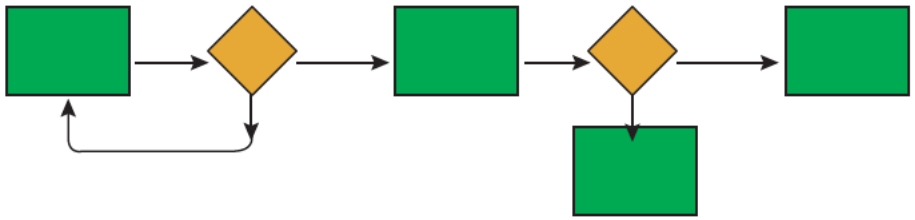
PDCA cycle



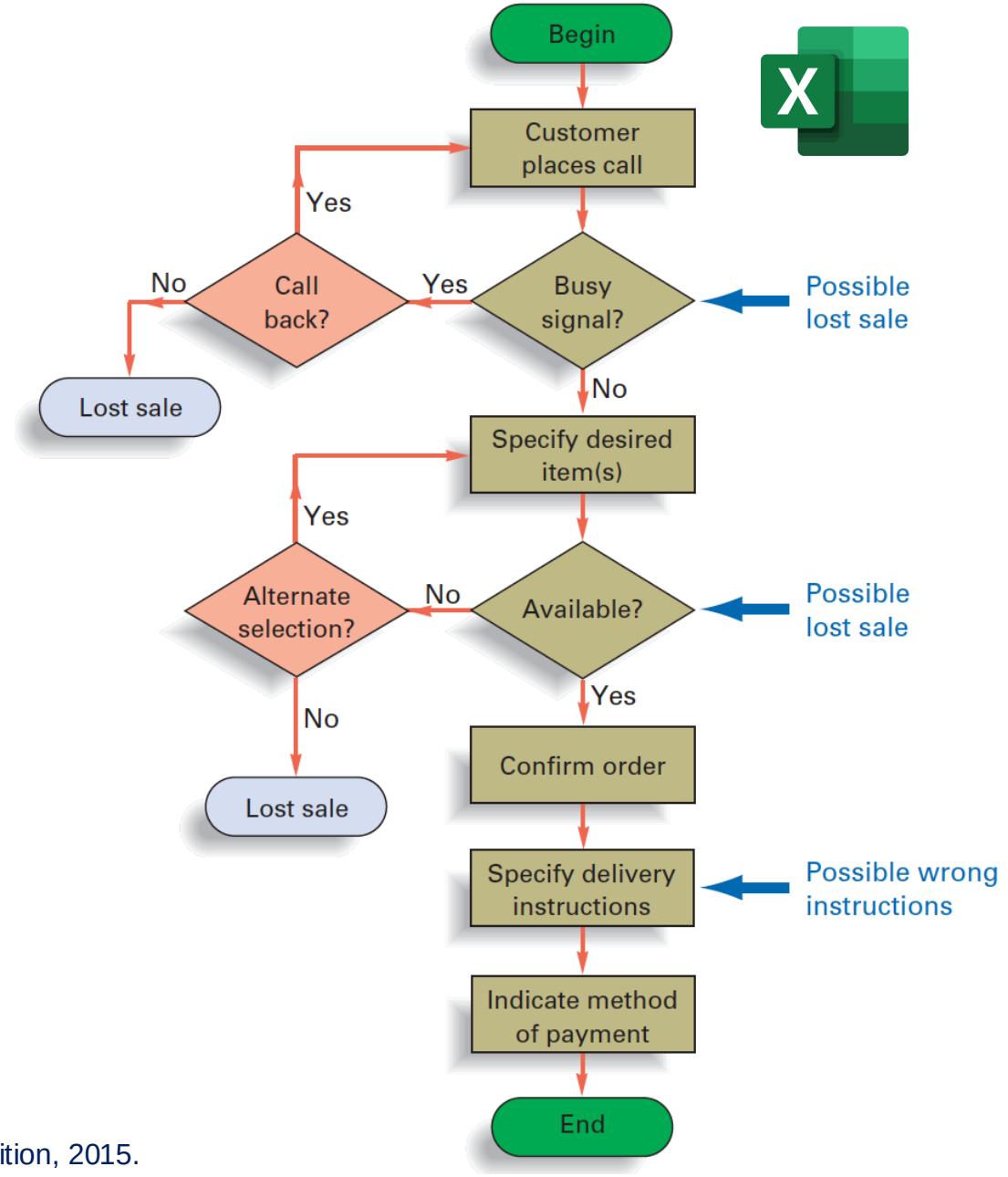
DMAIC

Quality tools (1) – Flowcharts

- **Definition:** A diagram of the steps in a process.



Example: Phone call and product delivery



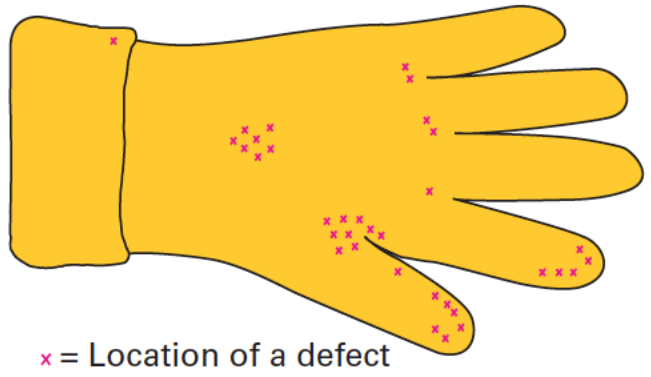
Source: William J. Stevenson, Operations Management, McMcGraw-Hill Education, 12th edition, 2015.

Quality tools (2) – Check Sheet

- **Definition:** A tool for recording and organizing data to identify a problem.

Day	Time	Type of Defect: Missing label	Off-center	Smeared print	Loose or folded	Other	Total
M	8–9	IIII	II				6
	9–10		III				3
	10–11	I	III	I			5
	11–12		I		I	I(Torn)	3
	1–2		I				1
	2–3		II	III	I		6
	3–4		II	IIII			8
Total		5	14	10	2	1	32

An example of check sheet

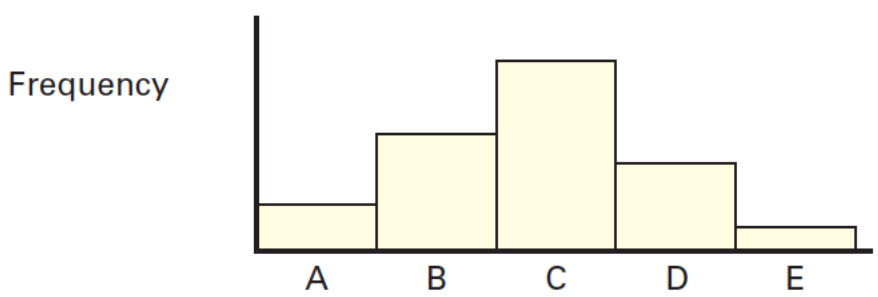


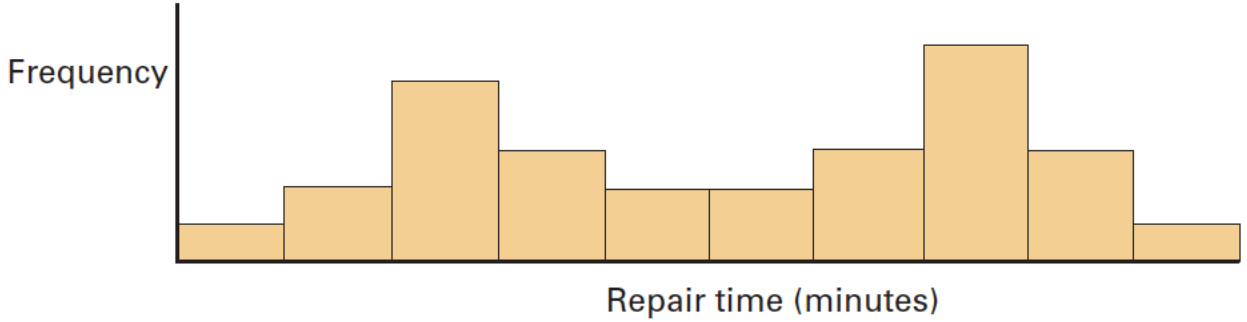
A special-purpose check sheet

Source: William J. Stevenson, Operations Management, McMcGraw-Hill Education, 12th edition, 2015.

