



LEAN
SOLUTIONS
ACADEMY

A group of five professionals (three men and two women) in business attire are huddled together, smiling and looking down at something in their hands. The image is overlaid with a blue geometric design.

Lean & Six Sigma Training Green Belt Certification

brought to you by:



**PATRICK
ADAMS**
CONSULTING

CLASS SCHEDULE

Day 1

- Yellow Belt Class Refresh
- DEFINE
 - Introduction to DMAIC
 - Charters
 - SIPOC
 - Gantt Charts
- MEASURE

Day 2

- Green Belt Project Review
- ANALYZE
 - Fishbone Diagram
 - 5 Whys
 - Value Stream Mapping
- IMPROVE
 - Impact/Effort Matrix (Affinity Diagram)
- Facilitating a Kaizen Event

Day 3

- Green Belt Project Review
- CONTROL
 - Control Plan
 - Layered Audits
- Strategy Execution/ Hoshin Kanri
- Change Management



PROJECT CHECK-IN'S

- What is your Problem Statement?
- What are your measures of success?
- What is your timeline? Milestones?
- Do you have any roadblocks?
- Do you need help with anything?
- What are your next steps?

DEFINE

MEASURE

ANALYZE

IMPROVE

CONTROL

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TIME STUDIES

- Establishes a Baseline
- Measure's Improvements
- Internal/External Customers
- Break Down Each Component

DEFINE

MEASURE

ANALYZE

IMPROVE

CONTROL



Time Study Practice



Add in time study example – do a blank time study form with the steps

Product:													
Wk Ctr:													
Process:													
Date													
Name													
	Repetition : Time in Seconds										Lowest Repeatable Time		
Work Element	1	2	3	4	5	6	7	8	9	10		Task Observation	
Get up from Chair													
Walk to Flipchart													
Pick up marker													
Write on flipchart													
Put down marker													
Walk back to chair													
Sit down in chair													
Total For One Cycle:													

DEFINE

MEASURE

ANALYZE

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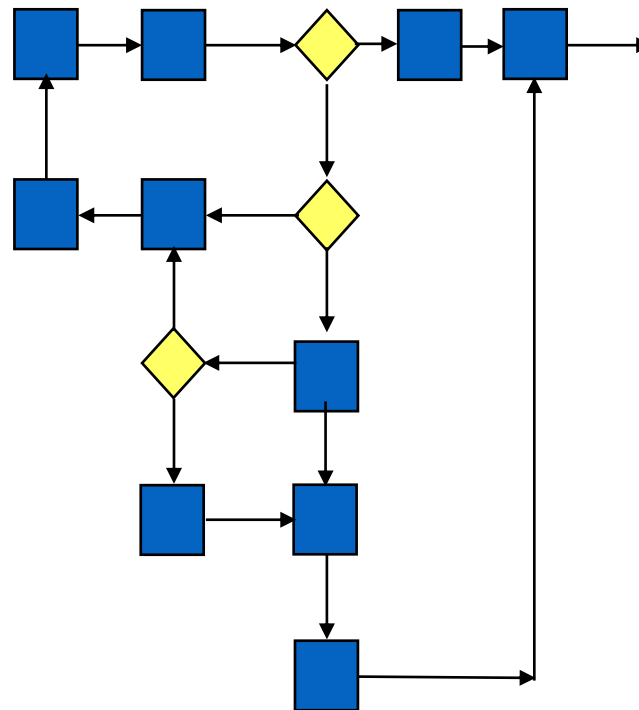


Process Observed Writing on Flipchart		TIME OBSERVATION FORM										Page <u>1</u> of <u>1</u>	
Product/Service CP-550-0382												Observation Date/Time March 14, 20YY/9:00:00 AM	
												Observer(s) Hank Ford	

No.	Component Task		Observed Cycles										D Lowest Repeatable Component Task Time	Machine Cycle Time	Points Observed	
			1	2	3	4	5	6	7	8	9	10				
1	Get up from chair	Cumulative	0:03	0:31	0:59	1:32	1:57	2:25	3:01	3:26				2		
		Task Time	3	2	2	2	2	3	2	2						
2	Walk to flipchart	Cumulative	0:09	0:38	1:04	1:37	2:03	2:31	3:06	3:32				5		
		Task Time	6	7	5	5	6	6	5	6						
3	Pick up marker	Cumulative	0:11	0:43	1:07	1:39	2:06	2:34	3:08	3:34				2		(cycle #2) dropped marker
		Task Time	2	5	3	2	3	3	2	2						
4	Write on flipchart	Cumulative	0:18	0:49	1:20	1:46	2:12	2:41	3:14	3:41				7	D*	(3) made mistake, had to rewrite
		Task Time	7	6	13	7	6	7	6	7						
5	Put down marker	Cumulative	0:21	0:51	1:23	1:48	2:15	2:44	3:16	3:44				2		
		Task Time	3	2	3	2	3	3	2	3						
6	Walk back to chair	Cumulative	0:27	0:54	1:28	1:53	2:20	2:56	3:21	3:50				5		(2) sprinted back to chair, (6) stop and talked to team member
		Task Time	6	3	5	5	5	12	5	6						
7	Sit down in chair	Cumulative	0:29	0:57	1:30	1:55	2:22	2:59	3:24	3:52				2		
		Task Time	2	3	2	2	2	3	3	2						
		Cumulative														
		Task Time														

UNDERSTANDING THE PROCESS

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

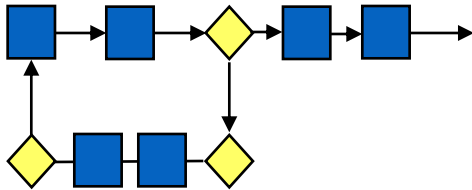


PROCESS MAPPING

There are usually 3 view of a process:

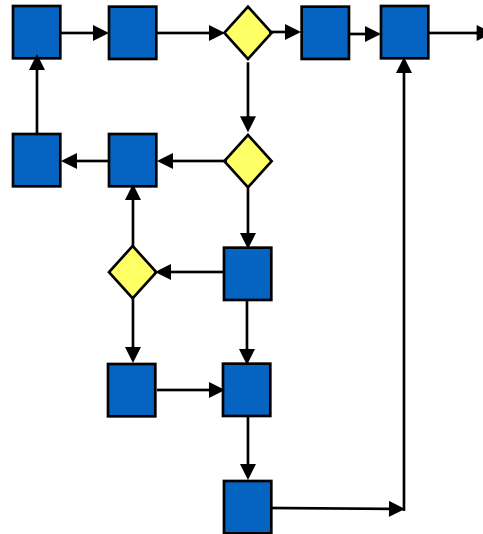
1

What people *THINK* it is..



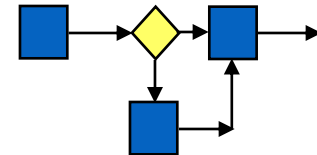
2

What it *ACTUALLY* is..



3

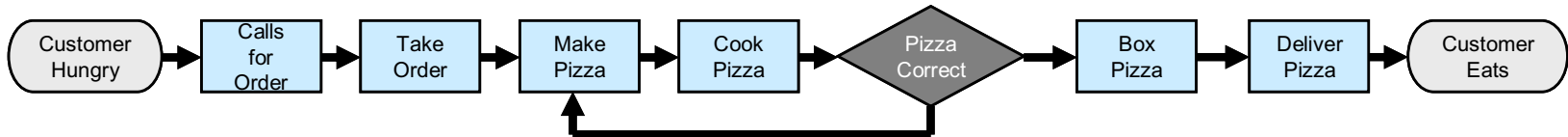
What it *SHOULD* be..



Process mapping is used to identify all steps and decisions of the process visually

