4 Types of Problems

Coaching Problem Solving & Developing People Toyota Style

Learning Session Outline

- 4 Types of Problem Framework
- Type 1 – Troubleshooting
- Type 2 – Gap from Standard
- Type 3 – Target State
- Type 4 – Innovation
- Summary

Background - Lean / Toyota

Toyota Kamigo
Overhead

Kamigo
Entrance

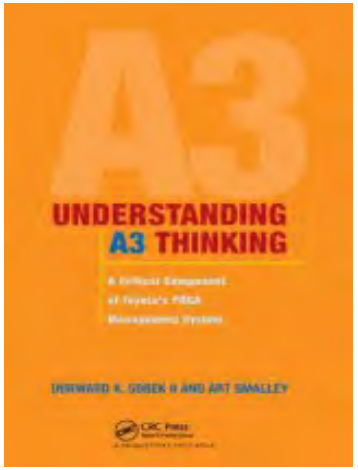
Taiichi
Ohno

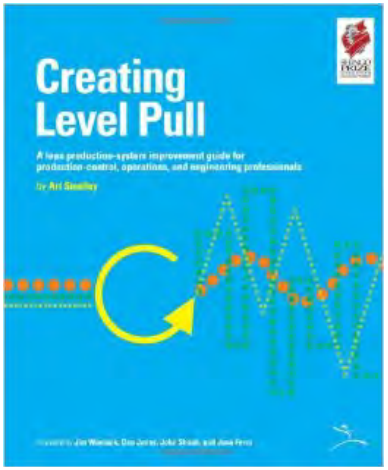
Precision & Machine
Intensive

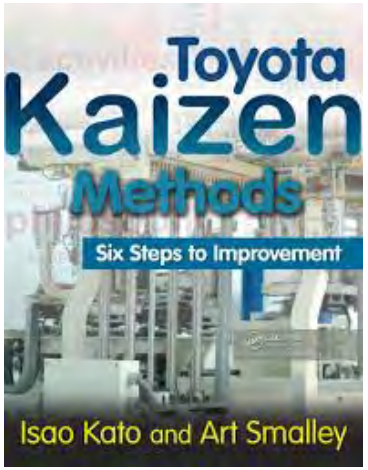
Lower Volume &
Higher Mix

High Volume &
Lower Mix

Other Background - Work

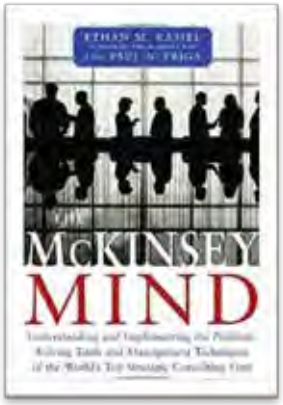






www.artoflean.com

Other Background - Stuff



TPS Development Timeline

Western Influences:

Mass Production &
moving conveyor lines

Scientific Principles
Of Management

Standardization
Of Parts

Many Others….

Taiichi
Ohno

TPS Development

Loom Business

Automotive Company

1902 1937 1950 1973 2016

Sakichi
Toyoda

Kiichiro
Toyoda

Taizo
Ishida

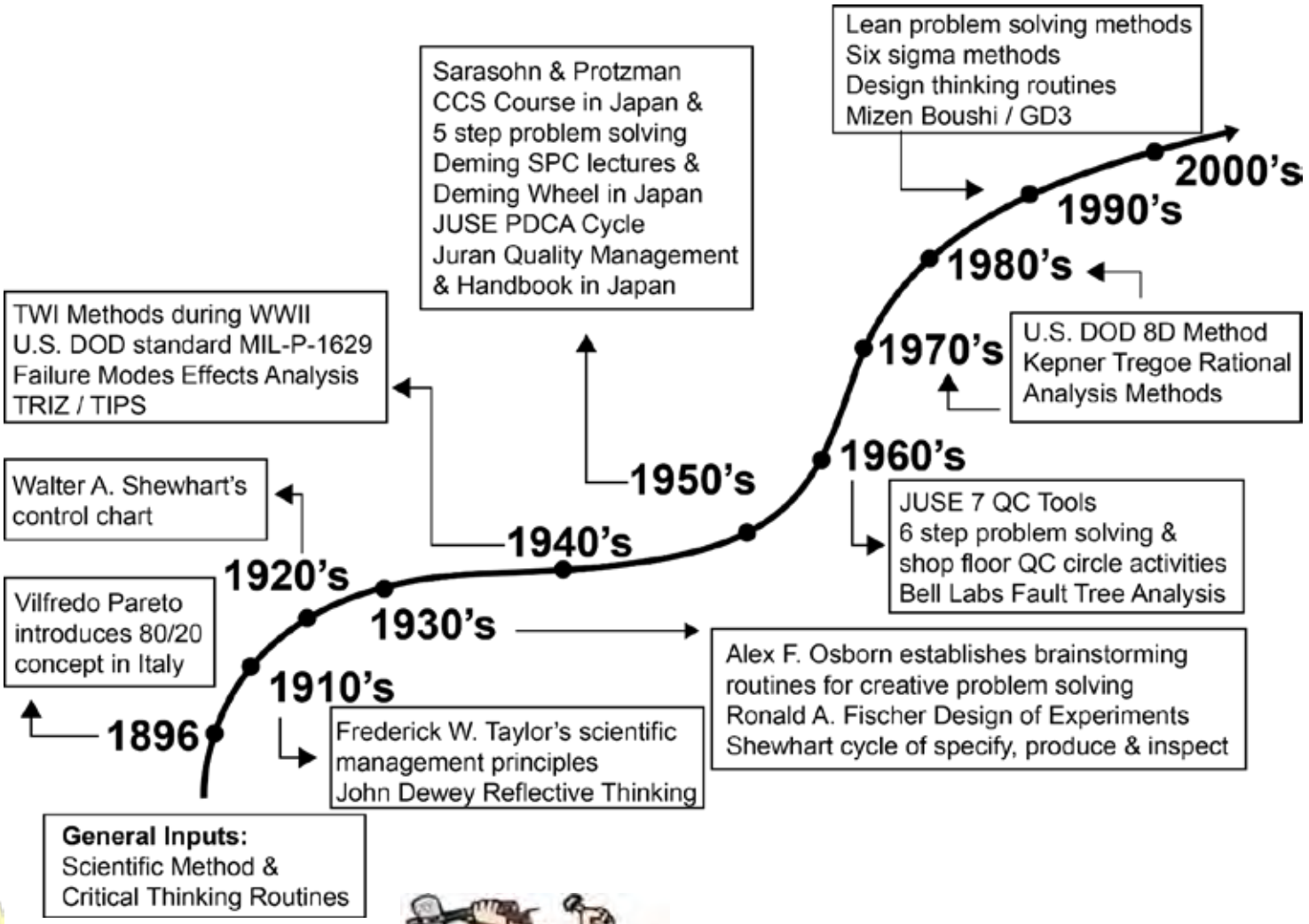
Fukio
Nakagawa

Eiji
Toyoda

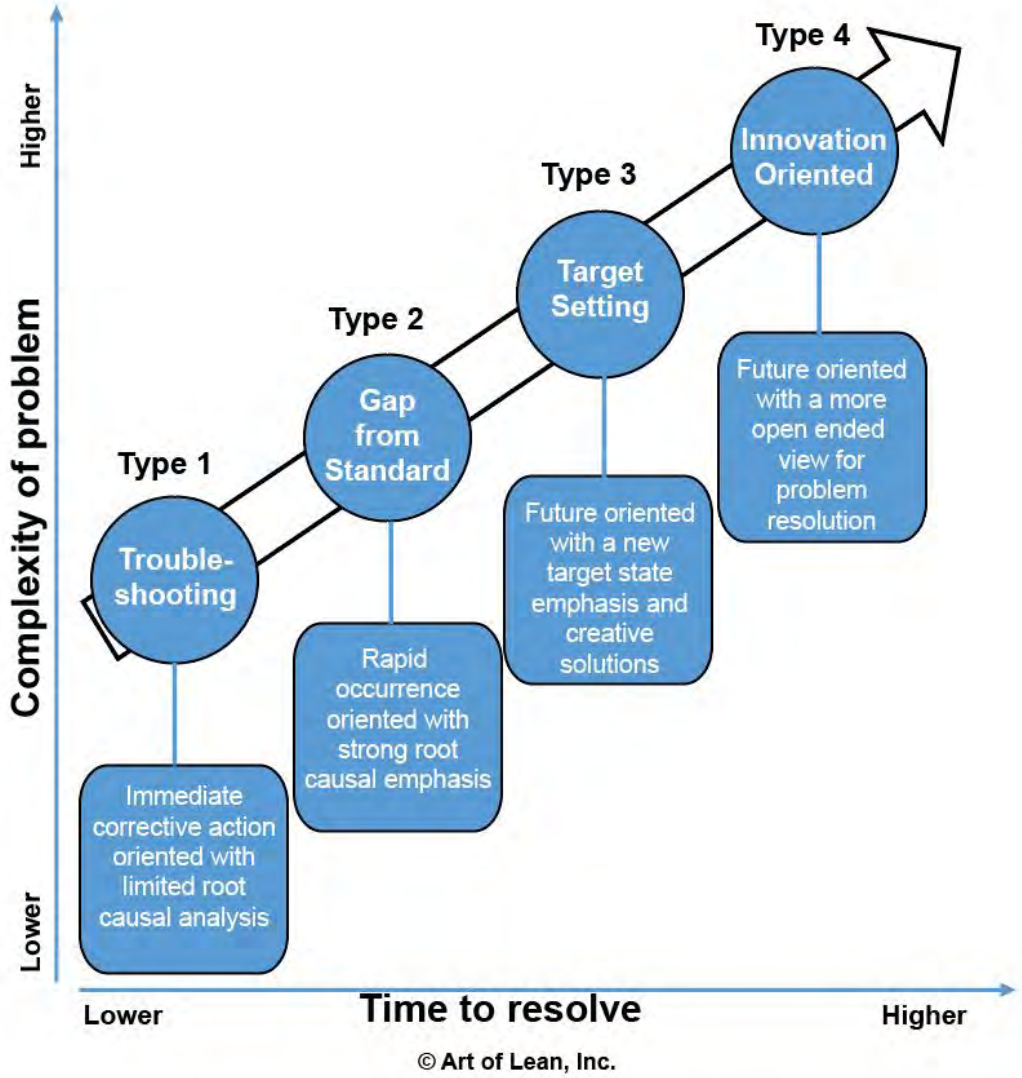
Fujio
Cho

Various parties and key individuals
involved over a long period of time

20th Century & Problem Solving



4 Types of Problem Situations



4 Types & Benkei Analogy

Benkei

7 QC Tools

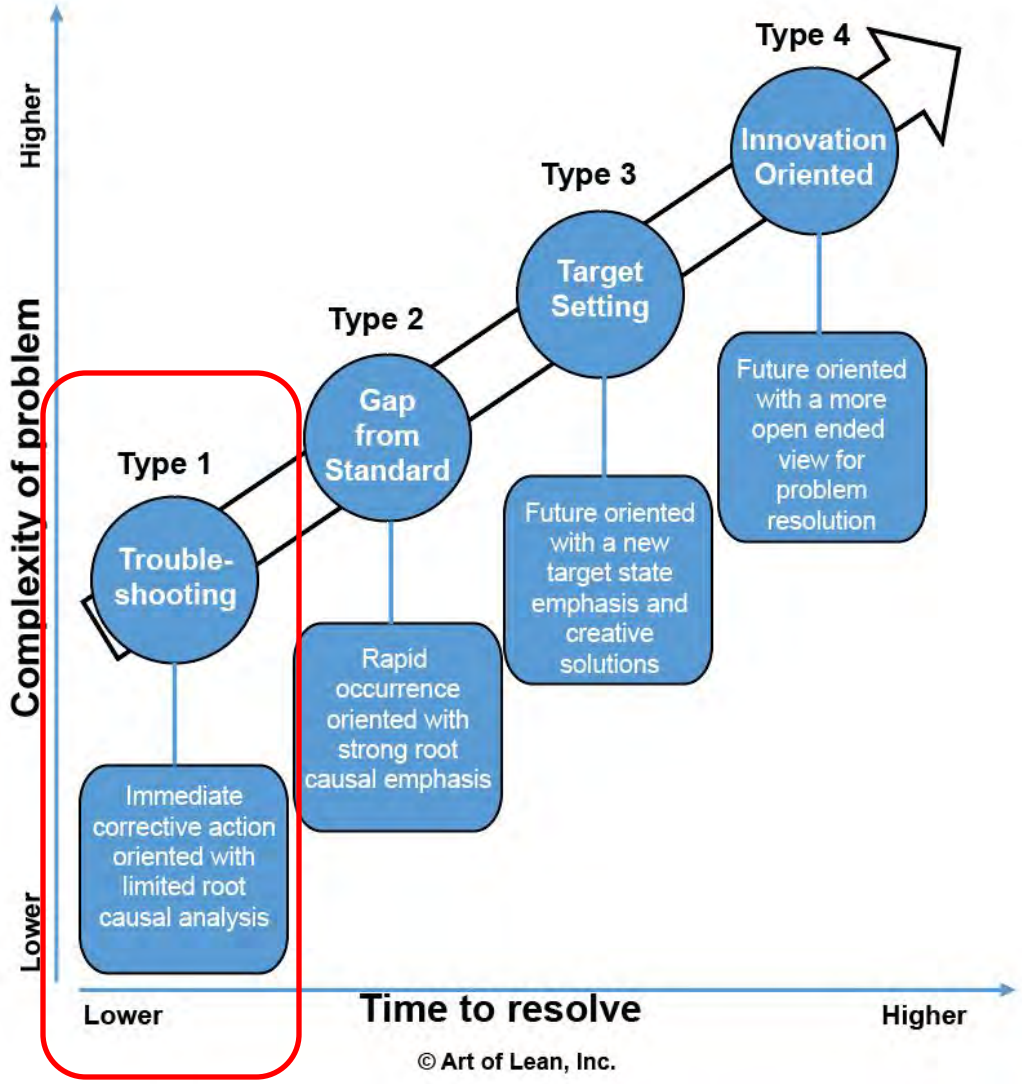
1. Data Collection / Check sheets
2. Cause-and-effect diagram
3. Flow charts
4. Histogram
5. Pareto chart
6. Control chart
7. Scatter diagram

Kaoru Ishikawa

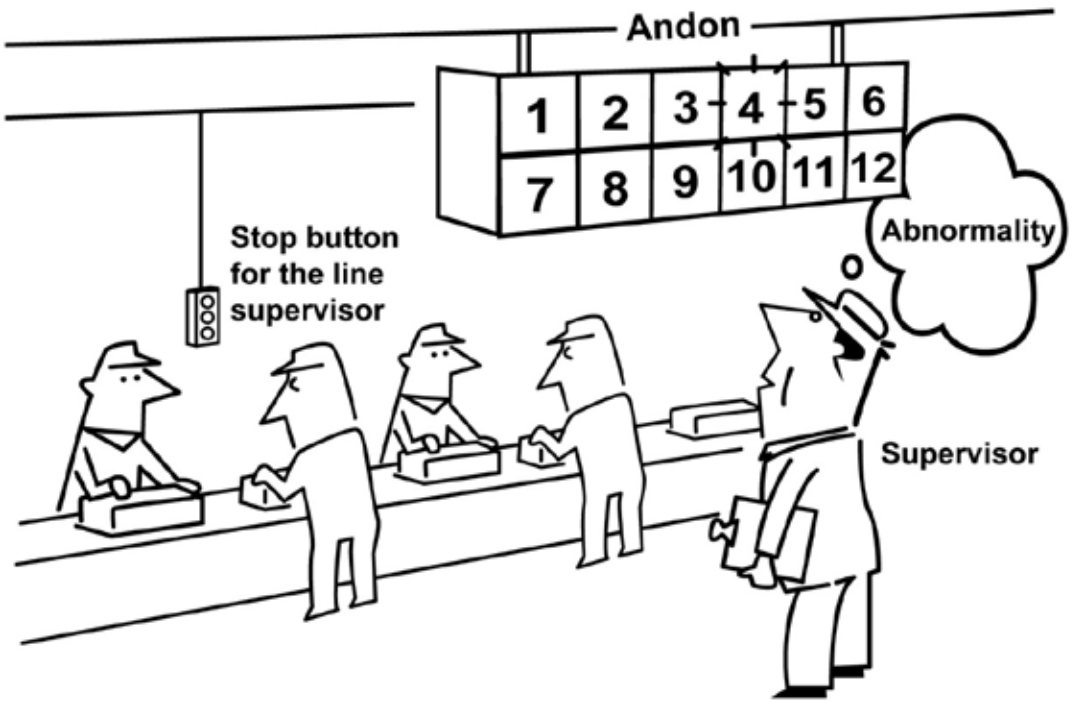
The term "7 QC tools" is named after the seven tools of Musashibo Benkei the famous warrior monk. Benkei owned seven weapons which he used to win all his battles. Similarly from my own experience you will find that you will be able to solve 95% of the problems you face if you properly use the 7 QC tools.

Professor Emeritus
University of Tokyo

4 Types of Problem Situations



Type 1 – Troubleshooting



Condition based trigger
Either human or machine

Andon Response Example

1. Automated process cycling normally

2. Mechanical probe detects broken cutting tool and stops the machine

3. Probe signals an “andon” board for visual display

4. The operator **immediately takes corrective action** and confirms good products to the following process

Type 1 – Troubleshooting

Production Analysis Board

Line/Cell Name:	Team Leader:	Date:
Quantity Required:	Takt Time:	Shift:
		Num of Operator:

Time	Hourly Plan / Actual	Cumulative Plan / Actual	Problem/Causes	Sign-off
: ~ :	/	/		
: ~ :	/	/		
: ~ :	/	/		
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Kaizen Express

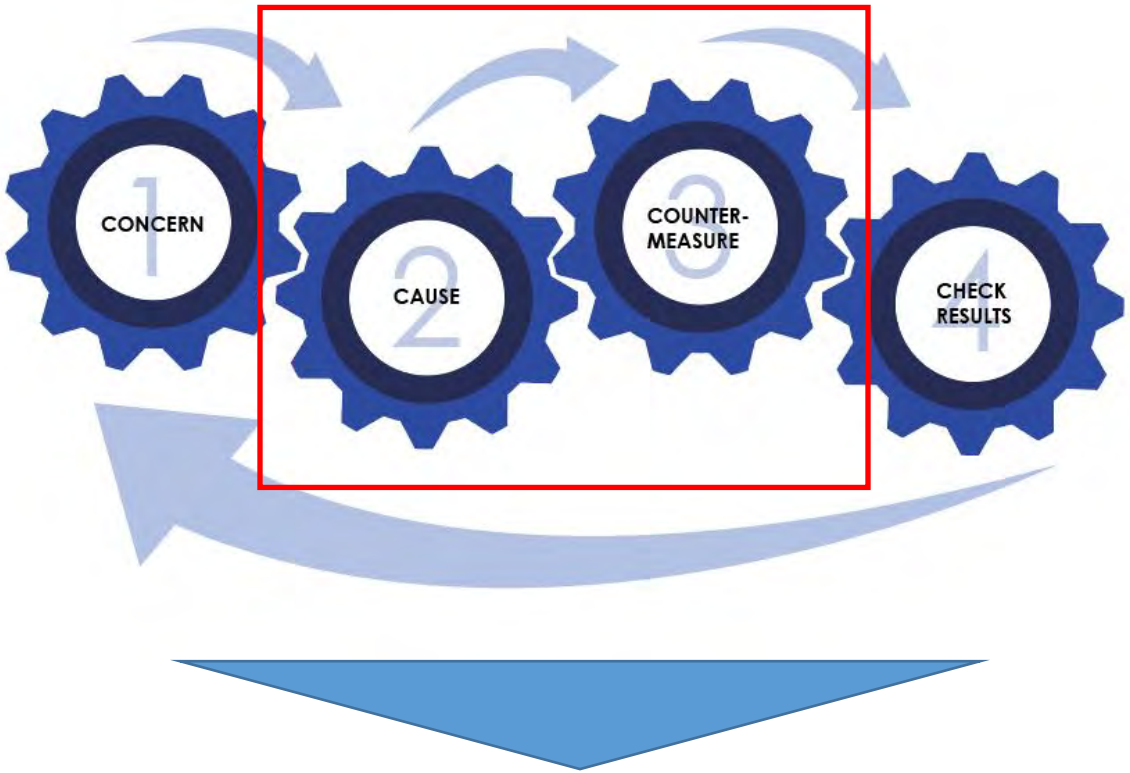
Lean Enterprise Institute

Rapid Problem Solving

- Concern
- Cause
- Countermeasure
- Check

Time & quantity based triggers
Reviewed hourly by supervisor

4 C's Thinking



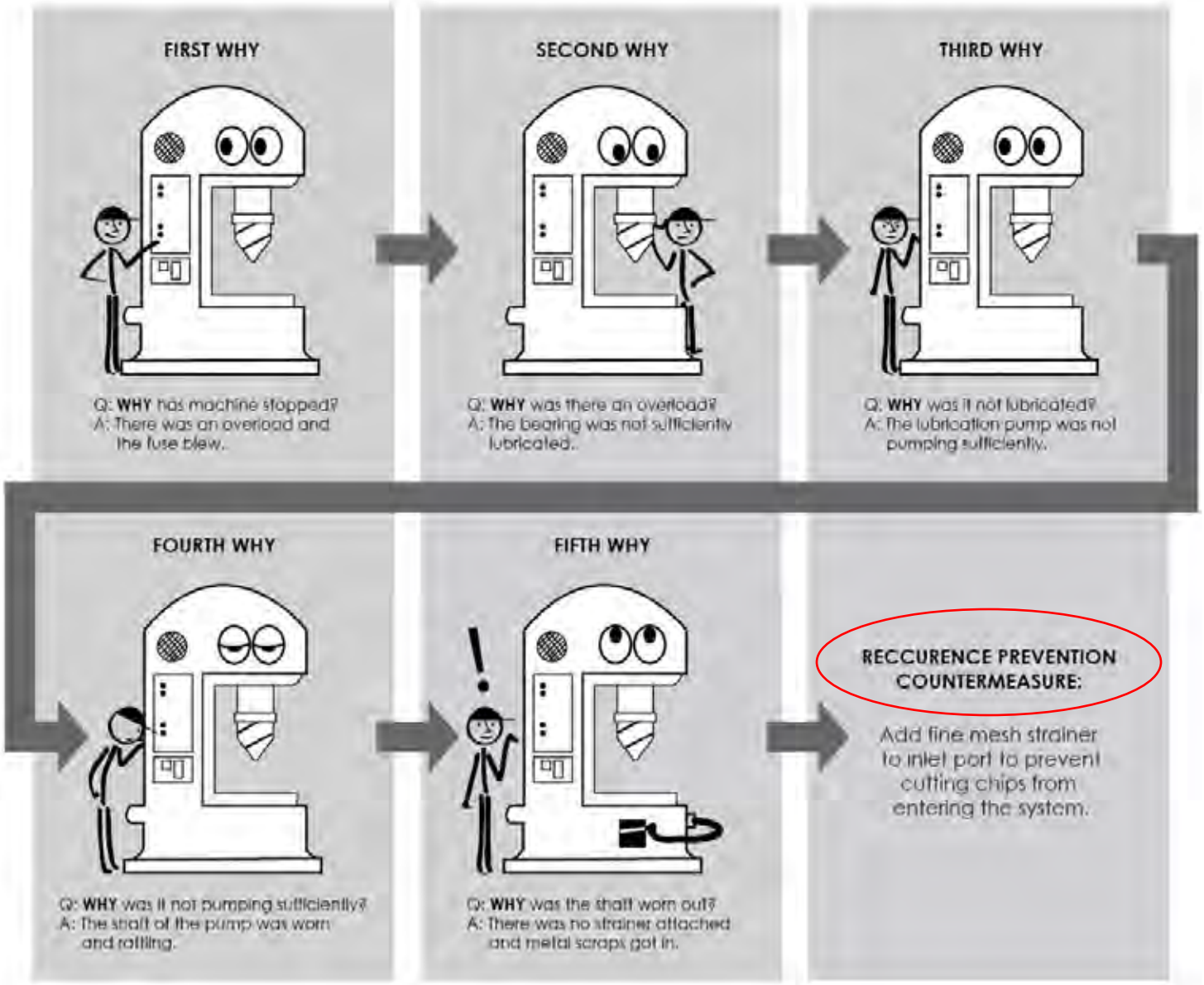
Minimal (if any) documentation involved. No A3's.
Mainly discussion, thinking, rapid action & follow up.

Yes - 5 Why is the Ideal

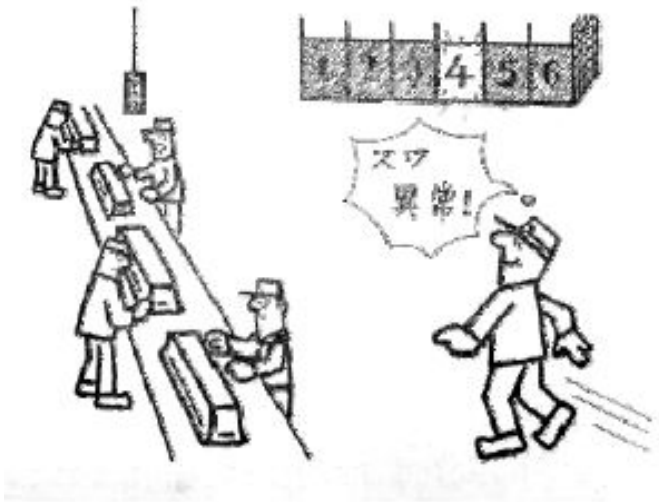
Situation: A machine tool has stopped working halting production.

1) "Why did the machine stop working?"
    - "Because the machine overloaded blowing the fuse in the control panel."
2) "Why did the overload condition result?"
    - "Because there was insufficient lubrication to the spindle bearing."
3) "Why was there insufficient spindle bearing lubrication?"
    - "Because there was insufficient lubrication drawn up by the pump."
4) "Why was there insufficient lubrication draw from the pump?"
    - "Because the pump shaft was worn and rattling."
5) "Why was the pump shaft worn?"
    - "Because there was no strainer on the lubrication device inlet port, and small metal cutting chips entered the system causing damage."

Key Point is the Countermeasure!



Toyota Supervisor Image



Rapid response to problems and abnormal conditions by production

- -Team Member
- -Team Leader
- -Group Leader
- -Manager
- -Plant Manager

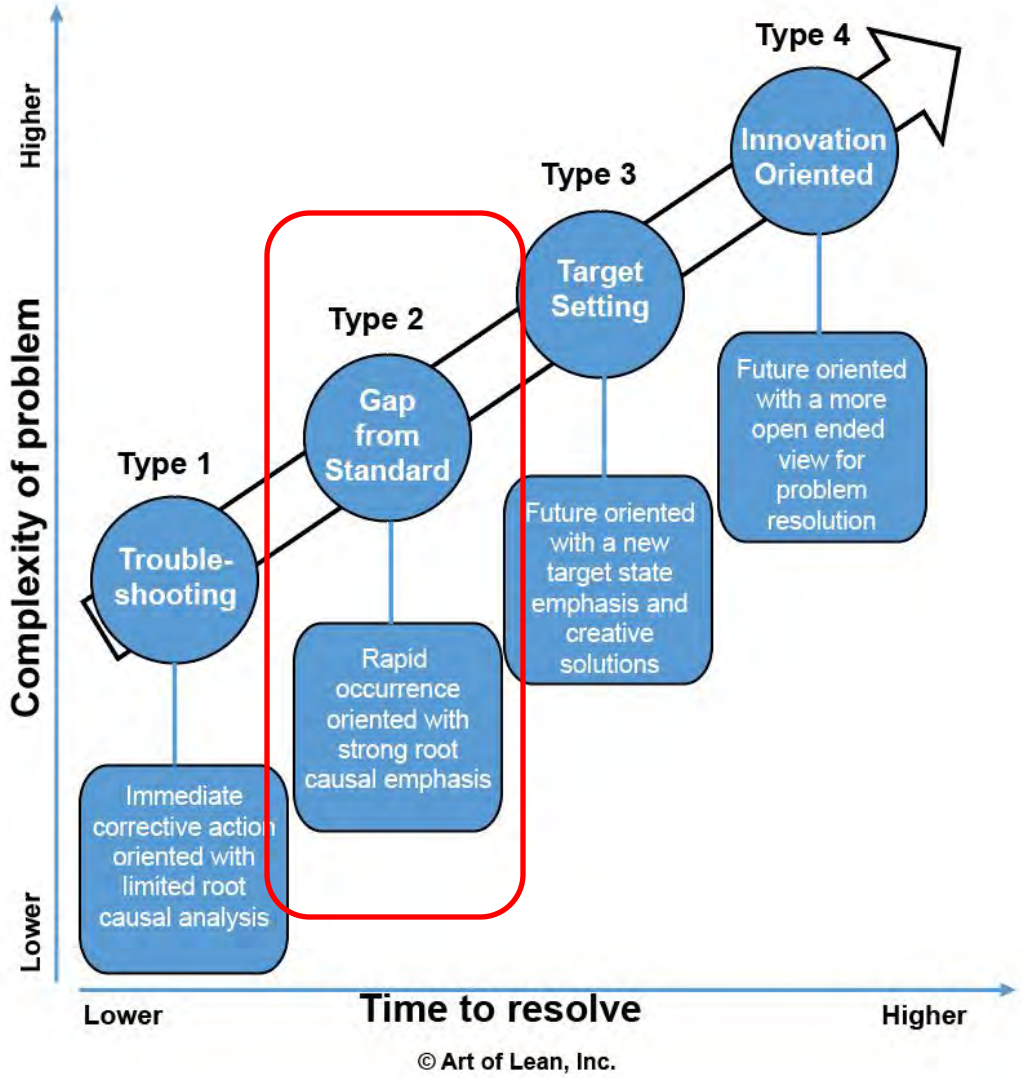
"All Mighty" Supervisor Image

1. Safety
2. Job Ability
3. Team Leadership
4. Kaizen Skills / Problem Solving
5. Technical Knowledge
6. Human Relations

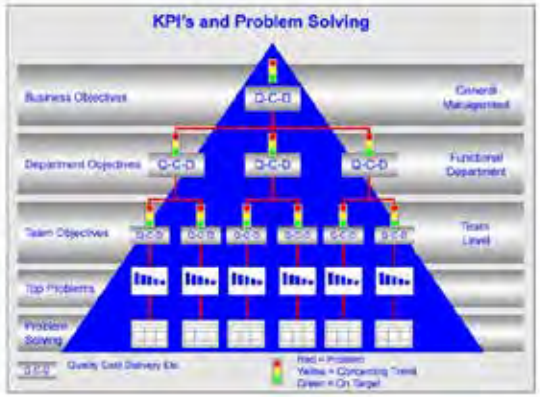
Exercise & Discussion

- Small Groups
- Create hourly surfacing example
- Create trouble shooting examples 1 per person
- Frame them in the language of 4C’s
- Vote and decide on best one for sharing
- Prepare flip chart presentation
- Present to audience

4 Types of Problem Situations



Type 2 – Gap from Standard

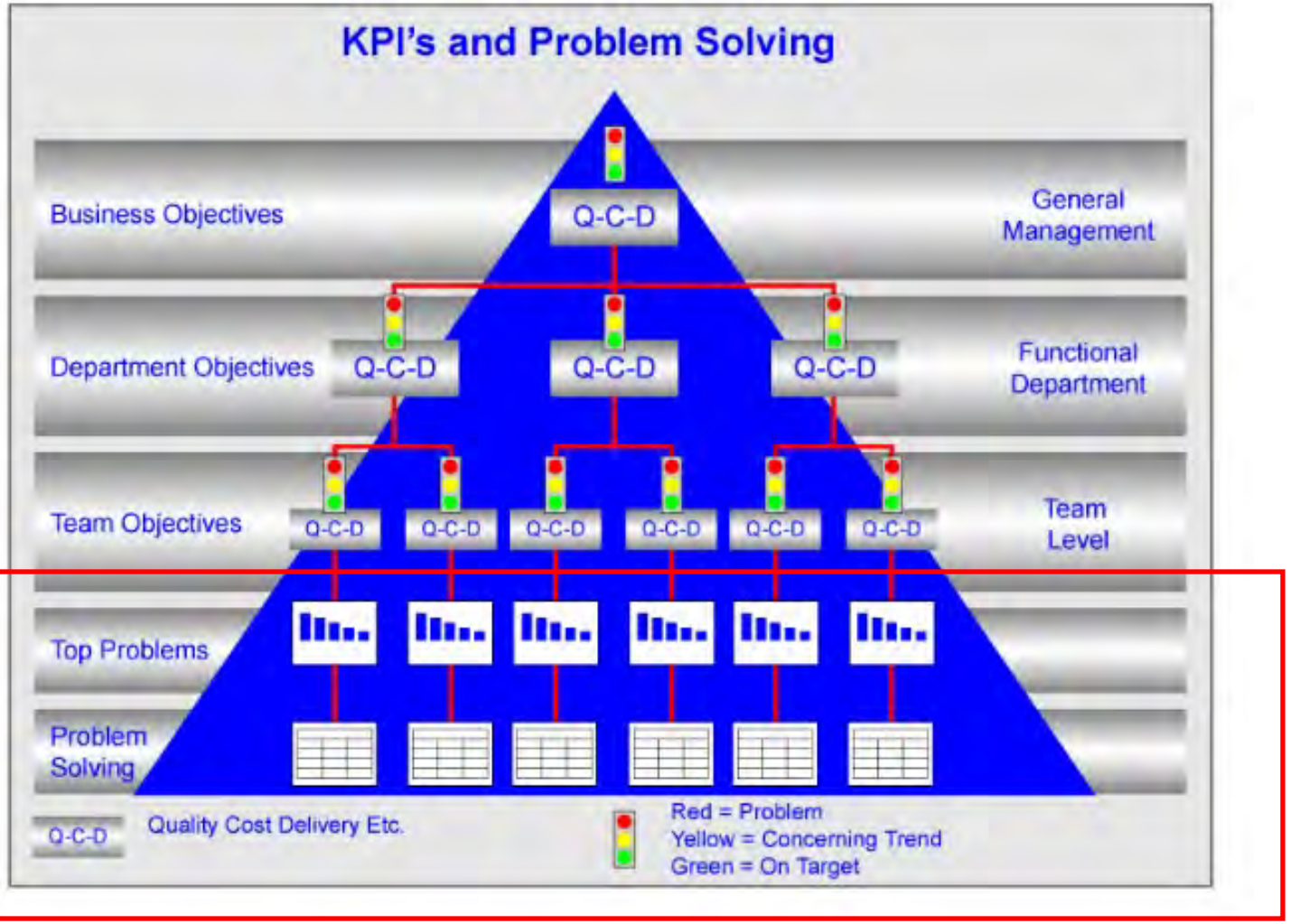


P	Step 1	Clarify the Problem Background
	Step 2	Define the Problem
	Step 3	Establish a Goal
	Step 4	Root Cause Analysis
D	Step 5	Implement Countermeasures
C	Step 6	Check Results
A	Step 7	Follow Up & Standardized

Vague Problem Understanding

5W 1H & 5th Why Emphasis

KPI's & Problem Solving



Daily Meeting

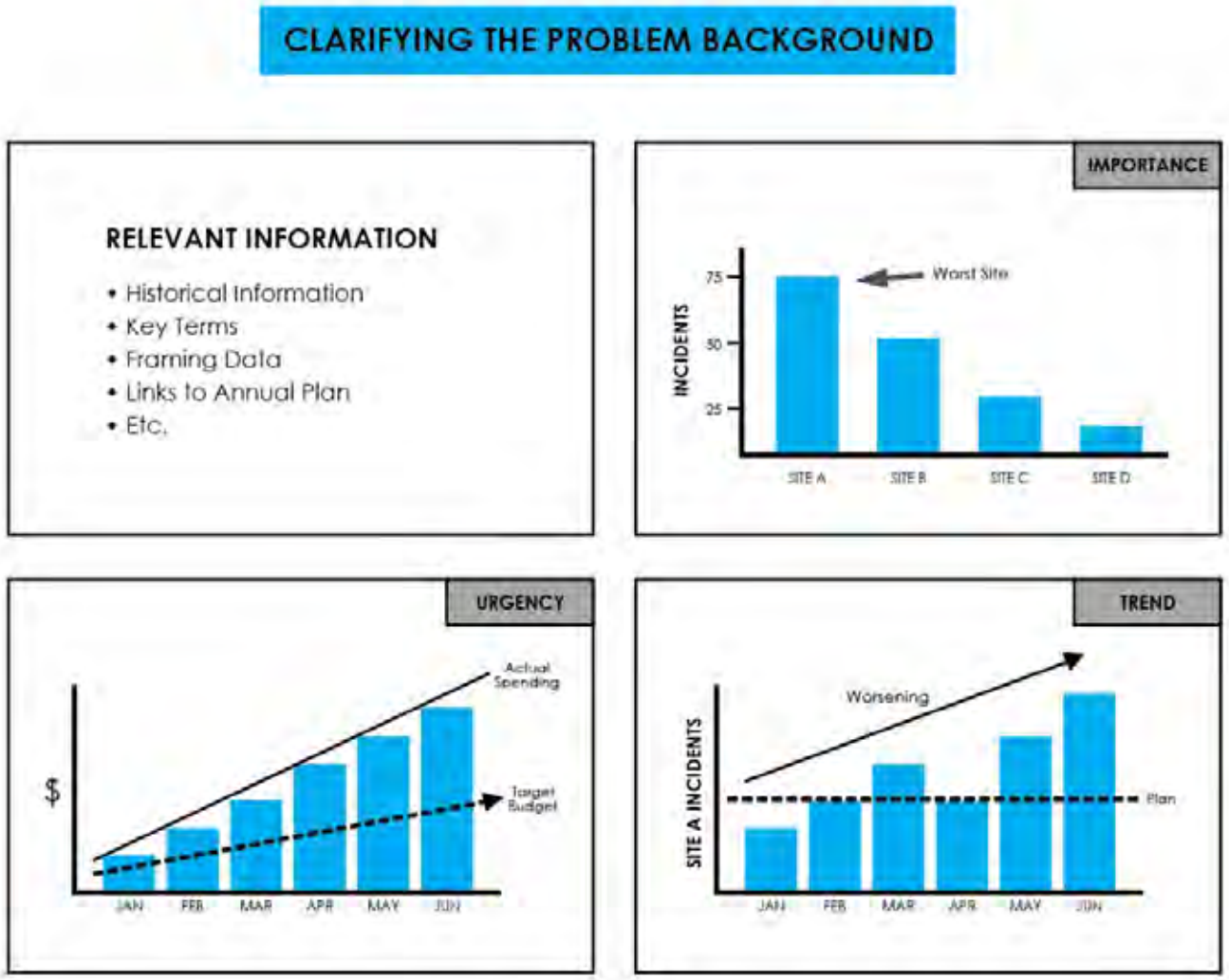
Start of 8 hour shift
Daily performance trend
Major problem communication
Departmental coordination
Priority alignment & clarification
Hop topics, etc.
May or may not have problem type A3's posted here

Shop Floor Management Board

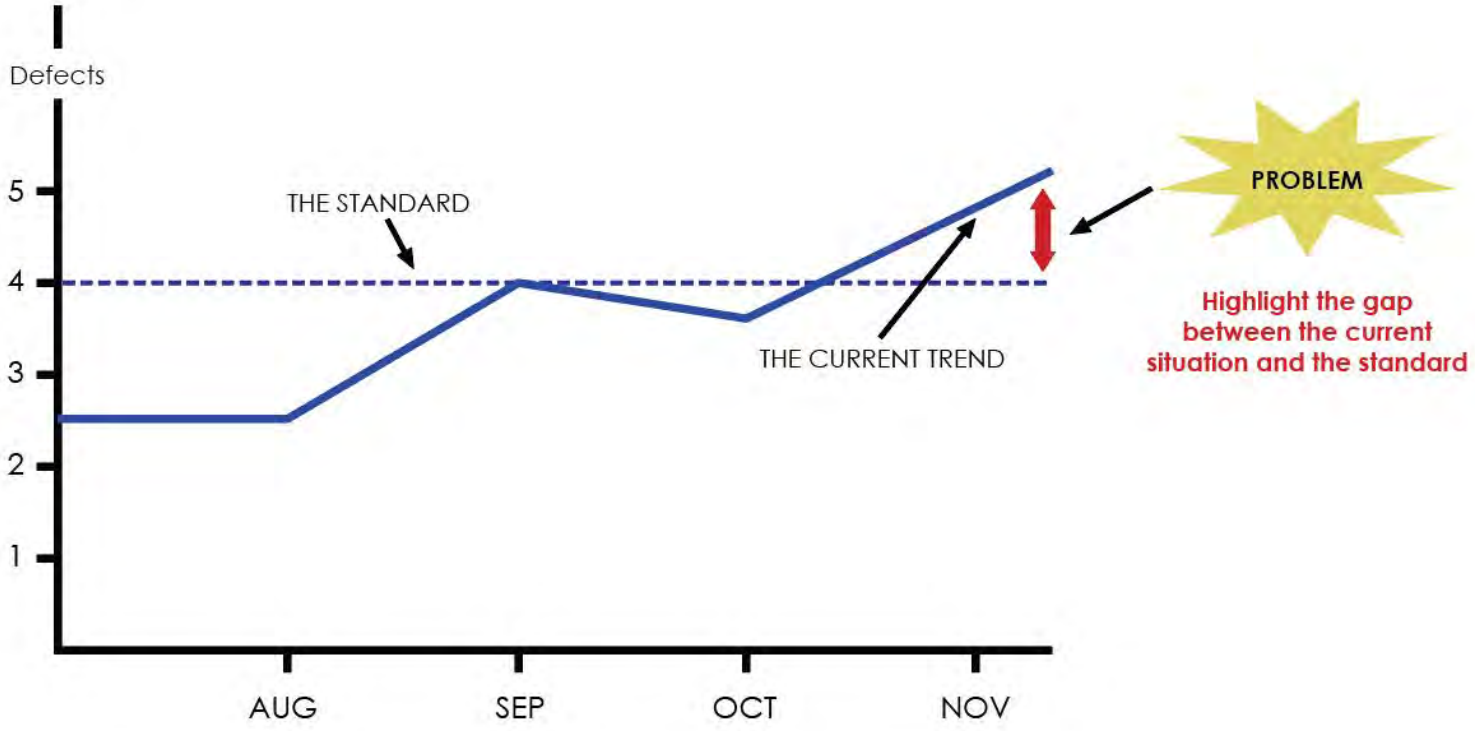
Problem Solving Report / A3

Problem Background	**Countermeasures**
Problem Definition	
Goal	**Check Results**
Root Cause Analysis	**Follow Up & Standardize**

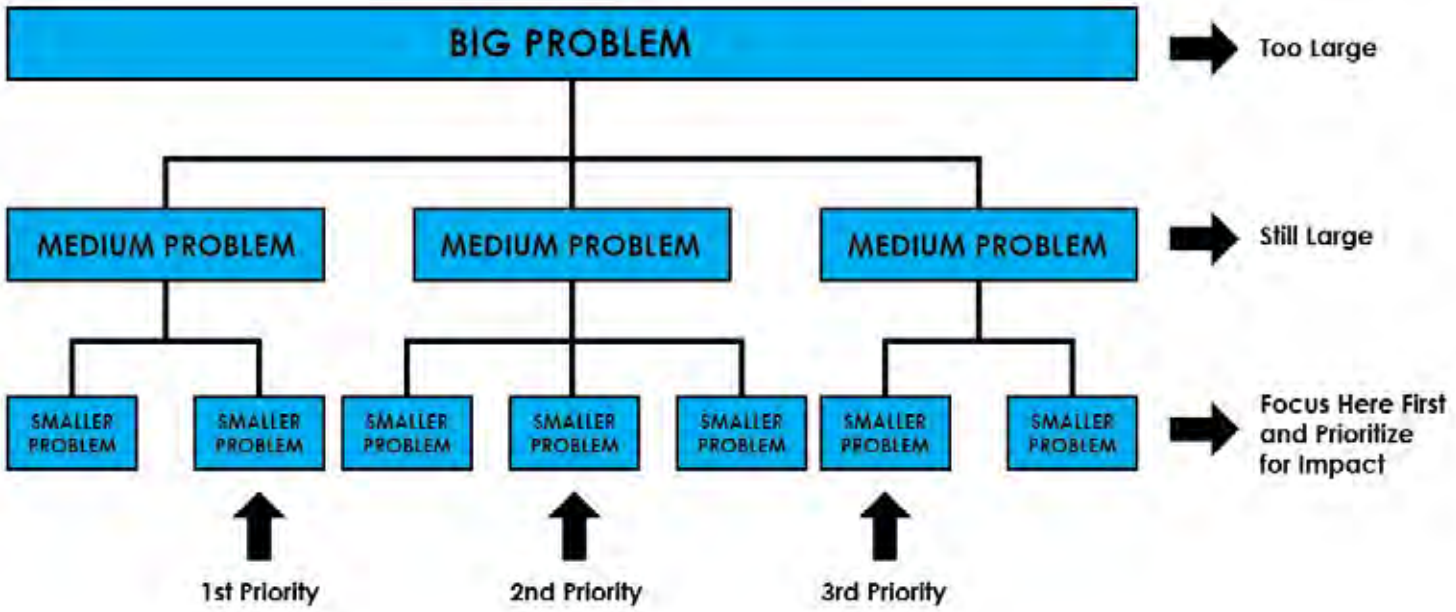
Clarify the Problem Background



Define the Problem



Define the Problem



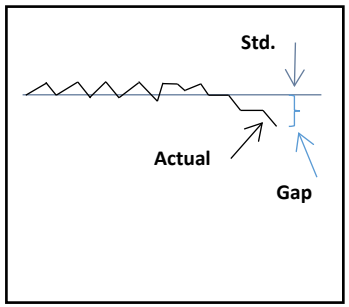
Problem Investigation

TPS

TPS

A. Immediate abnormality signal

B. Go to actual machine and see status

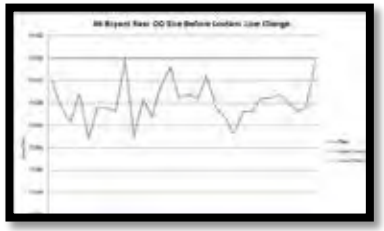


C. Ascertain actual problem situation

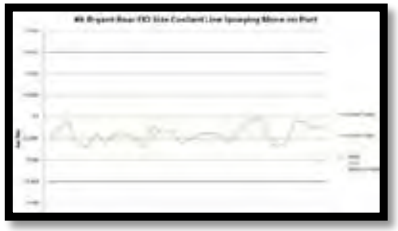
TPS

D. Problem Investigation Sequence

1. Measure actual dimensional extent of problem
2. Look for obvious contamination or abnormalities
3. True and re-dress grinding wheel and observe status
4. Check actual grinding wheel (check “pores”)
5. Confirm actual (not theoretical) stock removal
6. Send part to QC Mat’l lab for hardness and HT depth check
7. Check actual cutting conditions
   - Wheel RPM
   - Feed Rate, Depth of Cut, etc.
   - SFPM
8. Confirm status of datum features
9. Measure spindle run out
10. Coolant check
    - Flow rate / pressure
    - Nozzle condition and direction
    - Temperature
    - Concentration



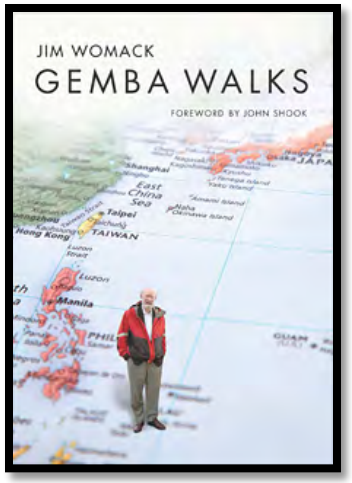
Cpk 1.15



Cpk 2.33

Dig Deeper! 8G's

• Genba	現場	Actual Place
• Genjyou	現状	Actual Condition
• Genchi	現地	Actual Location
• Genbutsu	現物	Actual Object
• Genjitsu	現実	Actual Facts
• Genji	現時	Actual Time
• Genpō	現法	Actual Method
• Genin	現因	Actual Cause



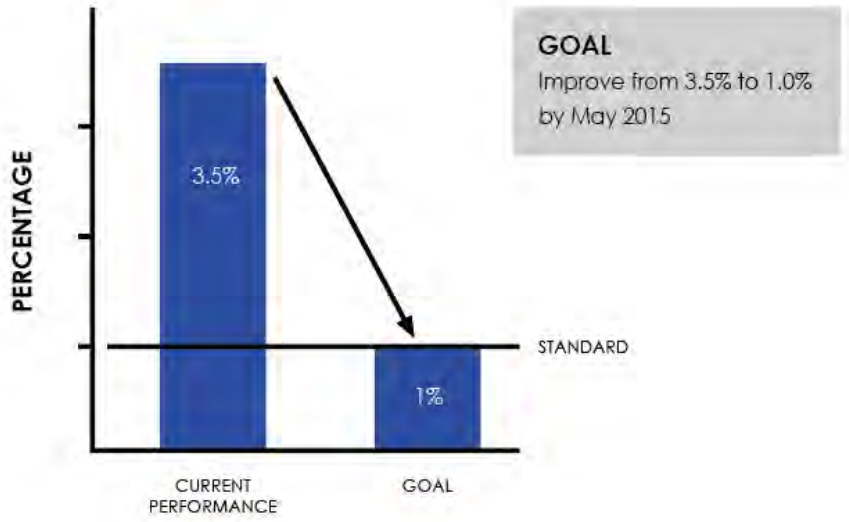
現地現物

Genchi Genbutsu - "Go and See"

Dig Deeper! Plain English

5W 1H	Level 1	Level 2	Level 3	Level 4	Level 5
Who?	Site	Department	Group	Team	Individual
When?	Day	Shift	Hour	Minute	Actual instant of occurrence
Where?	General area	Specific production line level	Specific process	Actual location in the process	Actual point of occurrence
What?	Occurrence	Symptom	Broad problem	Categorical problem	Specific problem
Why?	1st cause	2nd cause	3rd cause	4th cause	5th cause
How / How much?	Non-conformance issue	Dimensional variation	Above standard allowed	Comparison to actual Standard	Gap from actual standard: e.g., .001 mm

Set a Goal



3 Factors

From what level?
To what level?
By when?

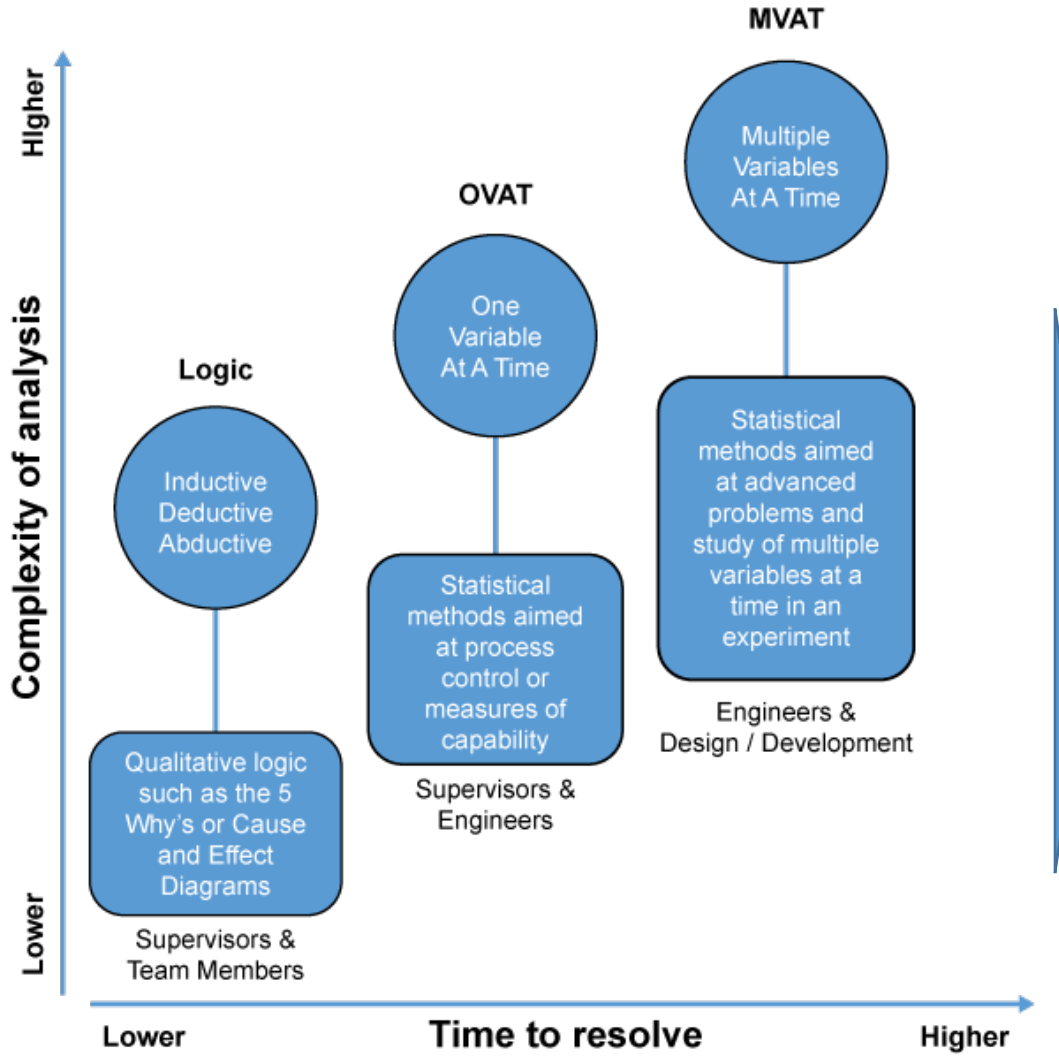
SMART

Specific?
Measurable?
Attainable?
Relevant / Realistic?
Time bound?

Poor examples include:

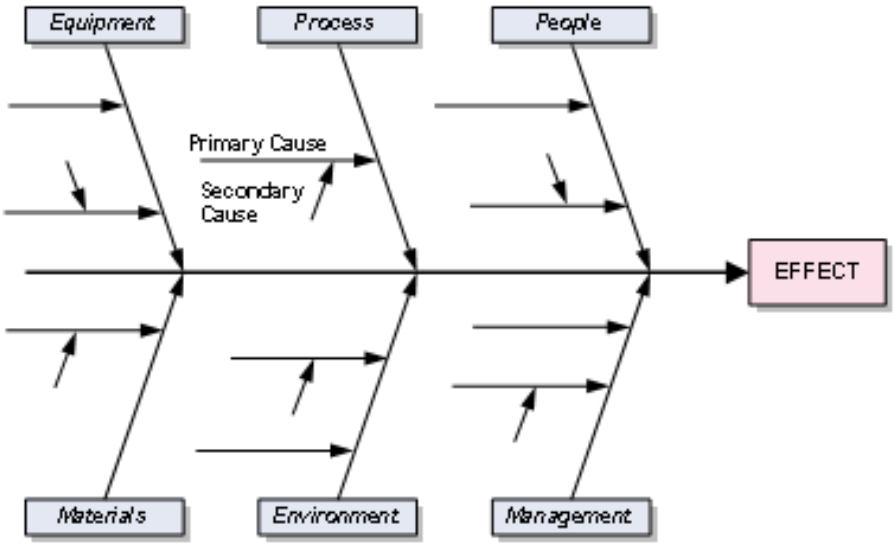
1) Find the root cause! (This is the next step of the process)
2) Implement lean tools like 5S or Standardize Work, etc. (This is an action item)
3) Train the employee (This is jumping to conclusions)

Analyze the Problem



Convergent
Focused
Analytic
C&E Relationship
Standard attainment
Scope control

Logic Based - Fishbone



Fishbone is the common name for a structured Cause & Effect diagram
You do not “brainstorm” a fishbone
Distinguish between critical thinking and creative thinking
Simply writing down random opinions = Wishbone diagram

Logic Based – 5 Why

Situation: A machine has stopped working halting production.

1) **"Why did the machine stop working?"**
   - **"Because the machine overloaded blowing the fuse in the control panel."**
2) **"Why did the overload condition result?"**
   - **"Because there was insufficient lubrication to the spindle bearing."**
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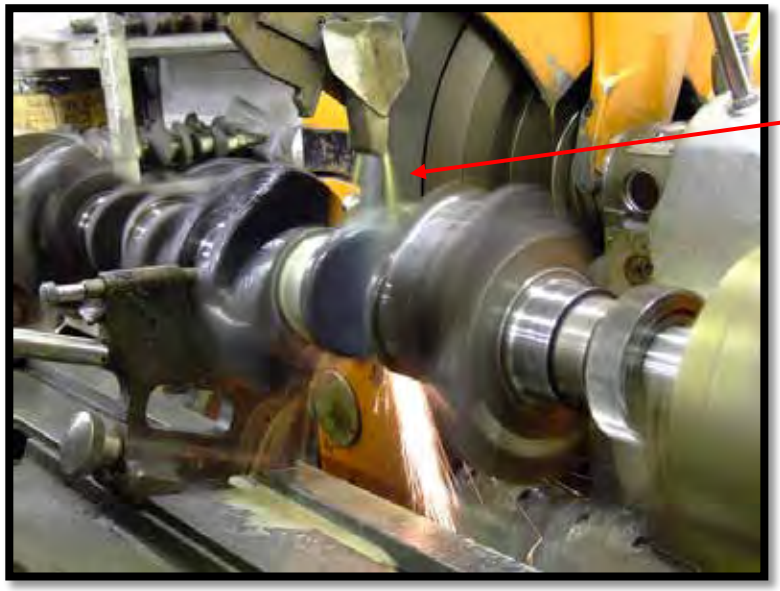
   - **"Because the pump shaft was worn and rattling."**
5) **"Why was the pump shaft worn?"**
   - **"Because there was no strainer on the lubrication device inlet port, and small metal cutting chips entered the system causing damage."**

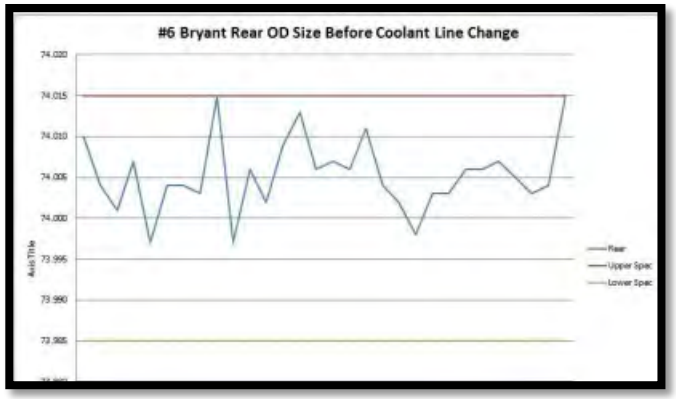
Note deeper causes exist!!!!
However here at this level a quick, inexpensive, and effective countermeasure can be established

Statistical Based - OVAT



Simple case of inadequate coolant flow to the part due to a blocked / damaged coolant line.

One variable (coolant flow) cause the entire problem….



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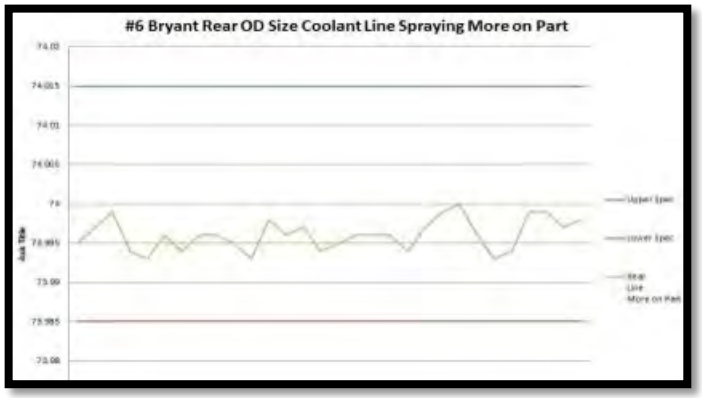
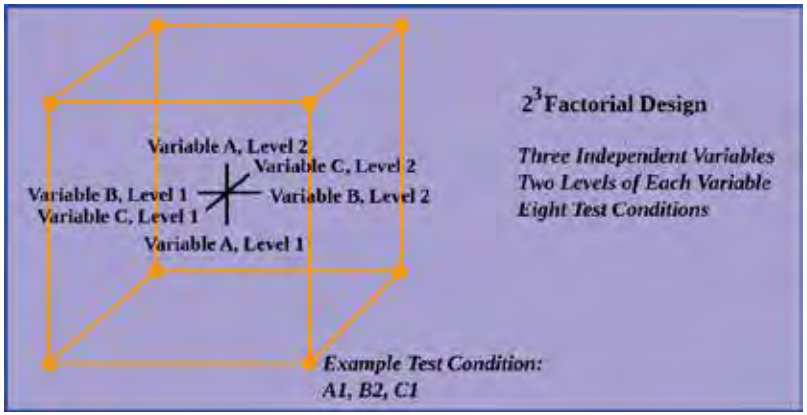
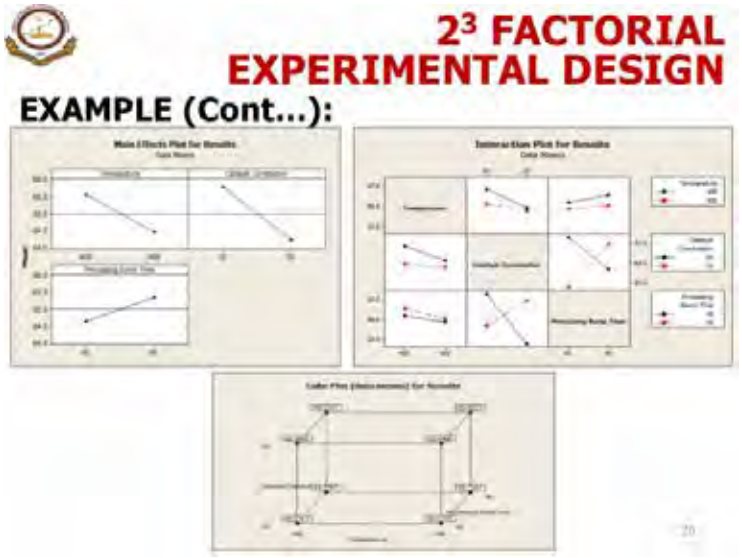


After Cpk 2.33

Statistical Based - MVAT





Complex case of multiple <u>independent variables</u>

-Temperature
-Pressure
-Processing time
-Etc.

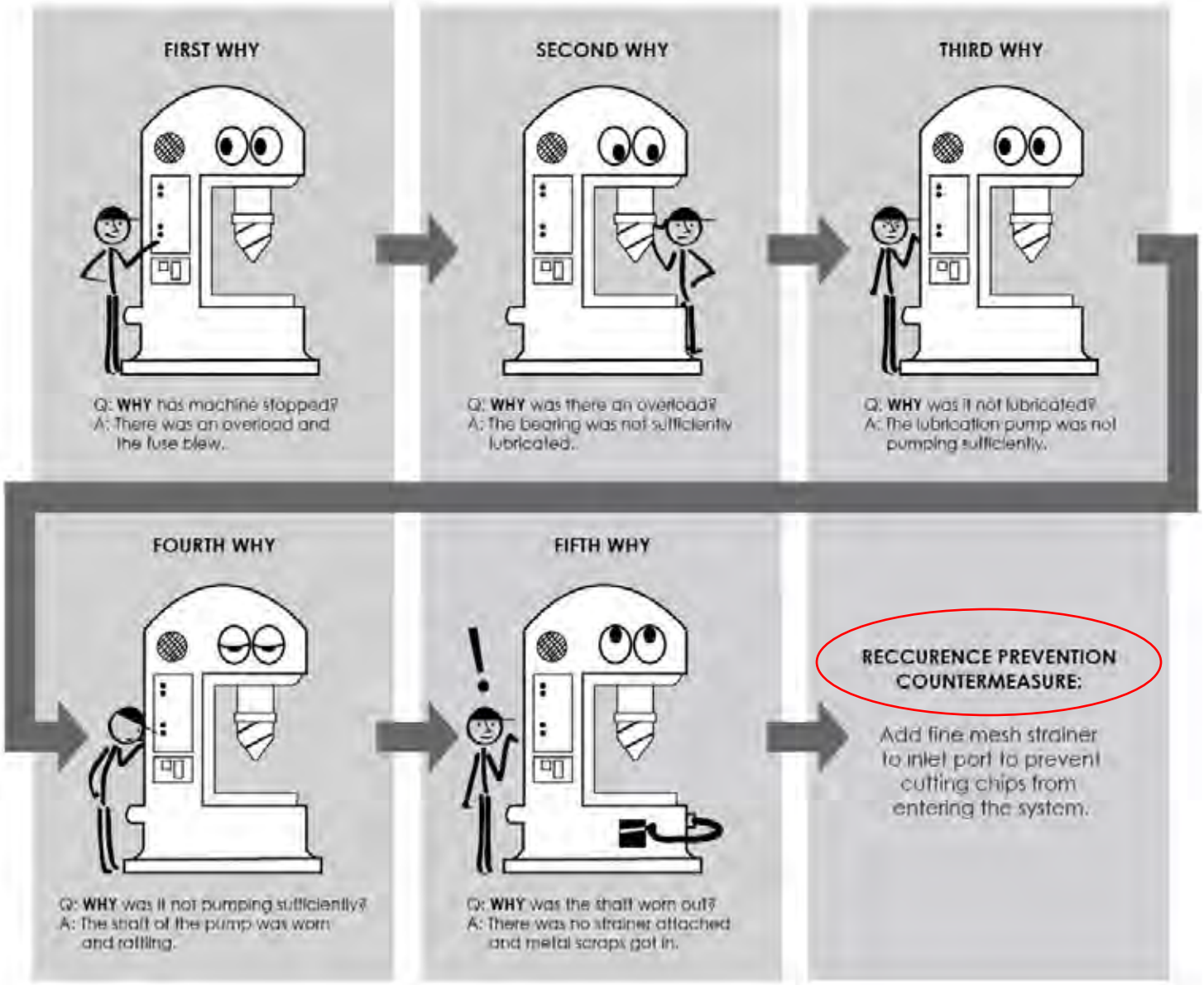
<u>Basic OTD Case & Multiple Factors</u>

-Inventory amount
-Order entry system
-Lead time to produce
-Material storage
-Production schedule
-Set up time
-Production execution

Key Points in RCA

Area of emphasis	Key Points
Analytical	Break it down to the proper level for study. No one technique is always best.
Quantitative / Qualitative	Measure and organize carefully in order to understand relationships.
Detailed	Get the facts using 8G's or 5W 2H to the proper level for the problem in question.

5 Why & RCA Review



Establish Countermeasures

ADMINISTRATION	DETECTION	PREVENTION
• Examples include increasing inspection duties, adding training or altering work instructions for the operator. • These controls are generally weak and mainly acceptable as temporary short term countermeasures.	• Examples include any instances of sensors or alarms used to signal that an abnormality has occurred in the product or process and stops the defect from moving downstream. Mistake or error proofing in the process. • These controls are stronger in nature and contain defects internally better than administrative ones.	• Examples include creative usage of techniques to prevent the defect or abnormality from occuring in the product or process. Or elimination of the underlying condition or potential. • These controls either alone or in conjunction with detection for the strongest type of defect control.

Weaker ← STRENGTH → Stronger

Select countermeasures which are most likely the prevent recurrence of the problem. Training and inspection are not satisfactory countermeasures.

Administration Countermeasures

Standardized Work Chart

Acme Corp.

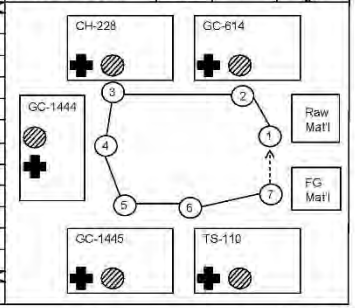
Standardized Work Combination Table

Date: | By: | Approved By:

Plant: Acme | Product: 8" Pinion Gear
Area: Gear Machining | Op. _1_ of _1_
Process: Gear cutting exercise | Pg. _1_ of _1_
Shifts: 2 | Takt Time: 46 secs. | Cycle Time: 46 secs.
Volume: 600

Working Sequence
Walking
----- Return to Start

No.	Major Steps	MAN TIME	AUTO TIME	WAIT TIME	WALK TIME	Safety	SWIP	Quality
1	Pick up raw material	1	--	--	2			
2	Unload, load part and start M/C GC614	5	38	--	2			
3	Unload, load part and start M/C CH228	6	7	--	2			
4	Unload, load part and start M/C GC1444	6	38	--	2			
5	Unload, load part and start M/C GC1445	6	30	--	2			
6	Unload, load part and start M/C TS110	7	3	--	2			
7	Pack FG in pallet	1	--		2			



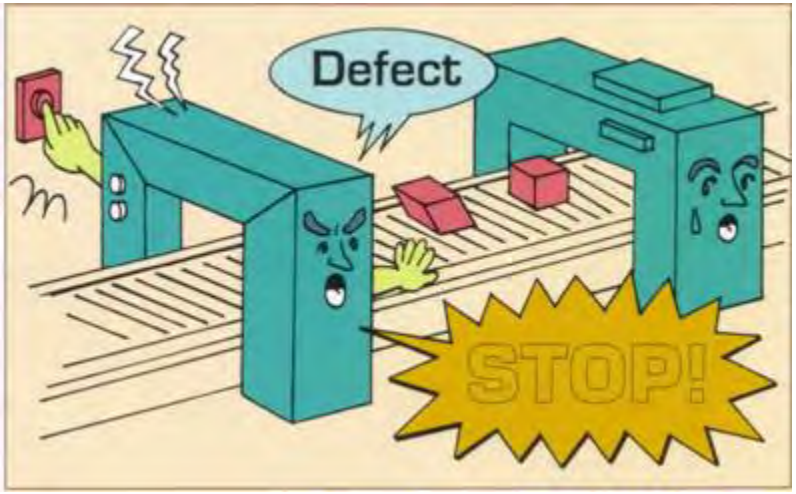
Slide 4-7

Examples of Administrative C/M

Standardized Work / Work Instructions
Inspection Frequency or Method
Training and Communication

Detection Countermeasures

Jidoka concept



Examples of Detection C/M

Error proofing
Sensors (Mechanical, Electrical, Optical, etc.)
In-process auto measurement
Immediate post process auto measurement

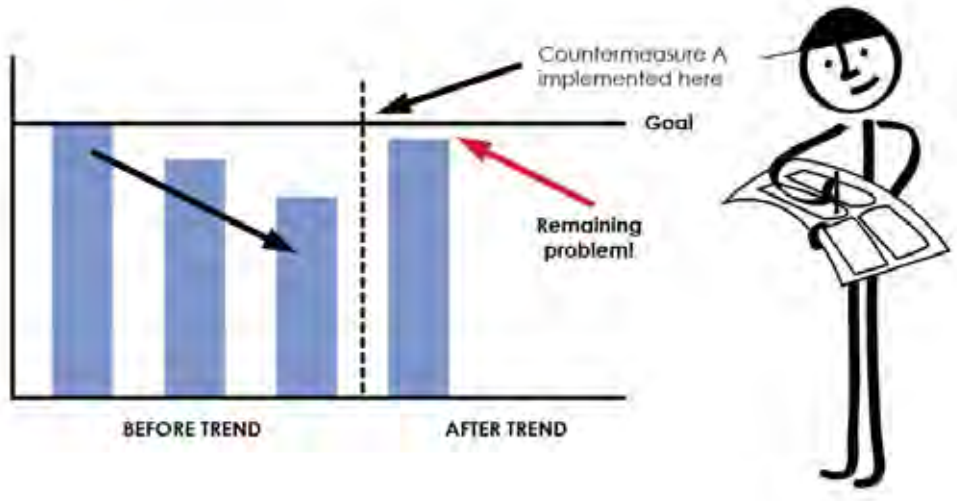
Automatically stop the process at any detection of a defect or abnormal condition

Prevention Countermeasures

3 Stages of Prevention

STAGE OF PREVENTION	PRIMARY	SECONDARY	TERTIARY
STAGE OF DISEASE	NONE (YET)	IMMINENT	ESTABLISHED
PRIMARY OBJECTIVE	DISEASE AVOIDANCE	EARLY DETECTION	MINIMIZE DAMAGE
INTERVENTION TOOLS	HEALTH RISK ASSESSMENT	BIOMETRIC SCREENING	ON-SITE MEDICAL CARE
	HEALTH/WELLNESS PORTAL	CVD SCREENING	PREDICTIVE CARE MGMT.
	SELF-CARE BOOK/CLASSES	CONSUMERISM CLASSES	LARGE CASE MGMT.
	LIFESTYLE COACHING	COMPLIANCE PROGRAM	MATERNITY MGMT.
	EXERCISE PROGRAMMING	NURSE HELP LINE	UTILIZATION MGMT.
	HEALTH EDUCATION		

Check Results



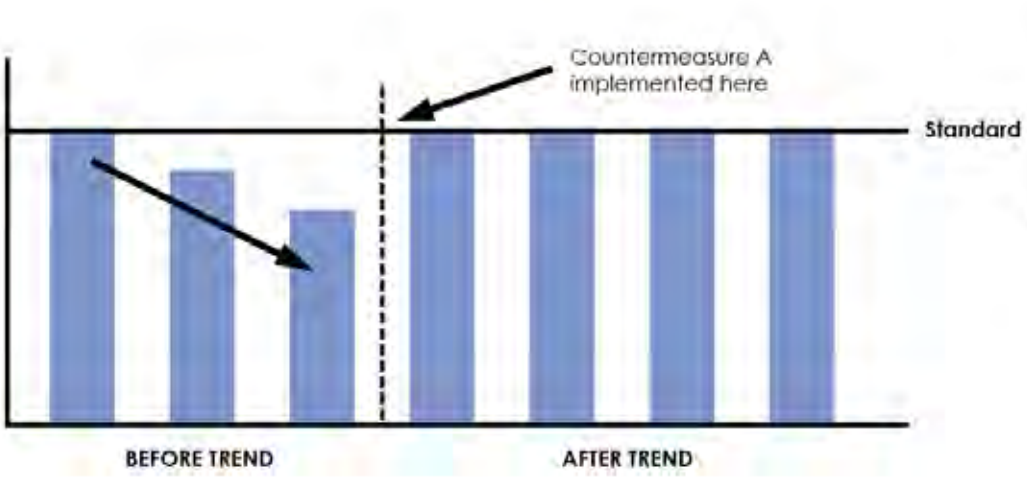
Primary Purpose:

1) Check and verify if you have attained your results goal
2) Check and verify if your process metrics are sound

Common Mistakes:

1) Falling into the mistake of checking the completion of action items. That is not the same thing as checking whether or not you have accomplished the goal!
2) Not checking if you attained your goal!

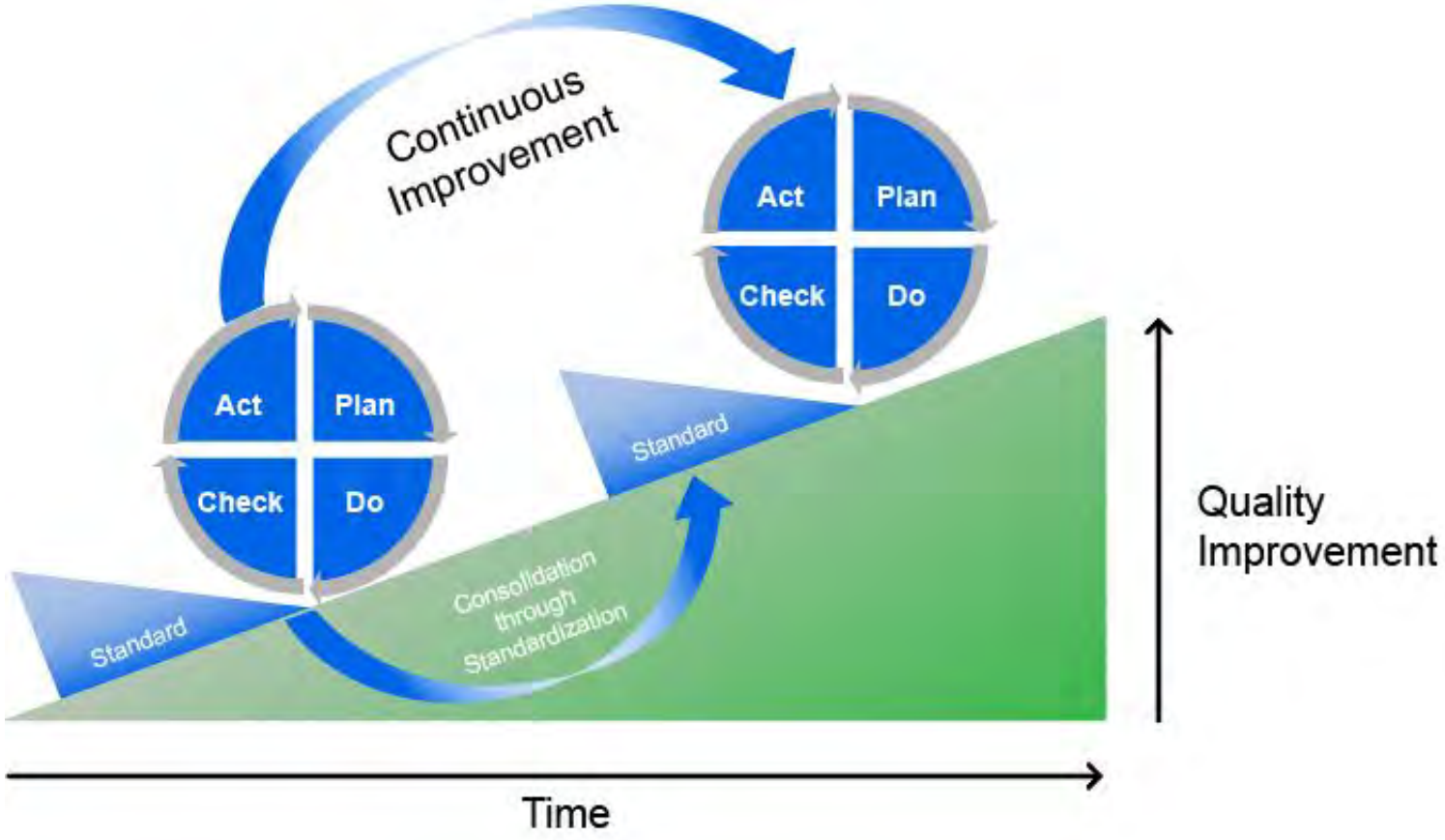
Check Results



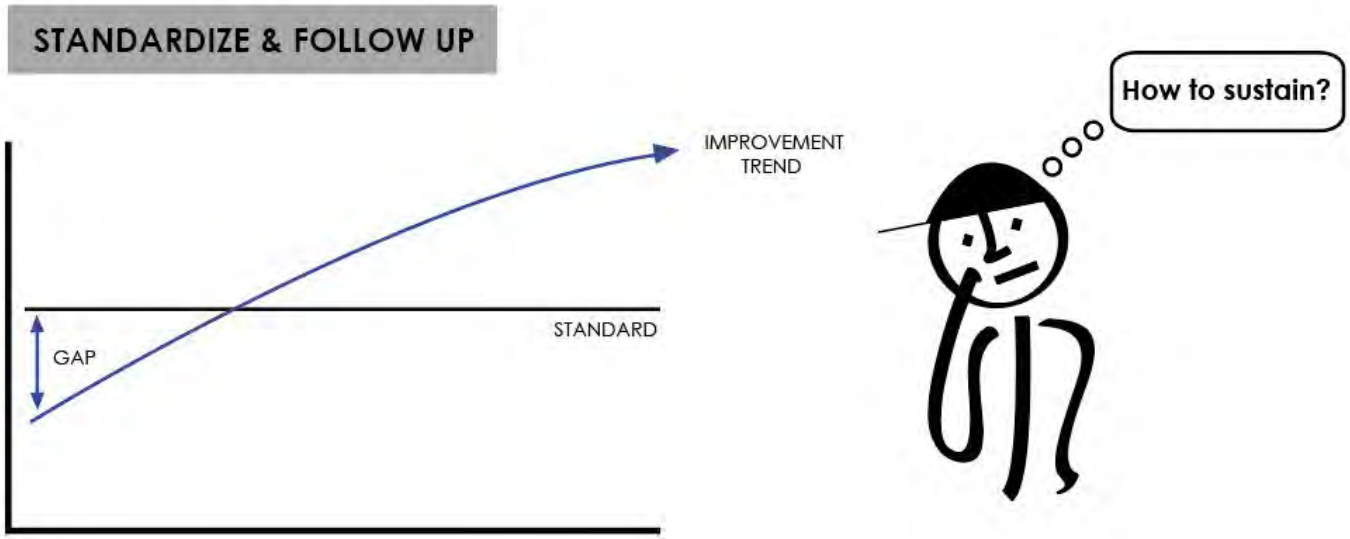
Key Points:

1) How long will you follow up to ensure success?
2) Are your countermeasures “sticky”?

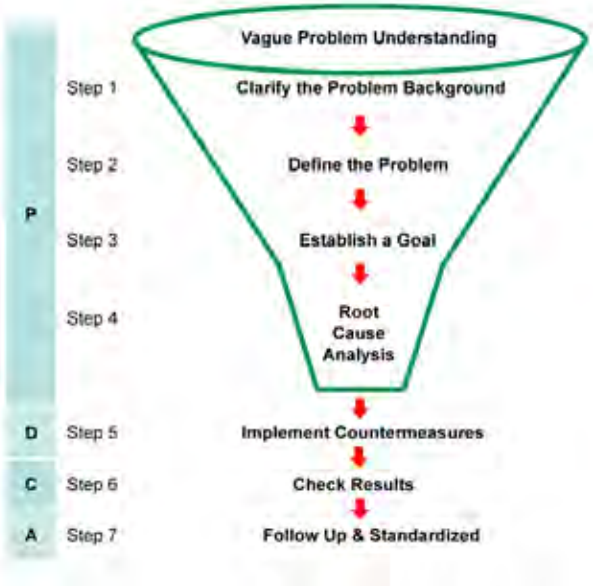
Follow Up & Standardize

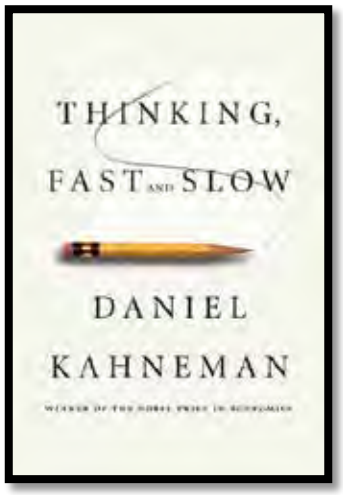


Follow Up & Standardize



Type 2 Summary





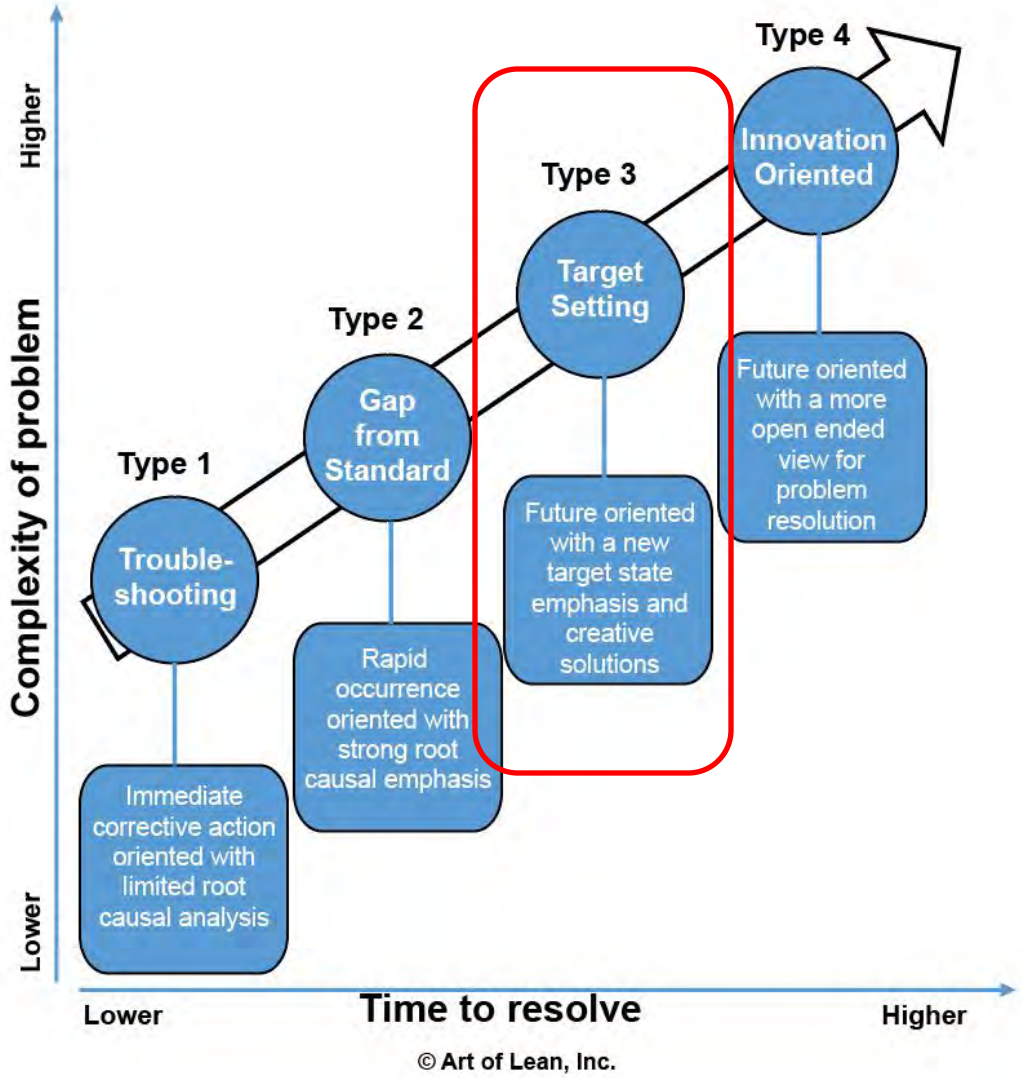
Type 1 Troubleshooting is about rapid action and response to the abnormal condition…an analogy is thinking fast.

Type 2 Gap from standard problem solving is about being more deliberate and slowing down to consider what is the **real problem** or **root cause**…an analogy is thinking slow.

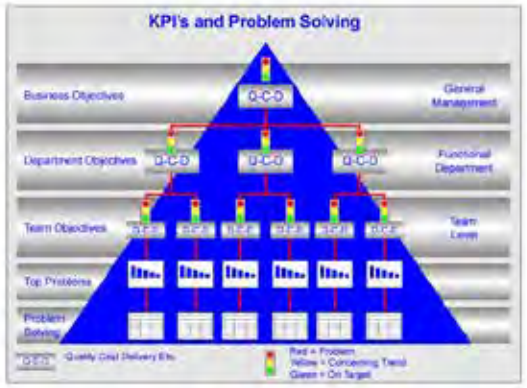
Exercise & Discussion

- Same as before
- Now prepare a Type 2 Problem for presentation
- Flip Chart – Basic Steps
    1. Problem Background
    2. Problem Definition
    3. