LEAN SOLUTIONS ACADEMY

Lean Six Sigma Training

Green Belt

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The ILSSI Exam

- Done online at ILSSI.org after training is finished
- Login and Password will be provided https://ilssi.org/login/
- Proctored by Webcam (ProctorU.com)
- Sign-in and Schedule exam on ProctorU.com
- Open Book
- 100 Multiple Choice Questions
- Pass mark is 70%
- Result issued immediately
- Retake is available

ilssi.org

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Body of Knowledge

1. The Fundamentals of Lean Six Sigma
2. Meanings of Lean and Six Sigma
3. General History of Lean Six Sigma
4. Lean Six Sigma Projects
5. DMAIC
6. PDCA
7. Kaizen and Kaizen Events
8. Root Cause Analysis
9. Voice of the Customer, and Business
10. Lean Six Sigma Belt Roles
11. Defining a Process
12. Critical to Quality Characteristics (CTQs)
13. Cost of Poor Quality (COPQ)
14. Pareto Analysis
15. Basic Lean Six Sigma Metrics
16. Selecting Lean Six Sigma Projects
17. Problem Statements
18. Building a Business Case & Project Charter
19. Project Metrics
20. SIPOC
21. The 8 Elements of Waste
22. 5S
23. Lean Thinking
24. Kanban
25. Poka-Yoke (Mistake Proofing)
26. Process Definition
27. Cause & Effect / Fishbone Diagrams
28. Process Mapping, SIPOC, Value Stream Map
29. Failure Modes & Effects Analysis (FMEA)
30. Six Sigma Statistics
31. Basic Statistics
32. Use of Excel , Minitab and Sigma XL
33. Descriptive Statistics
34. Normal Distributions & Normality
35. Graphical Analysis
36. Histograms
37. Box Plots
38. Measurement System Analysis
39. Precision & Accuracy
40. Bias, Linearity & Stability
41. Gage Repeatability & Reproducibility
42. Variable & Attribute MSA
43. Process Capability
44. Capability Analysis
45. Concept of Stability
46. Attribute & Discrete Data
47. Hypothesis Testing
48. Hypothesis Testing Uses
49. Practical vs. Statistical Significance
50. Alpha & Beta Risk
51. p-values
52. Types of Hypothesis Test
53. Hypothesis Testing with Normal Data
54. 1 & 2 sample t-tests
55. Hypothesis Testing with Non-Normal Data
56. Mann-Whitney
57. Simple Linear Regression
58. Correlation
59. Regression Equations
60. Non- Linear Regression
61. Multiple Linear Regression
62. Confidence & Prediction Intervals
63. Designed Experiments
64. OFAT
65. Full Factorial Experiments
66. Full Factorial Designs
67. Statistical Process Control (SPC)
68. Data Collection for SPC
69. I-MR Chart
70. X-bar-R Chart
71. U Chart
72. P Chart
73. NP Chart
74. X-S chart

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Class Schedule

Day 1

- What is Lean Six Sigma ?
- 8 Wastes
- 5S
- Voice of the Customer (VOC) and CTQs Process
- Mapping, Value Stream Mapping

Day 2

- Pull, Kanban and Flow
- Visual Management
- Poka Yoke
- Standardized Work
- SMED
- Kaizen / Kaikaku
- **Define Phase**
- Problem and Project Selection and Definition
- Business Case Project Charter
- **YELLOW BELT EXAM (as Homework)**

Day 3

- **Measure Phase**
- **Introduction to SigmaXL**
- Fishbone Diagram, Pareto Charts
- FMEA
- Six Sigma Statistics
- Measurement System Analysis

Day 4

- Process Capability
- **Analyse Phase**
- Correlation and Regression Analysis
- Introduction to Design of Experiments (DOE)

Day 5

- Hypothesis Testing
- **Improve Phase**
- **Control Phase**
- Control Plans
- Statistical Process Control (SPC)
- Control Charts
- **Revision and Rework of Mock Exam Questions**
- **GREEN BELT EXAM (In own time)**

WHAT IS

LEAN SIX SIGMA?

Lean Six Sigma Timeline

Guinness Brewery

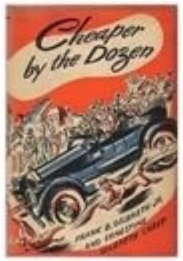
Walter Shewhart Introduces SPC Statistical Process Control

W. Edwards Deming

Joseph Juran

1900 1930 1950

Ford Assembly Line



Gilbreth,
•Management Theory
•Industrial Engineering

Toyota Production System

Taiichi Ohno
Shigeo Shingo
Kaoru Ishikawa

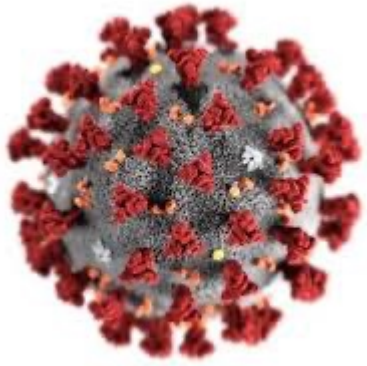
Lean Six Sigma Timeline

Lean Six Sigma Timeline

Shift in Focus

2008 Financial Crisis

Covid-19



Cost Cutting
Automation
Down-sizing
'*Do More with Less*'

Survival
Innovation
Adapting
Re-structuring
Re-designing

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Influential Leaders in Lean Six Sigma Principles

The evolution of Lean Six Sigma was heavily influenced by American and Japanese engineers, statisticians and quality control experts 1950-1980.

Walter Shewhart
(SPC and Control Charts)

W. Edwards Deming
(Quality Management
PDCA Plan, Do, Check, Act)

Joseph Juran
(Quality Planning, Quality Improvement
Quality Control)

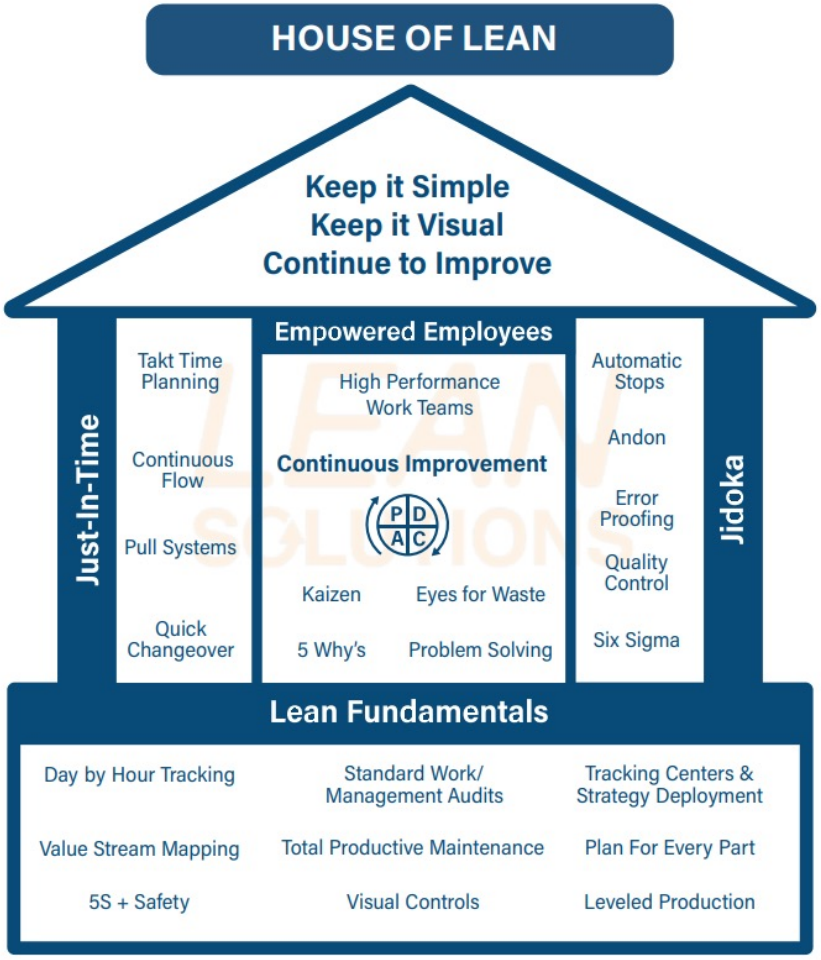
Taiichi Ohno
7-Wastes, Gemba-Walk

Shigeo Shingo
SMED, Poka Yoke

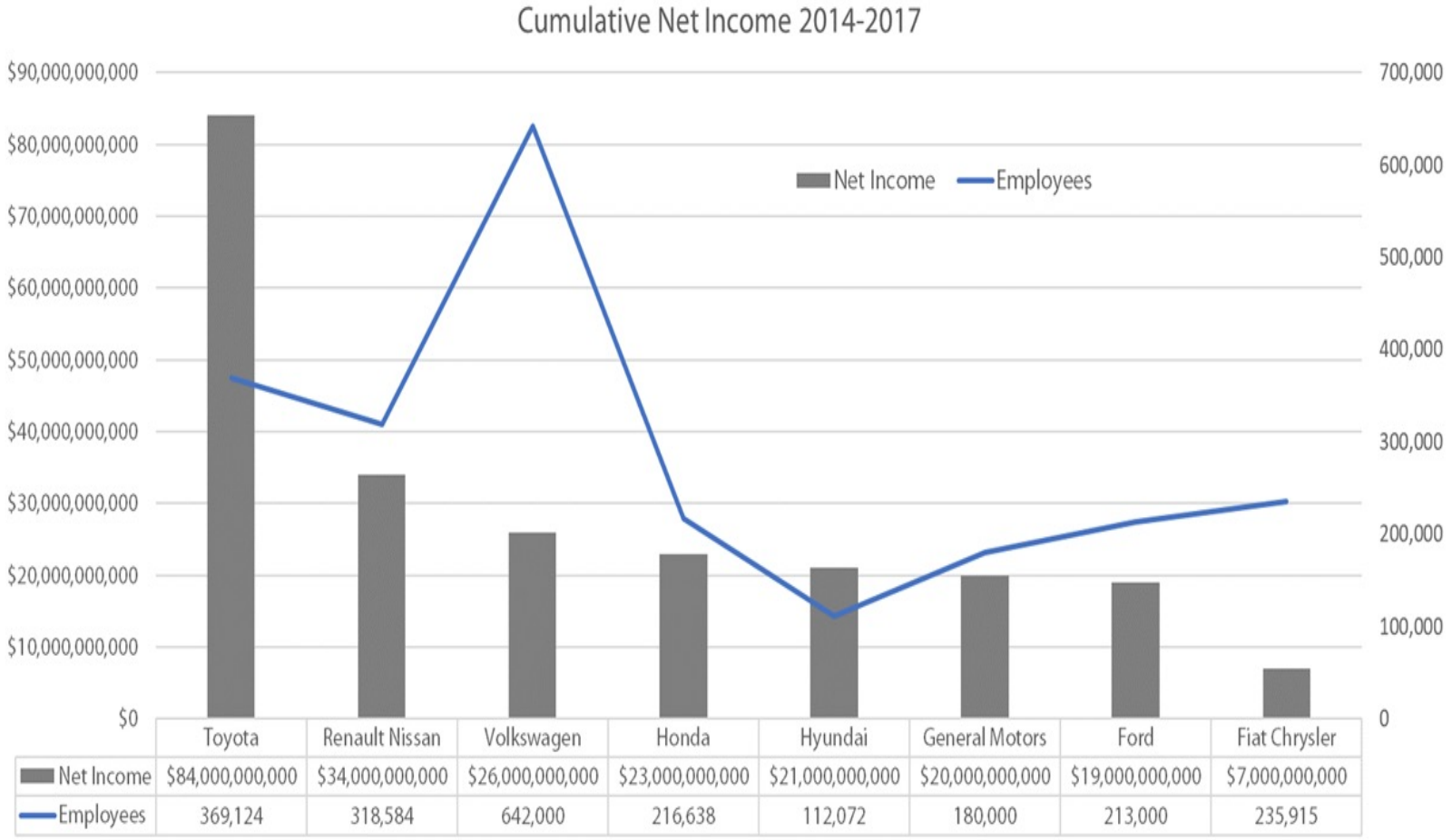
Lillian Gilbreth
Process Flow
Ergonomics

Kaoru Ishikawa
7-Quality Tools

Toyota Production System (TPS)



Superiority of the Toyota Production System (TPS)



	Toyota	Renault Nissan	Volkswagen	Honda	Hyundai	General Motors	Ford	Fiat Chrysler
Net Income	$84,000,000,000	$34,000,000,000	$26,000,000,000	$23,000,000,000	$21,000,000,000	$20,000,000,000	$19,000,000,000	$7,000,000,000
Employees	369,124	318,584	642,000	216,638	112,072	180,000	213,000	235,915

Data Source: Yahoo Finance

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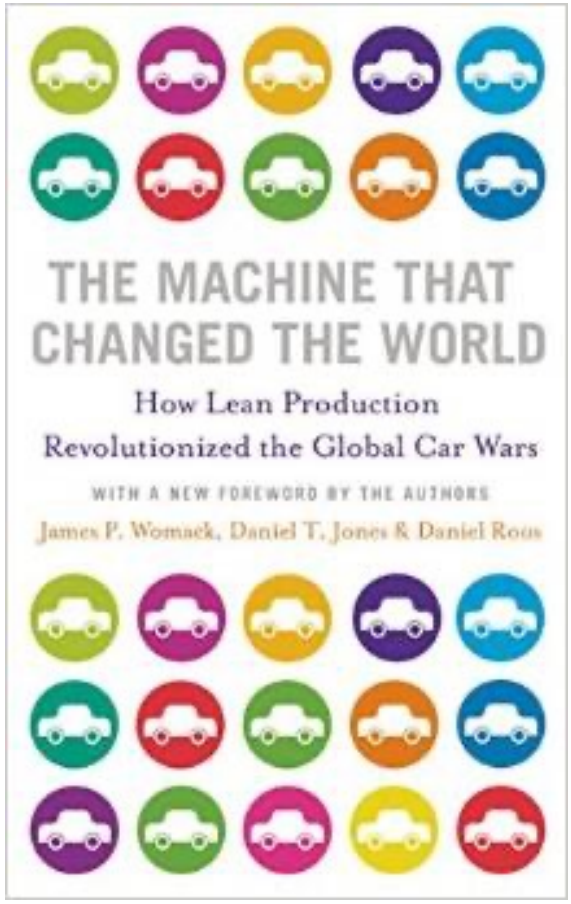
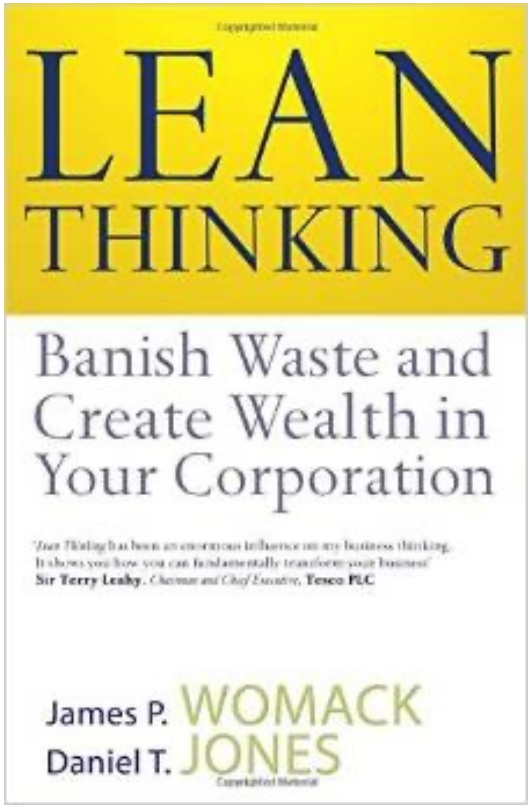
"The Machine that Changed the World" 1990





"Lean Thinking" (1993)

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Origins of Six Sigma : Motorola and General Electric (GE)

Bob Galvin : CEO of Motorola 1980's

MOTOROLA
intelligence everywhere

1985 Bill Smith coins the term "Six sigma"

1987 Motorola trademarks the term "Six Sigma"

Jack Welch : CEO of GE 1981-2001

Jack Welch (CEO) made Six Sigma the management and corporate culture of General Electric 1981 – 2001.