Quality tools (3) – Histogram

- **Definition:** A chart for an empirical frequency distribution.

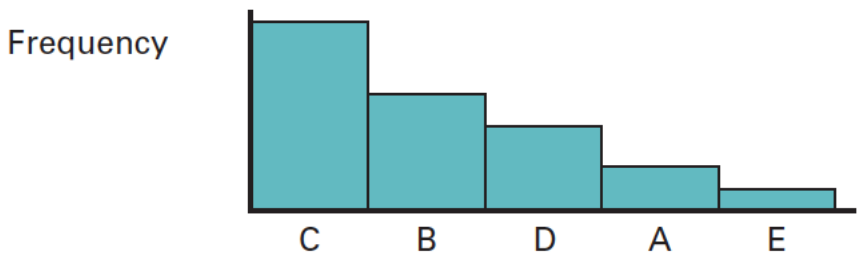


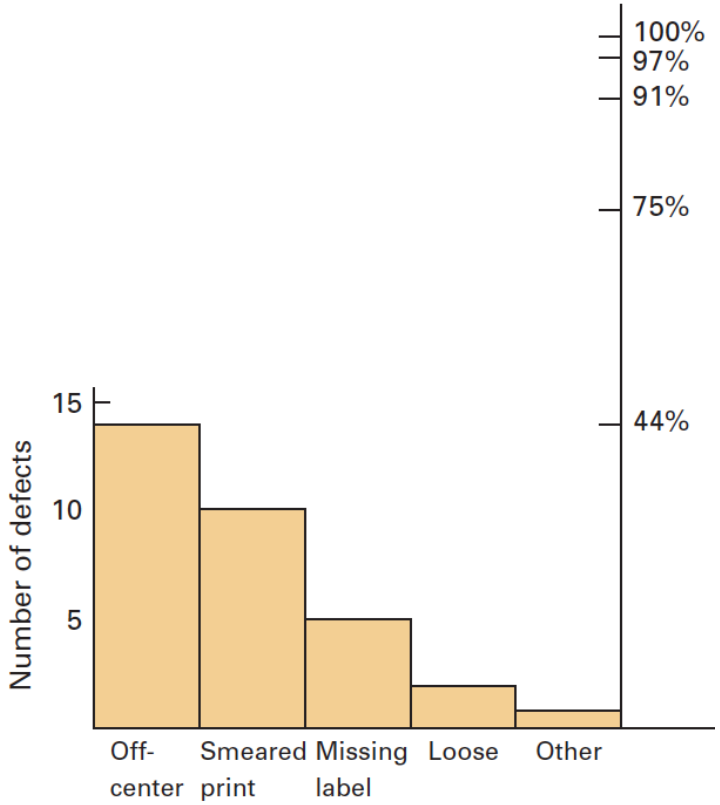


Source: William J. Stevenson, Operations Management, McMcGraw-Hill Education, 12th edition, 2015.

Quality tools (4) – Pareto Chart

- **Definition:** A diagram that arranges categories from the highest to lowest frequency of occurrence.