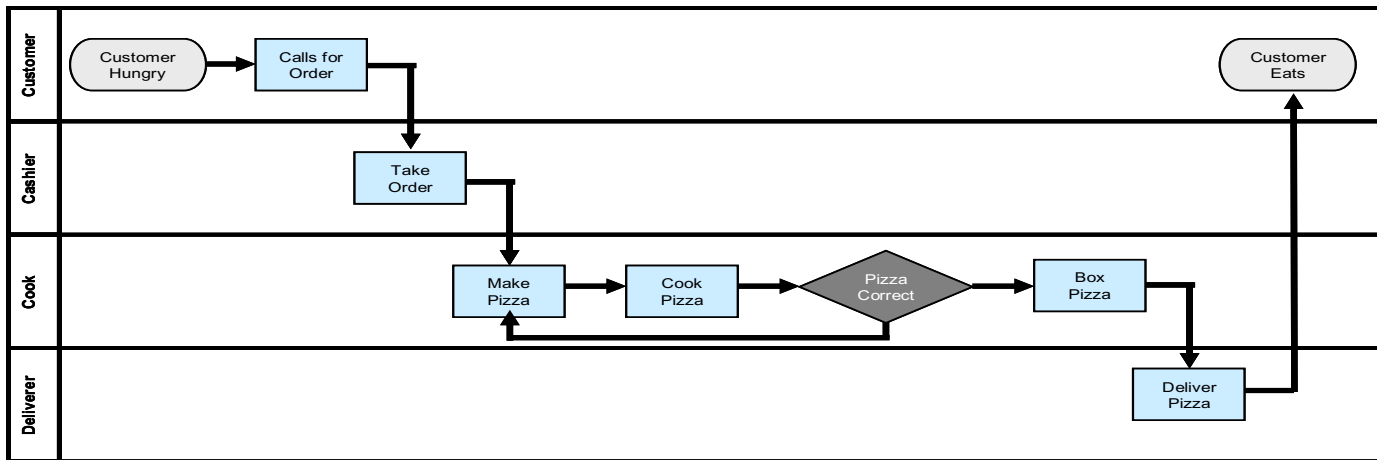
TYPES OF PROCESS MAPS

The Linear Flow Process Map



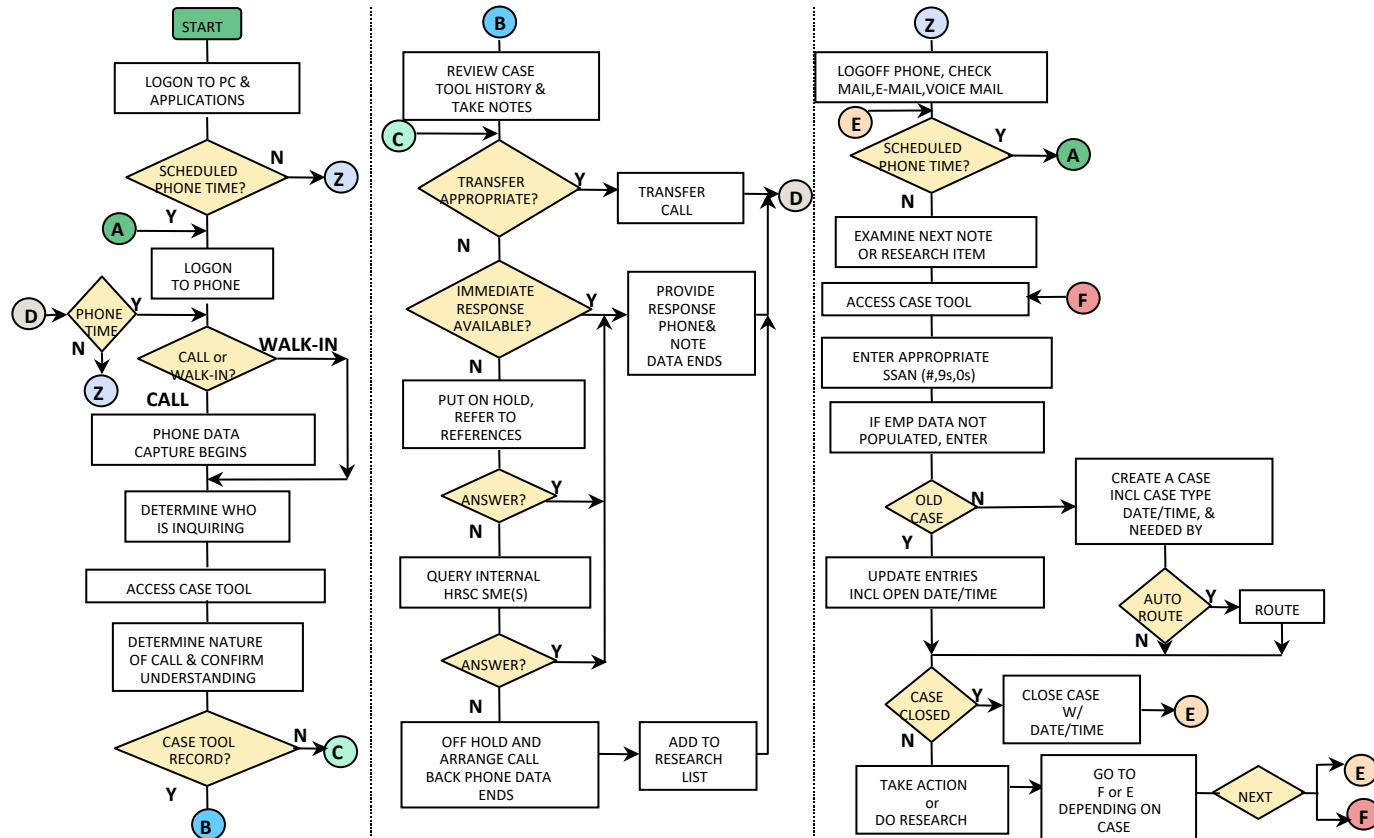
As the name states this diagram shows the process steps in a sequential flow, generally ordered from an upper left corner of the map towards the right side.

The Deployment-Flow or Swim Lane Process Map



The value of the Swim Lane Map is that it 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



DEFINE

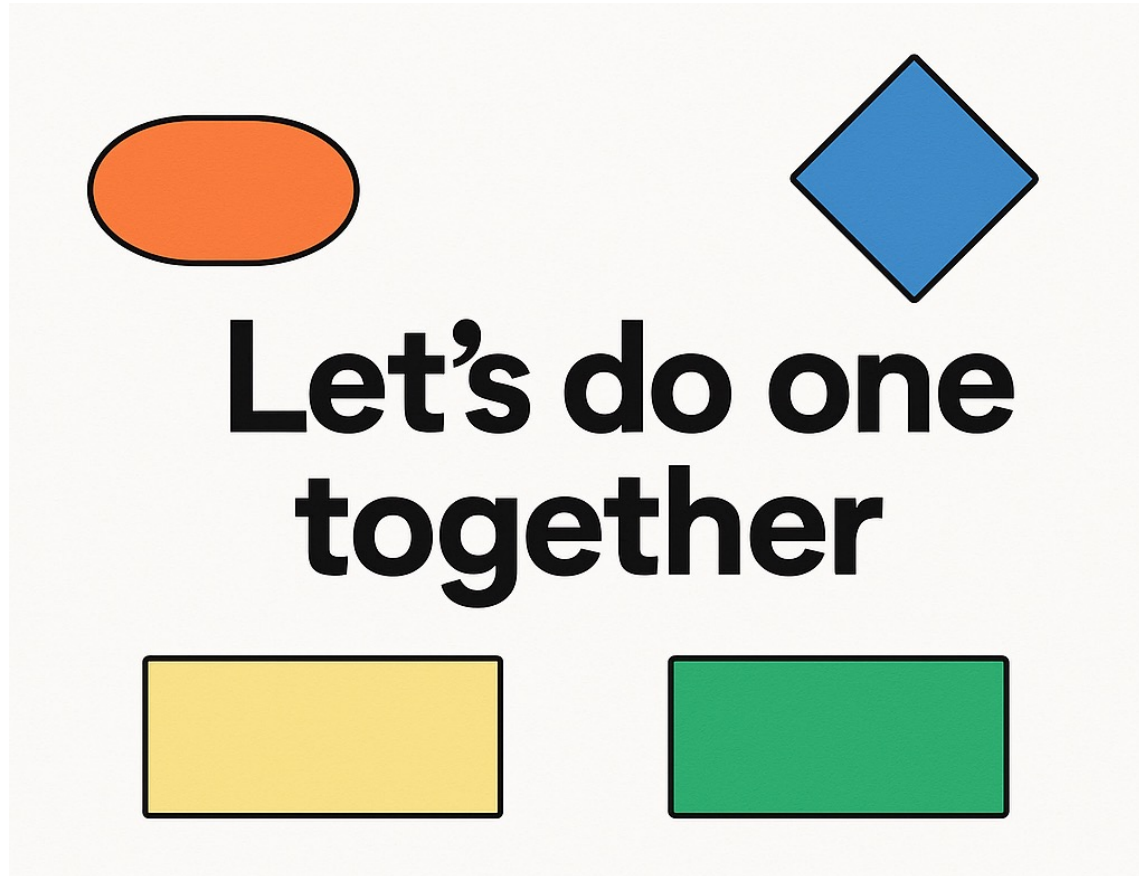
MEASURE

ANALYZE

IMPROVE

CONTROL

PROCESS MAP EXERCISE



DEFINE

MEASURE

ANALYZE

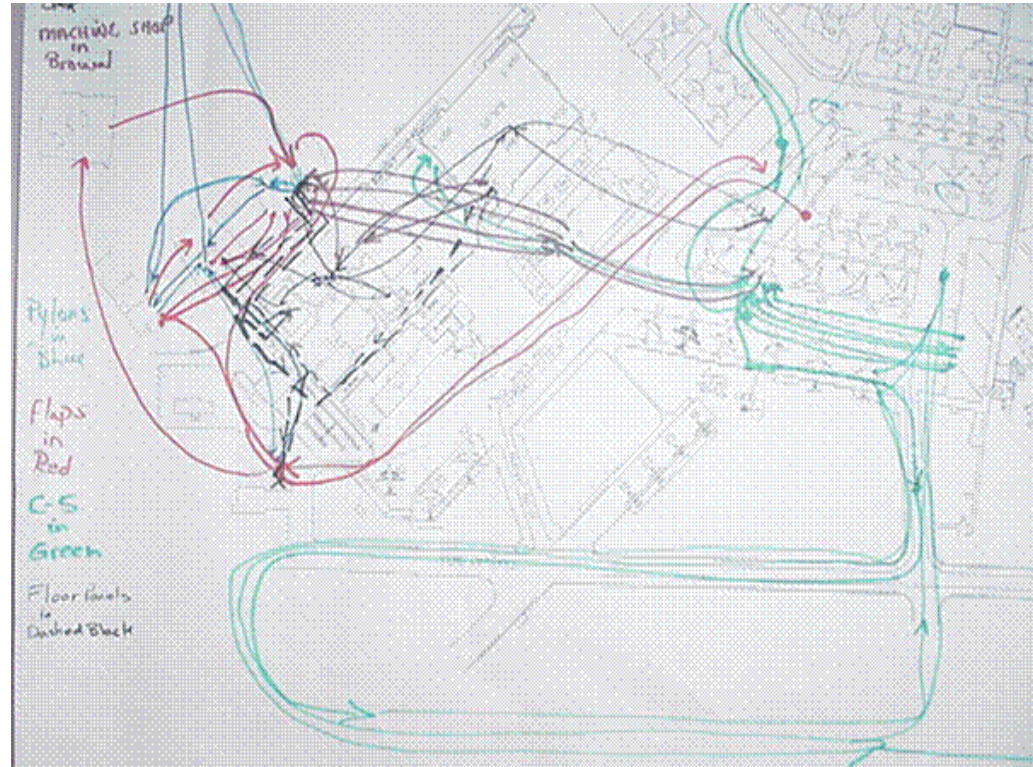
IMPROVE

CONTROL

Spaghetti Diagram

- Purpose

- Show the physical flow of members and materials
- Used to improve the physical layout



Spaghetti Diagram Preparation

- Think about what you want to show
 - Parts/part families
 - People
 - Functions
 - If showing multiple items, can show on same map in different colors
- Think about what you want to understand
 - Distance, # steps
 - Use these to quantify the resulting map

Spaghetti Diagram Steps to Create

1. Obtain a drawing of the area
 - Several copies, A couple plotted and a handful A3 size, and clipboards
2. Observe the process and record the steps
 - If it is in one area, observe to flip chart,
 - if distributed make assignments distribute clipboards and follow and map
3. Begin with the first step and draw lines between each successive step
 - Use arrowheads to show direction on map
 - "#x" to represent paths that are repeated numerous times
4. Record time and/or distance between each step
5. Record overall time and/or distance for the process
6. Identify improvement opportunities
 - Alternate layouts, draw a diagram of the improved process

QUIZ 2:



1. How do you calculate Takt Time?
 - **EFFECTIVE WORKING TIME PER TIME PERIOD / CUSTOMER DEMAND PER TIME PERIOD**
2. What is the difference between special cause and common cause variation?
 - **COMMON CAUSE IS EXPECTED WHILE SPECIAL CAUSE IS UNEXPECTED.**
3. What is the goal of the measurement phase?
 - **EVALUATE THE “AS-IS” CAPABILITY OF THE PROCESS**



VALUE STREAM MAPPING

DEEPER DIVE!

