1. Overview: Six Sigma and the Organization

A *Six Sigma and Organizational Goals*

B *Lean Principles in the Organization*

C *Design for Six Sigma Methodologies*

1A. Six Sigma and Organizational Goals

01 *Value of Six Sigma*

02 *Organizational Goals and Six Sigma Projects*

03 *Organizational Drivers*

1A1 Value of Six Sigma

Six Sigma Benefits

- Generated sustained success
- Project selection tied to organizational strategy
    - Customer focused
    - Profits
- Project outcomes / benefits tied to financial reporting system.
- Full-time Black Belts in a rigorous, project-oriented method.
- Recognition and reward system established to provide motivation.

Six Sigma Benefits

- Motorola:
  - 5-Fold growth in Sales
  - Profits climbing by 20% pa
  - Cumulative savings of $14 billion over 11 years
- General Electric:
  - $2 billion savings in just 3 years
- Bechtel Corporation:
  - $200 million savings with investment of $30 million

1A1 Value of Six Sigma

Six Sigma Philosophy

- Know What's Important to the Customer (CTQ)
- Reduce Defects (DPMO)
- Centre Around Target (Mean)
- Reduce Variation (Standard Deviation)

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Evolution of Six Sigma

- 1987 Motorola Develops Six Sigma
  - Control Charts by Walter Shewhart in 1924
  - Juran’s project by project improvement
  - Deming’s philosophy of process control, variation and PDCA
  - Ishikawa’s fishbone diagram for RCA
  - Process capability (Cp, Cpk) > DPMO
  - Design of Experiments – work of RA Fisher in 1920 - 1930

1A2. Organizational Goals and SS Projects

01 *Selecting Six Sigma Project*

02 *Input > Process > Output and Feedback*

Six Sigma Project Selection

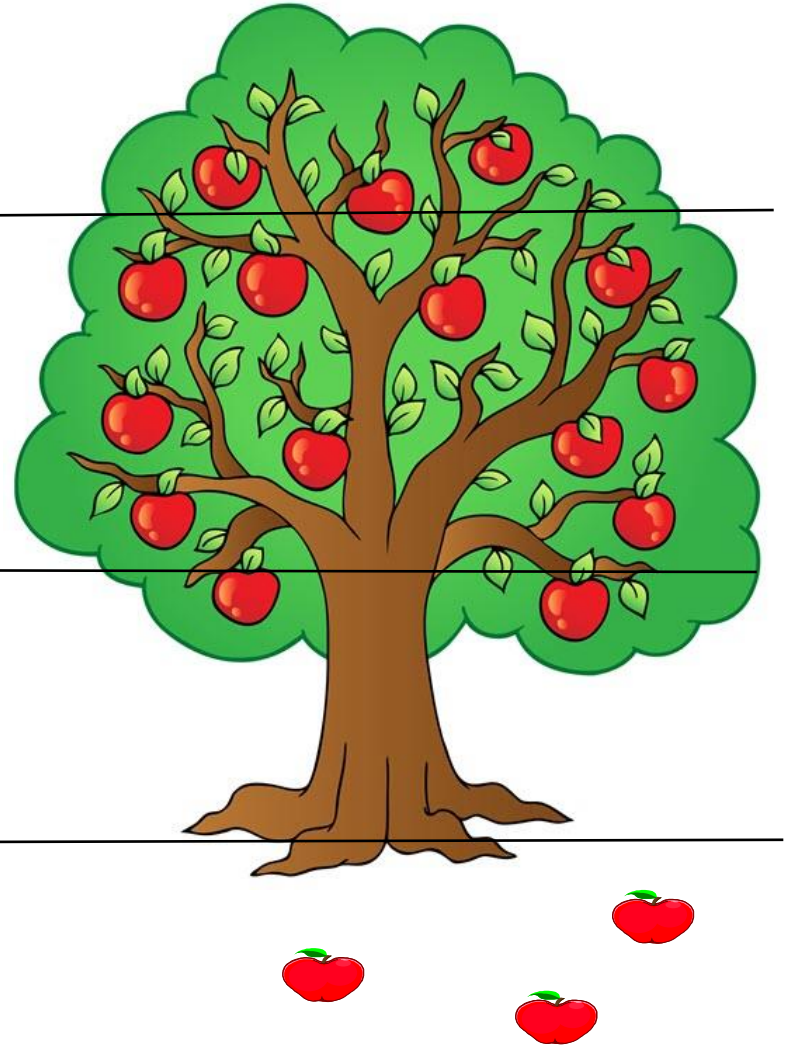
- External Sources:
  - Voice of Customer
    - What are we falling short of meeting customer needs?
    - What are the new needs of customers?
  - Voice of Market
    - What are market trends, and are we ready to adapt?
  - Voice of Competitors
    - What are we behind our competitors?

Six Sigma Project Selection

- Internal Sources:
  - Voice of Process
    - Where are the defects, repairs, reworks?
    - What are the major delays?
    - What are the major wastes?
  - Voice of Employee
    - What concerns or ideas have employees or managers raised?

Six Sigma Project Selection

Sweet Fruit
Design for Repeatability



Bulk of Fruit
Process Optimization

Low Hanging Fruit
Seven Basic Tools

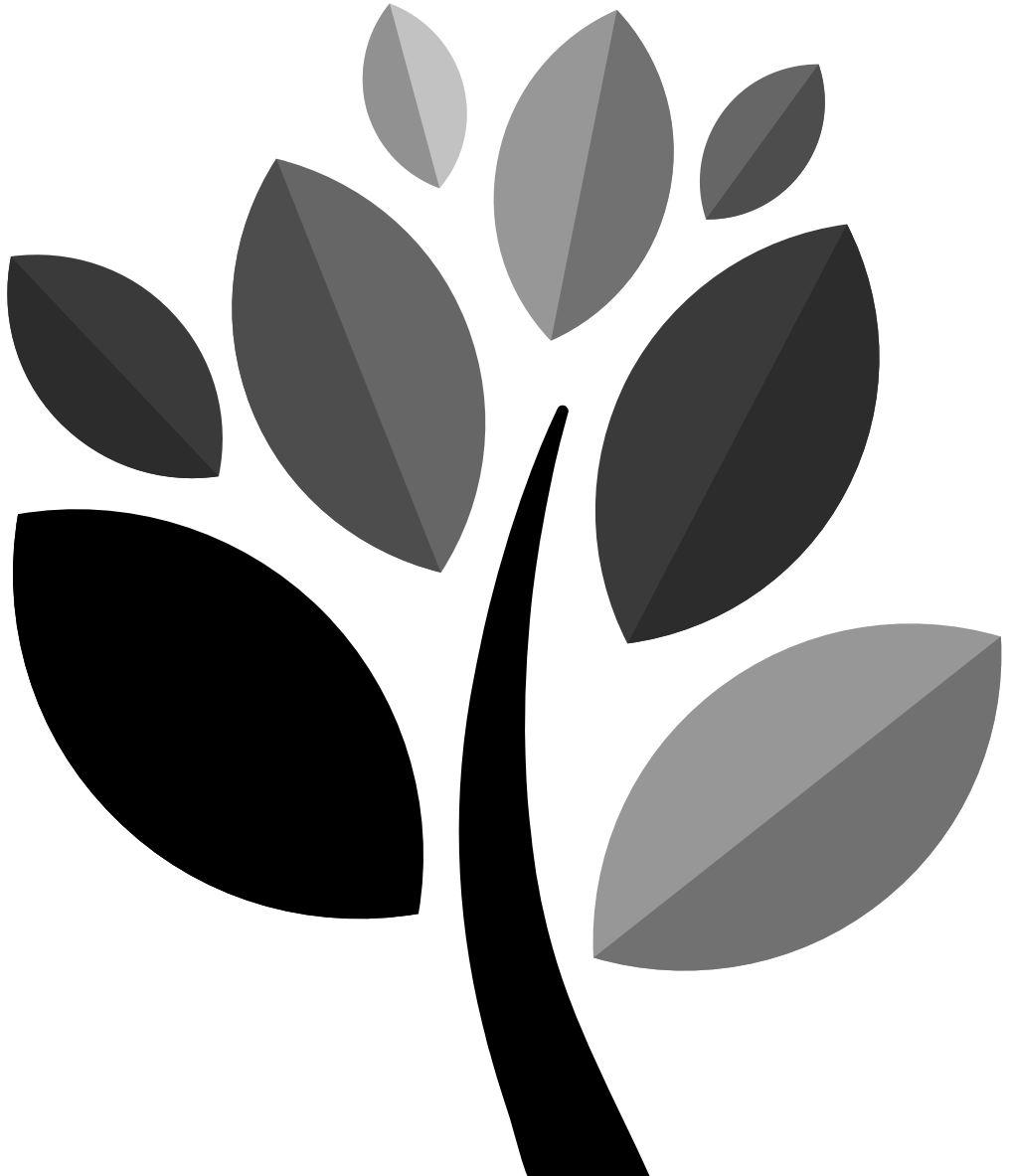
Ground Fruit
Logic and Intuition

Qualifications of a SS Project

1. **There is a gap between current and desired / needed performance.**

2. **The cause of problem is not clearly understood.**

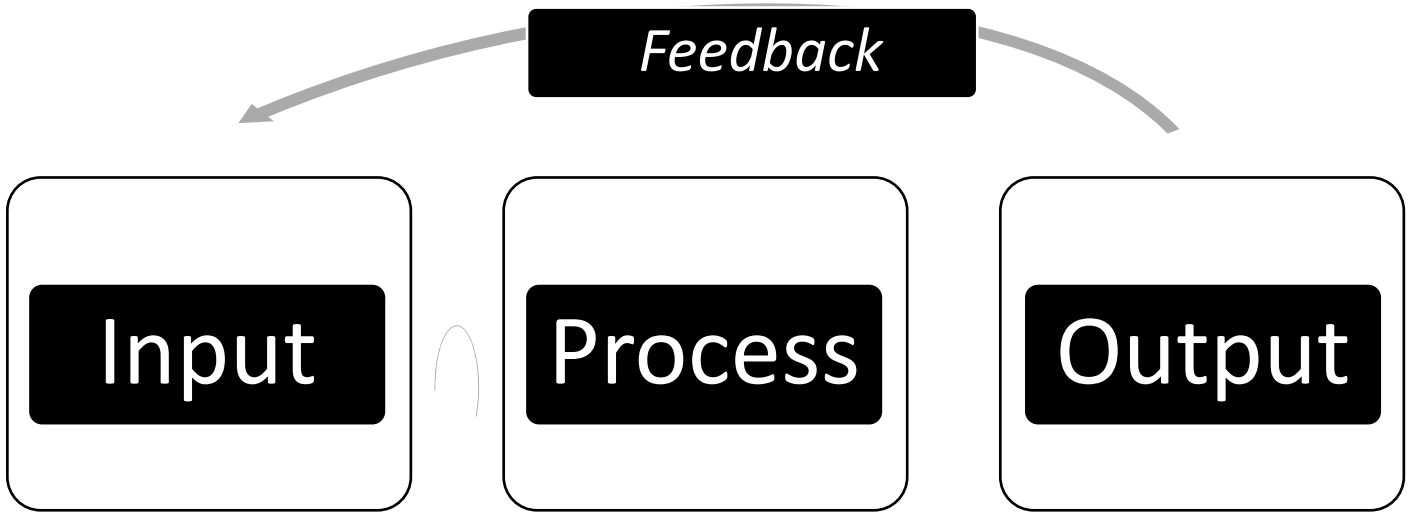
3. **The solution is not pre-determined, nor is the optimal solution apparent.**



Process

Process: Series of steps to produce a product or service.

Improve processes to improve the organization as a whole.



Y = f(X)

Six Sigma Aligned with Organizational Strategy

- Assure that Six Sigma project align with the Organization's vision and mission.
  - Profits
  - Market share
  - Customer acquisition
  - Patient safety
  - Client satisfaction

1A3. Organizational Drivers and Metrics

01 *Understanding Business Drivers*

02 *Key metrics and scorecards*

Business Key Drivers

Profit

Market share

Customer satisfaction

Efficiency

Product differentiation

Business Key Drivers

Focus on limited numbers of drivers.

- Those that are measurable
- Those that show the current performance of the organization
- Those which can be compared with competitors or benchmarks
- Those which provide actionable information

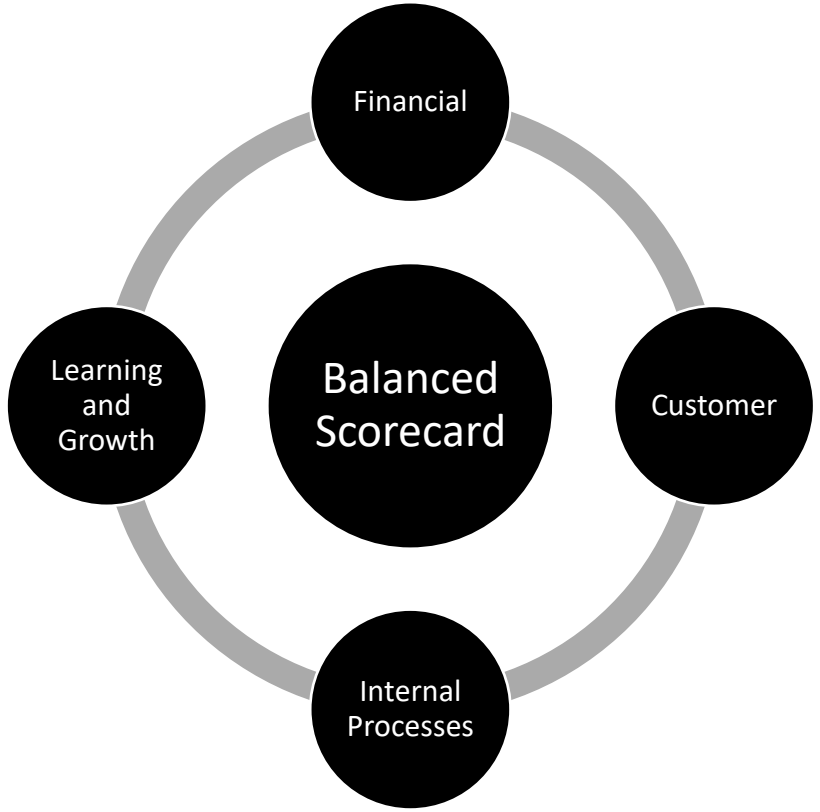
Key Metrics

- Metrics are aligned with the key drivers
- For example if the key driver is profit, then metrics may include:
  - Cost of production
  - Average sale price
  - Profit margins
  - Return on investment

Balanced Scorecard

View the organization from four perspectives, and develop objectives, measures (KPIs), targets, and initiatives (actions) relative to each of these points of view:

- Financial
- Customer/Stakeholder
- Internal Process
- Learning and Growth



2022 – Changes in the BoK - 1A

	A. Six sigma and organizational goals	
I.A.1	1. Value of six sigma Recognize why organizations use six sigma, how they apply its philosophy and goals, and the evolution of six sigma from quality leaders such as Juran, Deming, Shewhart, Ishikawa, and others. (Understand)	
I.A.2	2. Organizational goals and six sigma projects Identify the linkages and supports that need to be established between a selected six sigma project and the organization's goals including SMART goals, and describe how process inputs, outputs, and feedback at all levels can influence the organization as a whole. (Understand)	Added SMART goals
I.A.3	3. Organizational drivers and metrics Recognize key business drivers (profit, market share, customer satisfaction, efficiency, product differentiation, key performance indicators (KPIs)) for all types of organizations. Understand how key metrics and scorecards are developed and how they impact the entire organization. (Understand)	Added key performance indicators (KPIs)

Six Sigma Aligned with Organizational Strategy

- Assure that the Six Sigma project aligns with the Organization's vision and mission.
  - Profits
  - Market share
  - Customer acquisition
  - Patient safety
  - Client satisfaction

SMART Goals

- S – Specific
- M – Measurable
- A – Achievable
- R – Realistic
- T – Time-bound

To reduce the weld repair rate from 4.5% to 0.5% by end of Dec 2016.

Performance Measures (KPIs)

- Metrics to measure performance
- Commonly used performance measures for outsiders are financial
- Internal metrics include performance levels
  - Process yield
  - Defect rate
  - Average time to answer a call
  - Schedule

Balanced Scorecard

- By Robert S. Kaplan and David P. Norton
- Four perspectives
  - Financial (Costs, Savings, Productivity)
  - Customer (Delivery Time, Quality, Service)
  - Internal Business Processes (Defect Rate, QMS, Inf. System)
  - Learning and Growth (Training, Continual Improvement)

Leading vs Lagging KPIs

- Lagging measures are easy to measure
- Lagging measures are post-event (output)
- Leading are predictive measures (inputs)
- Leading indicators are not guaranteed and are difficult to decide, which one to select.
- Mix of both leading and lagging is good

1B
Lean Principles in the Organization

01 *Lean concepts – Philosophy, TOC & Wastes*

02 *Value Stream Mapping*

Benefits of Lean

- Reduce Waste
- Improved Quality/Customer Satisfaction
- Reduced Inventory
- Reduced Cycle Time
- Flexible Manufacturing
- Safe Workplace Environment
- Improved Employee Morale

Lean Philosophy

Specify what creates value from the customer's perspective.

Identify all the steps along the process chain

Make the value process flow

Make only what is needed by the customer

Strive for perfection by continually attempting to produce exactly what the customer wants

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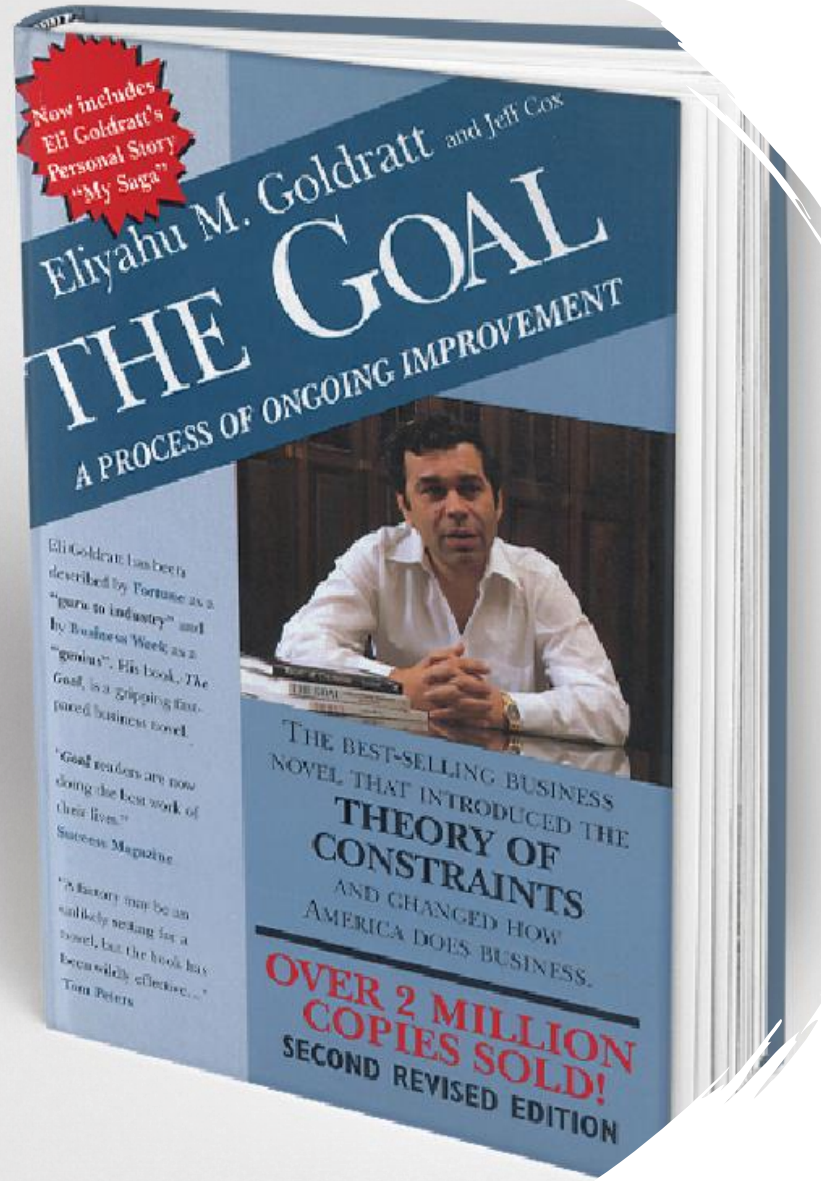
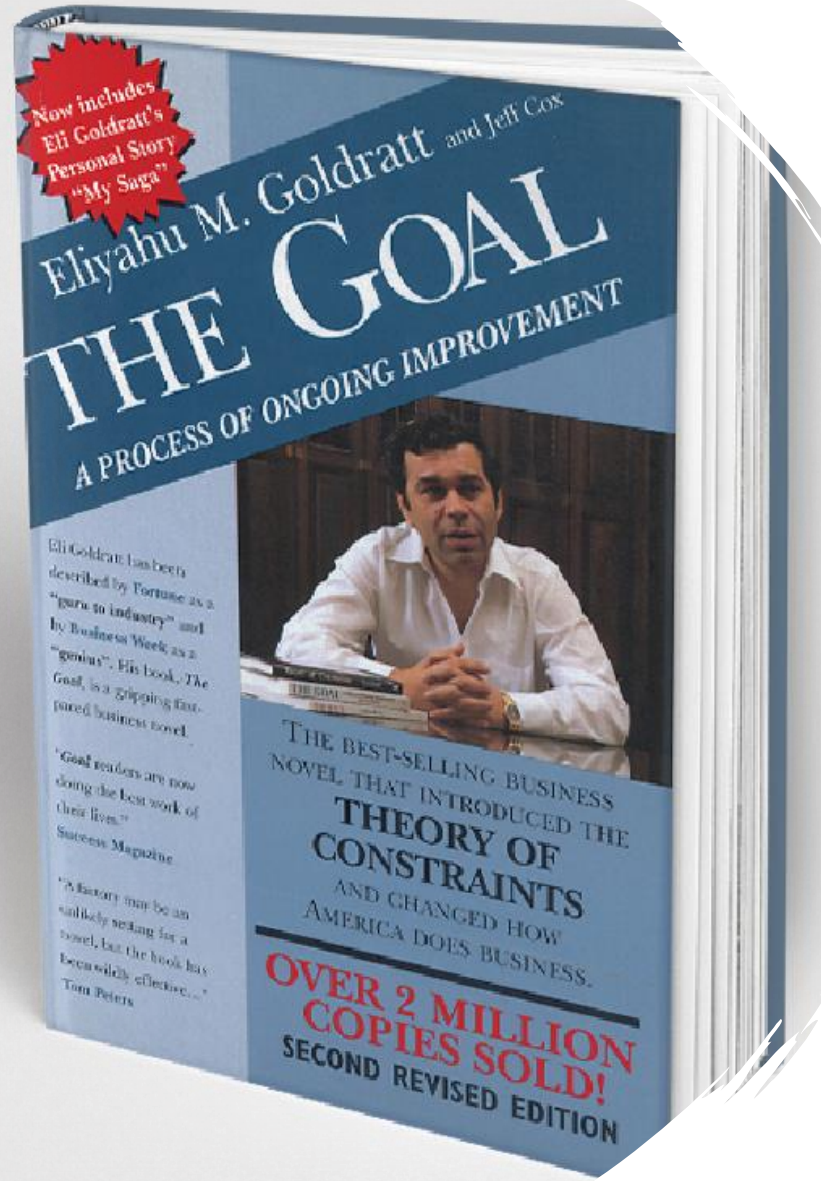


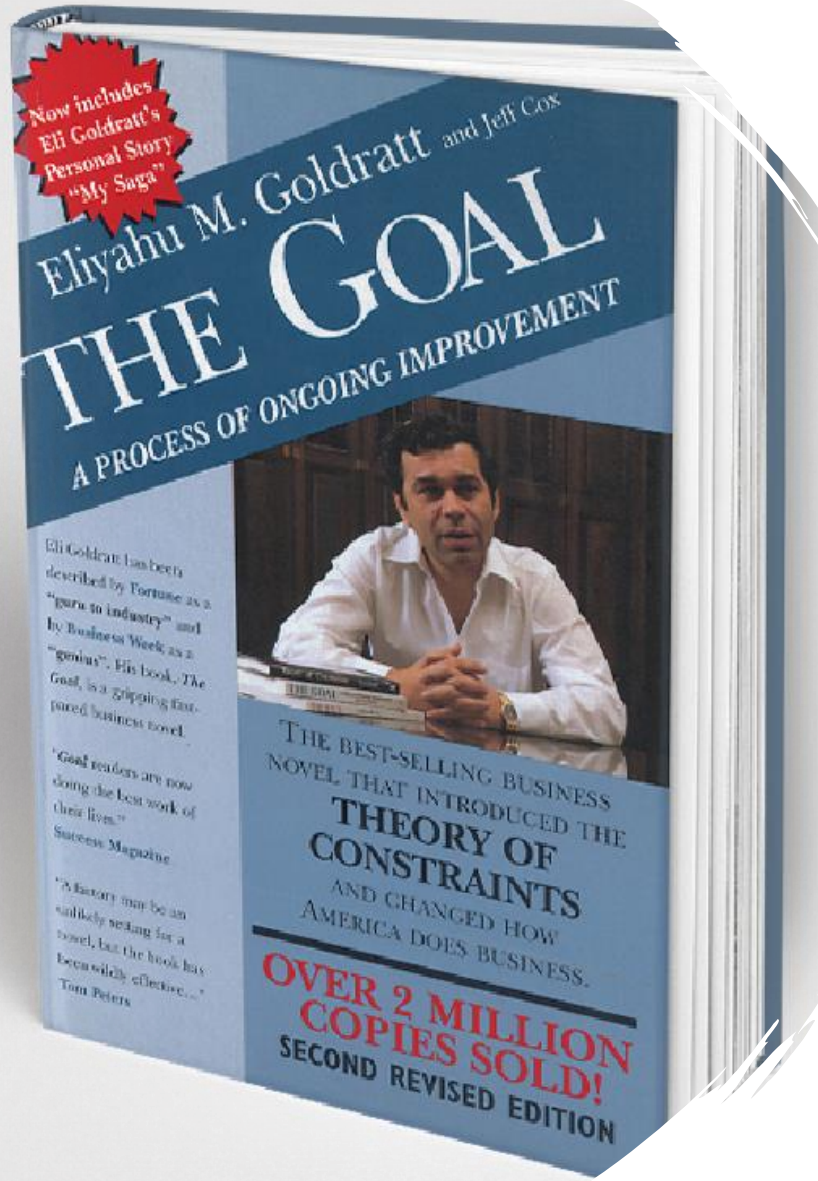
Theory of Constraints (TOC)

- The theory of constraints (TOC) was introduced by Eliyahu M. Goldratt in his 1984 book titled ***The Goal***.
- Identifying the constraint (factor which limits throughput / stands in the way of goal) and systematically improving that. Repeating this process to improve the next constraint.
- Constraint is the weakest link in the chain.