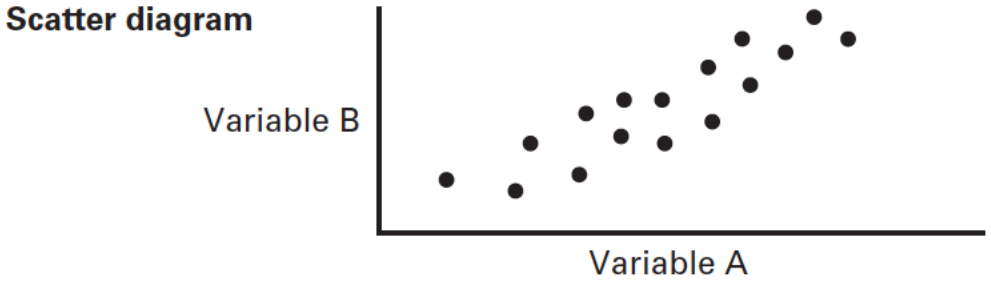


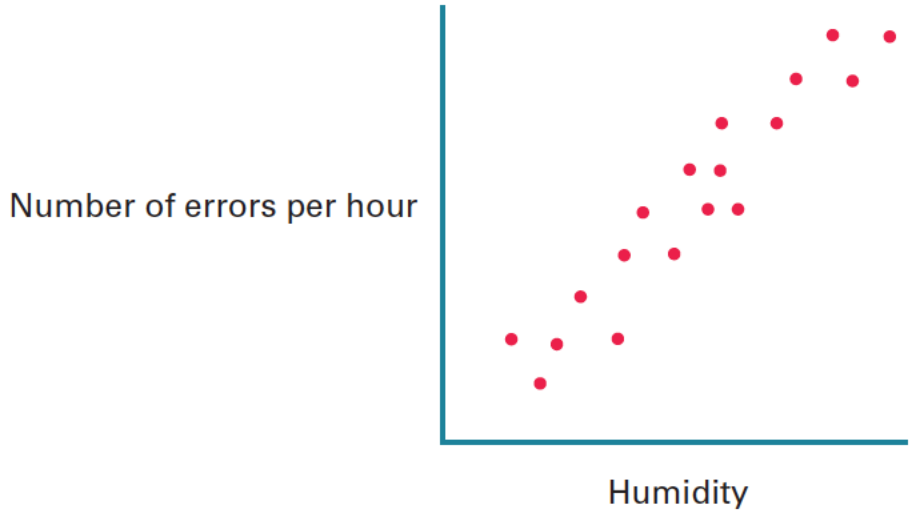


Source: William J. Stevenson, Operations Management, McMcGraw-Hill Education, 12th edition, 2015.

Quality tools (5) – Scatter Diagram

- **Definition:** A graph that shows the degree and direction of relationship between two variables.

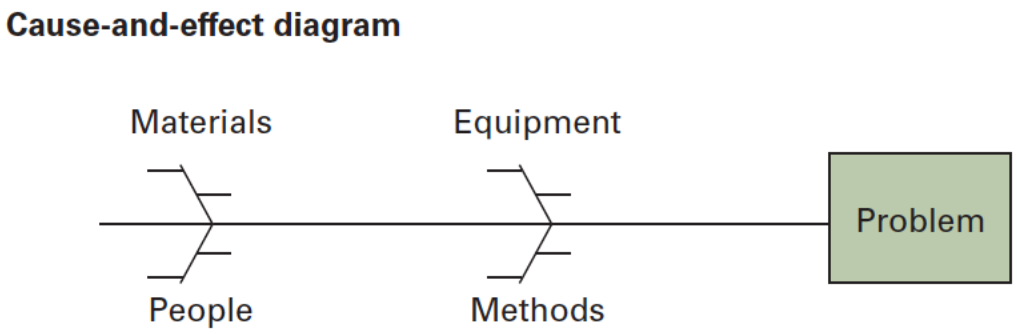


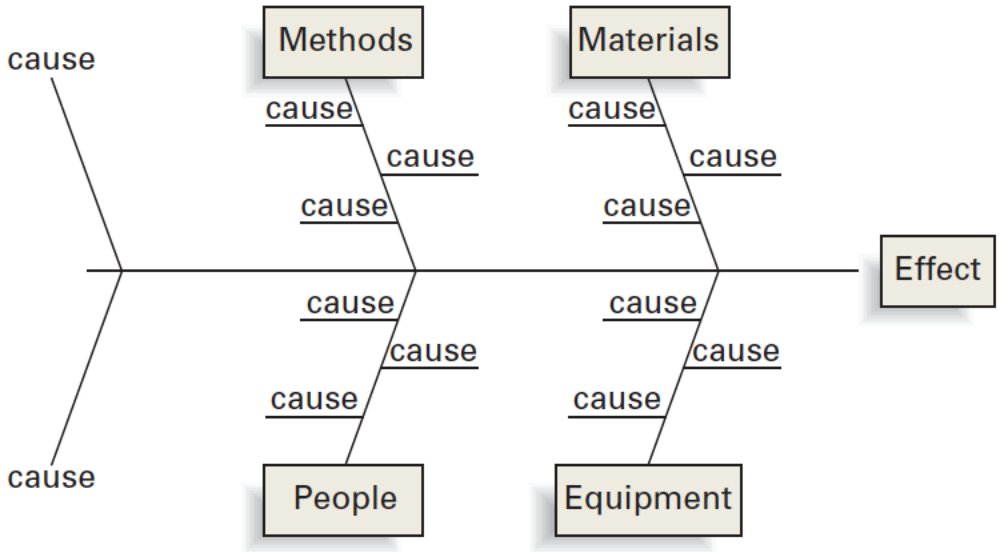


Source: William J. Stevenson, Operations Management, McMcGraw-Hill Education, 12th edition, 2015.

Quality tools (6) – Cause-and-Effect Diagram

- **Definition:** A diagram used to organize a search for the cause(s) of a problem, also known as a fishbone diagram.

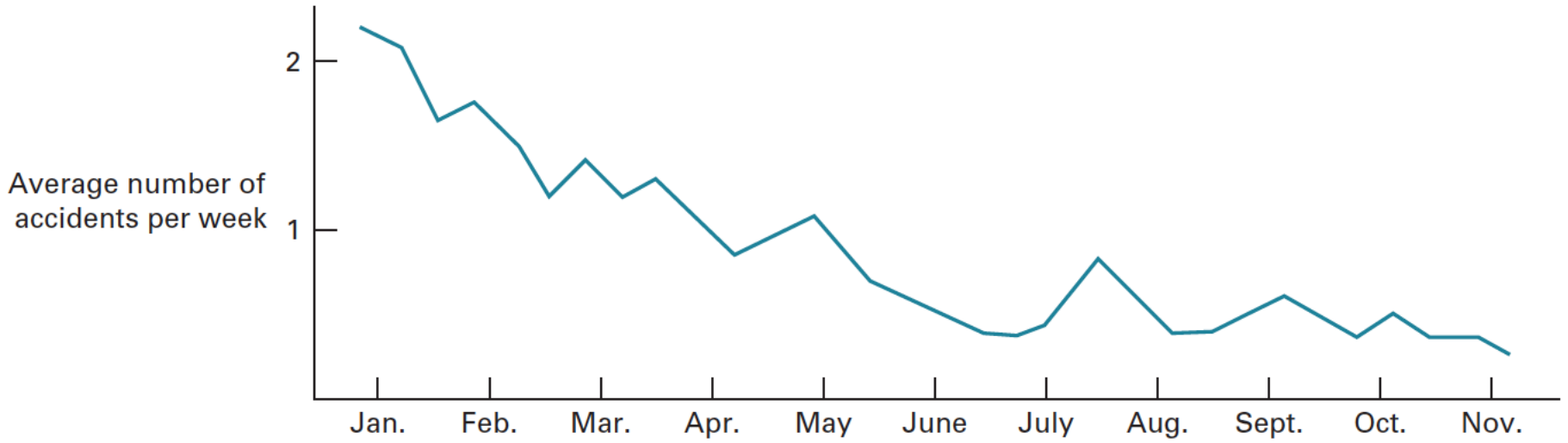




Source: William J. Stevenson, Operations Management, McMcGraw-Hill Education, 12th edition, 2015.

Quality tools (7) – Run Chart

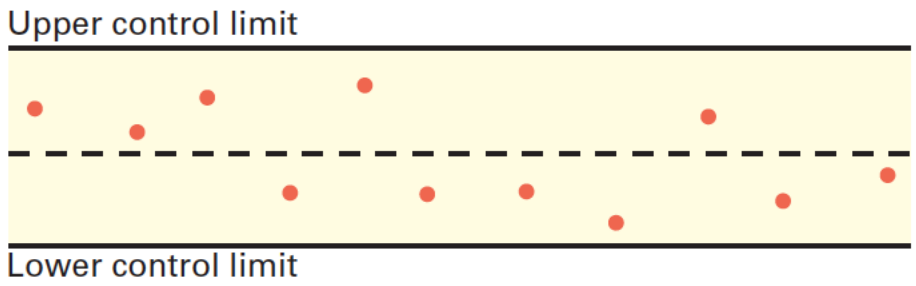
- **Definition:** A tool for tracking results over a period of time.

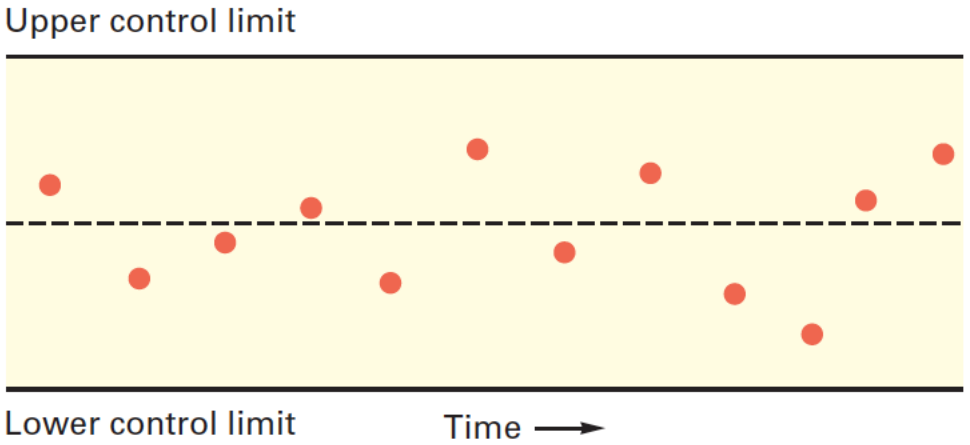


Source: William J. Stevenson, Operations Management, McMcGraw-Hill Education, 12th edition, 2015.

Quality tools (8) – Control Chart

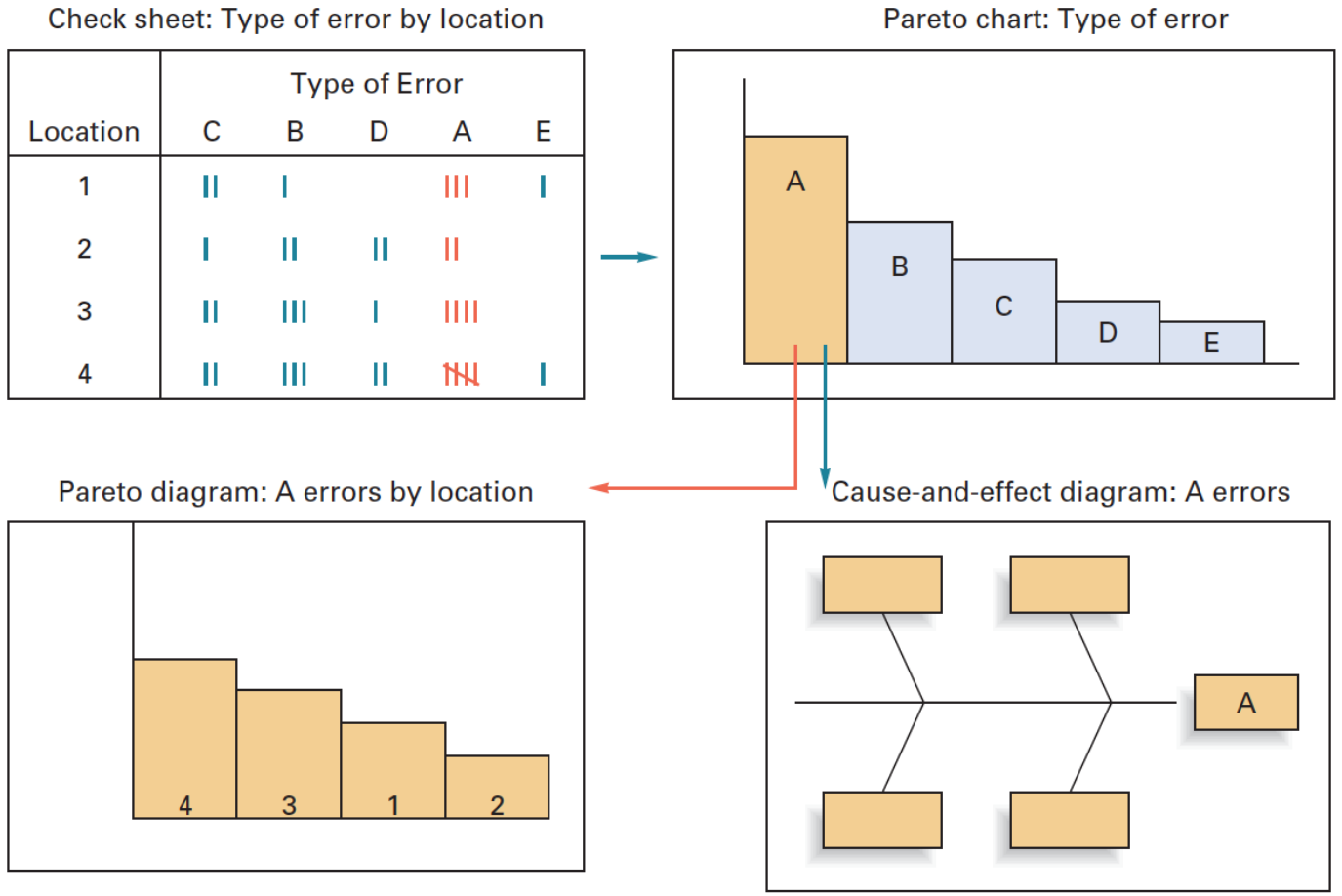
- **Definition:** A statistical chart of time-ordered values of a sample statistic (e.g., sample means).





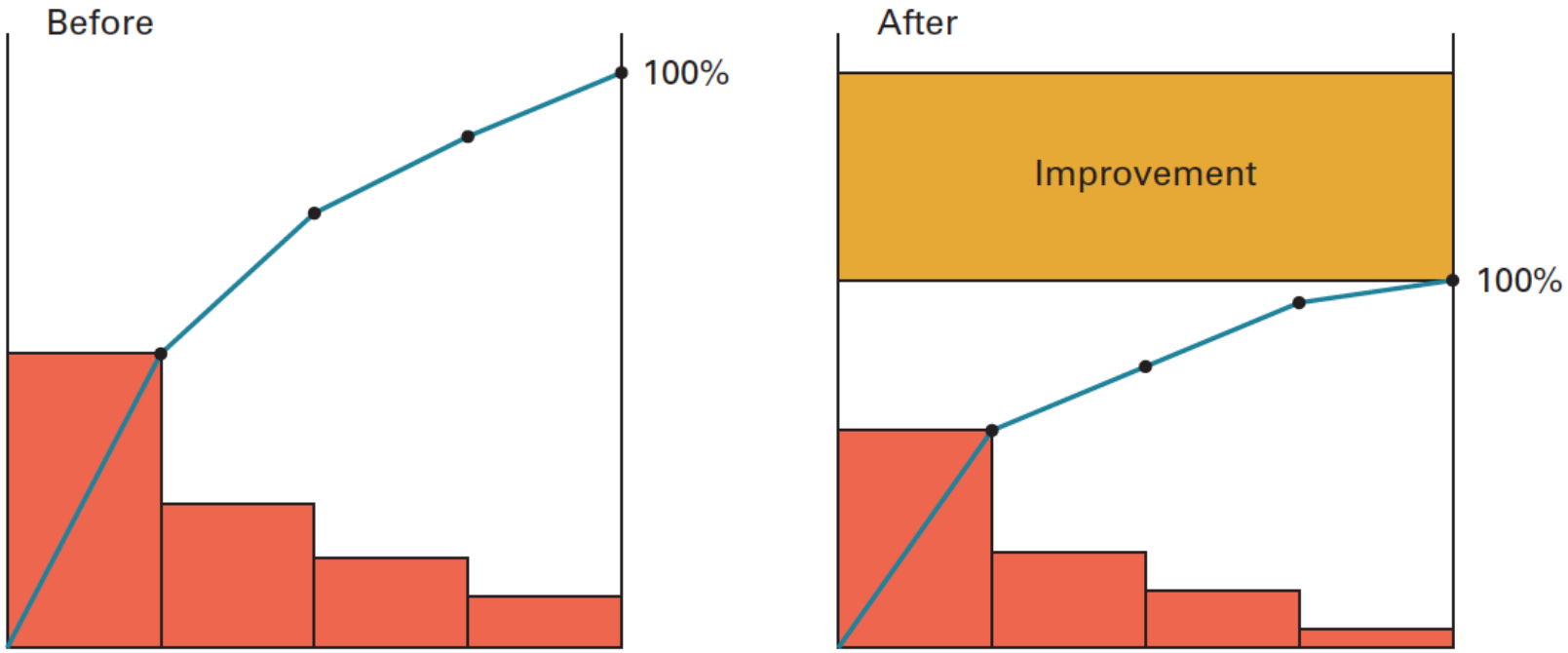
Source: William J. Stevenson, Operations Management, McMcGraw-Hill Education, 12th edition, 2015.

Quality tools – Using Tools to Improve Processes (I)



Source: William J. Stevenson, Operations Management, McMcGraw-Hill Education, 12th edition, 2015.

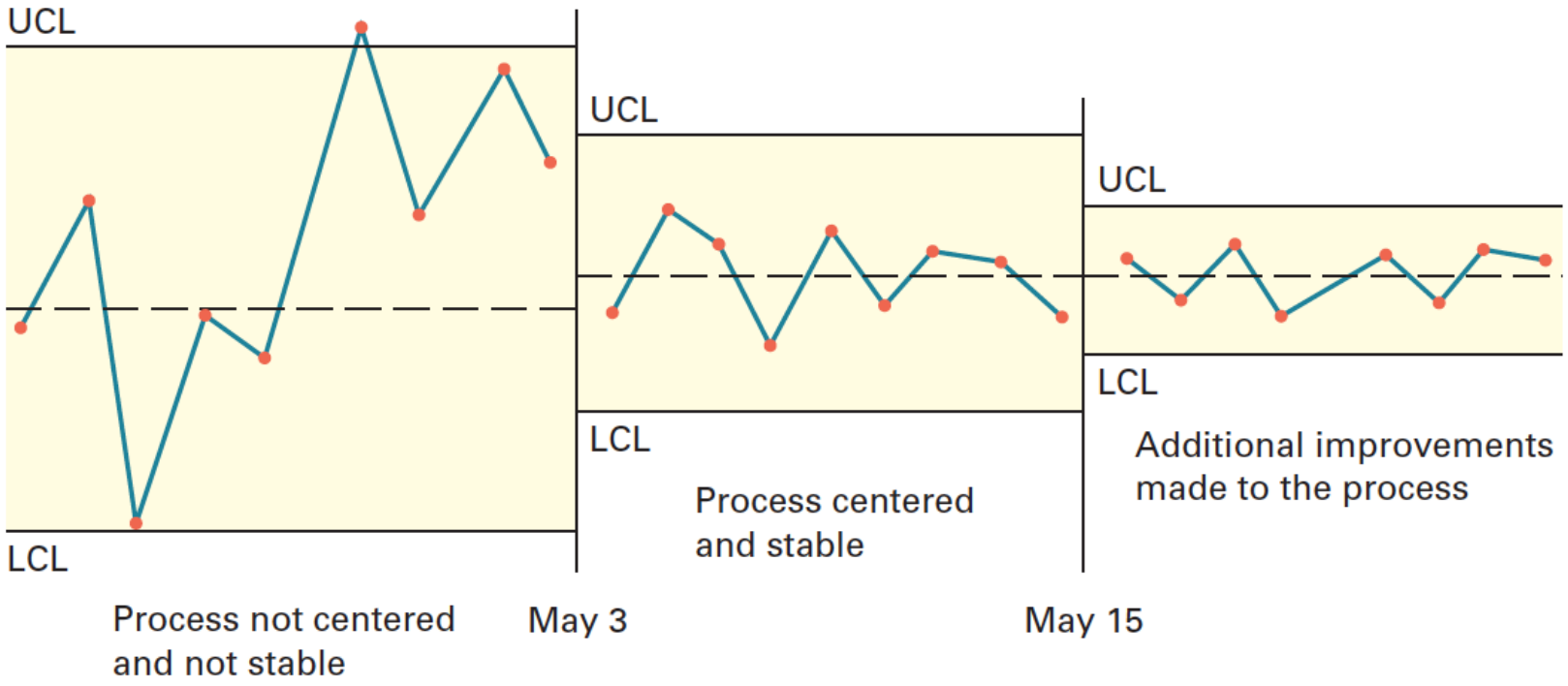
Quality tools – Using Tools to Improve Processes (II)



Using Pareto charts to track improvements

Source: William J. Stevenson, Operations Management, McMcGraw-Hill Education, 12th edition, 2015.

Quality tools – Using Tools to Improve Processes (II)



Using control chart to track improvements

Source: William J. Stevenson, Operations Management, McMcGraw-Hill Education, 12th edition, 2015.