Introduction to Continuous Process Improvement (CPI)

TOPIC LEARNING OBJECTIVES

Upon successful completion of this topic, the student will be able to:

1. Recognize the need for Continuous Process Improvement (CPI).
2. Recognize the definition of Lean.
3. Identify the five principles of Lean Thinking.
4. Recognize Lean terminology.
5. Recognize types of Lean waste.
6. Recognize the primary Lean roles.
7. Recognize the benefits of process improvement through a practical demonstration.
8. Recognize the basic assumption of Theory of Constraints and identify the 5 focusing steps.
9. Recognize the difference between a constraint and a bottleneck.
10. Recognize the goal of Six Sigma and its statistical basis of measurement (e.g., in defects per million).
11. Identify the Six Sigma methodology.

STUDENT PREPARATION

Student Support Material

1. Theory of Constraints: https://www.youtube.com/watch?v=2mbCBveHLMQ
2. Lean Six Sigma in 8 minutes: https://youtube.com/watch?v=s2HCrhNVfak
3. Lean 5S in MSICU: https://youtube.com/watch?v=aMkXICM1-98
4. Common vs Special Cause Variation (4:00-7:50) https://youtube.com/watch?v=1yEvI8s6OyM

Primary References

1. None

Additional References

1. Navy P2P Website: https://p2p.navy.mil
2. DAU Lean Six Sigma lunch & learn presentation on Lean Six Sigma for Manufacturing 22AUG18: https://www.dau.edu/events/Lunch-and-Learn---Lean-Six-Sigma-for-Manufacturing
3. DAU Continuous Learning Module: CLE 004 – Intro to Lean Enterprise
4. DAU Continuous Learning Module: CLE 007 – Lean 6 Sigma
5. DAU Continuous Learning Module: CLE 015 – Continuous Process Improvement
6. Lean Enterprise Institute: www.lean.org
7. Defense Acquisition University: www.dau.edu

Overview

- CPI
- Lean
  - Definition
  - Five Principles (Terminology)
  - Waste
  - More Lean Terminology
  - Lean Roles
- Theory of Constraints
- Six Sigma
- CPI practical demonstration

Why is CPI Important?

- Identified as a key behavior in application of the GRGB framework
- Engineering Duty Qualification Program has CPI/Lean requirements
- CPI methods are more tools for your EDO career toolbox
- CPI encompasses the use of industry recognized management and process improvement best practice methodologies
  - Theory of Constraints (TOC) - Focuses on identifying and eliminating constraints in a process
  - Lean - Focuses on efficiency and reducing waste
  - Six Sigma - Focuses on reducing variation and increasing quality

History of CPI Initiatives

- Roots of Lean: back to early 1900's
- Henry Ford: continuous flow production, waste elimination
- TWI: *(Training Within Industry), 1940-1945*
- Kiichiro Toyoda and Taiichi Ohno: low inventories, flexibility
- U.S. supermarkets: pull systems
- Shigeo Shingo: mistake proofing, reduced set up times
- Toyota Production System
- MIT and James Womack: bring Lean back to U.S.
- Eli Goldratt: published book "The Goal", early 1980's (TOC)
- Motorola & others: developed Six Sigma early 1990's
- CNO Gilday 2022 – "Get Real, Get Better"

Primary Goals of CPI

To increase speed of decisions, transactions, paperwork, etc.

To increase/enhance quality of outputs

To increase customer satisfaction

To increase/enhance quality of work life

To reduce overhead costs

To increase safety

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Lean

- Definitions
  - Lean is ***a continuous improvement system that focuses on removing waste from a value stream***
  - Waste is ***any action that does not add value to the customer***

- Lean is ***not***
  - ☒ Cleanup/housekeeping program
  - ☒ An inventory reduction program
  - ☒ Resource management program
  - ☒ Personnel reduction initiative
  - ☒ Process to improve technical performance

Five Principles of Lean

- Value
  - Providing the customer:
    - The right product/service
    - At the right price
    - At the right time
- Value Stream
  - Sequence of activities required to ***design, develop, manufacture, and sustain*** a specific product for customers
- Flow
  - The progressive achievement of tasks along the value stream with no stoppages, scrap, or backflows
- Pull
  - Nothing is produced until the customer signals a need, or literally pulls the product through the value stream
  - This signal is also known as a Kanban
- Perfection
  - The state at which all activities along a value stream create or add value (no waste)

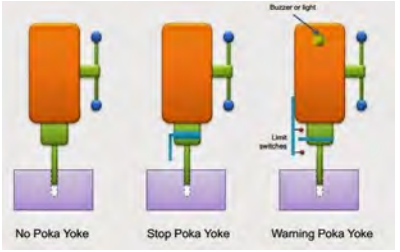
Waste (or *Muda*)