- Every manager was trained as at least To Green Belt level.
- During his tenure at GE, the company's value rose 4,000%.

Why is it called Six Sigma ?

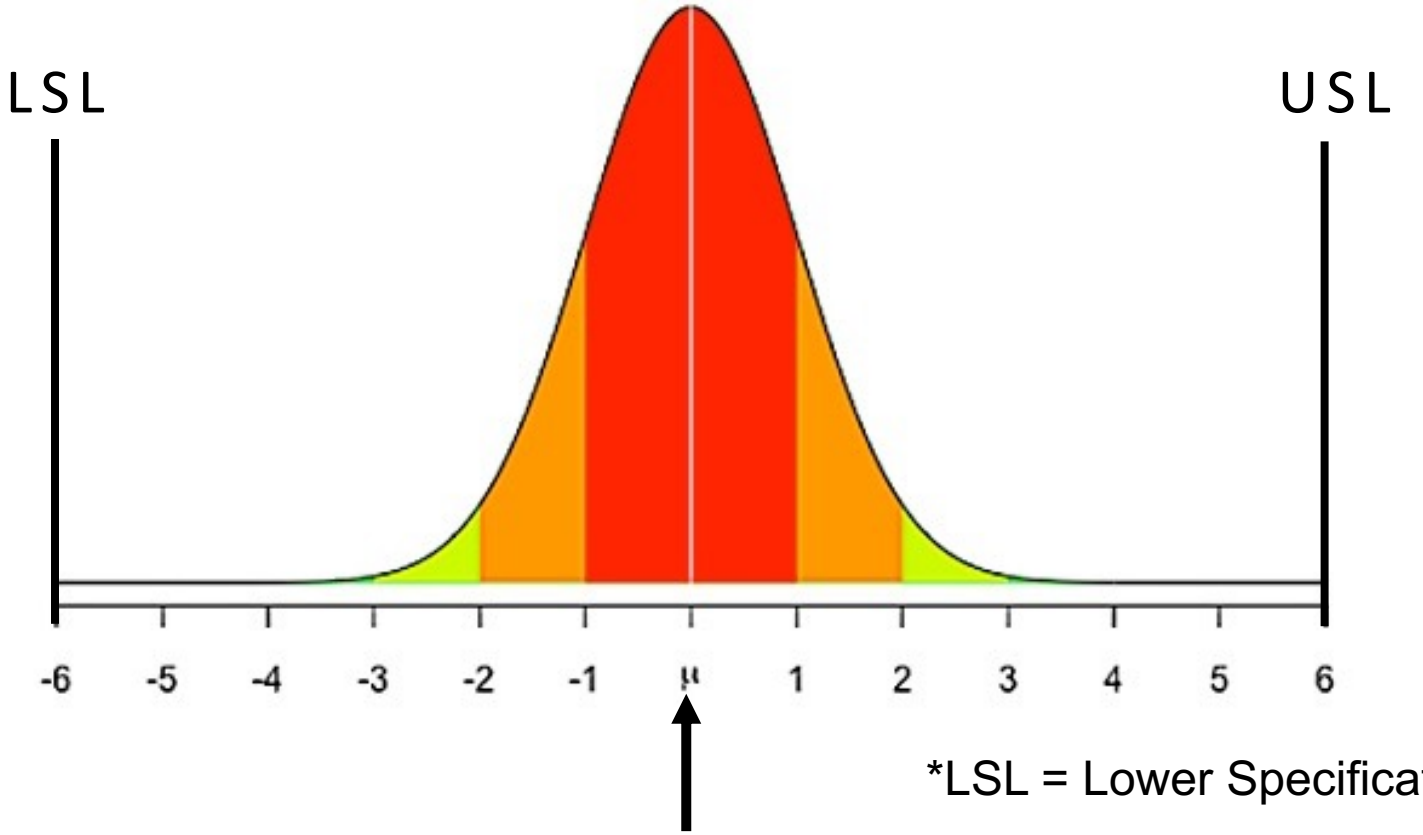
σ, *sigma*

'Sigma' is a Greek Symbol to signify the mathematical concept called **Standard Deviation** . This is an important measure of **Variation** in a process.

$$\sigma = \sqrt{\frac{\sum_{i=1}^{N} (X_i - \mu)^2}{N}}$$

You don't need to remember or even
To understand this equation…
Its just 'behind the scenes' !!

Six Sigma refers to a process having 6 Standard Deviations (Sigmas) between the mean average of the process (center) and the closest customer specification limit.



*LSL = Lower Specification Limit

*USL = Upper Specification Limit

Defects vs Process Sigma Level

Process Sigma Level	Defects per Million Opportunities (DPMO)
1	691,500
2	308,500
3	66,800
4	6,200
5	233
6	**3.4**

DPMO = Defects per Million Opportunities (for Defects)

DEFINITION :
A "Six Sigma Process" is one that produces no more than 3.4 defects per million opportunities for defects

3.4 DPMO

A "Six Sigma Process" is often described one that produces no more than
3.4 Defects Per Million Opportunities for defects

3.4 DPMO (Defects Per Million Opportunities)

0.00034 % Defects

99.99966 % Correct

What is a 0.1% Defect Rate look like ?

What is 99.9% Quality ?
0.1 % Defects

- 1 unsafe plane landing per day at JFK
- 100 wrong drug prescriptions per day in US
- 10,000 Houses without electric / day in US
- 100,000 wrong bank transfers per day
- 1 million e-mails sent incorrectly per day

This is why we need Six Sigma processes !

3-Star Manufacturing Inc.

What are the possible Defects ?

- **Shapes**
- **Colours**
- **Size**
- **Concentric**

What Defect Rate is acceptable ?

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Lean and Six Sigma COMPLIMENT each other

Lean can work alone

Six Sigma can work alone

Lean Six Sigma

They Perfectly Complement Each Other !!

Lean Principles

1. Understand the **value** in the product or service
2. Identify the **value stream** in each product or service
3. Make the product or service **flow**
4. **Pull** value from the downstream (just in time delivery)
5. Continuous Improvement towards **perfection**
6. Involve workers and **respect workers** opinions

NOTE: *Only the first 5 Lean Principles were taught. Many books and videos still refer to the '5 Lean Principles'*

**Source: Lean Thinking by James P. Womack and Daniel T. Jones*

Six Sigma Principles

1. Reduce Variation and you will reduce Defects / Errors
2. Root Cause Analysis of problems (RCA)
3. Use Data for Decision making (instead of guessing !)
4. Use of Statistical Analysis tools and charts
5. Process Optimization using Designed Experiments and Regression Analysis, Predictive Modelling. Hypothesis Tests
6. Improvement projects using the DMAIC Framework

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We use Lean Six Sigma for ....

PROCESS IMPROVEMENT

Increase Value

Traditional View of Our Processes

Inputs

Raw Materials
Raw Data
Manpower
Energy

Operations

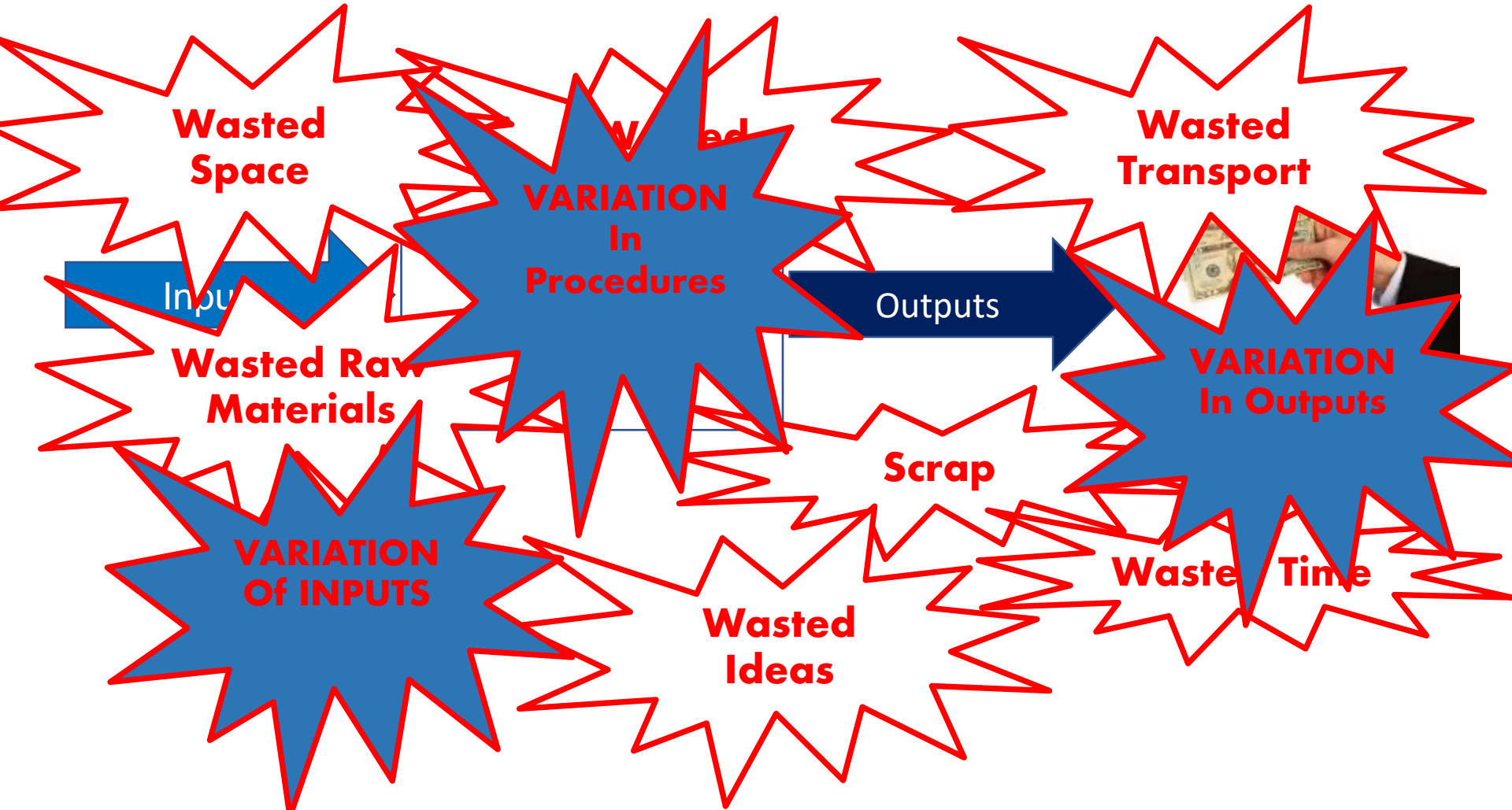
Outputs

Finished Goods
Refined Materials
Information
Services
etc

Customer

Lower Value → **Higher Value**

What our processes actually look like



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3-Star Manufacturing Inc.

Perfect for Cake Decorations

- **3 Star Shapes**
- **3 different Colors**
- **3 different Size Stars**
- **Concentric Shapes**

- **Target Weight = 10 grams**
- **Upper Specification Limit = 12 grams**
- **Lower Specification Limit = 8 grams**

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ROLL → WEIGH → FLATTEN → CUT → ASSEMBLE → WEIGH





<u>Roll Ball</u>

Small : 8 to 12 grams Target = 10 grams

Medium : 13 to 17 grams Target = 15 grams

Large : 18 to 22 grams Target = 20 grams

Everything is a process

Inputs

What do we need to create Value for Customers ?

Hint **: The '4 M' rule**

M A T E R I A L S

M A N P O W E R

M A C H I N E S

M E T H O D

Inputs

What do we need to create Value ?

Examples of Inputs in your work (Which 'M' is it ?) :

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____

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Operations

Transforming the Inputs into Outputs (Operations)

Examples of Operations at your company :

1. _____
2. _____
3. _____
4. _____

Outputs

What your Customer wants (Outputs)

The 'TOP 5' Outputs at your company :

1. _____

2. _____

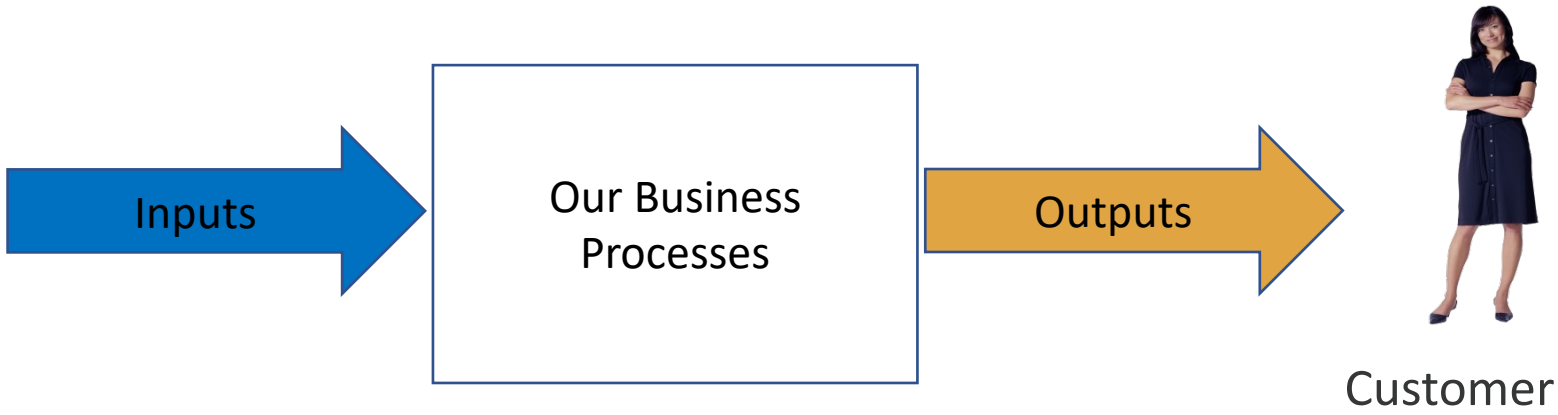
3. _____

4. _____

5. _____

Increase Value

Lower Value → Higher Value



- Safer
- Easier
- Better Quality (less defects and rework)
- Faster (on time)
- Lower Cost

What did Shigeo Shingo say about this ?

Shigeo Shingo : 1909 - 1990

- '*There are four purposes of improvement:* ***easier, better, faster, and cheaper.*** *These four goals appear in order of priority. Hence the first is to make the work easier for workers while improving the fruits of their labour.'*
- *'Intensifying the work should never be undertaken even if the same working hours are maintained.'*

Non-Stock Production : The Shingo System of Continuous Improvement', (1988)

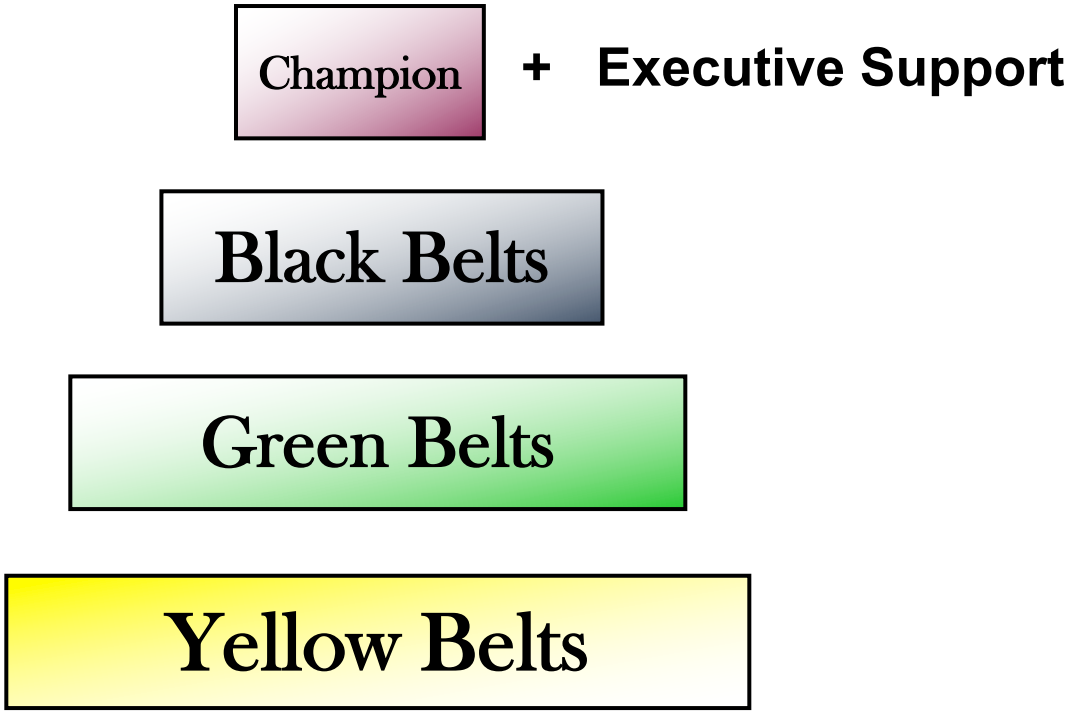
Shigeo Shingo was a primary architect in the development of the Toyota Production System.

SQDC

1. Easier and **Safer** for workers (S)
2. Produce Better **Quality** Outputs for customers (Q)
3. **Deliver** the Outputs on Time (D)
4. Lower the **Cost** of Production (C)

The **SQDC** model of Production

Lean Six Sigma Roles and Responsibilities



Champion/Process Owner

Champions help to identify and select the most important projects to work and break down political barriers / roadblocks for Lean Six Sigma to succeed

- Assist with Project selection and initiation
- Obtain needed project resources and eliminate roadblocks
- Participate in project review meetings
- Provide Governance / Ask the right questions
- Set up a training programs

Black Belt

Black Belts are Lean Six Sigma process experts, think strategically and lead larger projects within the business.

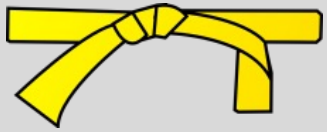
- Approx 1 Black Belt every 50 - 100 employees (1 %)
- Dedicated to process improvement 100% of time
- Project team leader for larger / high profile projects
- Facilitates DMAIC teams and helps Green belts
- Thinks strategically and towards Enterprise level goals
- Works cross-functionally

Green Belt

Green Belts are practitioners of Lean Six Sigma improvement and lead small/medium projects or support larger Black Belt Projects.

- Approx 1 Green Belt for every 10 - 30 employees (5 %)
- Involved approx 50% time on projects
- Typically works projects within their Functional Area
- Team members for larger projects
- Team leaders for small / medium projects

Yellow Belt



Yellow Belts are Workers and Functional Specialists and apply the Lean Six Sigma Methodology to their own work and serve on project teams on a part-time basis.

- As many as possible (target is 100% of workers)
- Functional workers, Subject Matter Specialists. Team members
- Provide support to Black Belts and Green Belts as needed
- Team members on DMAIC teams
  - Supporting projects with process knowledge and data collection

Summary

At this point you should be able to:

- Describe the goals of our process improvement
- Understand the origins of Lean and Six Sigma
- Describe the principles of Lean
- Describe the principles of Six Sigma
- Describe the defined roles of Lean Six Sigma belts

Quiz 1 :

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- What was the name of the first company to use the name 'SIX SIGMA' to describe its Quality Management System.
- **MOTOROLA**

- What is the First Principle of Lean production ? What is the most important thing that a Lean process must produce ?
- **VALUE** (for the customer of the process)

- Which Japanese company is considered as being the first to use true 'Lean Production' effectively and successfully ?
- **TOYOTA**

- A basic principle of Six Sigma is to always find the true original source of a defect or problem. This is called _____?
- **ROOT CAUSE ANALYSIS**

- A "Six Sigma Process" is often described one that produces no more than 3.4 DPMO What does DPMO stand for ?
- **DEFECTS PER MILLION OPPORTUNITES FOR DEFECTS**

What is the role of a Yellow Belt on a Lean Six Sigma project?

A YELLOW BELT IS A TEAM MEMBER WHO ASSISTS A GREEN OR BLACK BELT, USING THEIR KNOWLEDGE OF THE PROCESS THAT THEY CURRENTLY ARE WORKING WITHIN.

What is the role of a Green Belt in an organisation ?

A GREEN BELT IS A PROJECT TEAM LEADER FOR SMALL AND MEDIUM SIZED PROCESS IMPROVEMENT PROJECTS.

What is the role of a Black Belt in an organisation ?

A BLACK BELT IS A PROJECT TEAM LEADER FOR LARGE PROBLEM SOLVING / IMPROVEMENT PROJECTS or OVERSEES THE WORK OF GREEN BELTS FOR MULTIPLE PROJECTS. A BLACK BELT IS A FULL TIME PROBLEM SOLVER FOR THE ORGANISATION.

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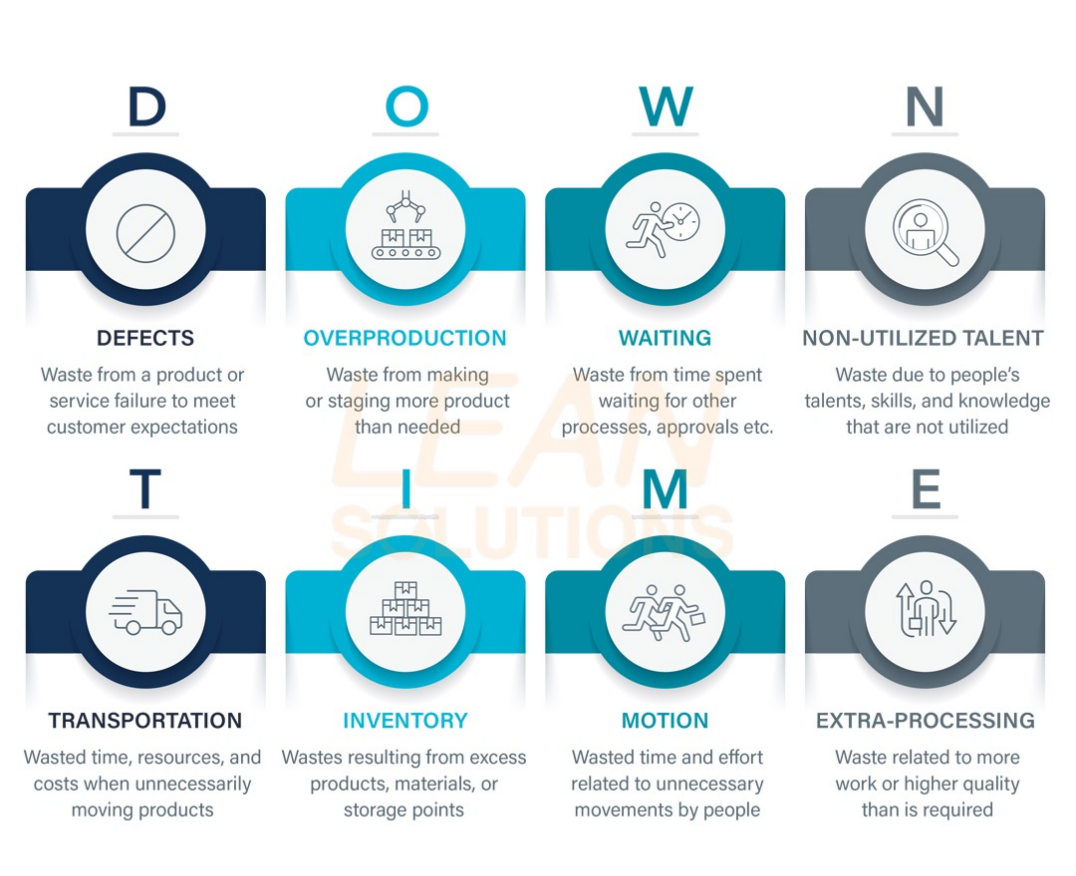
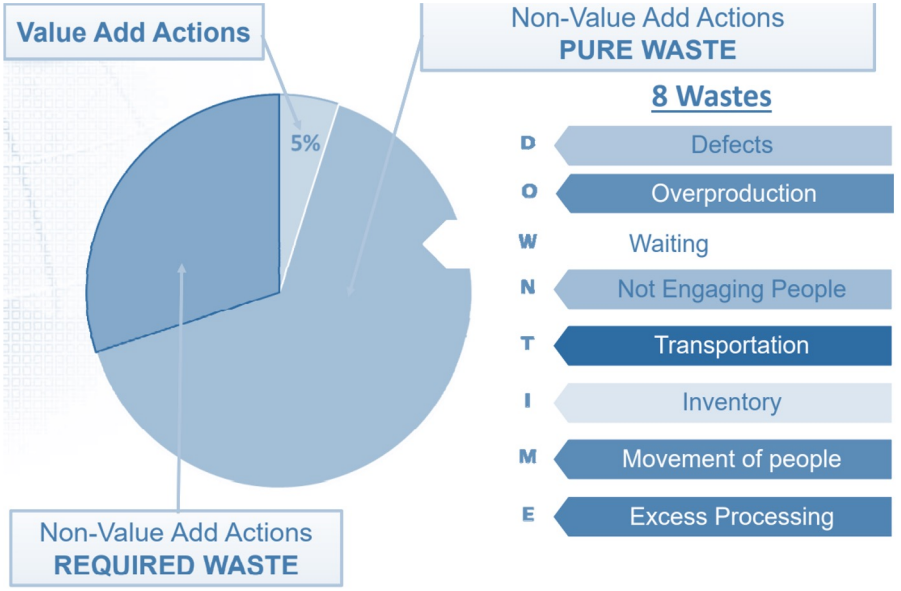
Recognizing Waste


D
DEFECTS
Waste from a product or service failure to meet customer expectations
O
OVERPRODUCTION
Waste from making or staging more product than needed
W
WAITING
Waste from time spent waiting for other processes, approvals etc.
N
NON-UTILIZED TALENT
Waste due to people's talents, skills, and knowledge that are not utilized
T
TRANSPORTATION
Wasted time, resources, and costs when unnecessarily moving products
I
INVENTORY
Wastes resulting from excess products, materials, or storage points
M
MOTION
Wasted time and effort related to unnecessary movements by people
E
EXTRA-PROCESSING
Waste related to more work or higher quality than is required

CATEGORIES
OF ACTION



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WASTE
WALK

A planned visit to where work is being performed to observe what's happening and to note the waste.

- Explain to the people in the area of observation what you are doing.
- Study the area for 20-30 minutes.
- As you see work that appears to be waste, jot down the example you see.
- Take action immediately if possible or develop a plan to remove waste

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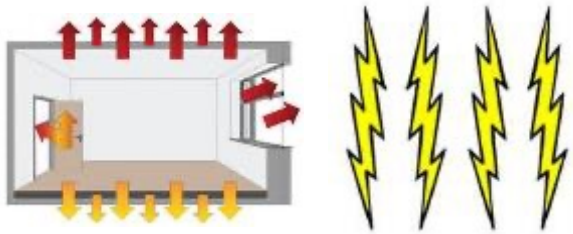
Other 'Non-Traditional 'Categories of Waste



Utility / Energy (Heat / Electrical) losses

Mis-Communications

Over - Communications

Skilled Staff Losses

3-Star Manufacturing Inc.

Where is the **Waste** ?

ROLL → WEIGH → FLATTEN → CUT → ASSEMBLE → WEIGH




Quiz 2:

- Which of the traditional 8-Wastes of 'DOWNTIME is concerned with reducing the complexity of processes and taking out unnecessary steps or activities ?
- **Non-Essential Processing / Over Processing**

- What is the name of the Waste of producing more that the customer demand can absorb ?
- **Over-Production**

- What is Waste called when an activity or step in process needs to be repeated because it was not done 'Right-First-Time' ?
- **Rework / Defects**

- What Waste results in Queues or Backlogs of materials or work ?
- **Waiting (due to a Bottle-next in the process)**

- What is the Japanese word for 'Waste' ?
- **MUDA**

5S

Continuous Improvement
should not be just an event.

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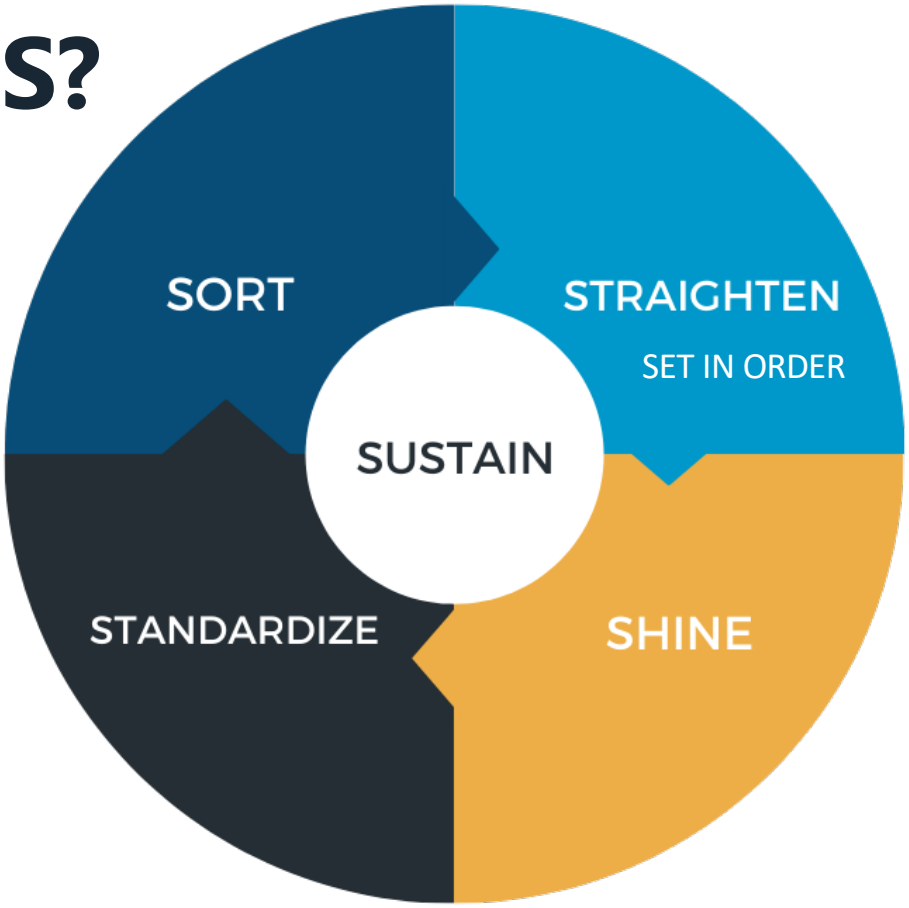
WHAT IS 5S?



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WHY 5S?

Workplace Organization and Visual Management Fundamental to Your Facility

- SAFER!
- Problems Become Visible
- Promotes culture

Result: Improved Safety, Quality and Cost

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FIND A FLATHEAD SCREWDRIVER

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FIND A FLATHEAD SCREWDRIVER

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EXERCISE #1

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LEAN
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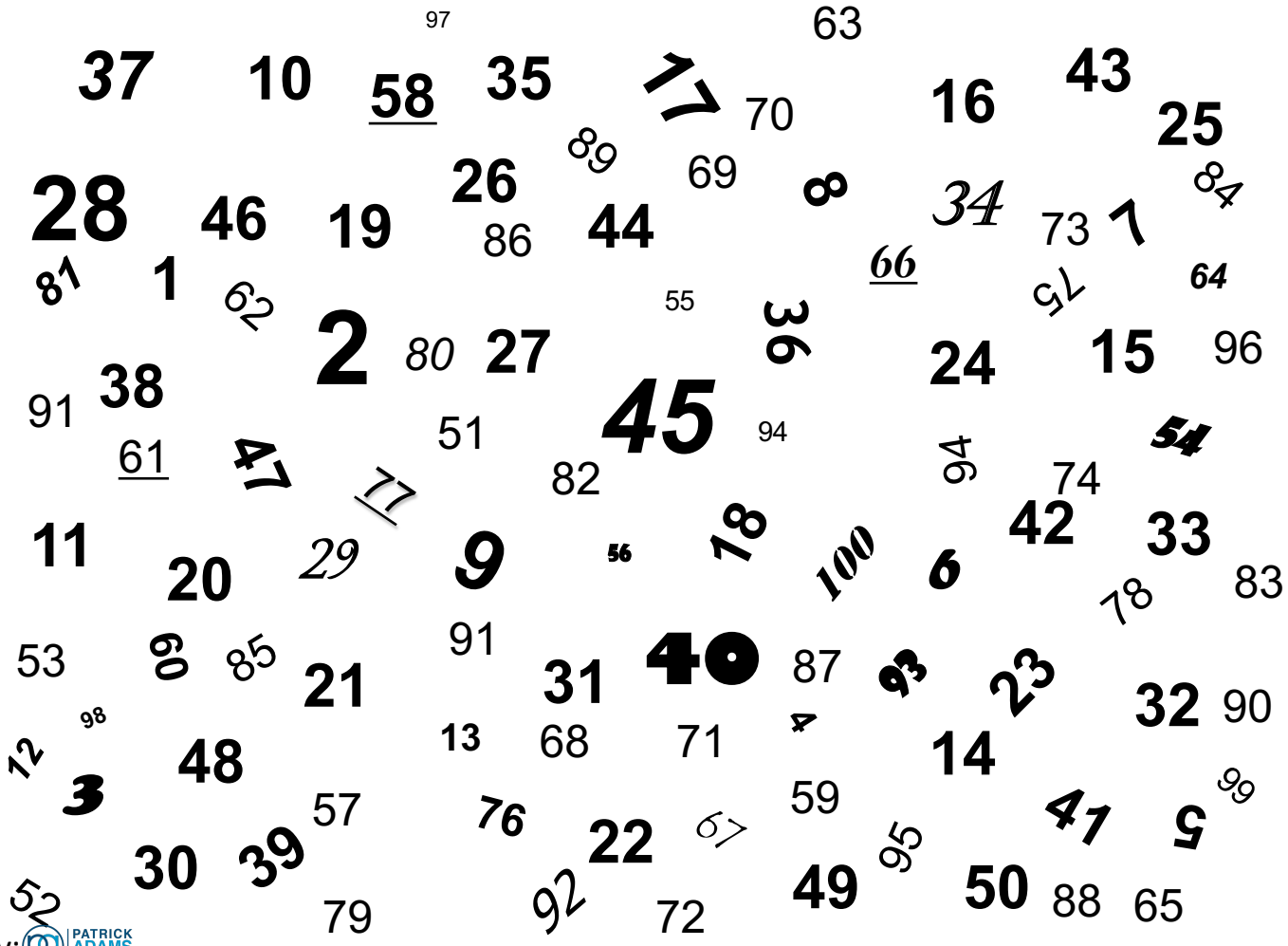

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SORT

- Critically examine everything
- Red Tag Process
  - Always use-Have a place for it
  - Sometimes use-Tag and Date
  - Never use-Red tag area
- Need a 6mm Hex? Keep only the 6mm Hex, not a whole set
- Members know best what is needed
- Everything in the area should have a purpose

EXERCISE #2

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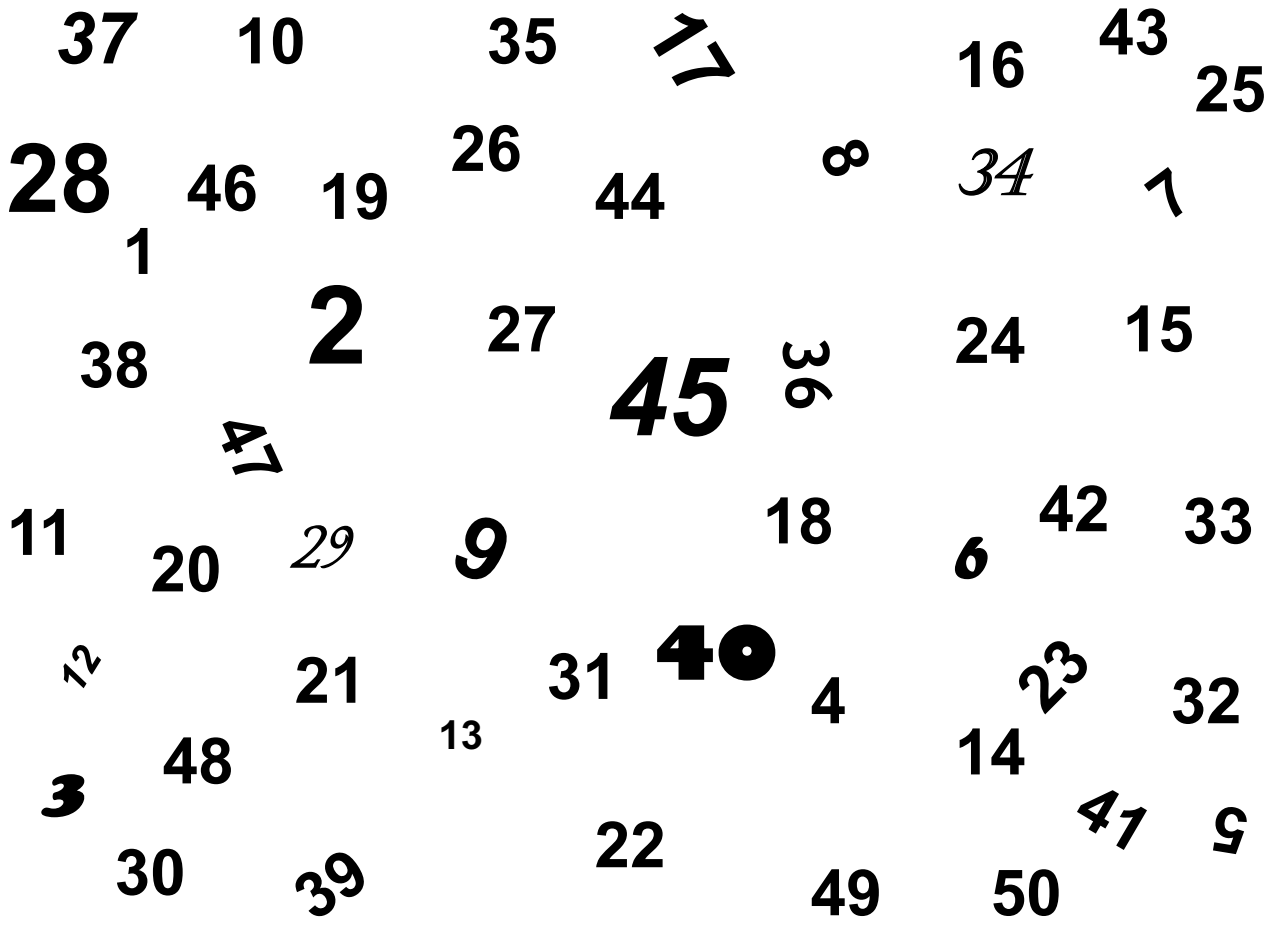

STRAIGHTEN or SET IN ORDER

- For what's left, where does it go?
- Be mindful of frequency of use and how much is used
- Be Visual
- Arrange so things are easy to find and readily retrieved.
- "A place for everything and everything in it's place."

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SHINE

- Clean the area (tools, equipment, lighting, etc.)
- Re-painting may be required
- Implement regular housekeeping so that any dirt or grease is immediately obvious.
- Always use your 5S Color Standards

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EXERCISE #3

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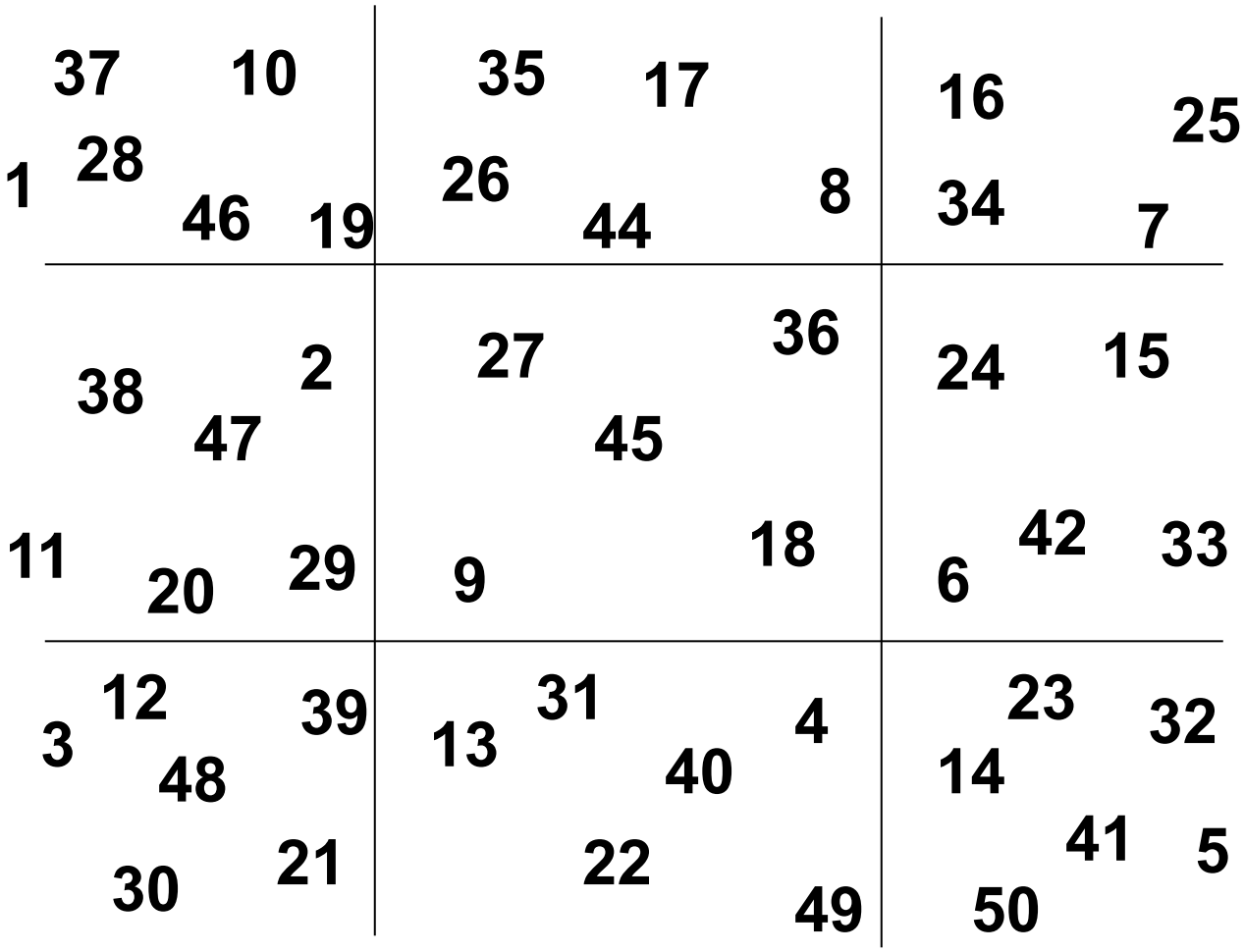

STANDARDIZE

- Implement Work Center 5S Board
- Take a picture of the area
- Assign an area owner
- Develop standard work for regular housekeeping
- Implement Daily End of Shift Checks

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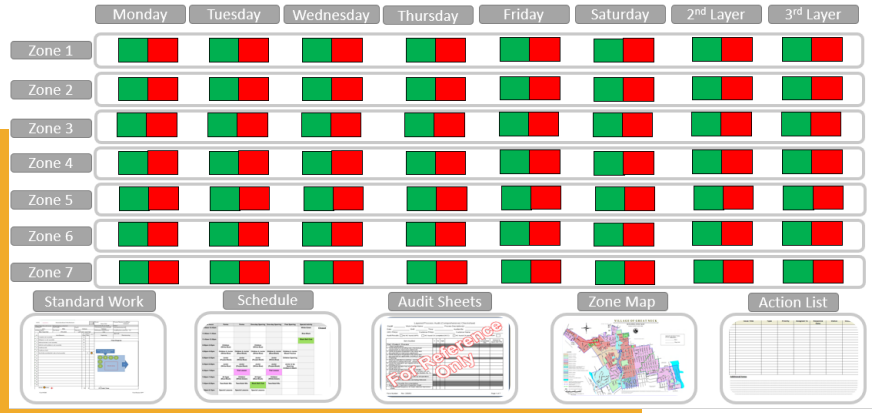
EXERCISE #4

LEAN
SOLUTIONS

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50



SUSTAIN

- Implement Layered Process Audit

  in order to sustain improvements

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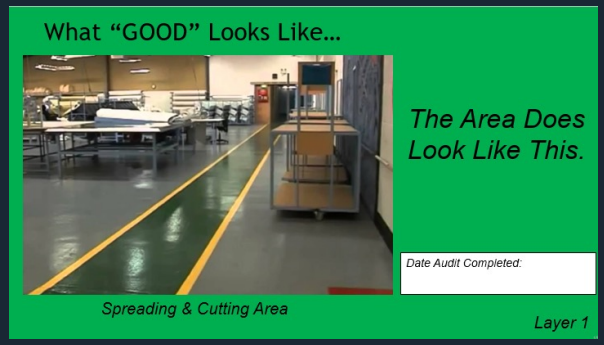
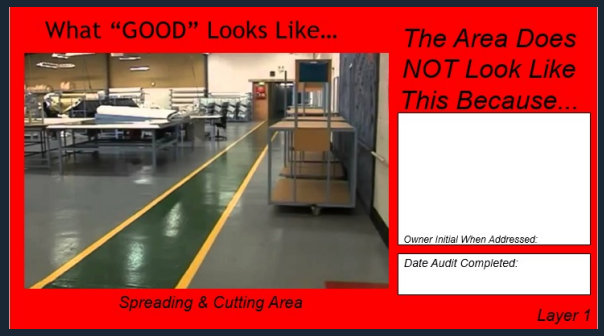
SUSTAIN

LAYER 1 AUDIT

- Layer 1 audits are completed daily by team leaders based on a posted schedule
- Area owner is responsible for any red items on Layer 1.
- Layer 1 checks that the area matches the picture and the work center 5S board is being completed





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SUSTAIN

LAYER 2 AUDIT

- Layer 2 audits completed by the area Supervisor one time per week.
- The Layer 2 audits are specifically auditing audit completion to schedule.
- The area Supervisor is responsible for any red items in Layer 2.

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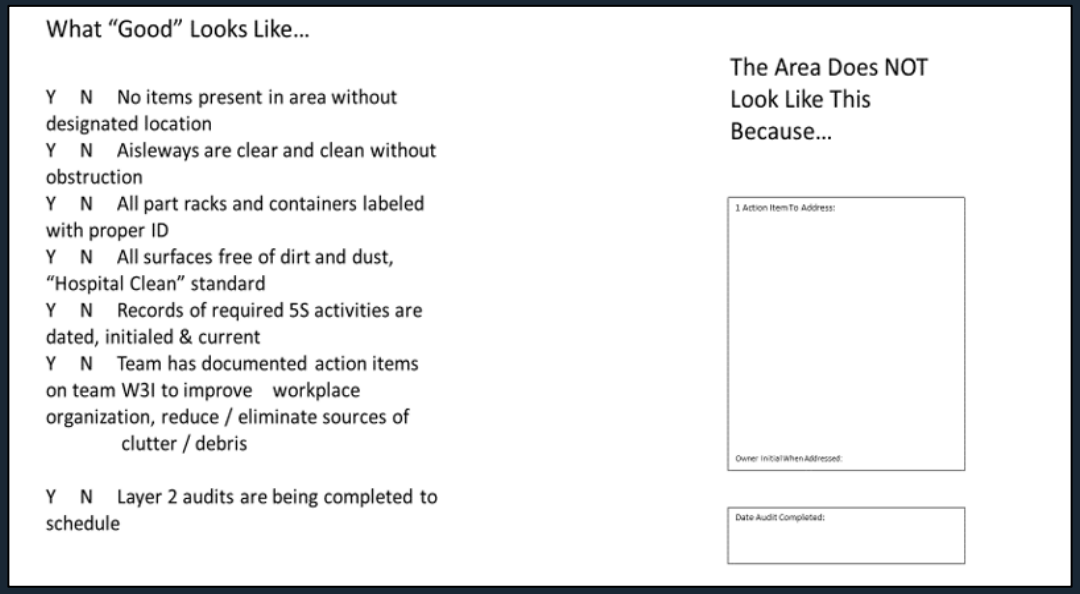
SUSTAIN LAYER 3 AUDIT

Layer 3 audits are completed by the Operations Manager or Plant Manager once per month.



What "Good" Looks Like...

Y N No items present in area without designated location
Y N Aisleways are clear and clean without obstruction
Y N All part racks and containers labeled with proper ID
Y N All surfaces free of dirt and dust, "Hospital Clean" standard
Y N Records of required 5S activities are dated, initialed & current
Y N Team has documented action items on team W3I to improve workplace organization, reduce / eliminate sources of clutter / debris

Y N Layer 2 audits are being completed to schedule

The Area Does NOT Look Like This Because...

1 Action Item To Address:

Owner Initial When Addressed:

Date Audit Completed:

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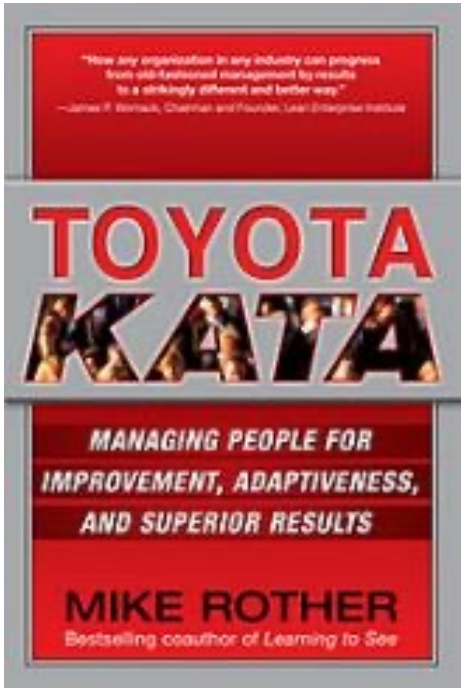
Kata for Sustain

"A routine that is practiced so that it becomes second nature"



TOYOTA KATA by Mike Rother
(Lean Enterprise Institute)

https://www.youtube.com/watch?v=F6mhirDTLpA

TOYOTA KATA
What is the Improvement Kata?

Lean Enterprise Institute
lean.org/kata

&

MICHIGAN ENGINEERING
UNIVERSITY of MICHIGAN

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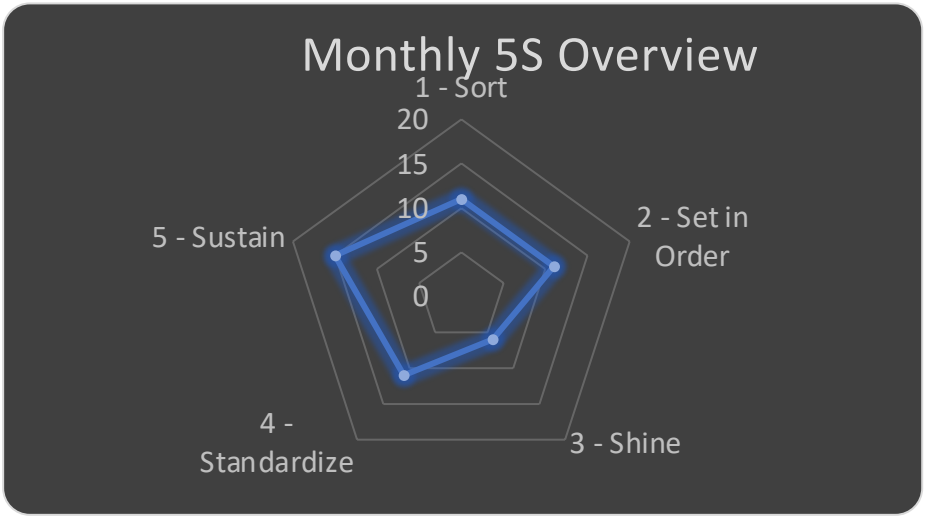
5S Audit & Results

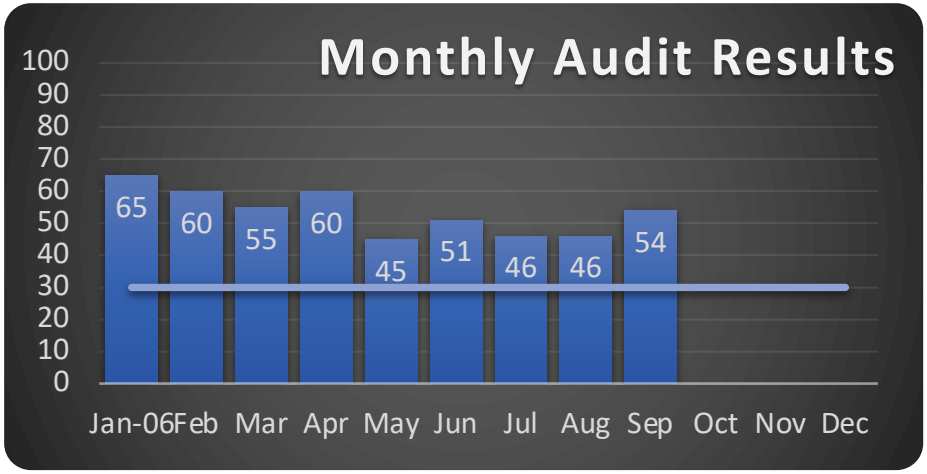
5S Workplace Scan Checklist

Department: | Date: | Scored By:

Place an "x" in the appropriate box based on number of issues observed.

		Number of Observations >>	0	1-2	3-4	5-6	>6
Sort	**Distinguish between what is needed and not needed**						
	1	Unneeded equipment, tools, furniture, etc. are present			x		
	2	Unneeded items are on walls, notice boards, etc			x		
	3	Items are present in walkways, stairways, corners, fire exits etc.				x	
	4	Unneeded inventory, supplies, parts, or materials are present				x	
	5	Safety hazards (water, oil, chemical, machines) exist		x			
		Subtotal >>	0	1	4	6	0
Set in Order	**A place for everything and everything in it's place**						
	1	Correct places for items are not obvious			x		
	2	Items are not in their correct places			x		
	3	Walkways, workstations, equipment locations are not indicated				x	
	4	Items are not put away immediately after use				x	
	5	Height and quantity limits are not obvious		x			
		Subtotal >>	0	1	4	6	0
Shine	**cleaning, and looking for ways to keep it clean and organised**						
	1	Floors,walls stairs, and surfaces are free of dirt, oil, and grease			x		
	2	Equipment is not kept clean and free of dirt, oil, and grease			x		
	3	cleaning materials are not easily accessible		x			
	4	Lines, labels, signs, etc are not clean and unbroken	x				
	5	Other cleaning problems of any kind are present		x			
		Subtotal >>	0	2	4	0	0
Standardize	**Maintain and monitor the first three categories**						
	1	Necessary information is not visible			x		
	2	All standards are not known and visible			x		
	3	Checklist don't exist for all cleaning and maintenance jobs				x	
	4	All quantities and limits are not easily recognizable				x	
	5	How many items can't be located in 30 seconds		x			
		Subtotal >>	0	1	4	6	0
Sustain	**Stick to the rules**						
	1	How many workers understand the 5s principals					x
	2	How many times last week was daily 5s not performed					x
	3	Number of times that personal belongings are not neatly stored				x	
	4	Number of times job aids are not available or up to date				x	
	5	Number of times last week daily 5s inspection were not performed		x			
		Subtotal >>	0	1	0	6	8
		Total >>	0	6	16	24	8
		Grand Total 5S Score	54				





5S your computer hard/shared drive

5S Principle	Description
Sort	• Check all your files and software, and get rid of any that are unnecessary
Set In Order	• Organize your files and optimize the use of file folders • Keep in mind how often you need them and how much time you need to store them • Create specific shortcut icons for the most used files or programs
Shine	• Eliminate any files under deleted items, sent items and the recycle bin
Standardize	• Establish procedures for maintaining your computer 5S system
Sustain	• Include hard drives in 5S audits • Focus on how people maintain files and program organization, and the time they spend ding so

5S 3-Star Manufacturing Inc.

5S in your company (Discuss)

- What areas of your work could do with 5S ?
- Who do you need to get involved ?
- When are you going to try 5S ?

Quiz 3 :

- Which stage of the 5S method is used to ensure that the workers have the good habits and discipline to continue the other 4S tasks.
- **SUSTAIN**

- In 5S the action of removing unnecessary tools, equipment and materials from the workspace is called _____.
- **SORT**

- Cleaning the workplace of dirt, dust and litter is called what in 5S ?

- **SHINE**

- Give one example of a 5S method used for **SET IN ORDER / STRAIGHTEN** ?
- **SHADOW BOARDS**
  RACKS
  COLOURED LABELS, FLOOR MARKING etc

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Lean Principles and Tools

Value

Remember the 6 fundamentals of Lean ?

1. Value 
2. Value Stream
3. Flow
4. Pull
5. Perfection

Who is your customer ?

In Lean Six Sigma …

- Value is always viewed “Through the eyes of the Customer”
  - Who is our customer ?
  - What is The Voice of our Customer (VOC) ?
  - What is Critical to Quality (CTQ) to our Customer ?

Who is your Customer ?

'Internal Customers' vs 'External Customers'

- An internal Customer could be a different department or operation. It could be the next downstream operation in the process.

- Can you name some different types of ' External Customers' ?

What is a CTQ?

Critical to Quality (CTQ's) are measures we use to capture VOC properly.

- Also referred to in some literature as :
  - CTC's – Critical to Customer
  - CTS's – Critical to Satisfaction
  - CTQC - Critical to Quality Characteristics

- CTQ's are a tool to help to break down VOC into well defined and measurable terms.

Defining CTQs

Customer CTQs usually fall into one of 4 categories :

1. ***Functions and Features***
   - Does the product or service provide what the customers expect and need?
   - Is the right colour, texture, taste, variety available ?
2. ***Reliability and Quality***
   - Does the customer experience or find defects in the product or service?
   - Is there consistency in your product or service ?
   - Can they trust your product not to break down ?
3. ***Delivery Speed / Responsiveness***
   - Does the process meet the customer's time frame for delivery ?
   - Is the customer always able to obtain the product or service when they need it ?
4. ***Expense / Price***
   - Does the customer perceive value for price?
   - What is the price elasticity of demand for the product or service ?

Developing CTQ's

Step 1

Identify Your Customers

- Listing
- Segmentation
- Prioritization

Step 2

Capture VOC

- What is important to your customers ?
- Tools include **KANO ANALYSIS**

Step 3

Develop CTQ's

- Translate VOC to CTQ's (measurable)
- Determine **Specification Limits** for each CTQ from customer
- Prioritize the CTQs according to customer

Specification Limits

"Specification Limits" are Lean Six Sigma's way of defining your customer expectations

USL = Upper Specification Limit

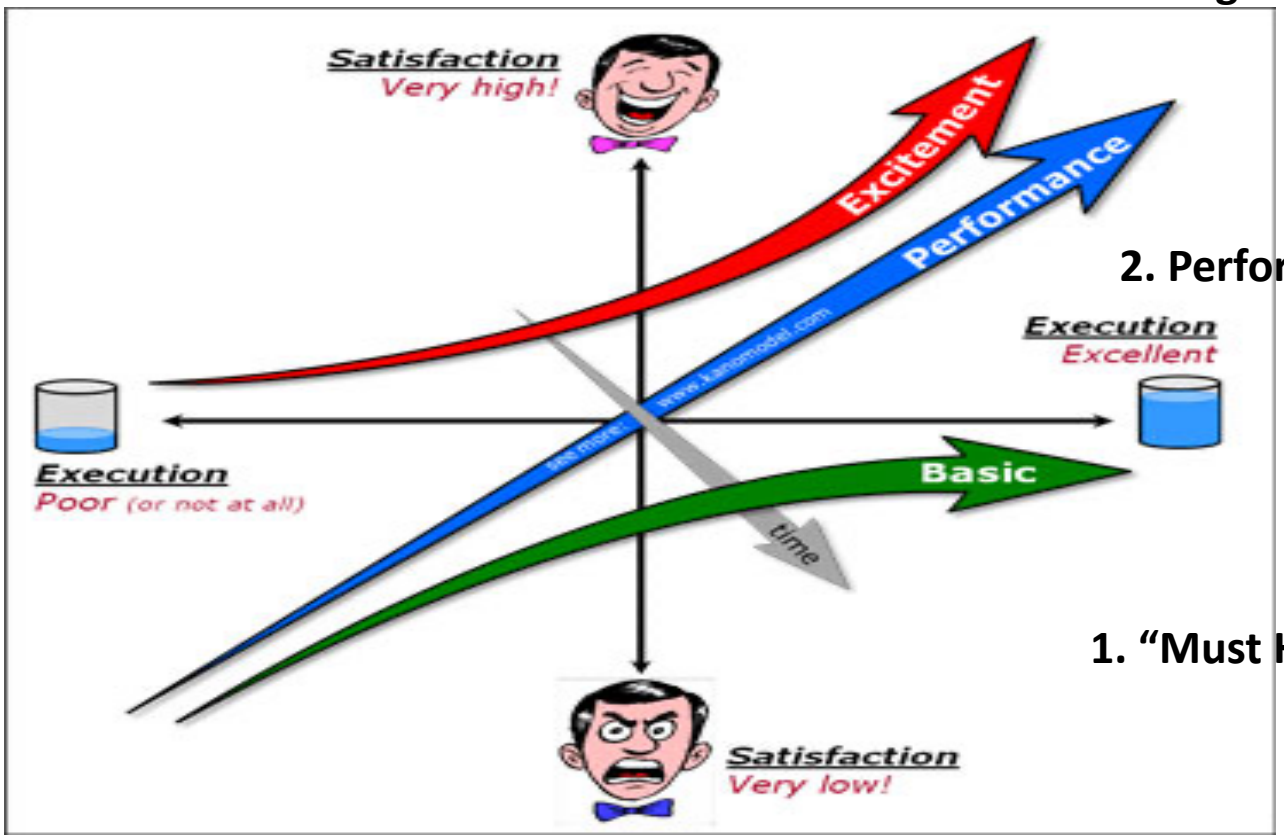
LSL = Lower Specification Limit

Also called 'Tolerance limits' in some businesses

Kano Analysis

- Developed in the 1980s by Professor Noriaki **Kano**, which classifies customer preferences into three main categories

3. Delighters



2. Performers

1. “Must Haves”

Kano Analysis

The Kano Model has three main categories of attributes:

Threshold or Basic Attributes:

These are the basic attributes in a product or service.
The product/service is believed to be incomplete without them.
Their presence will not ensure the satisfaction of the customers; however, their absence can lead to dissatisfied customers.

Performance or Linear Attributes:

Companies generally schedule their investments and decisions using performance attributes.
A customer's willingness to pay for a product is directly related to the performance attributes.
The higher the performance attributes, the more the customer is willing to pay.

Excitement or Delighter Attributes:

The excitement attributes help in driving the hidden needs of the consumers that they have never thought about before.
Building in excitement attributes in the product or service can help organizations create a competitive advantage over their market competitors.

CTQs and KANO

Consider a 3-Star Manufacturing

- What are the CTQs for the process ?
- What at the Basic Requirements ?
- What are Performers ?
- What at Delighters ?

Customer

3-Star Manufacturing Inc

CTQs : _____

_____

_____

_____

- Basic Requirements

  _____

- Performers

  _____

- Delighters _____

Quiz 4 :

- What Tool is used to understand what is Critical to Quality (CTQ) by Forming 3 categories, 'Basic Requirements' , 'Performers' and 'Delighters' ?

- **KANO ANALYSIS**

- Splitting Customers into groups according to different needs or behaviours is called _____.
- **SEGMENTING**

- CTQs are also sometimes called CTCs or CTSs. What does CTS stand for ?

- **CRITICAL TO SATISFACTION**

- Give one example of a method used to understand the **Voice of the Customer** ?
- **SURVEYS**
  FEEDBACK
  FOCUS GROUPS , REPEAT SALE METRICS etc

Value Stream

Remember the 6 fundamentals of Lean ?

1. Value
2. Value Stream 
3. Flow
4. Pull
5. Perfection

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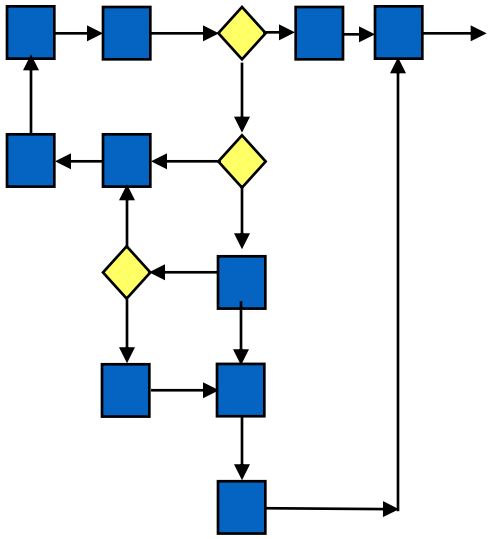
The Value Stream
&
Value Stream Maps

Understanding the process

We must first understand the Process Flow and the Value Stream before Process Problems can be understood.

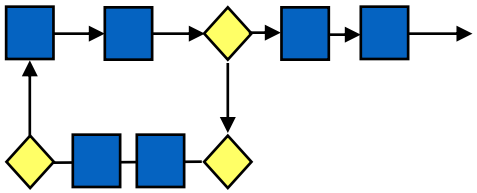


Process Mapping

There are usually three views of a process:

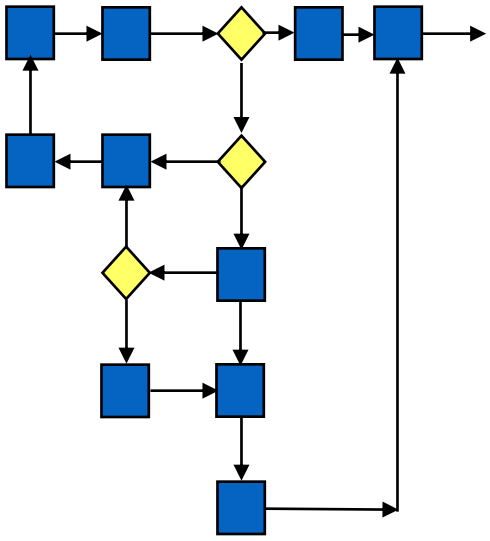
1

What people *THINK* it is..



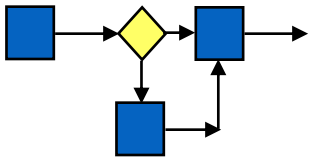
2

What it *ACTUALLY* is..

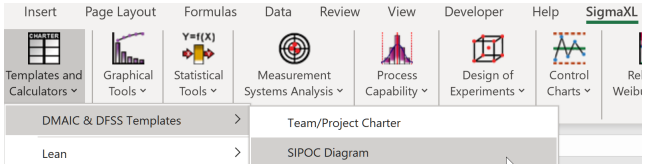


3

What it *SHOULD* be..



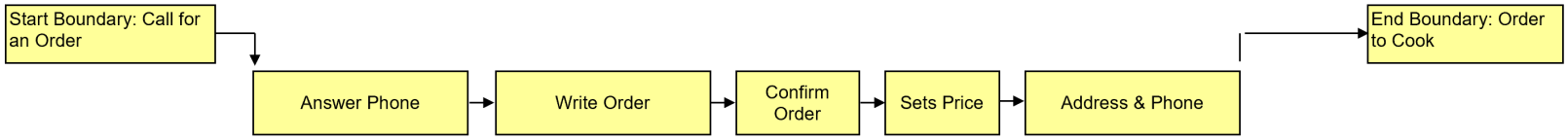
SIPOC



SIPOC DIAGRAM for Customer-Order Process

Process/Project Name:	**Customer Order Process**
Date:	
Prepared By:	
Notes:	

Suppliers	Inputs		Process	Outputs		Customers
Provider	Input Description	Input Requirements (optional)		Output Description	Output Requirements (optional)	Recipient of Output
ATT Phones	Pizza Type		See High Level Process Steps Below	Price		Cook
Office Depot	Size			ConfirmOrder		Accounting
TI Calculators	Quantity			Bake Order		
NEC Cash Regiser	Extra Toppings			Data on Cycle Time		
Customer	Special Orders			Order Rate Data		
	Drink Types/Quantities			Order Transaction		
	Other Products			Delivery Info		
	Phone Number					
	Address					
	Name					
	Time/Day/Date					
	Volume					



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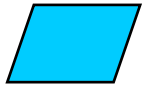
Standard Process Mapping Symbols

Standard symbols for Process Mapping:

(available in Microsoft Office™, Visio™, iGrafx™ , SigmaFlow™ and other products)

*A **RECTANGLE** indicates an activity. Statements within the rectangle should begin with a verb*



*A **PARALLELAGRAM** shows that there are data*

*A **DIAMOND** signifies a decision point. Only two paths emerge from a decision point: No and Yes*

*An **ELLIPSE** shows the start and end of the process*

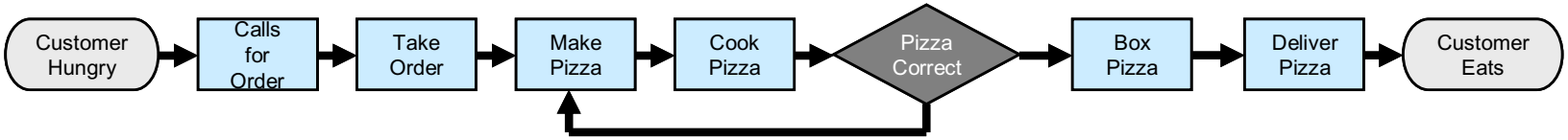
*An **ARROW** shows the connection and direction of flow*

*A **CIRCLE WITH A LETTER OR NUMBER INSIDE** symbolizes the continuation of a flowchart to another page*

FYI : Frank and Lilleth Gibreth produced the first Process Flow diagram with standard symbols in 1921

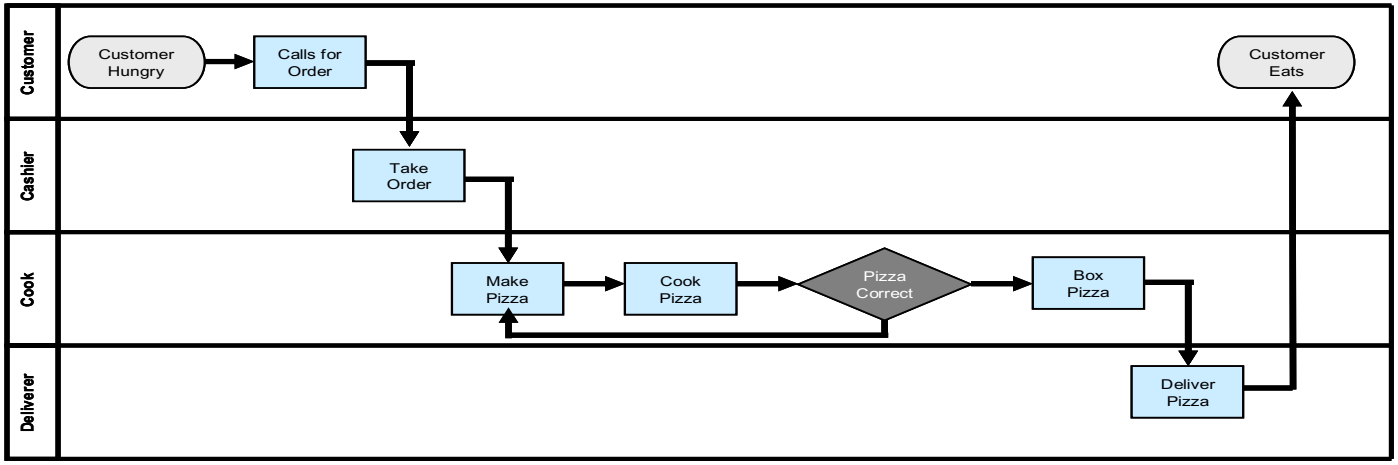
Types of Process Maps

The Linear Flow Process Map



As the name states this diagram shows the process steps in a sequential flow, generally ordered from an upper left corner of the map towards the right side.

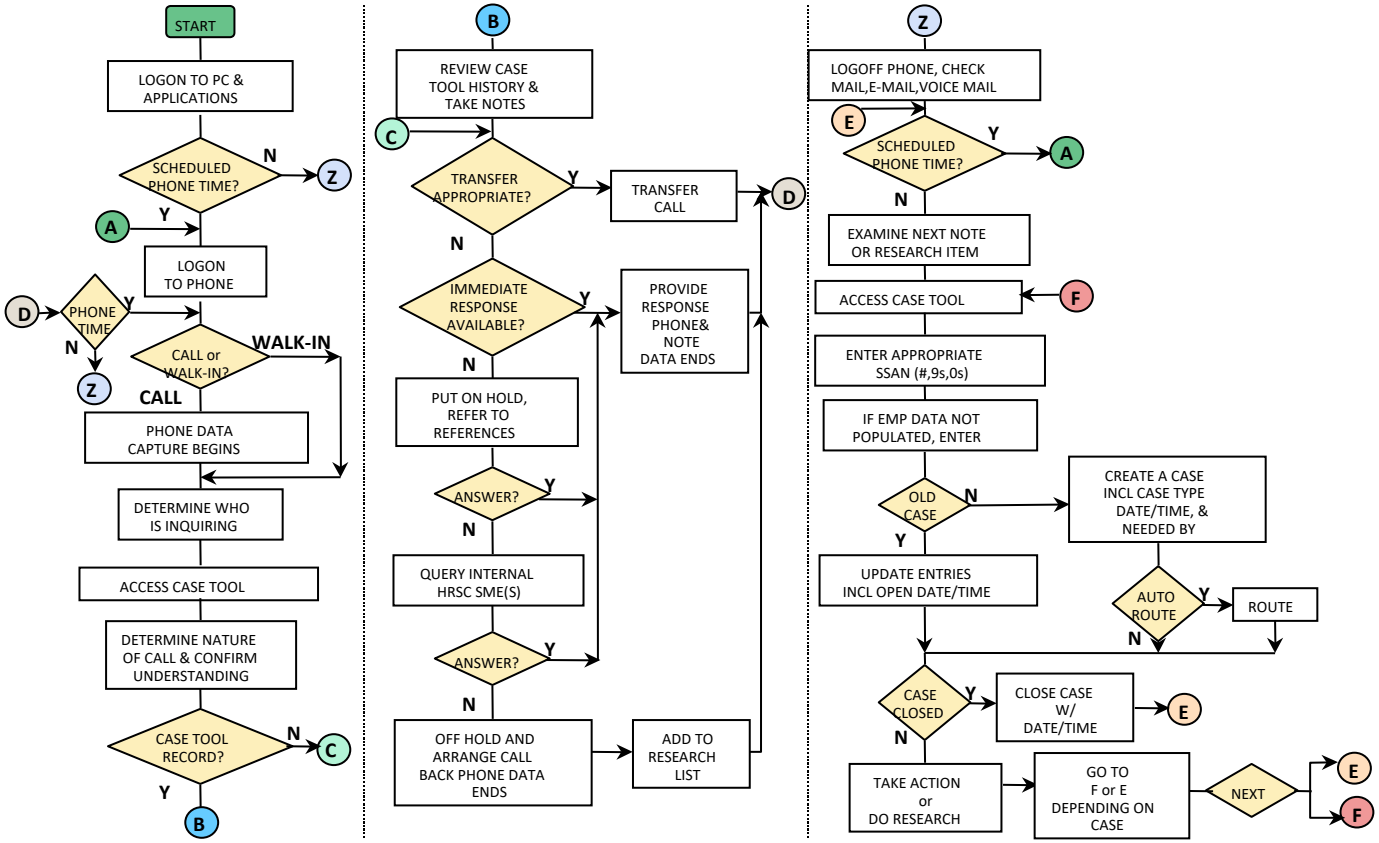
The Deployment-Flow or Swim Lane Process Map



The value of the Swim Lane Map is that is shows you who or which department is responsible for the steps in a process. A timeline can be added to show how long it takes each group to perform their work. Also each time work moves across a Swim Lane there is a "Supplier – Customer" interaction. This is usually where bottlenecks and queues form.

Process Map Example

Example : Process Map for a Call Center -



Value Stream Map

- A **Value Stream Map** traces all the processes all the way from the suppliers to your customers. It shows information (data), times (Value Add time and Non-Value Add time), costs and quantities of resources used at each stage.

- Map the “AS-IS” State as well as the “TO-BE” State

- Used to identify WASTE in your system

- Value Stream Maps start with a **High Level Process Map**
- Add:
  - **QUANTITIES** (Inventory, Scrap, Number of Operators etc)
  - **TIMES** (Cycle Times, Takt Times, Value Add Time, NVA Time)
  - **COSTS** ($ / unit, $ per delivery, $ per sale, $ of returns etc)
  - **DATA** (Calculated metrics such as OEE, Activity Ratio, Yields)

Value Stream Map

What Moves in a Value Stream ?

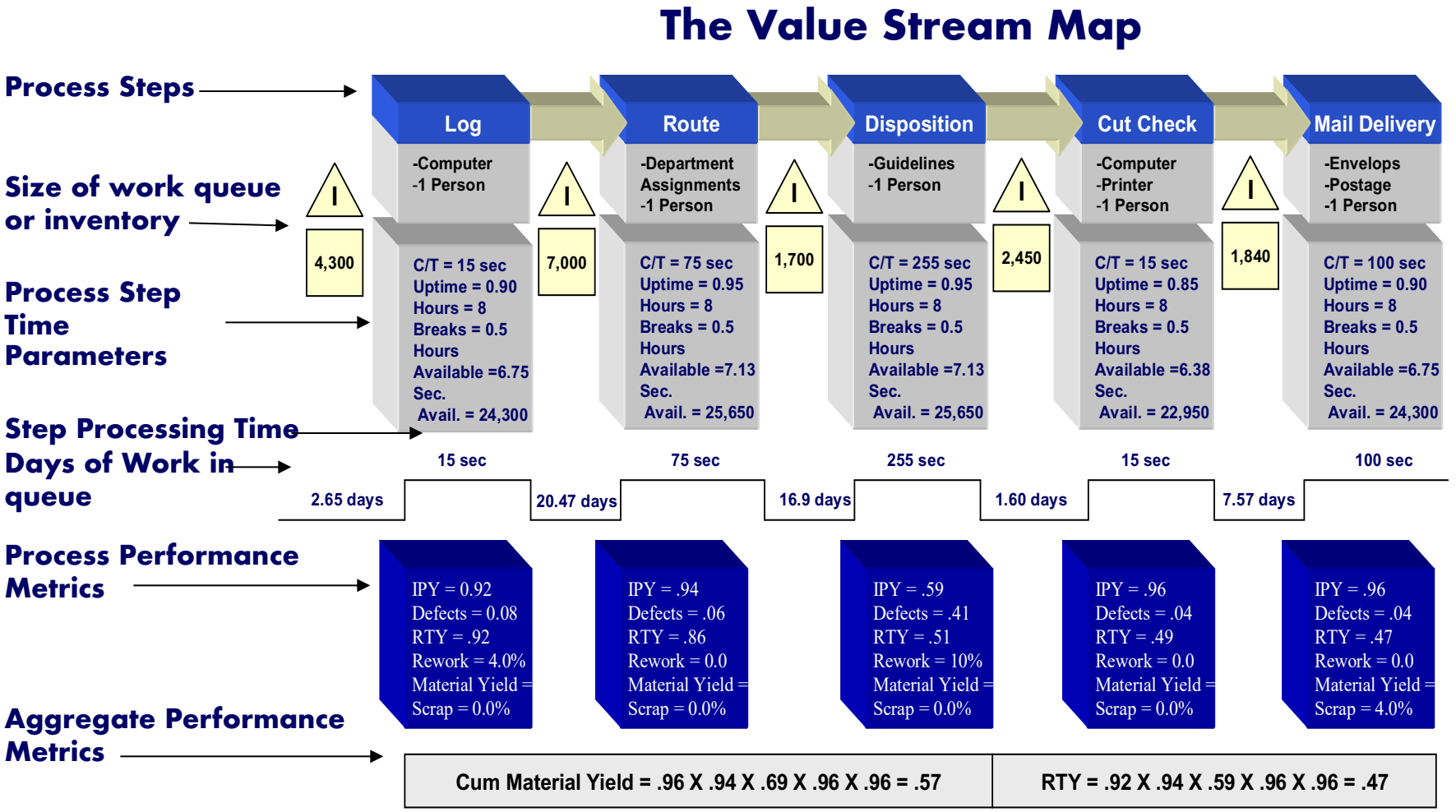
In Manufacturing?
….materials flows

In Shops and markets?
….finished goods and money flows

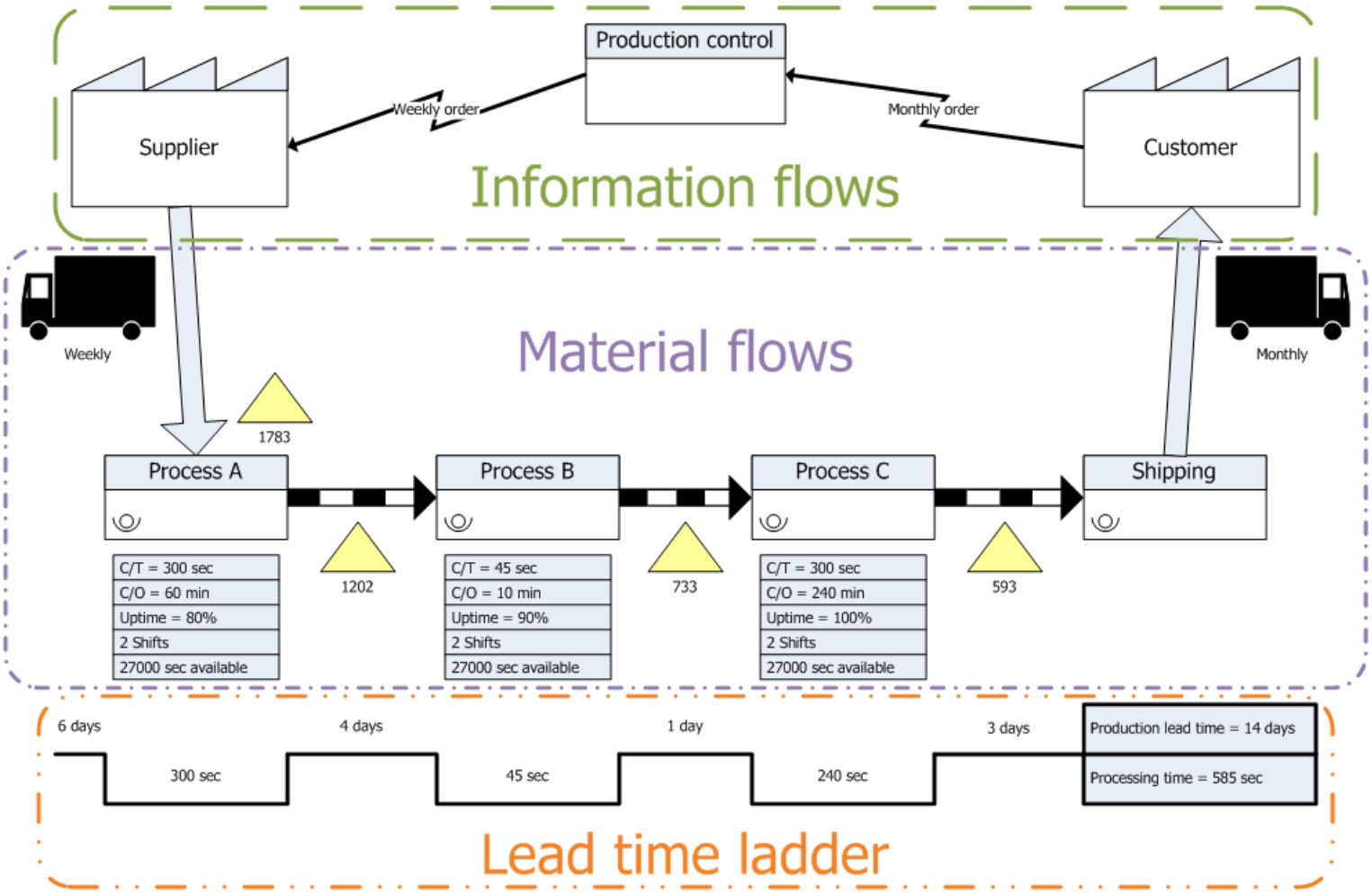
In Design, Marketing and Financial Services?
….data flows

In Transport, Hospitals and Human Services?
….people flow

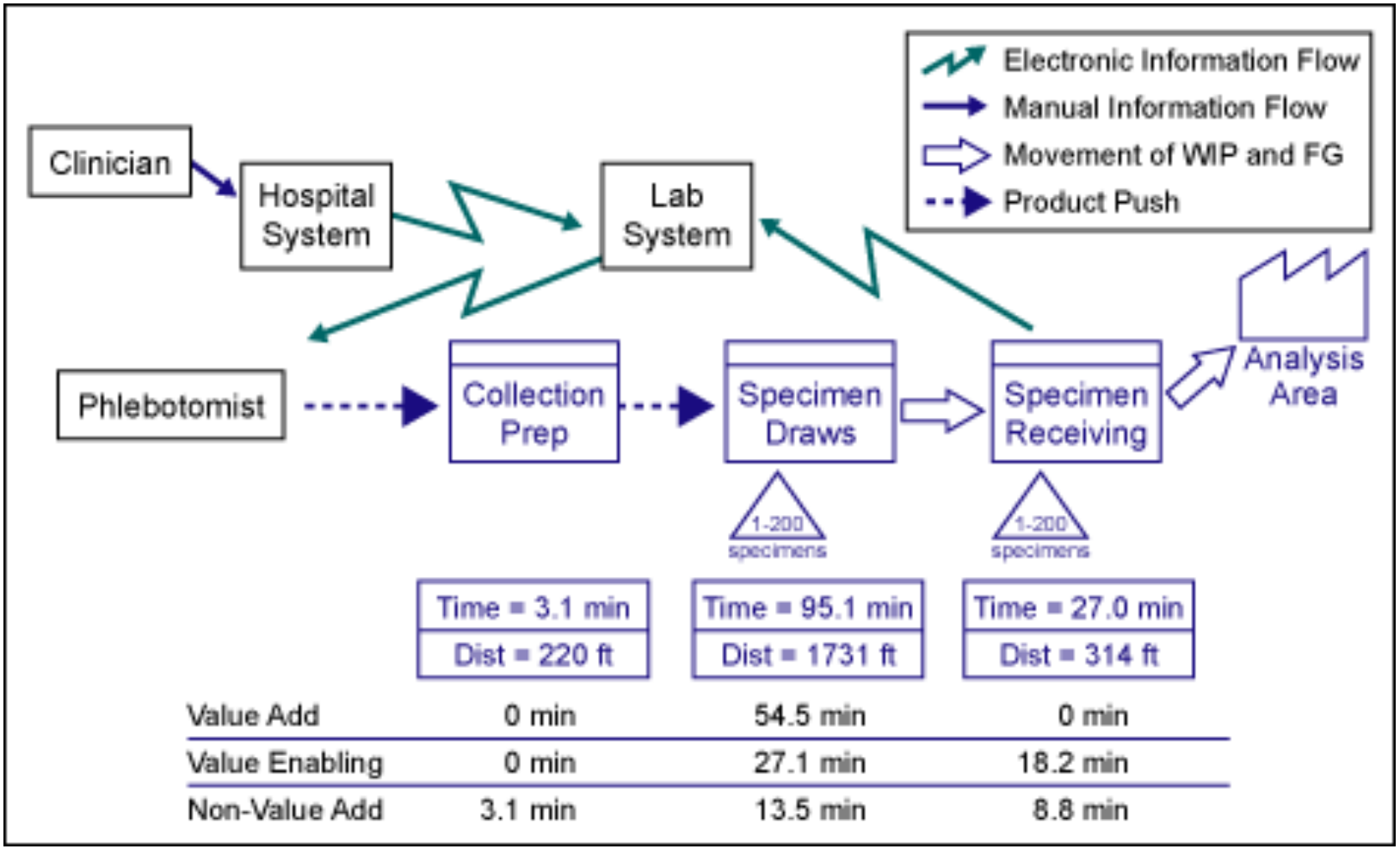
Value Stream Map – Style 1



Value Stream Map – Style 2

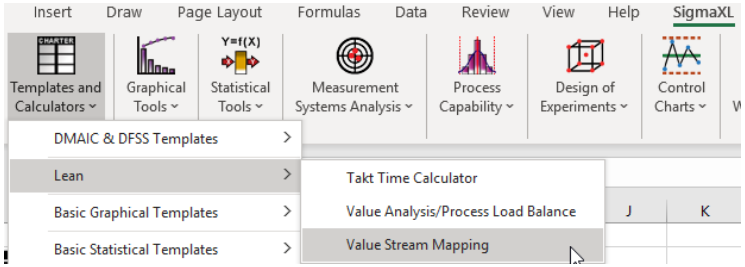


Value Stream Maps in Service Organizations



Value Add	0 min	54.5 min	0 min
Value Enabling	0 min	27.1 min	18.2 min
Non-Value Add	3.1 min	13.5 min	8.8 min

Value Stream Map Symbols



SigmaXL Value Stream Mapping Symbols

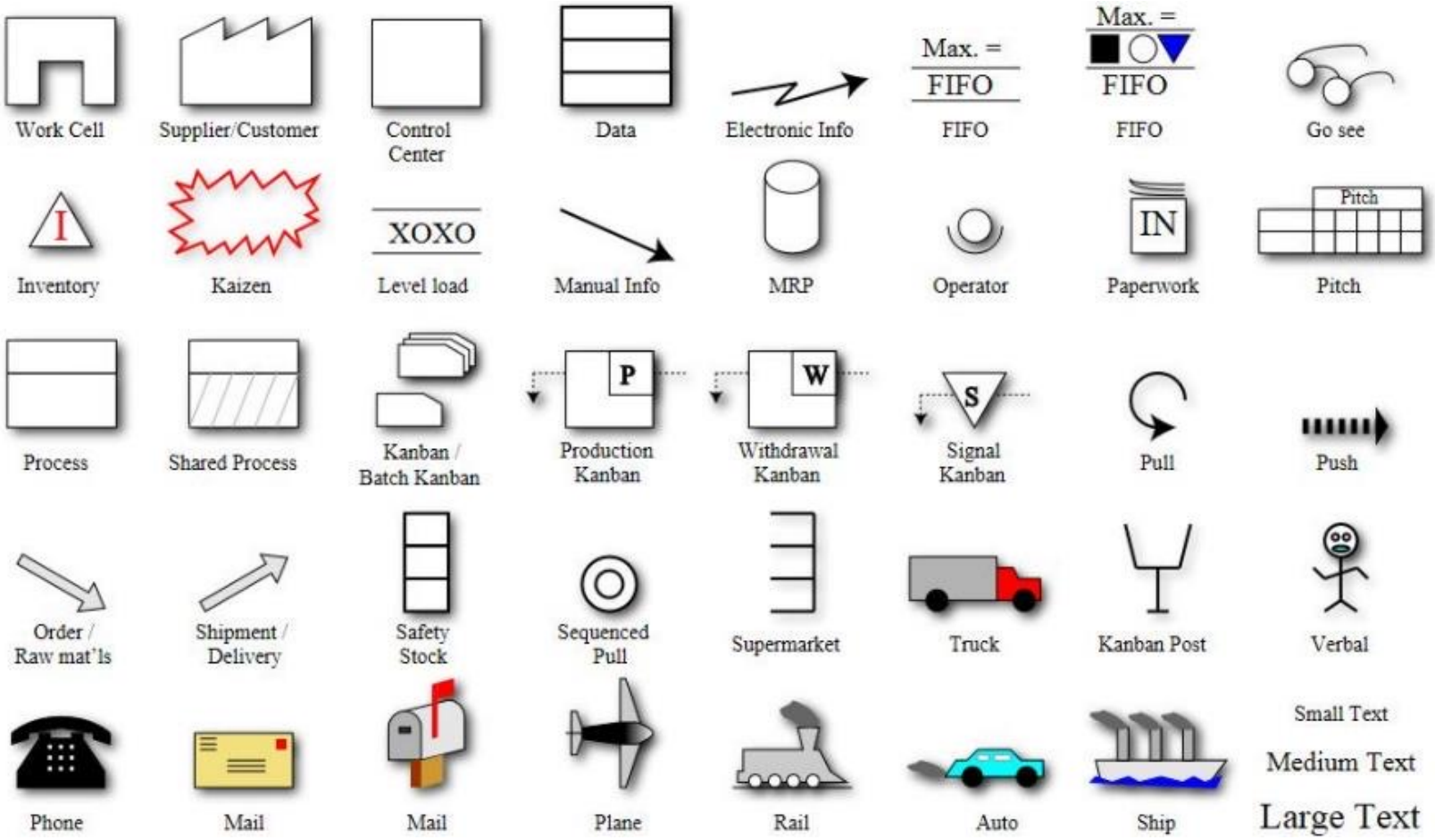
Process, Material Flow & General Symbols

Customer/Supplier Company Supplier when placed in the upper left of VSM; Customer when in the upper right	**External Shipment** Frequency External shipment from suppliers or to customers (truck, rail or boat)	**Supermarket** Small inventory used when continuous flow is not practical
Process Process Resources Process, department, operation or machine, through which material flows	**External Shipment (Air)** Frequency Air shipment from suppliers or to customers	**Safety Stock** Temporary safety stock
Data Box C/T = C/O = Batch = % Uptime = FPY = Typical data includes: Cycle Time (C/T), Operator Cycle Time, Auto Cycle Time, Changeover Time (C/O), Batch Size, % Uptime, Available Capacity, First Pass Yield (FPY), Rolled Throughput Yield (RTY), Value Added Time (VA), Scrap Rate, Distance Travelled	**Inventory** I Quantity Inventory count	**Material Pull** Physical removal from supermarket
Data Box data Miscellaneous data or other information	**Push Arrow** Movement of material that are "pushed" by the production process regardless of the needs of the downstream process	**Warehouse** Inventory storage (goal should be to reduce or eliminate)
Work Cell Multiple processes integrated in a workcell	**Material Movement** Finished goods or raw material movement	**Kaizen Burst** Kaizen Highlight area for improvement, to be addressed in a Kaizen Blitz Event
Operator/People 1 Number of operators or employees required to perform an operation	**FIFO Lane** FIFO Maximum Quantity First-In First-Out inventory	**VA/NVA Timeline** VA time NVA time Highlight value added cycle times versus non-value added wait times

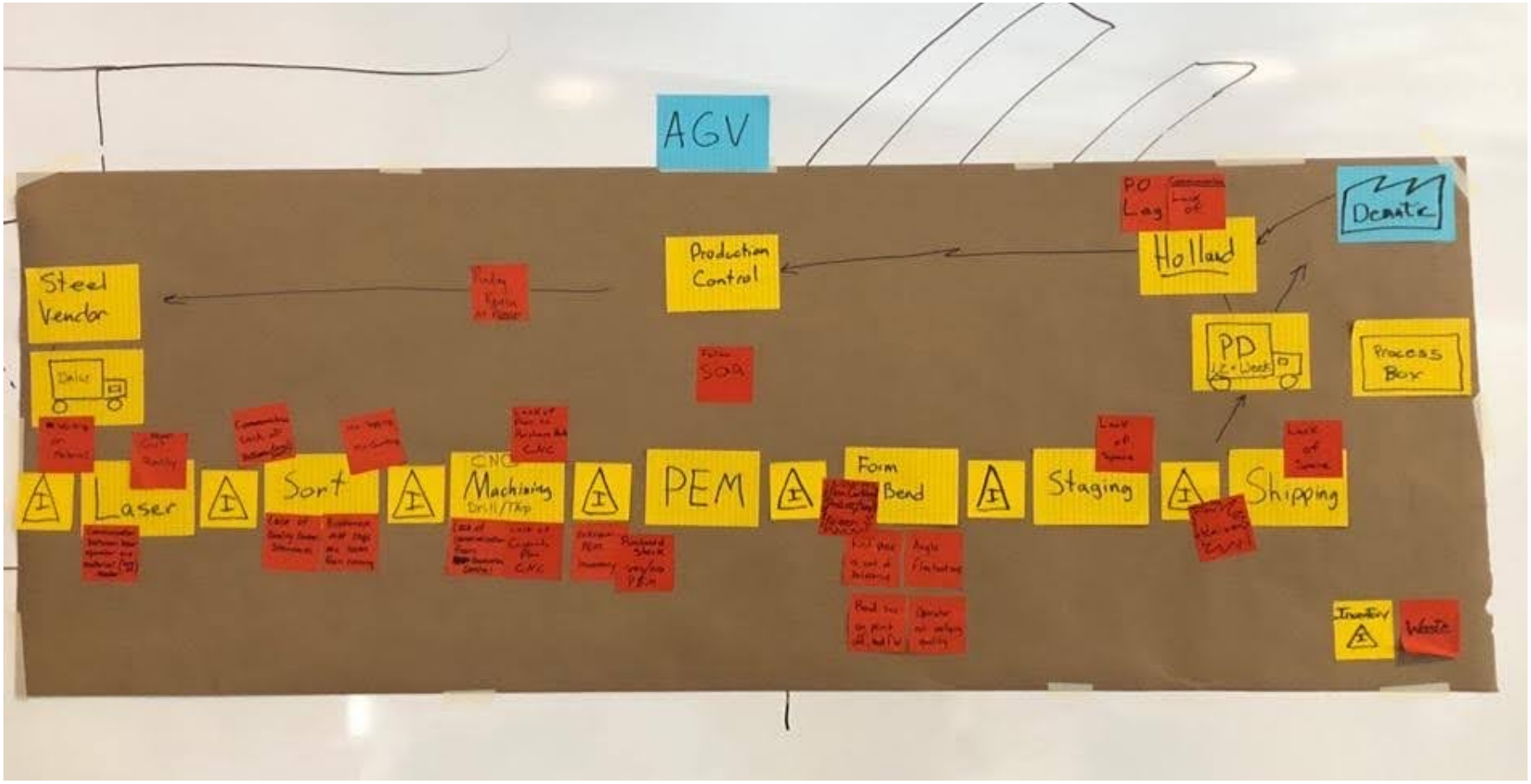
Information Symbols

Production Control PRODUCTION CONTROL Central production scheduling or control	**Production Kanban** Quantity Triggers production of a pre-defined number of units.	
Information Type Weekly Schedule Monthly Forecast Information type includes: Monthly Forecast, Weekly Orders or Schedule, Daily Orders or Schedule	**Withdrawal Kanban** Quantity Instruction to obtain items from the supermarket	
Manual Information Flow Manual information flow from memos, reports, or verbal. Add information type icon above as necessary.	**Signal Kanban** S Initiate a batch operation	
Electronic Information Flow Information flow via computer network. Add information type icon as necessary.	**Kanban Post** A physical location for kanban cards	
MRP/ERP MRP Schedule using MRP/ERP system	**Load Leveling** XOXO Batch kanbans to load level production	
Go See Gather information visually	**Sequenced Pull** Kanban signal, without using a supermarket	

Value Stream Map Symbols



Value Stream Map Example



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Value Stream Map Example

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Value Stream Map Example

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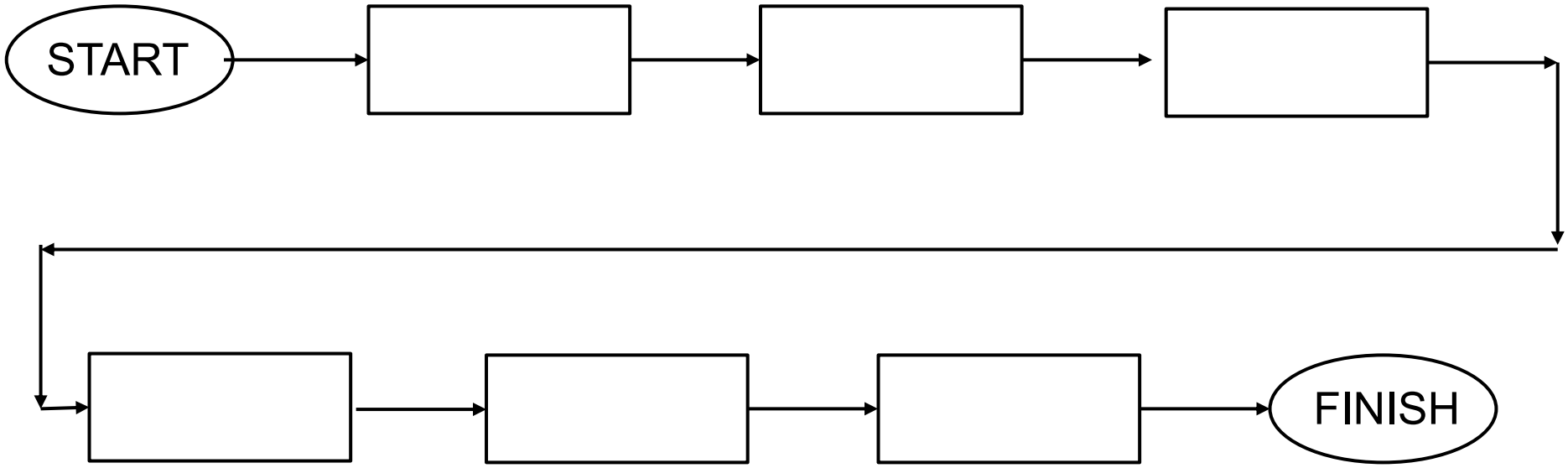
Value Stream Mapping exercise

ROLL → WEIGH → FLATTEN → CUT → ASSEMBLE → WEIGH

Class Exercise (In Pairs)

Draw a VALUE STREAM MAP

Including the times of each step and any waiting times



END OF DAY 1