DEFINE

MEASURE

ANALYZE

IMPROVE

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INTRODUCTION

Definition: All the actions (both value added and non-value added) currently required to bring a product from raw material to customer.

- Shows the “Big Picture”.
- Documents the path from customer to supplier and back.

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WHY IS THIS

AN ESSENTIAL TOOL?

- Helps you “see” the flow
- Identify the waste and its source
- Provides a common language
- Decisions about the flow become apparent
- Linkage between information flow and material flow
- Allows team to document current AS IS and determine TO BE states

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REDUCE

LEAD TIME

- Lead time is measured from the point where flow is initiated or triggered in a process until the product or service reaches the customer
- The aim is to reduce this timeframe by only producing in response to a pull from the customer (or the next process as customer) and eliminating the things that waste time and resources.
- LT reduction is often accomplished by eliminating queue times between processes



"All we're trying to do is shorten the time line..."

Taiichi Ohno

DEFINE

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CURRENT STATE VS MAP STEPS

- **Step 1:** Identify customer requirements and calculate takt time
 - Our customer is sometimes internal or external
 - Our customer is also the shareholder
- **Step 2:** (DATA BLOCKS) Identify Main Processes In Order
 - Each one will be different and unique to the area you are working with.
 - A data block is created when a person or area passes a product or service to the next step.

CURRENT STATE VS MAP STEPS

- Step 3: Add arrows for the Flow of Information.
 - Straight arrows
 - Right Angles (NO diagonals)
 - Information flow arrows
- Step 4: Walk the Value Stream: Add inventory / delay queues. Note movement and inventory
 - What will be considered the WIP? What is considered inventory?
 - Inventory triangles should be noted between process blocks.
 - Stay customer centric here. A customer doesn't care if you have a price on a line item if they are waiting for a package...

CURRENT STATE VS MAP STEPS

- **Step 5:** Walk the Value Stream - Populate the Data Boxes with Metrics
 - Identify Key Performance Indicators for the Value Stream.
 - For today => See Data Box
- **Step 6:** Summarize Value Stream Metrics - Calculate Lead Time Ladder
 - Lead time complete = lead time PLUS Inventory



DATA INTEGRITY

There are four scenarios for data collection.



Data exists



Data can be gathered through observation of work



Data can be collected through simulation of activities



If you cannot observe or simulate the activity you may have to make an educated “estimate”

DEFINE

MEASURE

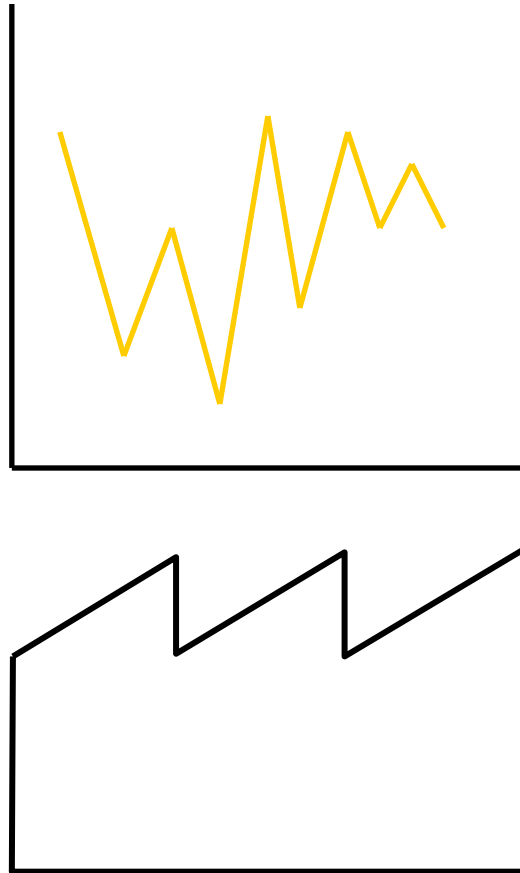
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CREATING THE CURRENT STATE VALUE STREAM MAP



Always Start With the Customer

- What capability /service do you provide?
- What are the boundaries of your map?
- What is the demand profile?

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TAKT TIME


$$\text{Takt Time} = \frac{\text{Time Available / Period}}{\text{Customer Demand / Period}}$$

Takt Time – *The available production time divided by customer demand.*

- Defining the “right goods or services”, is done in the design and development process.
- The steps to transform the raw material or data to the customer defined value are captured as the work elements.
- To provide goods and services “in the right quantity, at the right time”, customer demand (takt time) must be understood.
- Cycle Time should be $\leq$ to Takt Time

TAKT TIME EXAMPLE

Takt Time = Demand Rate

- Synchronizes pace of processing to match pace of customer need.

$$\begin{aligned}\text{Takt Time} &= \frac{\text{Effective working time per time period}}{\text{Customer requirement during the time period}} \\ &= \frac{460 \text{ minutes / day}}{46 \text{ quotes}} = 10 \text{ minutes per quote}\end{aligned}$$

Ideally, one quote every 10 minutes must be processed

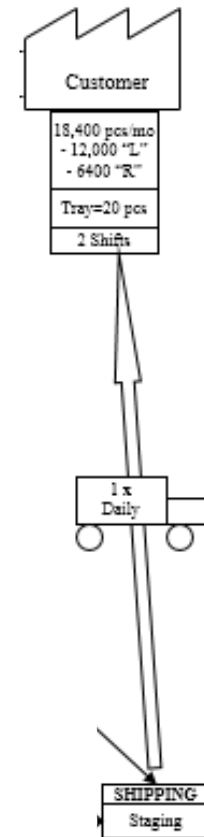
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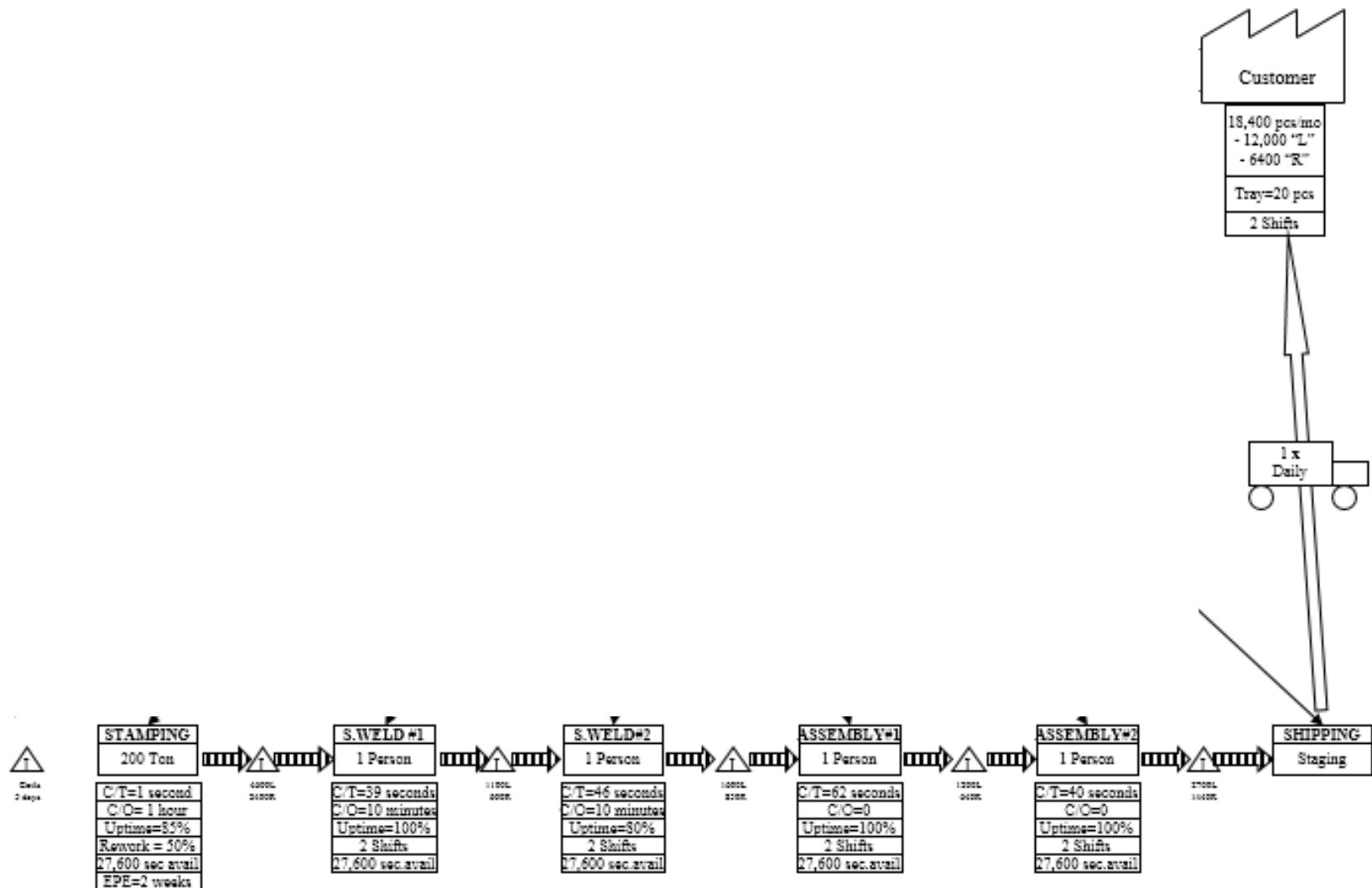
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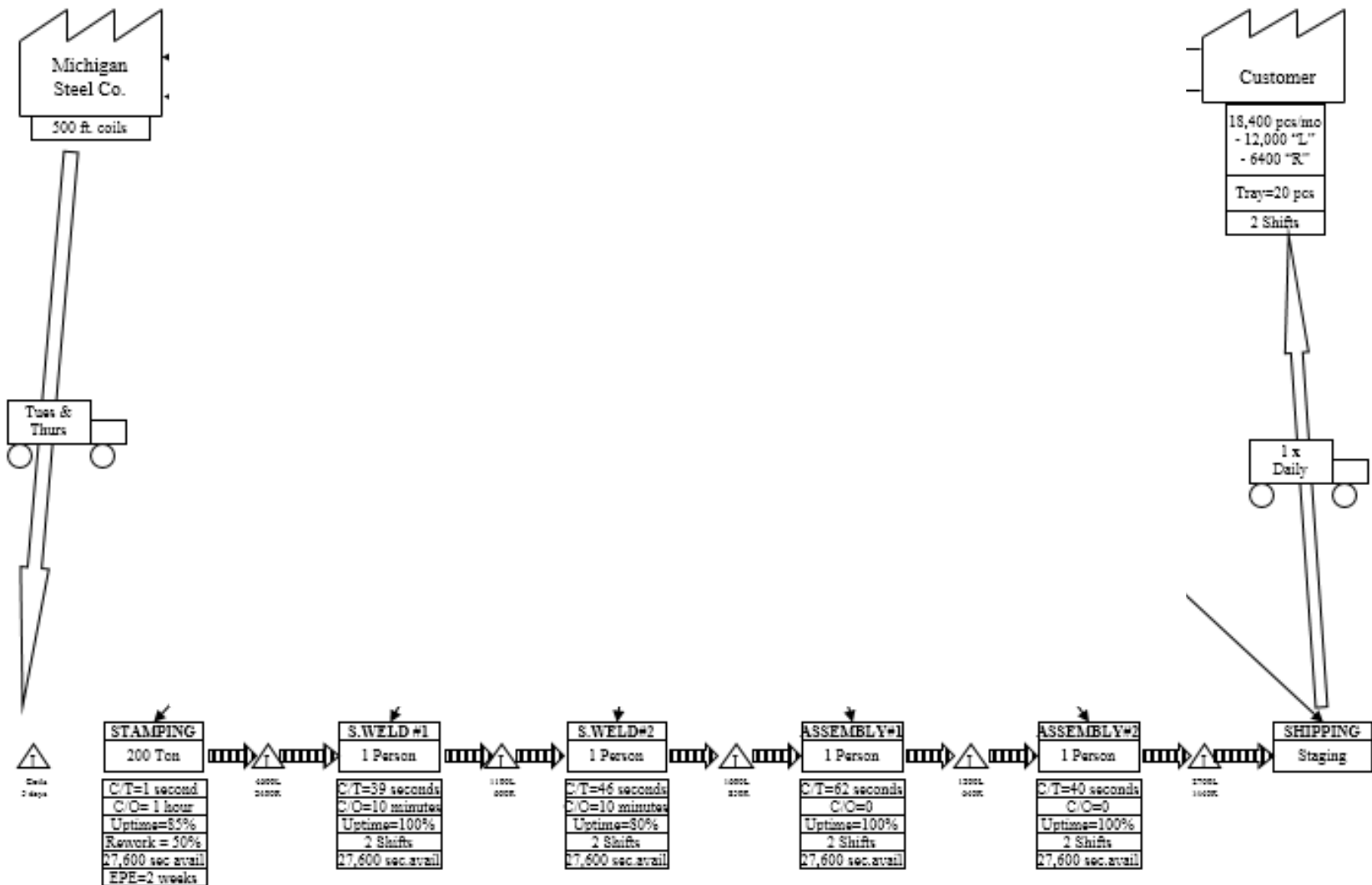
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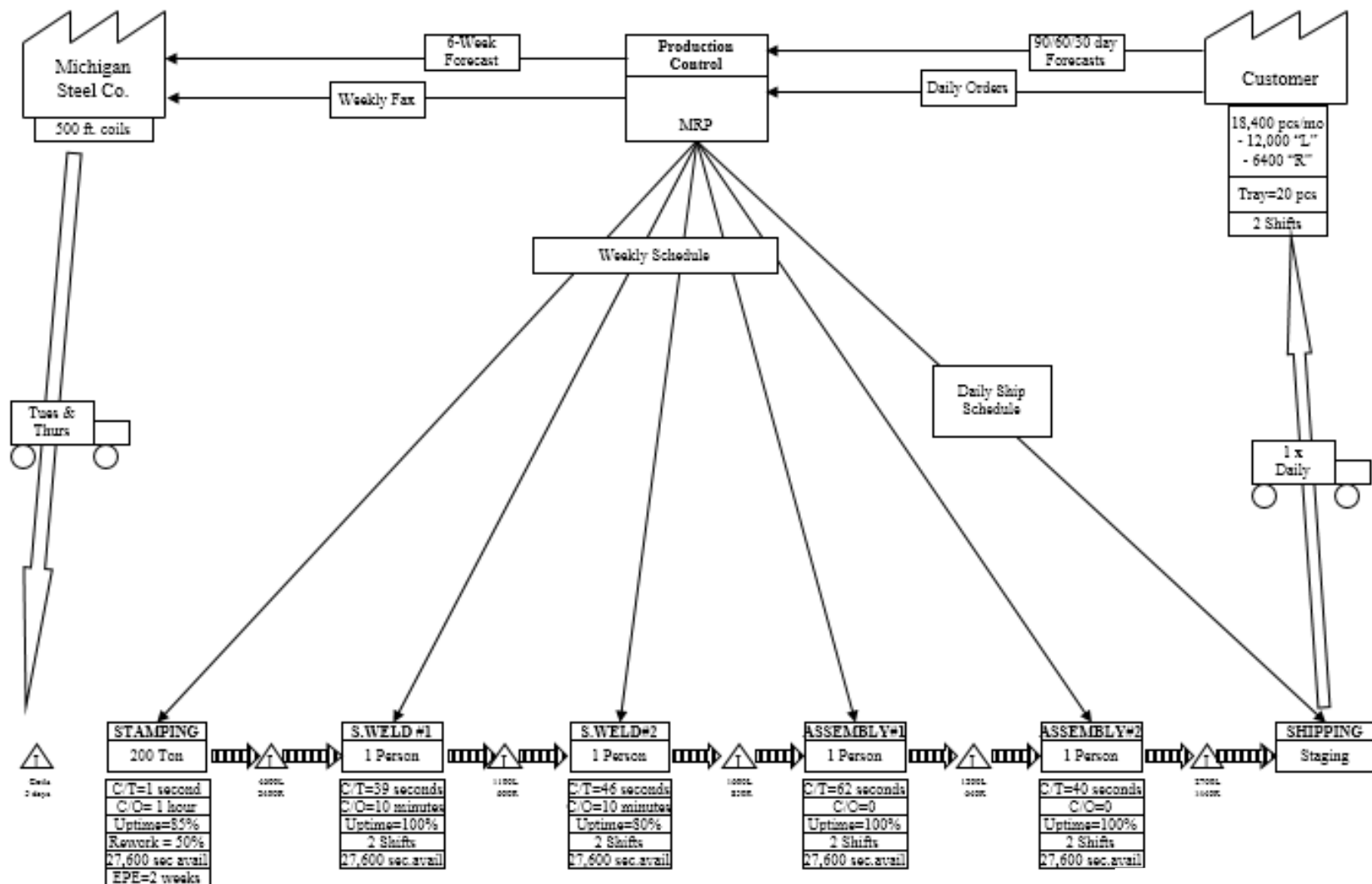
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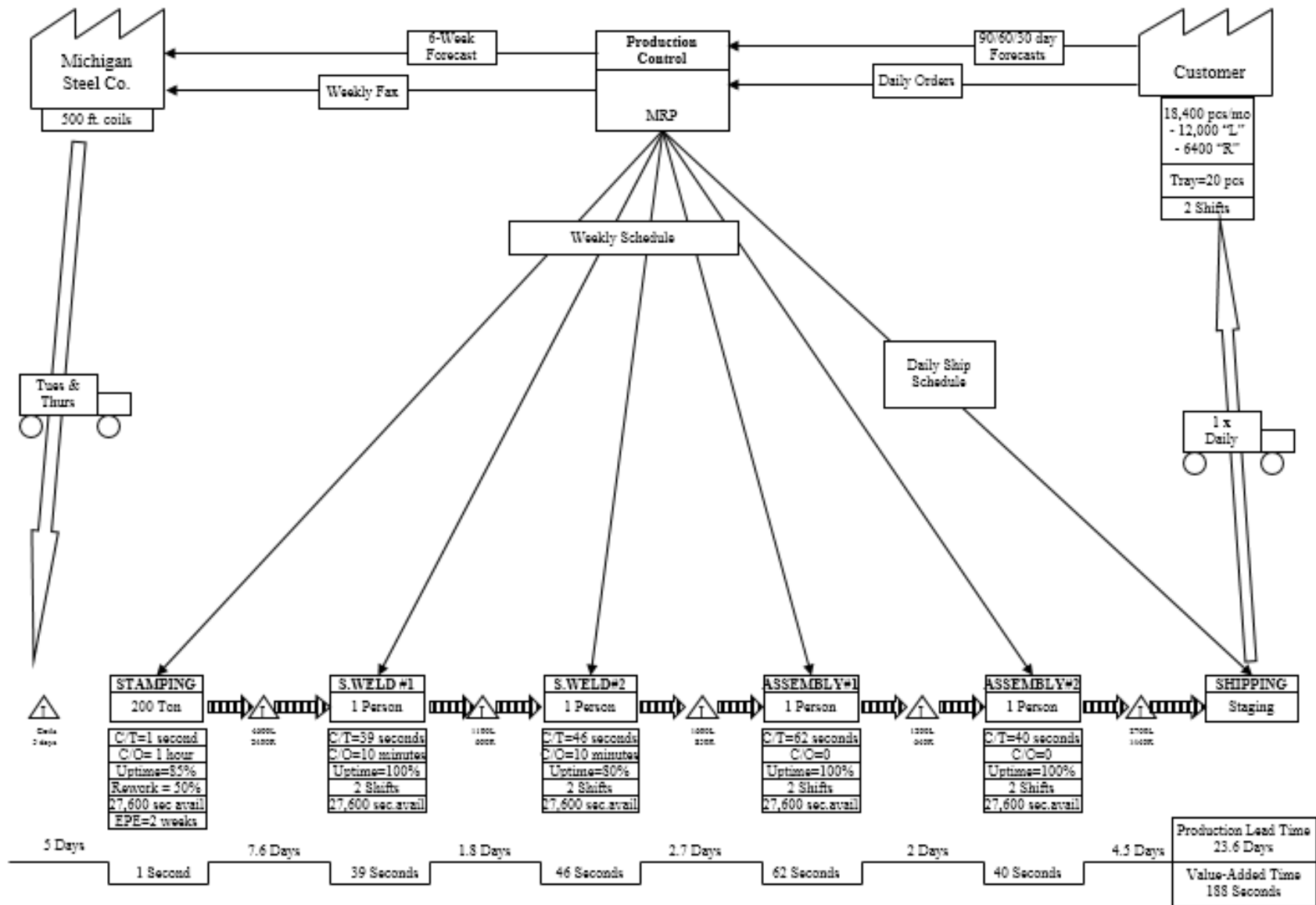
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DEFINE

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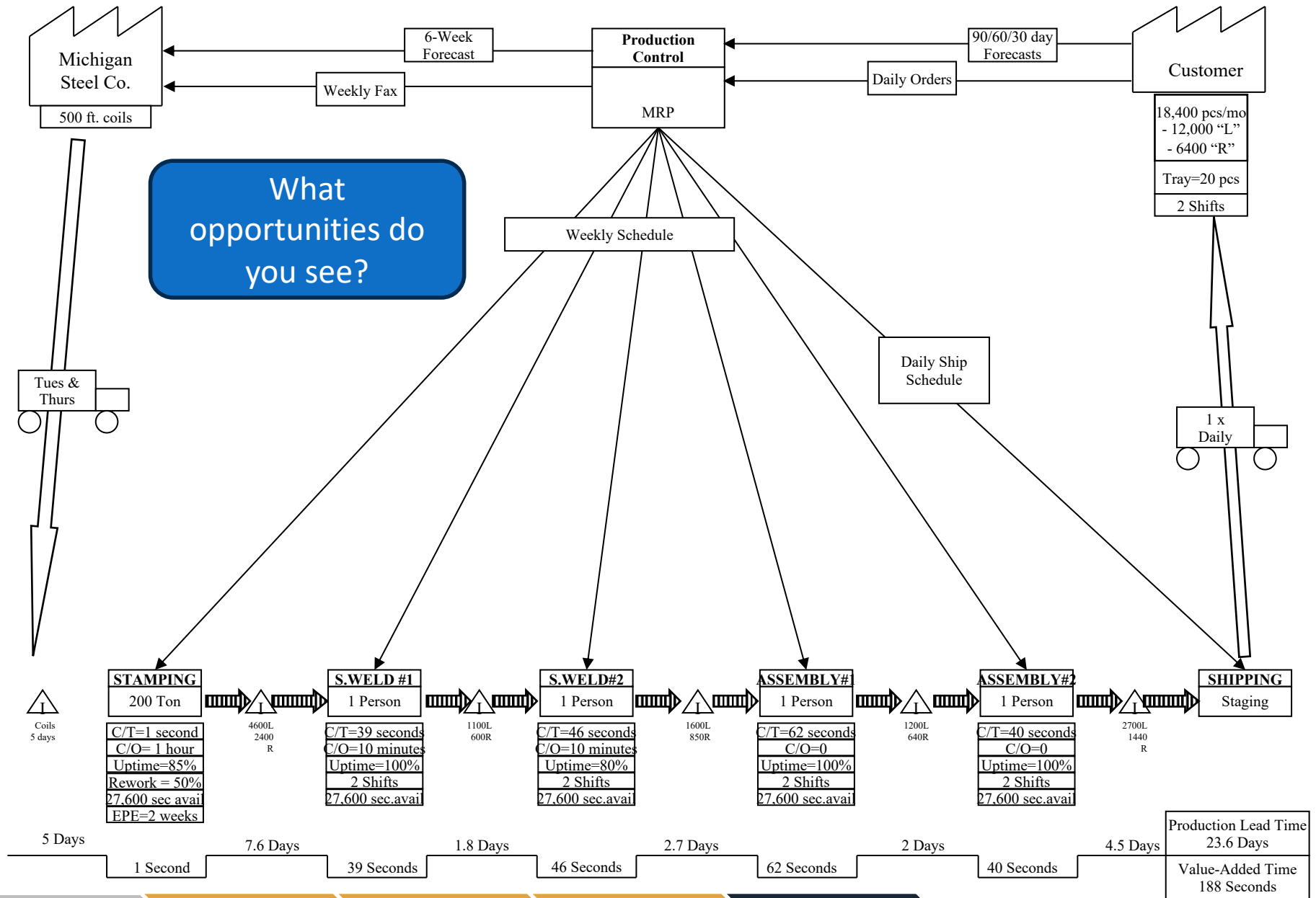
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CURRENT STATE MAP



FUTURE STATE VSM



8 Point Criteria



Takt Time – Ensure that can meet the takt time



Finished Good Strategy – Make to Stock or Make to Order



Continuous Flow- Where can 1 pc flow be put into place



FIFO – If no 1 pc flow, where can FIFO and what size of FIFO



Pull – if can't flow, need to pull



Scheduling only 1 point – typically pacemaker

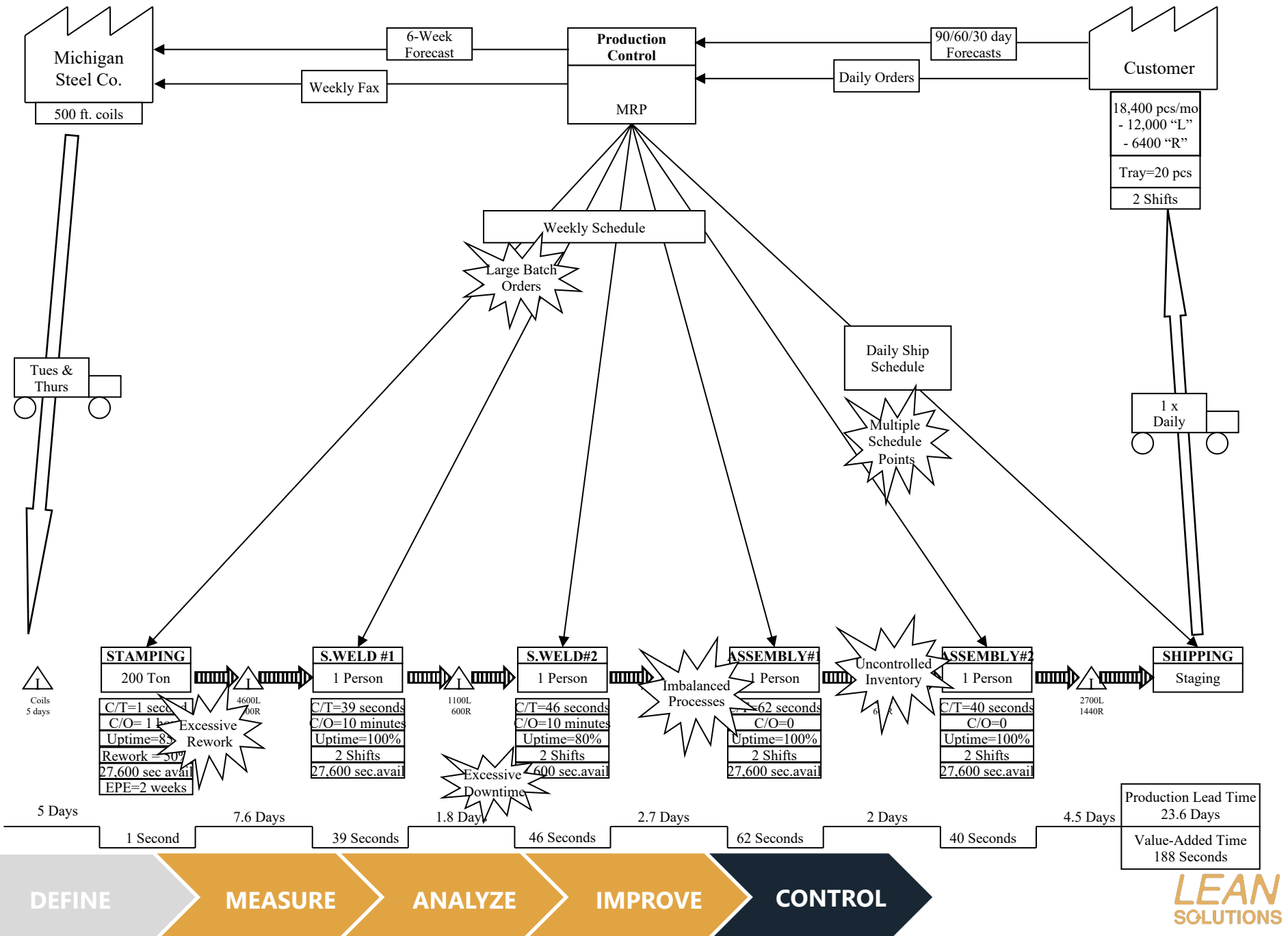


EPEI – Interval (how often run through every regular product)

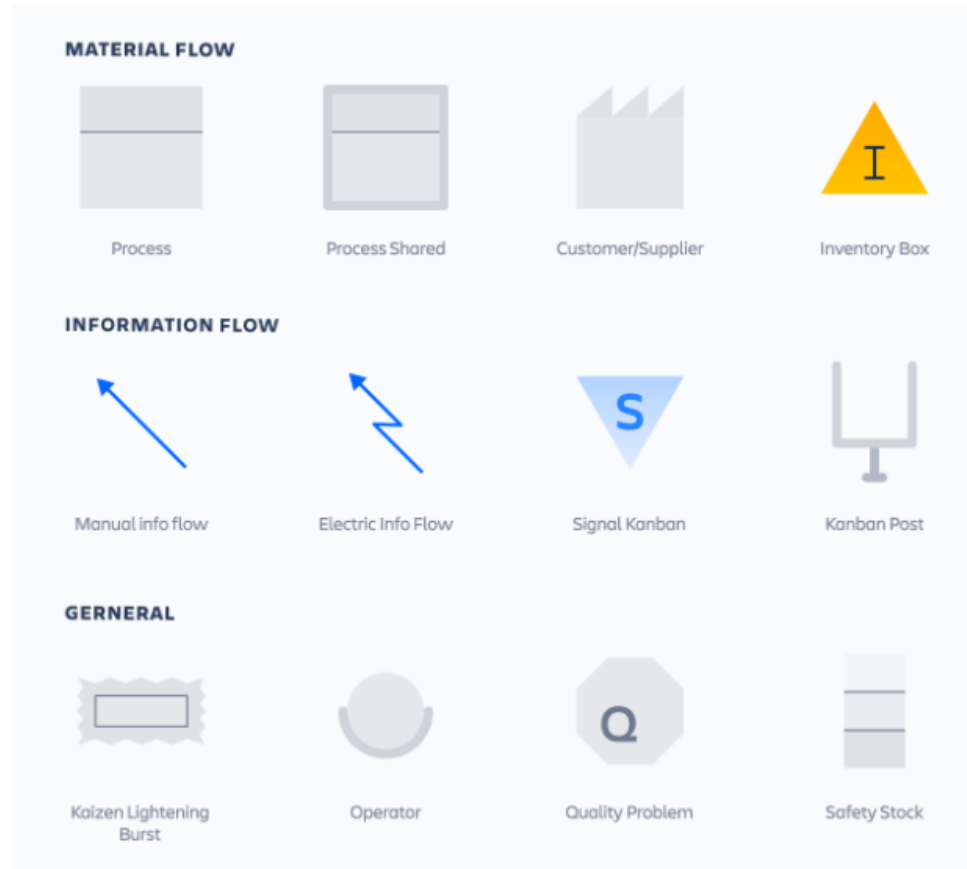


Pitch – How often release and take work away from pacemaker

CURRENT STATE MAP



VALUE STREAM SYMBOLS



DEFINE

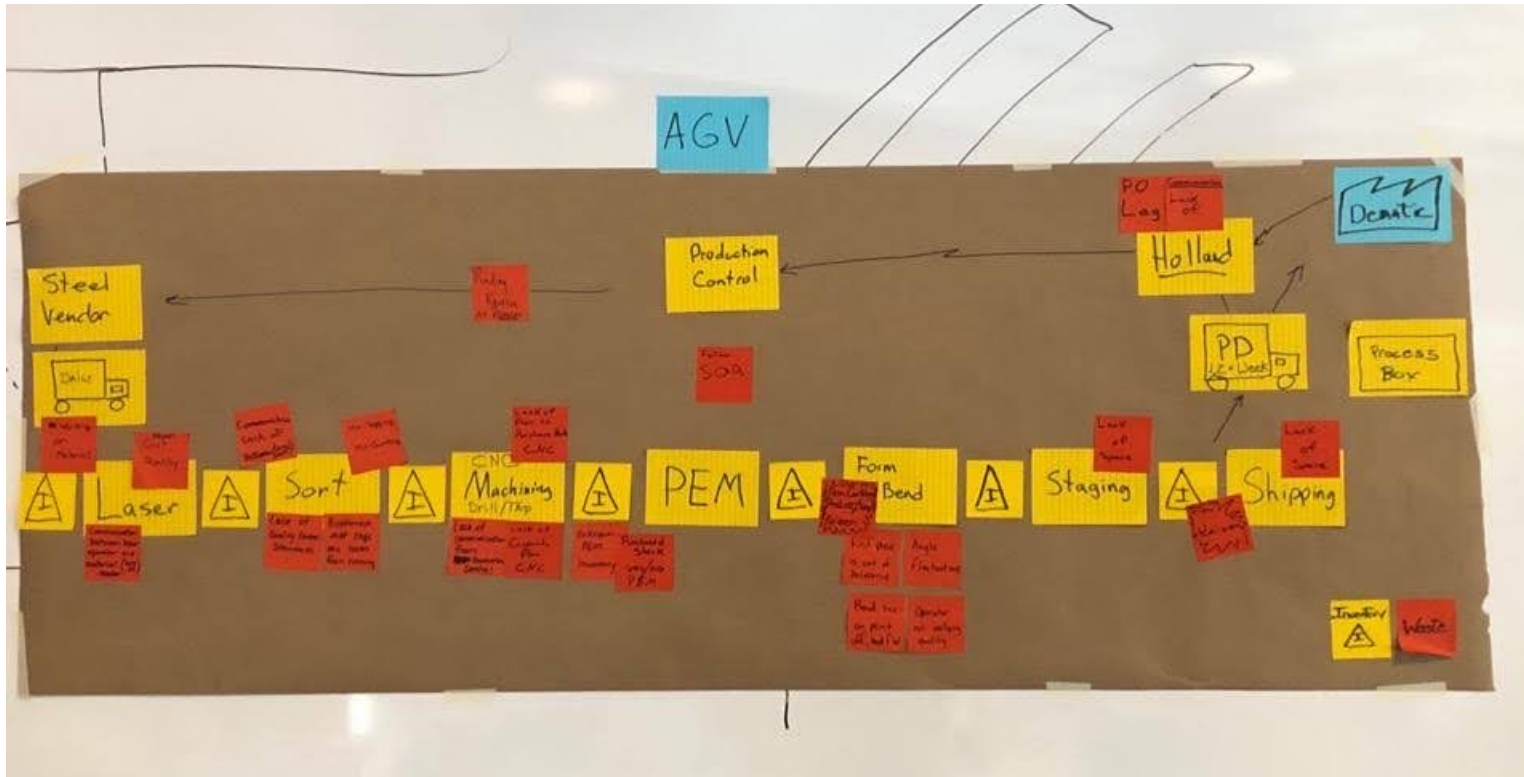
MEASURE

ANALYZE

IMPROVE

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VALUE STREAM MAP EXAMPLE



VALUE STREAM MAP EXAMPLE



VALUE STREAM MAP EXAMPLE



DEFINE

MEASURE

ANALYZE

IMPROVE

CONTROL



LET'S CREATE ONE TOGETHER!

DEFINE

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VSM or Process Map?

Feature / Use Case	Value Stream Map (VSM)	Process Map
Scope	Broad – entire value flow across departments	Narrow – specific process or subprocess
Focus	Flow of materials and information	Sequence of tasks and decisions
Purpose	Identify delays, inventory, and handoffs	Understand steps, roles, rework, and variation
Time-based metrics	Yes – includes lead time, process time, takt time	Optional – usually focuses on step sequence
Cross-functional use	Yes – shows interaction across teams	Often used within a single function
Best used when...	Improving end-to-end delivery or lead time	Standardizing or improving a local process

DEFINE

MEASURE

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Update the A3

A3				
Project Title:	Project Champion:	Project Manager:	Core Team Members	Original Creation Date:
	0	0	0	
	Process Owner(s):			Rev Date/ Rev #
	0			
Problem Statement			Measure	
What is the problem to be solved (use a metric), when and where is it occurring, what is the requirement and who is affected.				
Business Case			Analyze	
Why should we work on solving this problem now, why is it important to the business.				
Scope			Improve	
In Scope		Out of Scope		
Include both what is in scope and out of scope. SIPOC can help with this				
Goal			Project Champion Approval	
What is the goal of this project (x to y by when)? What are the process characteristics of the project in addition to the metric change (for example, one piece flow)? Note: this should not be the solution.				
Define			Control	

- For everything you have learned during the Measure Phase update the A3



Remember, the Goal of the Measure Phase was to:

Evaluate the “As-Is” Capability of the
Process.

DEFINE

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ANALYZE PHASE

DEFINE

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The Analyze Phase is

The Analyze Phase is for determining the ROOT CAUSE of the problem that we are trying to solve.

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METHODS USED TO ANALYZE THE DATA



Pareto



Brainstorming



Fishbone, Cause and Effect, or Ishikawa Diagram



5 Whys

DEFINE

MEASURE

ANALYZE

IMPROVE

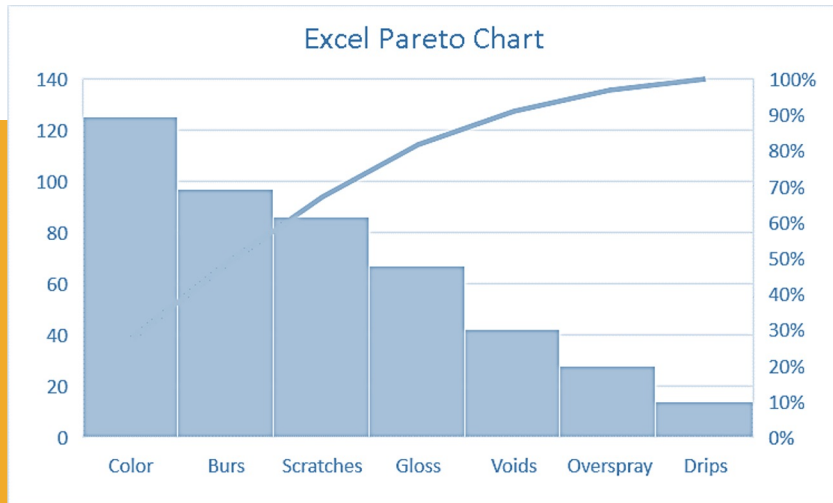
CONTROL

THE PARETO PRINCIPLE

- The Pareto Principle was first developed in 1906 by Italian economist, Vilfredo Pareto, who observed that 20% of the population owned 80% of the wealth.
 - Also called the 80 : 20 rule.
- Joseph M. Juran adapted Pareto's economic observations to business applications.
- Juran stated that “80% of Defects in Process Outputs are as a result of 20% of the total Defective Process Inputs

PARETO

CHART



A Pareto Chart is a vertical bar graph in which values are plotted in descending order of frequency from left to right. This classifies problems and defects by type in the order of quantities and illustrates the cumulative percent total as a line graph.

The Pareto principle is also called the 80/20 rule because roughly 80% of the problems come from 20% of the causes.

DEFINE

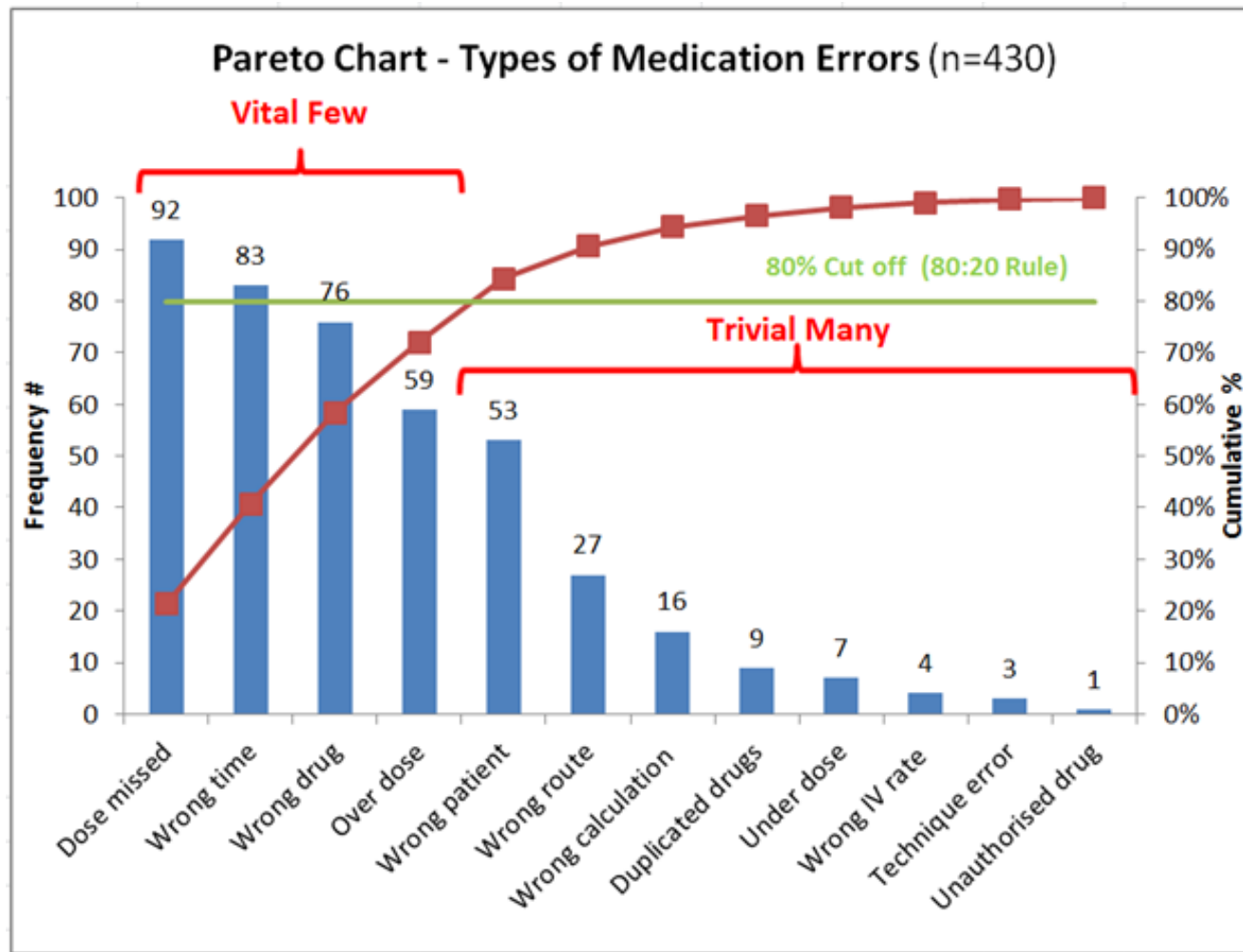
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PARETO CHART EXAMPLE

DEFINE

MEASURE

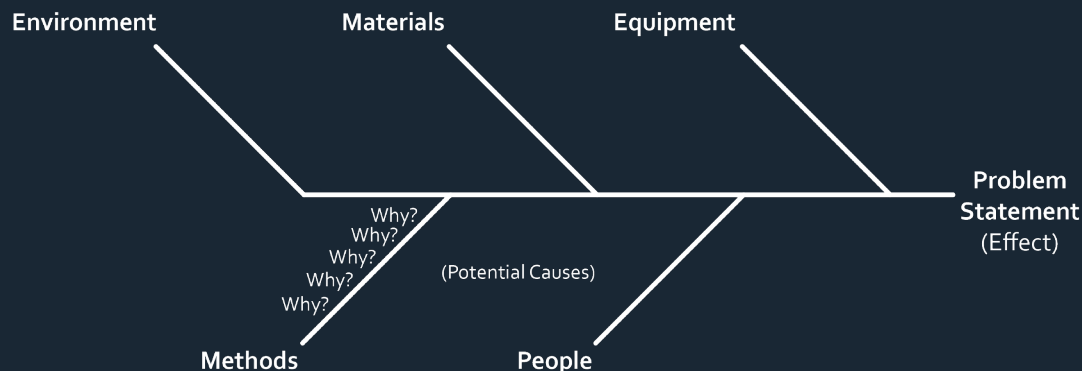
ANALYZE

IMPROVE

CONTROL

CAUSE & EFFECT DIAGRAM

- Also known as Ishikawa or Fishbone Diagram
- Using a Cause & Effect Diagram, consider potential causes in each category.
- Going for quantity of ideas at this point
- Use branches, stems, and twigs on the diagram to display each response.



CAUSE & EFFECT DIAGRAM

Fishbone Diagram			
Man	Method	Mother Nature	
How does interaction with operators, Mgt, potentially cause problem? Look for shift to shift and/or person to person variation	Focus on standard work, work instructions, control plans or the lack of them and how this potentially causes problem.	Focus on environmental causes: time, temperature, location, time, culture.	
potential cause potential cause	potential cause	potential cause	
			Problem Statement
potential cause potential cause	potential cause potential cause	potential cause potential cause	
How does documents, information, parts, inventory needed by the process potentially cause the problem?	How does equipment, computers, tools etc required to accomplish the work potentially cause the problem?	How does the measurement equipment usage, capability, etc potentially cause the problem?	
Material	Machine	Measurement	

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Develop a Fishbone

In the last 4 days, our coffee maker produced 100% of the coffee with a terrible bitter taste, which my wife and I disliked.

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Now that we have ID potential Causes where do we begin?

CLUSTERING METHOD + N/3 METHOD

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CLUSTERING

THE DATA



- combine the same/similar possible causes into groups
- pick the top 3-5 biggest groups to move forward with
- Groups indicate that these are common ideas

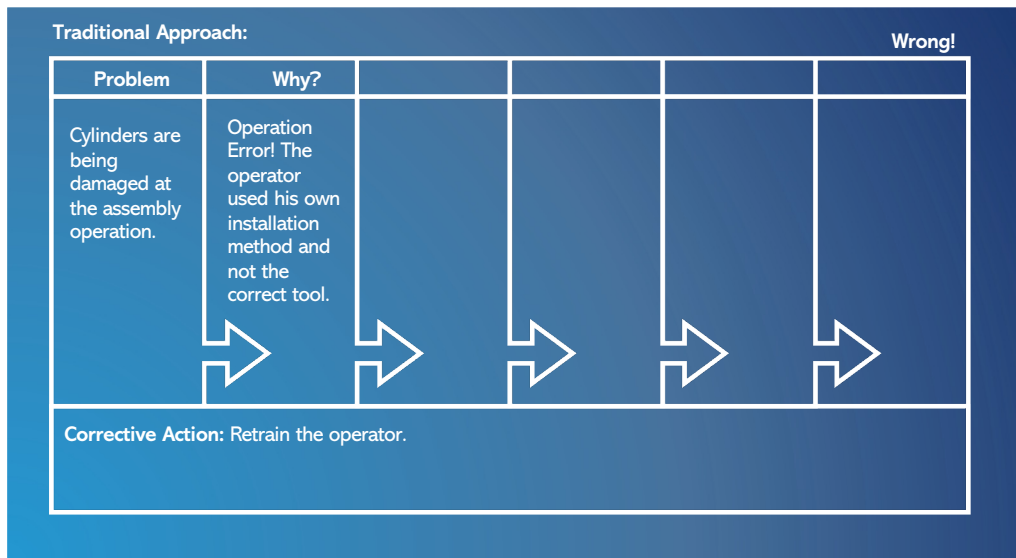


N/3

Multivoting

- This is a method used to “vote” for the most likely causes
- Take the number of people on the team (N) and divide by 3 to give the number of votes each person gets
- For a team of 12 divide by 3 and each person gets 4 votes
- For smaller teams, I would typically give at least 2-3 votes

5 WHY ANALYSIS

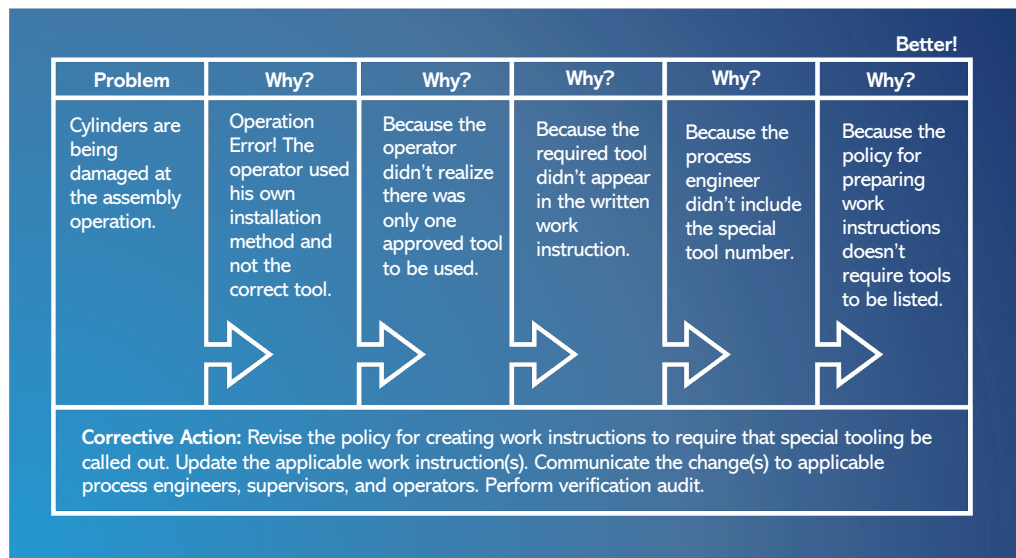


One of the most effective tools in determining root cause is to simply keep asking why something occurs/happened.

The traditional approach usually jumps to a quick conclusion which often results in repeat occurrences of the same or similar kind.

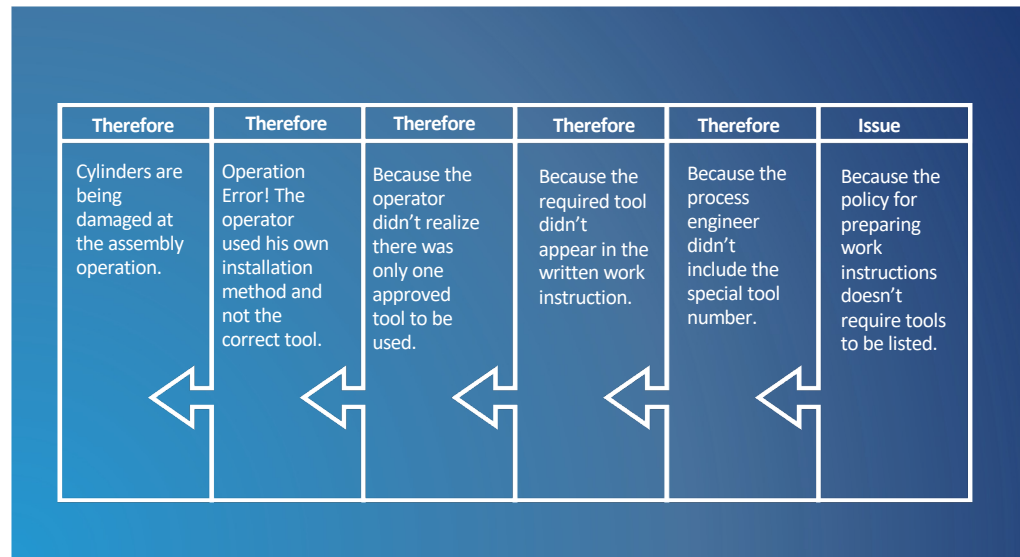
5 WHY ANALYSIS

On the other hand, continually asking 'why?' generally gets to the underlying root causes

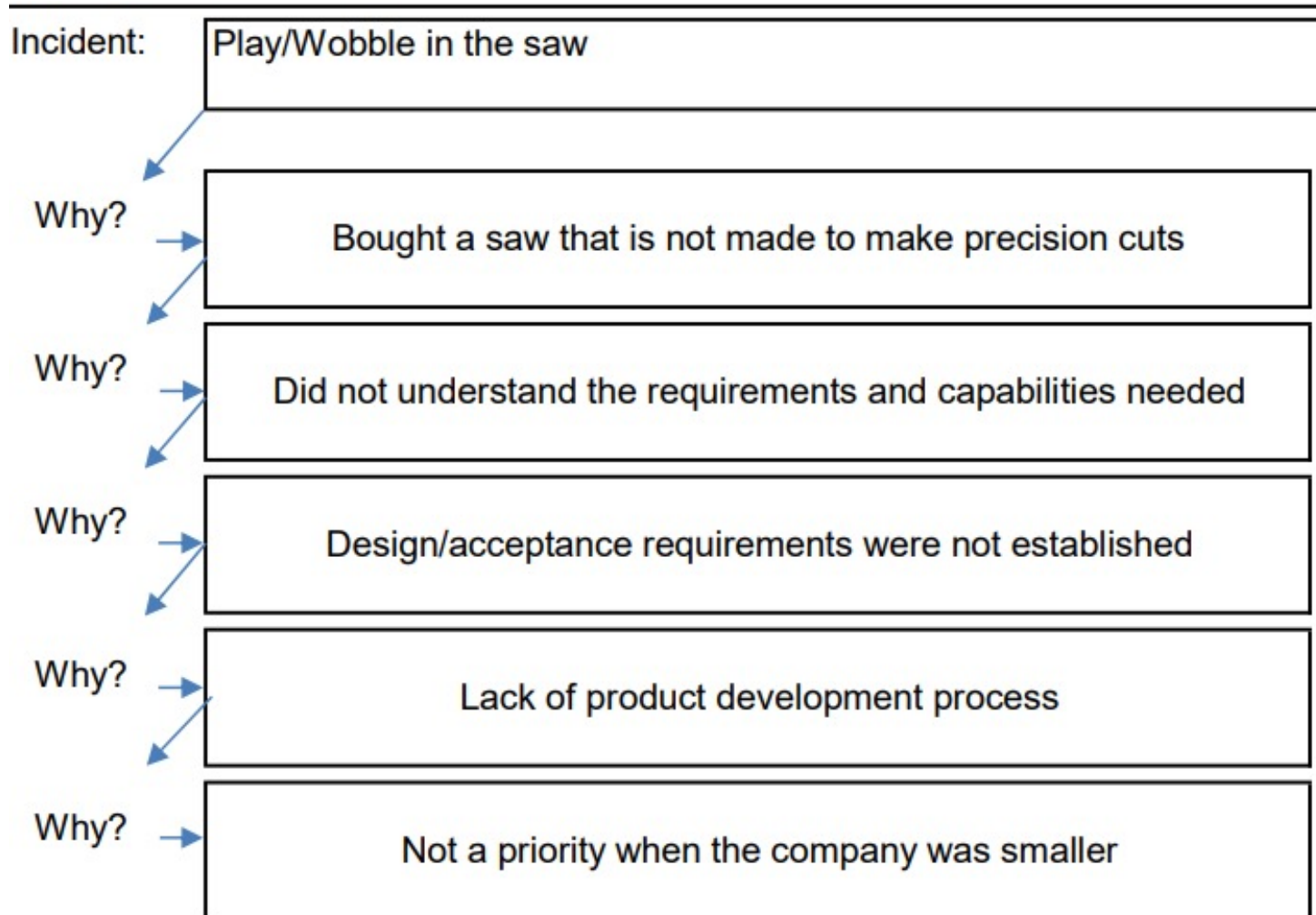


THEREFORE TEST

After you reach the potential root cause using the “5 why’s”, check the rationale using the “therefore test” to verify the resulting cause/effect relationship. Does it make sense?



5-Why Example





5-Why Practice

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Update the A3

A3				
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	0	0	0	
	Process Owner(s):			Rev Date/ Rev #
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Problem Statement What is the problem to be solved (use a metric), when and where is it occurring, what is the requirement and who is affected.			Measure	
Business Case Why should we work on solving this problem now, why is it important to the business.			Analyze	
Scope			Improve	
In Scope	Out of Scope			
Include both what is in scope and out of scope. SIPOC can help with this				
Goal What is the goal of this project (x to y by when)? What are the process characteristics of the project in addition to the metric change (for example, one piece flow)? Note: this should not be the solution.			Project Champion Approval	
Define			Control	

- For everything you have learned during the Analyze Phase update the A3

IMPROVE PHASE

DEFINE

MEASURE

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CONTROL



The IMPROVE Phase is

For developing, testing and implementing solutions that address the identified root causes.

DEFINE

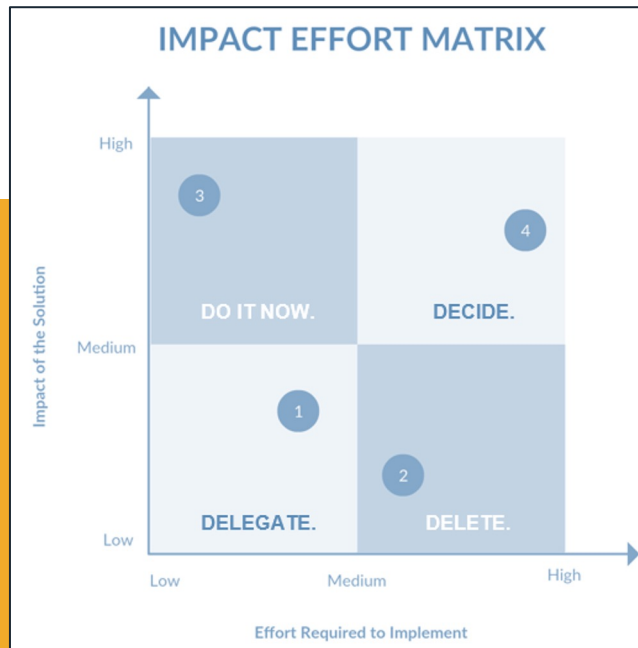
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IMPACT EFFORT MATRIX

- Brainstorm alternative solutions.
- Ensure that solutions address root causes.
- Impact / Effort matrix
- Perform trials or pilot tests.
- Don't get caught in "paralysis by analysis."

DEFINE

MEASURE

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FMEA (RISK ANALYSIS)

DEFINE

MEASURE

ANALYZE

IMPROVE

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WHY CREATE A FMEA?

Failure Modes and Effects Analysis
(FMEA) is a methodology to manage...

RISK!!!

DEFINE

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THE FMEA MATRIX

RPN = Risk Prioritization Number
SEV = Severity of the Failure
OCC = Probability of Occurrence of the Failure
DET = Difficulty to detect the Failure

Provides structure to capture and quantify risks of failure points.



Let's Practice!

FMEA															
#	Process Function (Step)	Potential Failure Modes (process defects)	Potential Failure Effects (Y's)	SEV	Potential Cause of the Failure (x's)	OCC	Current Process Controls	DET	RPN	Recommended Actions	Responsible Person & Target Date	SEV	OCC	DET	RPN
1	Add Water								0						0
2	Add Coffee Grounds								0						0
3	Turn on Machine								0						0
4	Pour Coffee								0						0

DEFINE

MEASURE

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POKA YOKE

What can you do with your solutions to make sure that we prevent mistakes/defects as opposed to correcting them?

Poka Yoke = Mistake Proofing

TRIALS

- Now that the team has identified potential solutions, you need to verify if it is able to turn the problem on/off
- Look for simple, safe ways to mimic the solution that ideally are cheap/free to test

TRIALS

Trial Title:	
What is the Trial?	How will we run it?
How will we measure?	What do we expect?
What did we get?	What did we learn?
Conclusion / Recommendation	

DEFINE

MEASURE

ANALYZE

IMPROVE

CONTROL

UPDATE GANTT CHART

For each step that must be completed in the improve think through:

Typical Gantt Fields

1. Who?
2. What?
3. When?
4. Where?

Additional

1. How?
2. How Much?

Make preparations to present it to the appropriate decision makers:

1. Project management tools
 1. Cost vs Benefits Analysis
 2. Milestone Charts



GET GUIDANCE & SUPPORT FROM

LEADER, PROCESS OWNER, CUSTOMER, &
OTHER STAKEHOLDERS. AVOID FALSE STARTS!

DEFINE

MEASURE

ANALYZE

IMPROVE

CONTROL

LEAN
SOLUTIONS

IMPLEMENT SOLUTION

- Brief all people involved about the plan so that they have ownership in its success.
- Use a Gantt chart to track all actions
- Remember that even a great plan will fail if not executed properly.
- Ask the leadership team to help remove roadblocks as needed.

Project Management Tools

1. Milestone Charts (High Level)
2. Task Lists (Detail Level)

Update the A3

A3				
Project Title:	Project Champion:	Project Manager:	Core Team Members	Original Creation Date:
	0	0	0	
	Process Owner(s):			Rev Date/ Rev #
	0			
Problem Statement			Measure	
What is the problem to be solved (use a metric), when and where is it occurring, what is the requirement and who is affected.				
Business Case			Analyze	
Why should we work on solving this problem now, why is it important to the business.				
Scope			Improve	
In Scope		Out of Scope		
Include both what is in scope and out of scope. SIPOC can help with this				
Goal			Project Champion Approval	
What is the goal of this project (x to y by when)? What are the process characteristics of the project in addition to the metric change (for example, one piece flow)? Note: this should not be the solution.				
Define			Control	

- For everything you have learned during the Improve Phase update the A3

QUIZ 3:



1. What is the purpose of the MEASURE Phase in DMAIC?
 - **TO UNDERSTAND THE CURRENT STATE (AS-IS) OF THE PROCESS THAT CONTAINS THE PROBLEM.**

2. Detailed Process Understanding is required in the Measure Phase ? Who are the People to involve to gain a better understanding of the process and problems ?
 - **THE PEOPLE WHO WORK ON THE PROCESS. THE WORKERS AT THE GEMBA**

3. Another name for an Ishikawa diagram is the _____ diagram.
 - **FISH BONE**

4. To ask your team '*Why does this happen ?*' more than once in order to understand the Root Cause is called the _____ method.
 - **5 WHYS**

5. What is another name for the 80/20 Principle ?
 - **PARETO PRINCIPLE**

QUIZ 4:



1. How do you calculate Takt Time?
 - **Effective working time per time period / Customer demand per time period**
2. What is the difference between special cause and common cause variation?
 - **Common cause is expected while Special cause is unexpected.**
3. What is the goal of the measurement phase?
 - **Evaluate the “As-Is” capability of the process**



HOMEWORK REVIEW

(Open Computers and Log into your Portal)



END OF DAY 2