Type	Physical Process	Transactional Example
Transporting	Parts Moving to Warehouse and Back	Data Handoffs
Inventory	Excessive Work-in-Process	Backlog of Design or Tooling Changes
Motion	Retrieving Parts, Tools, Information	Poor Office Lay-Out
Waiting	Parts, Tools, Information	Meetings, Approval, System Down Time
Over-Processing	Performing Unneeded Operations	Approvals (Too Many Sign-offs)
Over-Production	Working Ahead of Schedule	Printing Paper Too Soon
Defects	Scrap or Rework	Drawing or Planning Errors, Rework
Under utilization of employees	More people involved than required to perform physical or transactional tasks.	

Lean Terminology

- Kanban
  - Visible record or signaling system used to control the flow of production through a factory

- Poka Yoke
  - Japanese term ‘for mistake proof’
    - Poka Yoke devices prevent workers from making mistakes in the production of good



- Visual Control
  - The placement in plain view of all tools, parts, production activities, and indicators of production system performance, so the status of the system can be understood at a glance by everyone involved
  - Andon boards are one method of visual control

Lean Terminology

- 5S
  - Seiri – ***Sort*** and scrap
  - Seiton – ***Straighten/Set In Order*** (organize and label for easy use)
  - Seiso – ***Scrub*** or shine
  - Seiketsu – ***Standardize*** (conduct daily)
  - Shitsuke – ***Sustain*** (form a habit)

- Takt time
  - The available production time divided by the rate of customer demand
  - Sets the pace of production to match the rate of customer demand
  - The heartbeat of any Lean system

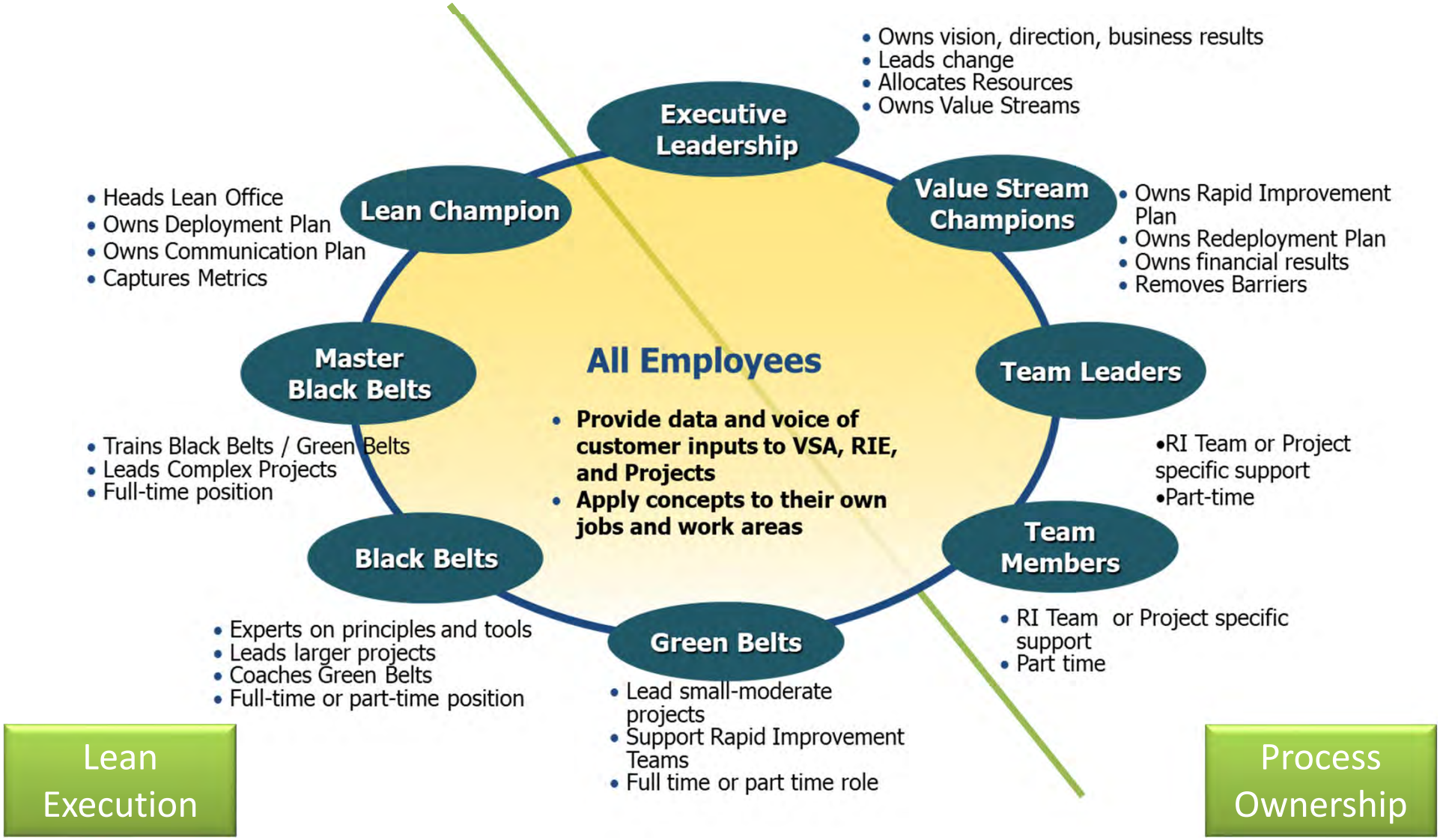
Example: 8 hours of production time per day, customer demand of 20 bicycles per day

Takt time = 480 minutes/20 bicycles = 24 minutes

Lean Terminology

- Value Stream Analysis (VSA)
  - A 3-5 day session where the ***current state*** of a value stream is mapped and analyzed
    - ID the waste
    - Create ideal and future maps of the value stream
  - Outputs are the future state map and the ***Rapid Improvement Plan*** that schedules:
    - Rapid Improvement Events
    - Lean Projects
    - Just-do-its
- Rapid Improvement Event (RIE)
  - Action oriented – typically ***3-5 days in length***
  - It takes about ***7 weeks to prepare***, conduct and follow-up on a rapid improvement event
  - Usually addresses workplace organization and layout, creating standard operations, implementing pull systems and visual controls

Lean Deployment Roles



Lean Qualifications

Value Stream Champion	• 3-day curriculum
Master Black Belt/Sensei	• 5-7 years
Black Belt	• 3-5 years
Green Belt	• 1-3 years
Team Leader	• 4 hour training
Team Member	• training during event
Lean Educated	• educated in 5 principles and basic tools

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- Theory of Constraints
- Six Sigma
- CPI practical demonstration

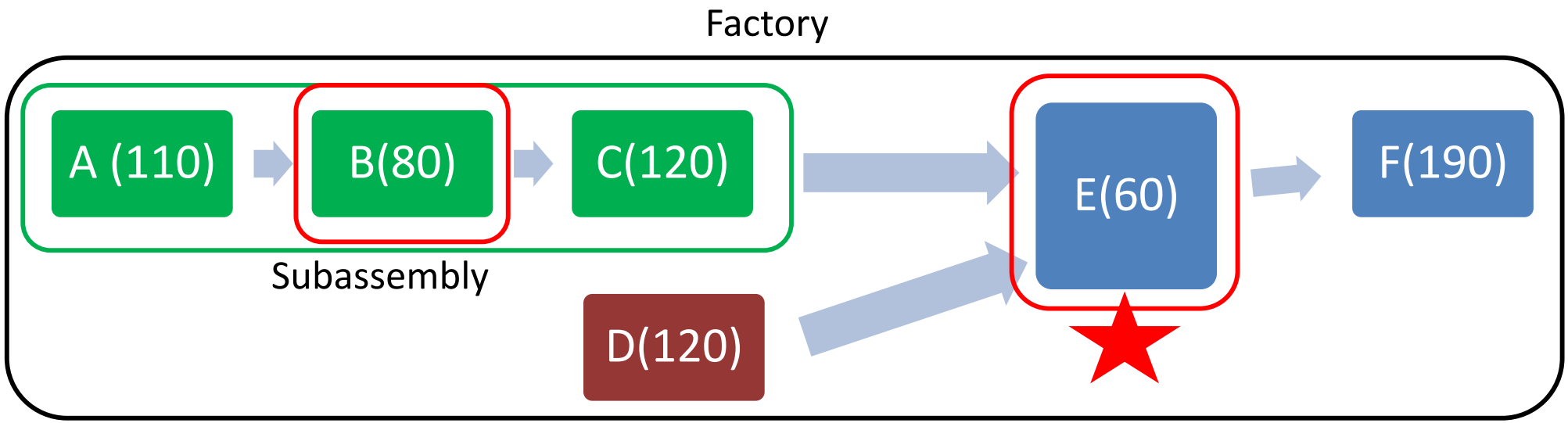
Theory of Constraints (TOC)

- Developed in the mid-80's by Dr. Eliyahu Goldratt
  - Published the process in a business novel, The Goal
- The Theory of Constraints is a process improvement methodology that emphasizes the importance of identifying the "system constraint" or bottleneck
- By leveraging this constraint, organizations can achieve their goals
  - better control over operations
  - less inventory
  - reduced conflicts between team members
  - reduced "firefighting"
  - identification of additional capacity without further capital investment or hiring additional workers

Theory of Constraints (TOC)

- Basic assumption: ***Every system has a constraint***
- You have to know where your constraints are to improve your overall performance
- Focuses improvement efforts to achieve your goals
- Definitions:
  - Bottleneck: a resource with capacity less or equal to demand
  - Constraint: a limiting factor to an organization's performance, an obstacle to the organization achieving its goal
    - Think of the constraint as the most significant bottleneck

Example

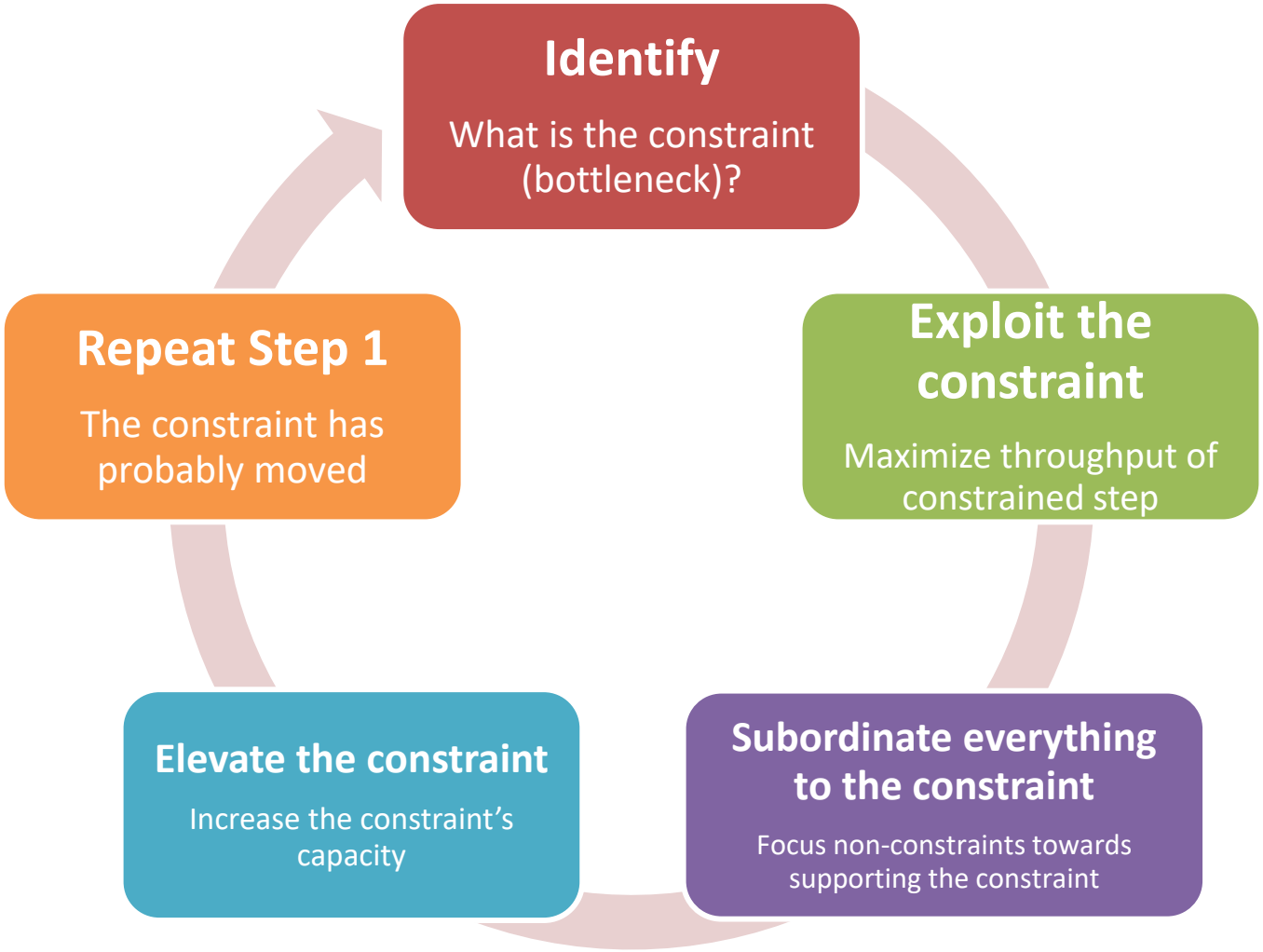


Goal: Produce 100 units per day

Where are the bottlenecks?

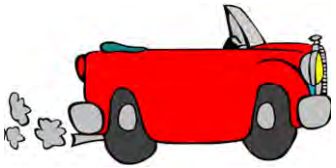
What is the constraint?

5 Focusing Steps of TOC



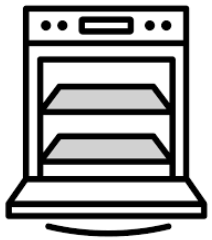
Constraint vs Bottleneck

- Constraint: Limiting factor of an organization's/process performance
- Bottleneck: Resource with capacity less than or equal to the demand put on it



20 min

22 min



35 min

9 min

- What is the constraint? Why?
- What are some ways to elevate the constraint?

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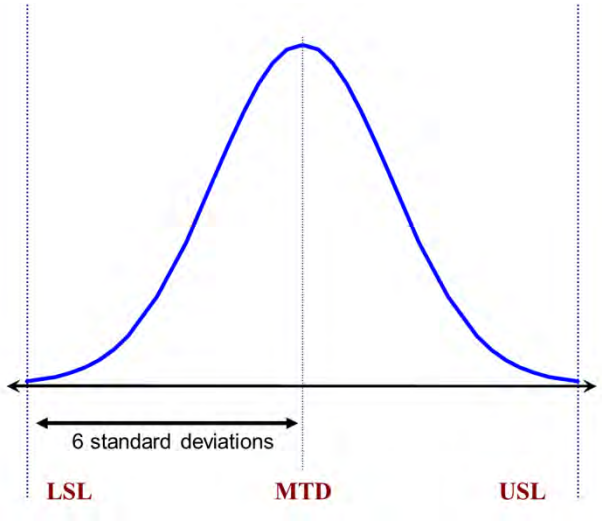
Six Sigma

- Developed by Motorola in early 1980's
  - Discovered that eliminating process variation will improve product quality and increase business bottom line
- Six Sigma
  - Statistical basis of measurement: 3.4 defects per million
  - A philosophy and a goal: As perfect as practically possible
  - A methodology
  - A symbol of business quality

Six Sigma

A basis of measurement

- Sigma (σ) = Standard deviation
  - Measures variation of values from the mean
- Six Sigma refers to a process having six standard deviations between the process mean and the nearest specification limit
  - Result – 3.4 defects per million
- σ = standard deviation = $\sqrt{\frac{\Sigma(x-\bar{x})^{2}}{n}}$
  - X = observed values
  - $\bar{x}$ = mean
  - n = number of observations
- +/- 1σ: 68.26% within spec
- +/- 3σ: 99.68 within spec
- +/- 6σ: 99.99966% within spec