Theory of Constraints (TOC)

- It helps in identifying what to improve.
- Current constraint should always be the top priority to make improvement.
- Improving a non-constraint process will not improve the overall throughput.
- Constraints examples – Physical, Policy, Paradigm, Marketplace



5 Steps to Identify and Eliminate Constraint

- Identify
  - Identify the current constraint
- Exploit
  - Make improvement using existing resources
- Subordinate
  - Ensure all activities support constraint
- Elevate
  - If constraint still exists, take further actions
- Repeat
  - Move to the next constraint

1B
Lean Principles in the Organization

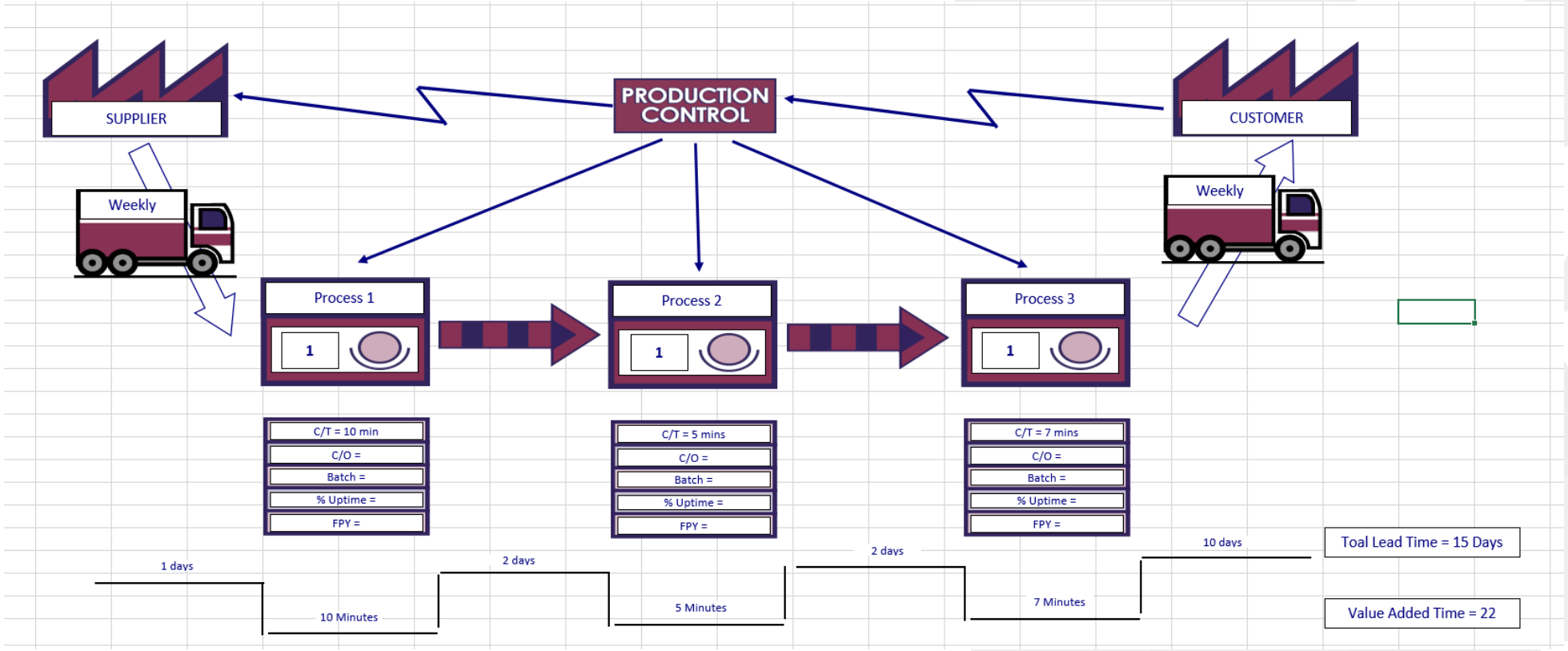
01 *Lean concepts – Philosophy, TOC & Wastes*

02 *Value Stream Mapping*

Value Stream Maps

- Type of Flow Chart showing how value flows through the organization
  - Flow of material
  - Processes to transform raw material to finished good
  - Flow of information

Value Stream Maps

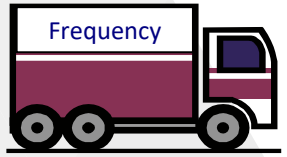


Source: SigmaXL software

Value Stream Maps

Supplier / Customer

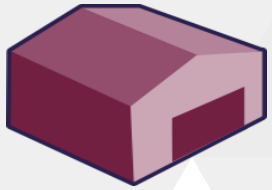
Production Control



External Shipment

Operator

Work Cell



Inventory Store

Source: SigmaXL software

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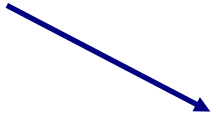
Value Stream Maps

Push Arrow

FIFO Lane



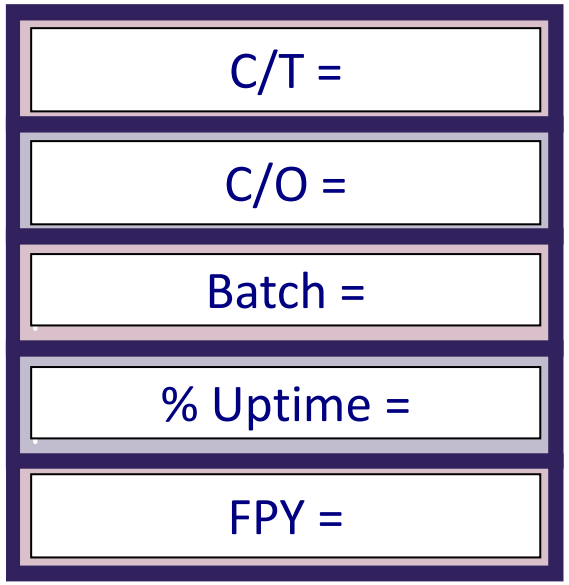
Manual Information Flow

Electronic Information Flow

Source: SigmaXL software

Value Stream Maps

Typical Process Information



Cycle Time

Changeover Time

Batch Size

% Uptime

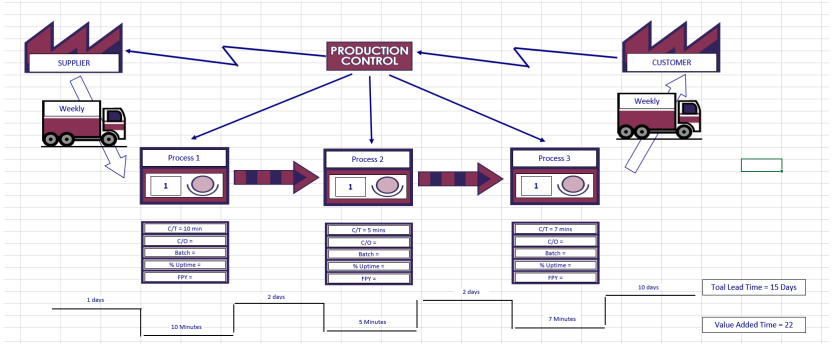
First Pass Yield

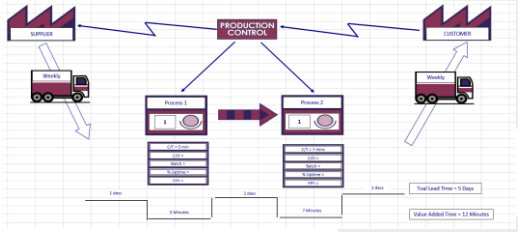
Source: SigmaXL software

Value Stream Maps

- Used to analyze waste

Current State + Lean Principles = Future State





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2022 – Changes in the BoK – 1B