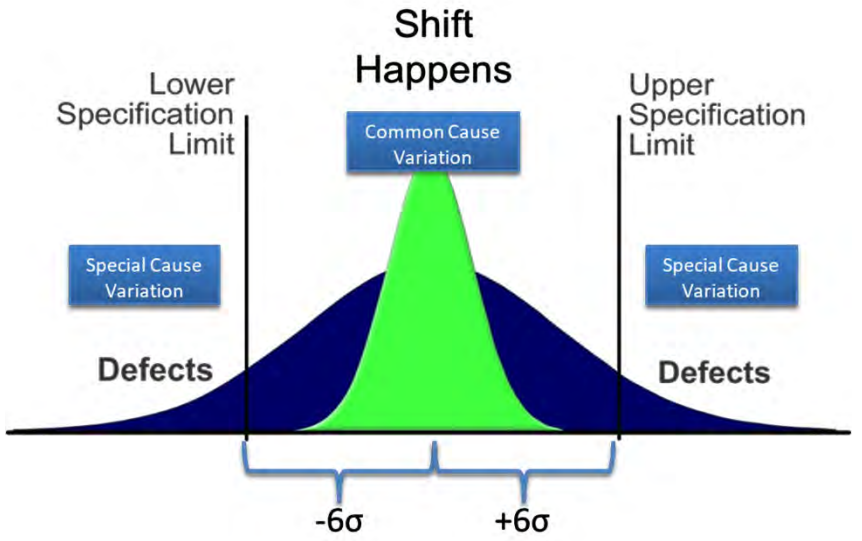


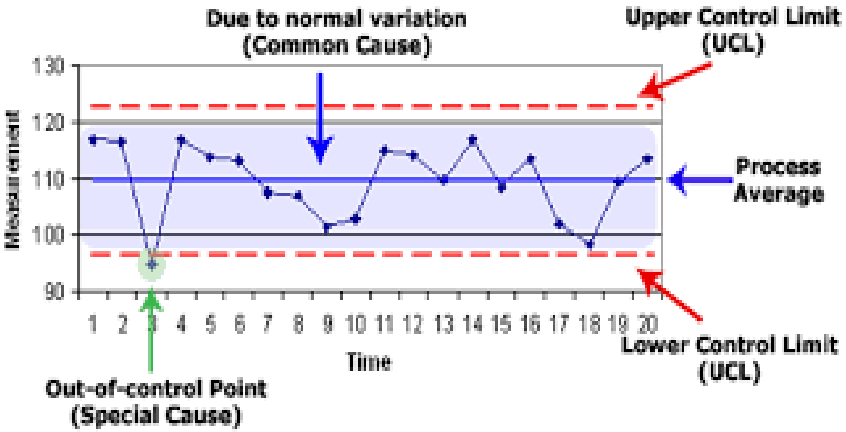
Basic Terminology

- Variation: Any difference between measurements
- Process Width: +/- 3σ
- Process Capability (C_p)

$$C_p = \frac{USL - LSL}{6\sigma}$$

- Common cause variation: "noise" in the process
- Special cause variation: abnormal instances that drive process outside of process width





Why Six Sigma?

99% (3 Sigma)		99.99966% (6 Sigma)
• 20,000 lost postal mail items per hour	→	• 7 lost postal mail items per hour
• 15 minutes of unsafe drinking water per day	→	• 1 unsafe minute every seven months
• 2 long/short landings per day at a major airport	→	• 1 long/short landing every five years at a major airport
• 5,000 incorrect surgical operations per week	→	• 1.7 incorrect operations per week
• 7 hours of lost electricity per month	→	• 1 hour without electricity every 34 years
• 20,000 incorrect prescriptions per month	→	• 68 wrong prescriptions per year

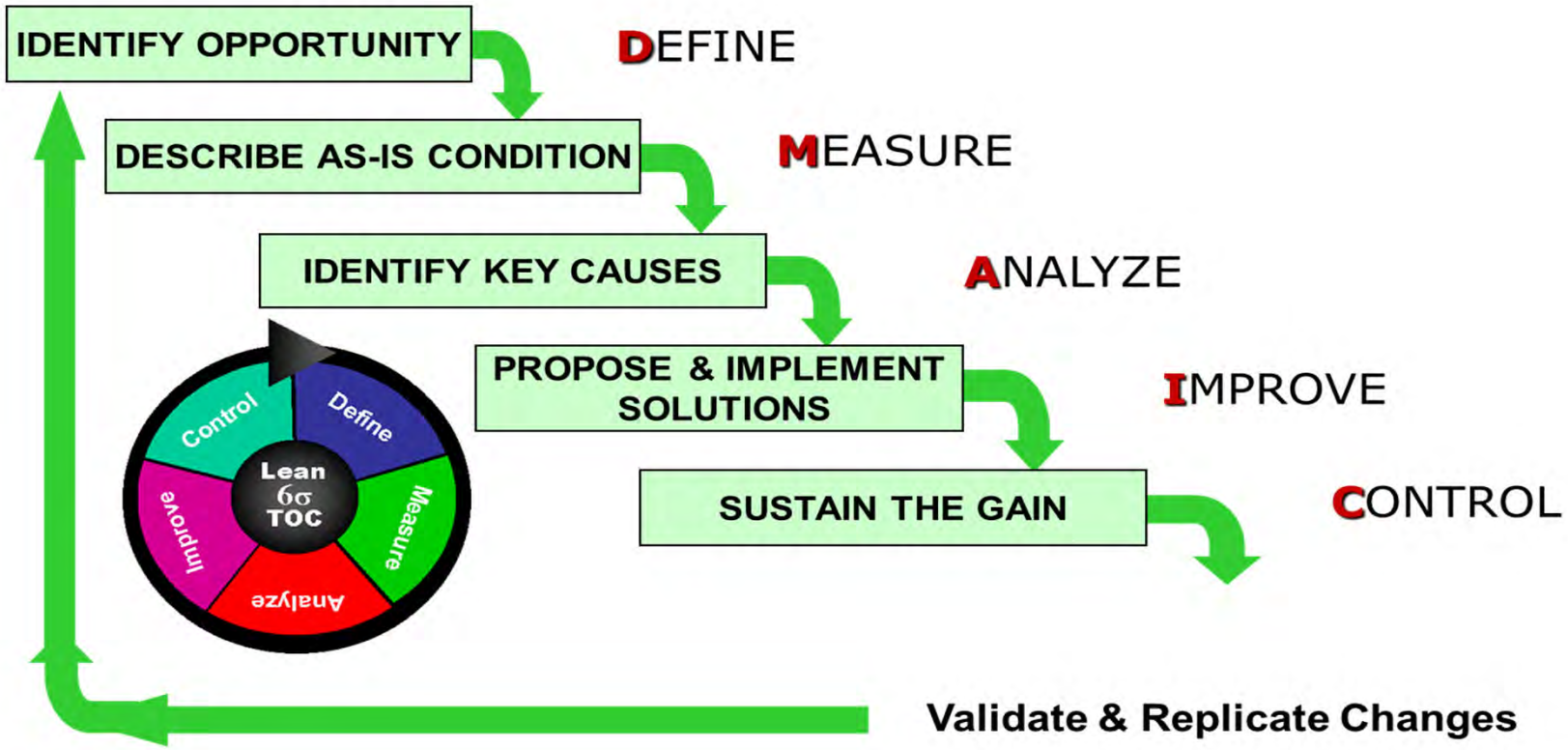
99% is good enough, right?

A Six Sigma process results in 3.4 defects per million opportunities (DPMO)

Six Sigma

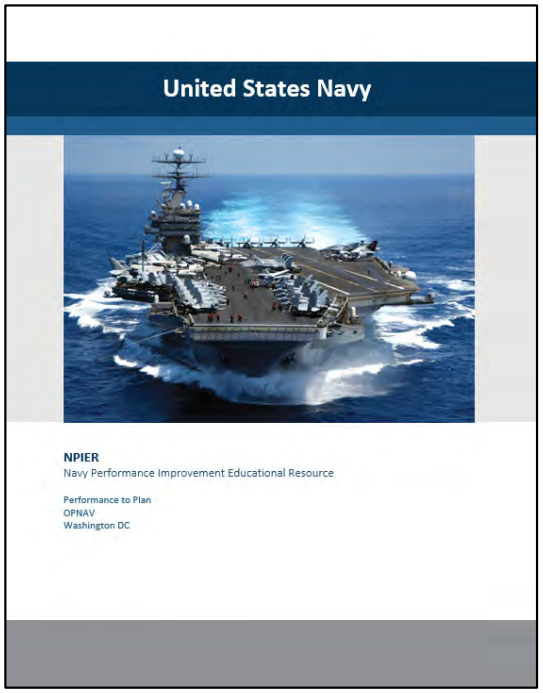
A methodology

- Define, Measure, Analyze, Improve, Control (DMAIC)
  - Six Sigma method for process improvement
  - Used to improve an existing process



DMAIC

NPIER - Navy Performance Improvement Educational Resource



NPIER provides the tools to execute each step of DMAIC

https://www.owa.navy.mil/Organizations/P2P-Home/About-NPIER/

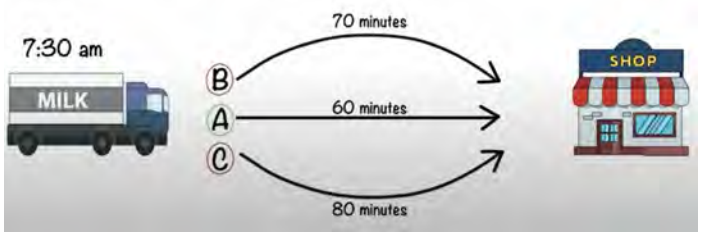
Example

- Milk company needs to stock the shop shelves by 0830
- Drivers are frequently late and get to the shop during the busy morning rush frustrating the customers
- How to improve performance?
- DMAIC
- What are the independent variable/factors in the process?
  - Warehouse
  - Truck
  - Driver
  - Routes
  - Departure time

Define: Company SMEs reviewed current state and determine routes and departure times and best focus areas

Example

Departure Time			
730			
Run	A	B	C
1	59	71	78
2	58	72	82
3	61	68	77
4	62	67	83
5	60	70	80
6	58	70	100
7	62	68	79
8	57	72	79
Average	60	70	82
Sigma	1.798	1.785	6.960

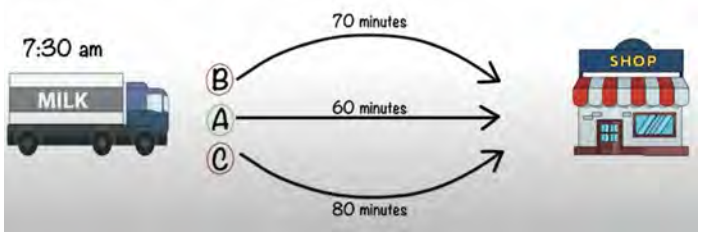


- What does data show?
- Any anomalies?
- What route is most reliable?

Data based on 24 different "runs" from the warehouse leaving at 0730 to the shop over 3 different routes

Example

Departure Time			
630			
Run	A	B	C
1	57	39	45
2	62	42	45
3	58	38	47
4	60	40	41
5	62	69	45
6	61	41	46
7	58	40	44
8	59	38	43
Average	60	43	45
Sigma	1.798	9.772	1.732

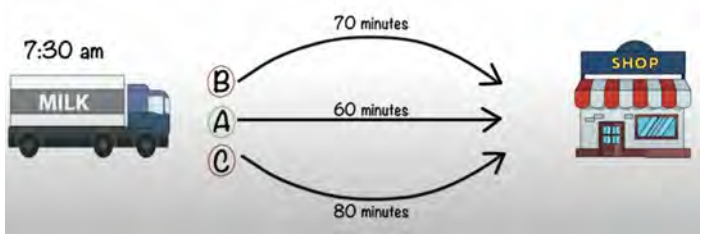


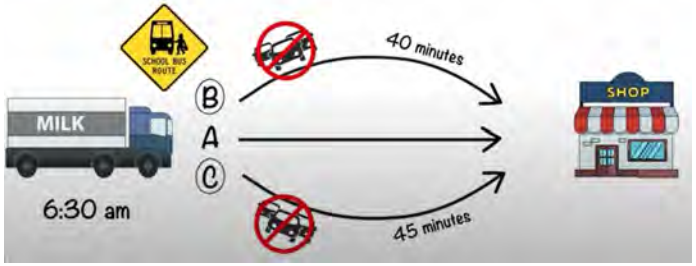
- What does data show?
- Any anomalies?

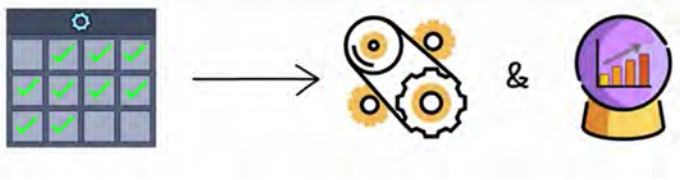
Data based on 24 different "runs" from the warehouse leaving at 0630 to the shop over 3 different routes

Example

- Define: Goals of project
  - Stock shelves by 0830
- Measure: Measure the current process
  - Milk truck routes A (60min), B(70min), C(80min) with 0730 departure
- Analyze: Why defects exist?
  - Experiment with independent variables such as route and departure time
  - Milk truck routes A (60min), B(40min), C(45min) with 0630 departure
- Improve: Lock in the new process
  - Change departure time and route
- Control: Track and monitor







Integrating a Culture of CPI

Program	Six Sigma	Lean Thinking	Theory of Constraints
Theory	Reduce Variation	Remove Waste	Manage Constraints
Application Guidelines	1. Define 2. Measure 3. Analyze 4. Improve 5. Control	1. Identify value 2. Identify value stream 3. Flow 4. Pull 5. Perfection	1. Identify constraint 2. Exploit constraint 3. Subordinate the process 4. Elevate constraint 5. Repeat cycle
Focus	Problem focused	Flow focused	System constraints
Assumptions	A problem exists Figures and numbers are valued System output improves if process variation is reduced	Waste removal will improve business performance Many small improvements are better than system analysis	Emphasis on speed and volume Uses existing systems Process interdependence
Primary Effect	Uniform process output	Reduced flow time	Fast throughput

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Summary

- What are the three industry-recognized best practices ?

- What are the five principles of Lean Thinking?

Definition of Lean:
continuous improvement system focused on removing waste
from a value stream

Summary

- List the types of waste:

- Lean Terminology:
  - The available production time divided by the rate of customer demand
  - The placement in plain view of all tools, parts, production activities and indicators
  - The Japanese term for “mistake proof”
  - A visible record or signal used to control flow

Summary

- The Theory of Constraints (TOC) is a process improvement methodology that emphasizes the importance of identifying the "system constraint" or bottleneck. What are the 5 focusing steps of TOC?
- What is the “system constraint”?
- Is the “system constraint” as bottleneck?

Summary

- What are the steps in the Six Sigma methodology?
- What is the goal of Six Sigma?
- What is the statistical basis of measurement that defines a Six Sigma process?