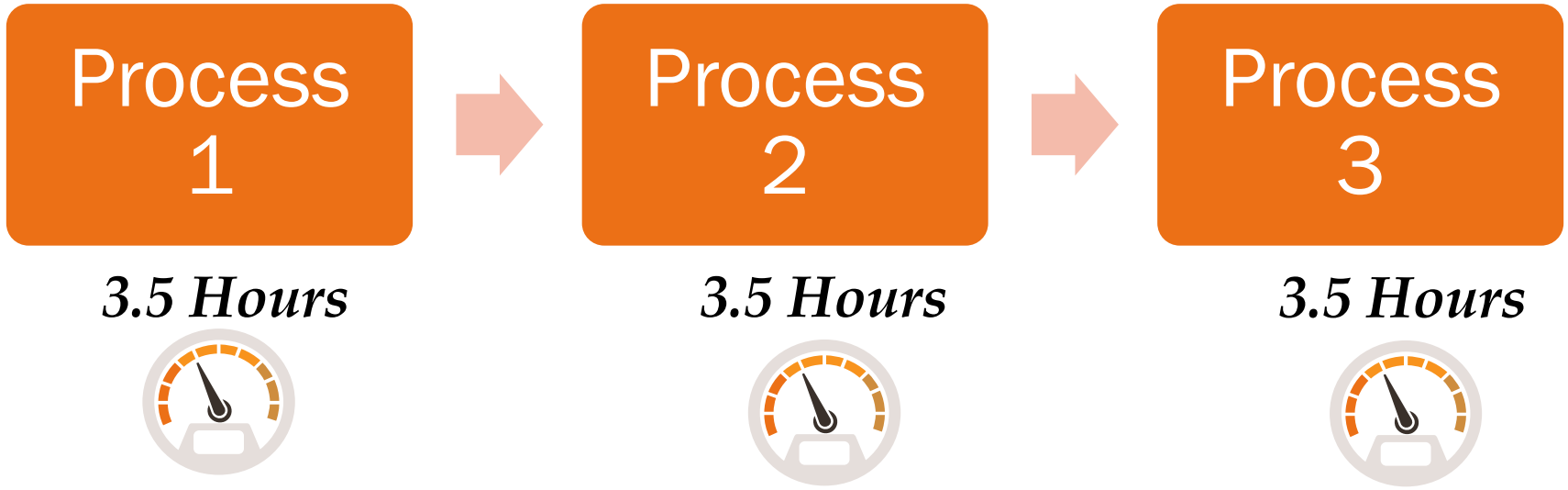
I.B	**B. Lean principles in the organization**	
I.B.1	1. Lean concepts Define and describe lean concepts such as theory of constraints, value chain, flow, takt time, just-in-time (JIT), Gemba, spaghetti diagrams, and perfection. (Apply)	Added takt time, just-in-time (JIT), Gemba and spaghetti diagrams
I.B.2	2. Value-stream mapping Use value-stream mapping to identify value-added processes and steps or processes that produce waste, including excess inventory, unused space, test inspection, rework, transportation, and storage. (Understand)	

Takt Time

- Takt time is the amount of time that must elapse between two consecutive unit completions in order to meet the demand.
- Takt Time = Total time available / Demand
- For example: A factory operates for 8 hours/day. There is one hour of lunch break. Customer demand is 2 units per day
- Takt time = (8 – 1) / 2 = 3.5 hrs

Cycle Time

- Cycle time describes how long it takes to complete a specific task from start to finish.



- Takt time = 3.5 hrs / Cycle time = 10.5 hrs

Cycle Time

- Cycle time describes how long it takes to complete a specific task from start to finish.

- Takt time = 3.5 hrs / Cycle time = 6.0 hrs

Just In Time

- JIT is a methodology with an aim to:
  - Minimizes inventory and increases efficiency
  - Reducing times within the production system
  - As well as reducing response times from suppliers and to customers.

Pull System

Pull:

- Produce based on demand
- Providing product or service when required by the customer or the next process.
- Limits the Work In Progress and Inventory. (JIT)

Push:

- Produce to stock
- Based on demand forecast

Kanban

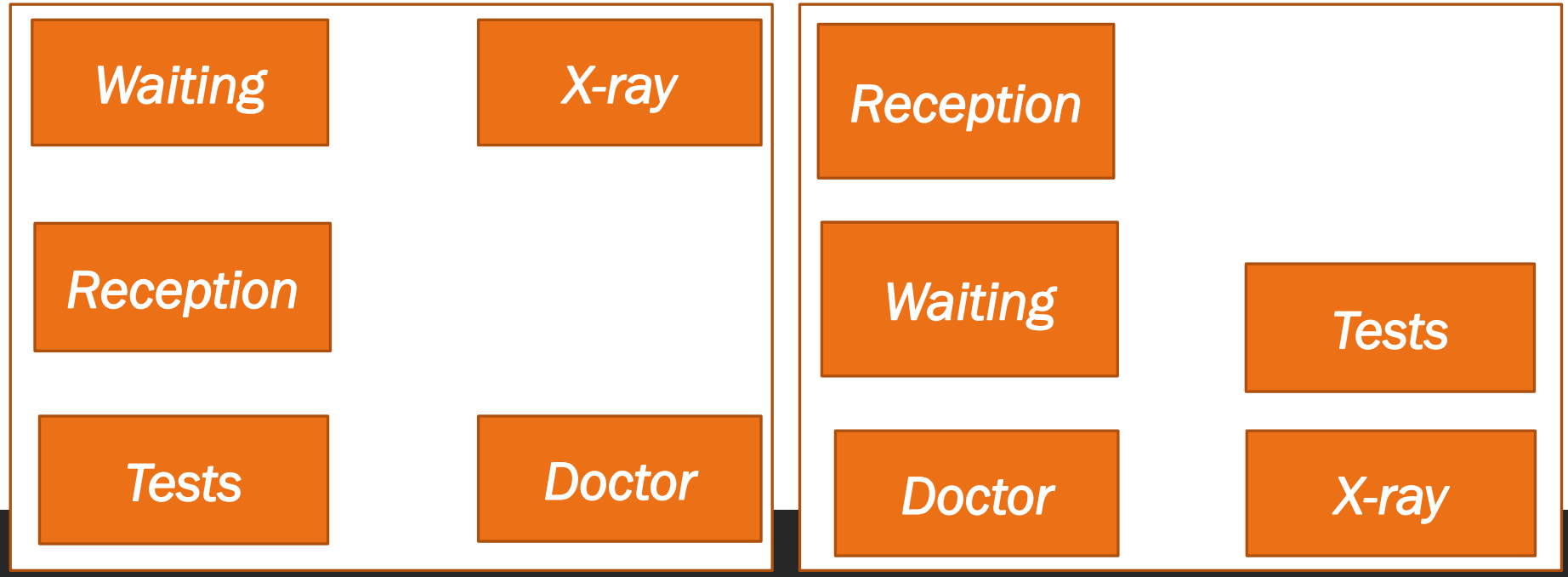
- Kanban means Signboard (or billboard) in Japanese.
- Kanban is an inventory-control system
- Taiichi Ohno developed it as a part of JIT

Gemba

- Gemba = work area or shop floor
- Originated from “gembutsu”, which means “real thing.”
- Gemba walk is the action of going to see the process, observe, understand, ask questions and learn.

Spaghetti diagrams

- Trace the path of a product/activity
- To reduce the transport and motion waste



1C Design for Six Sigma Methodologies

01 *Road maps for DfSS*

02 *Basic Failure Mode and Effects Analysis*

03 *Design FMEA and Process FMEA*

1C-1 Road maps for DfSS

01 DMADV

02 DMADOV

03 IDOV

DFSS Methodologies

- DMADV
- DMADOV
- IDOV

DMAIC vs DMADV

DMAIC

DEFINE MEASURE ANALYZE IMPROVE CONTROL

DMADV

DEFINE MEASURE ANALYZE DESIGN VERIFY

DEFINE	MEASURE	ANALYZE	DESIGN	VERIFY
Define the process or design goals	*Measure Critical to Quality aspects*	*Analyze designs*	*Detail design of the product or process*	*Verify chosen design*

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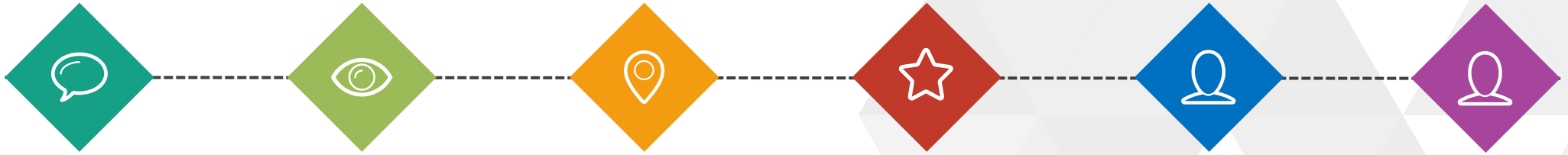
DMADOV



DEFINE

Define the process or design goals

MEASURE

Measure Critical to Quality aspects

ANALYZE

Analyze designs

DESIGN

Detail design of the product or process

OPTIMIZE

Refine the design

VERIFY

Verify chosen design

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IDOV

IDENTIFY

Define the Voice of Customer

DESIGN

Detail design of the product or process

OPTIMIZE

Analyze designs

VERIFY

Verify chosen design

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1C Design for Six Sigma Methodologies

01 *Road maps for DfSS*

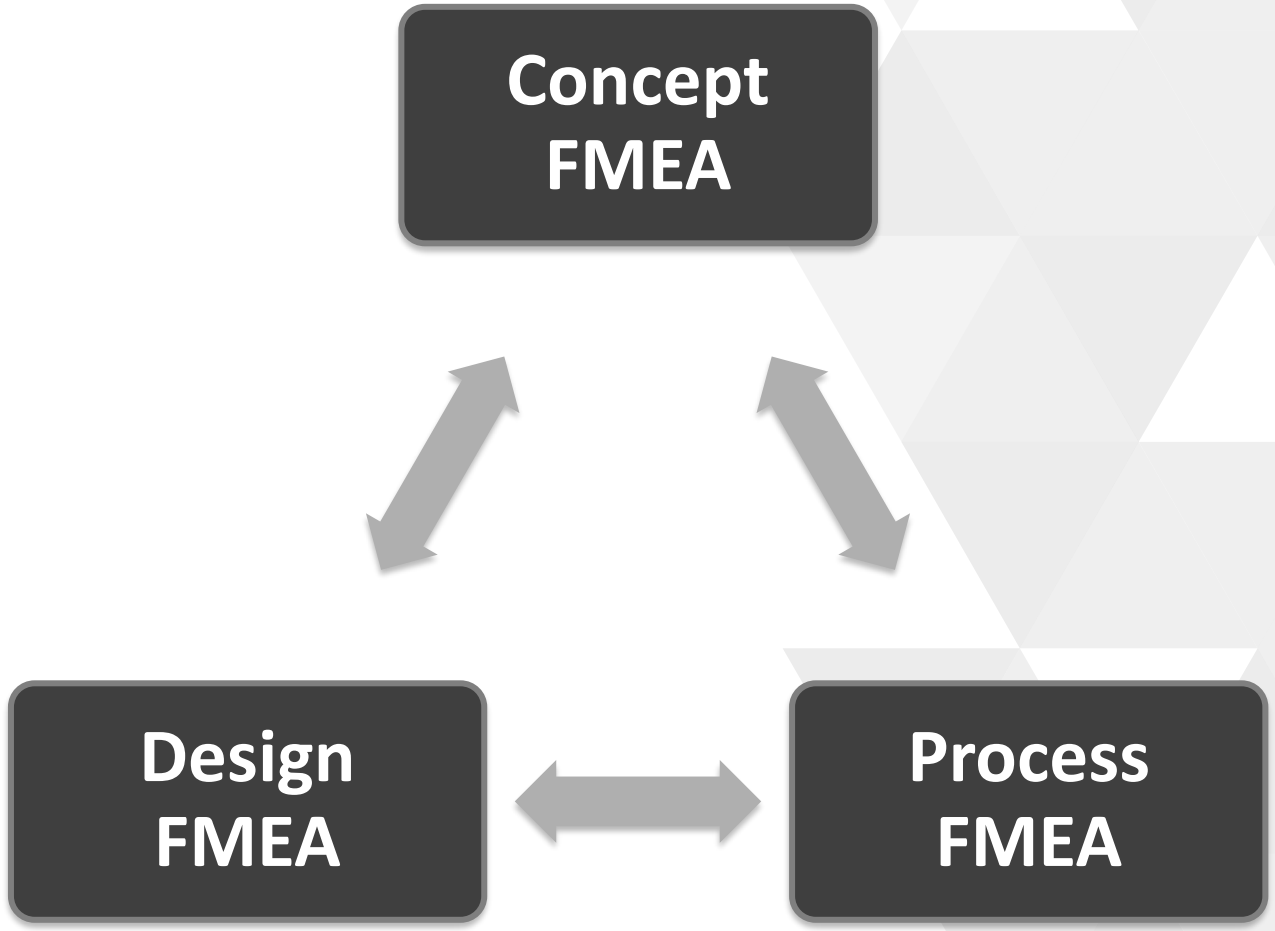
02 *Basic Failure Mode and Effects Analysis*

03 *Design FMEA and Process FMEA*

Failure Mode and Effect Analysis (FMEA)

- The FMEA is a design tool used to systematically analyze potential failures and identify their effects.
  - Identify
  - Prioritize

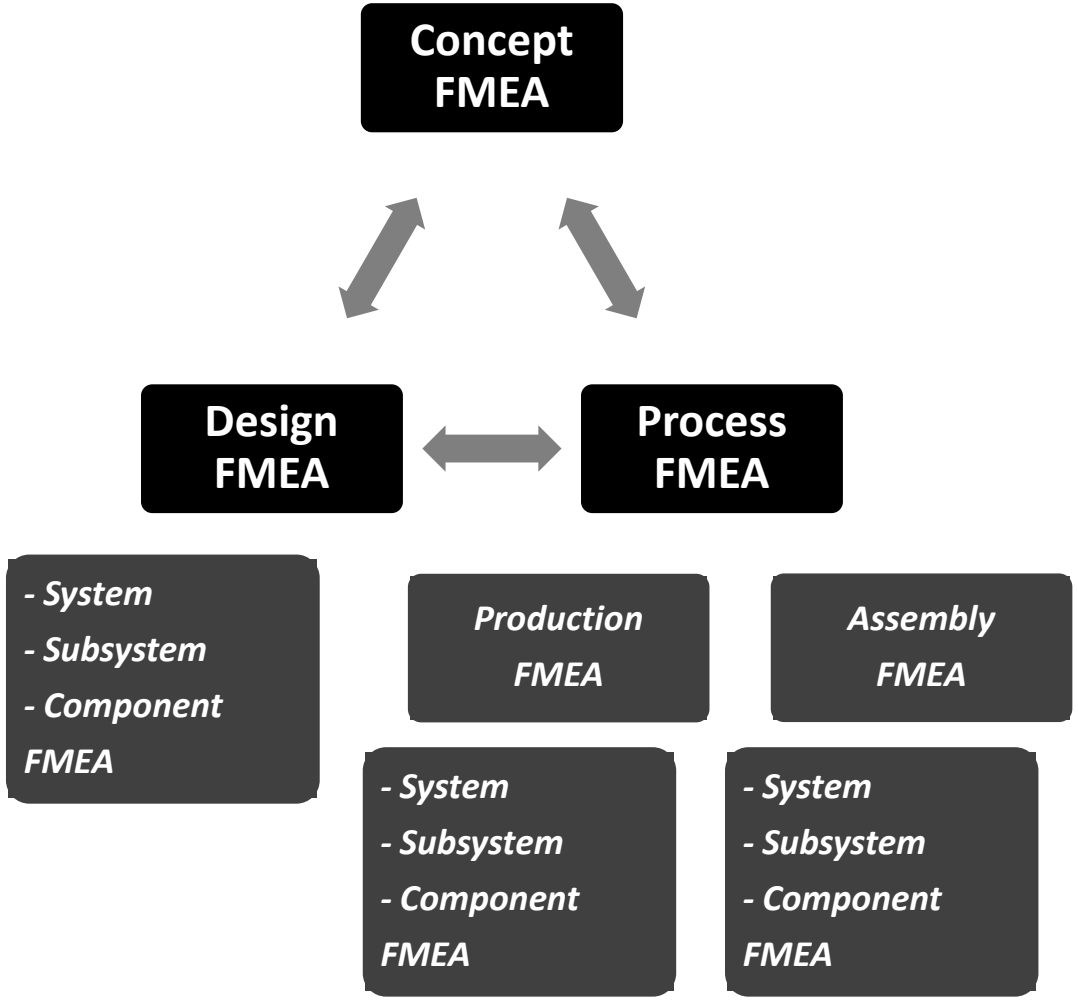
FMEA



FMEA

Design FMEA	Process FMEA
Identifies failures associated with product design: •Product malfunctions •Product life •Safety hazards	Identifies failures associated with processes: •Production quality •Process reliability •Customer dissatisfaction

FMEA


Concept FMEA
Design FMEA
Process FMEA
- System
- Subsystem
- Component FMEA
Production FMEA
- System
- Subsystem
- Component FMEA
Assembly FMEA
- System
- Subsystem
- Component FMEA

Failure Mode and Effect Analysis (FMEA)

- It is a proactive tool (Before the problem happens / not the after-effect analysis)
- It is a living document

Failure Mode and Effect Analysis (FMEA)

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FMEA

Process / Requirement	Failure Mode	Failure Effect	Severity (1-10)	Cause(s) of failure mode	Occurrence (1-10)	Current Controls (KPIVs)	Detection (1-10)	RPN	Recommended actions
<u>Perfume Making</u> • Receiving	• Wrong ingredients	• Inconsistent quality	(1-10) 8	• Unclear specification	(1-10) 3	• Review and approve specification by design	4	96	
				• Substandard material supplied by supplier	6	• Third party certification • In house test lab	4	192	
• Mixing									

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FMEA

- **Risk Priority Number (RPN)**
- Severity (1-10) x Occurrence (1-10) x Detection (1-10)

FMEA

- **Severity**
- Severity 1 – No effect/ client might not even notice it
- Severity 10 – Serious safety hazard without warning

Risk Priority Number (RPN) =
Severity (1-10) x
Occurrence (1-10) x
Detection (1-10)

FMEA

- **Occurrence**
- Occurrence 1 – Rare event, no data of such type of failure in past
- Occurrence 10 – Failure almost inevitable

Risk Priority Number (RPN) =
Severity (1-10) x
Occurrence (1-10) x
Detection (1-10)

FMEA

- **Detection**
- Detection 1 – Current system almost certainly detects the problem (automation)
- Detection 10 – Current system can not detect the problem

Risk Priority Number (RPN) =
Severity (1-10) x
Occurrence (1-10) x
Detection (1-10)

FMEA

- Identify key process steps
- Identify failure mode
- Identify failure effects/severity
- Identify causes/occurrence
- Identify controls /detection
- Calculate Risk Priority Number (RPN)
- Prioritize by RPN – Higher RPN first
- Determine action plan
- Recalculate RPN

FMEA

- Update FMEA when there is plan to change / actual change of :
  - Design
  - Application
  - Material
  - Process

- FMEA is a living document

2022 – Changes in the BoK – 1C

I.C	C. Design for six sigma (DFSS) methodologies	
2014 BoK	**2022 BoK Details**	**Notes**
I.C.1	1. Road maps for DFSS Distinguish between DMADV (define, measure, analyze, design, verify) and IDOV (identify, design, optimize, verify), and recognize how they align with DMAIC. Describe how these methodologies are used for improving the end product or process during the design (DFSS) phase. Understand how verification and validation are used to compare results against stated goals. (Understand)	Added verification and validation
I.C.2	2. Basic failure mode and effects analysis (FMEA) Use FMEA to evaluate a process or product and determine what might cause it to fail and the effects that failure could have. Identify and use scale criteria, calculate the risk priority number (RPN), and analyze the results. (Analyze)	
I.C.3	3. Design FMEA and process FMEA Define and distinguish between these two uses of FMEA. (Apply)	

Verification

- Definition as per ISO 9000:2015
  - Confirmation, through the provision of objective evidence, that specified requirements have been fulfilled

Validation

- Definition as per ISO 9000:2015
  - Confirmation, through the provision of objective evidence, that the requirements for a specific intended use or application have been fulfilled
- Validation could be done by:
  - Extensive testing, trials, worst-case tests etc.
  - Past Data

Verification vs. Validation

Verification	Validation
confirmation, through the provision of objective evidence, that **specified requirements have been fulfilled**	confirmation, through the provision of objective evidence, that **the requirements for a specific intended use or application have been fulfilled**
Typically internal process	Typically external process (meeting client needs)
Involves checking documents, code, design	Involves testing and validating the final product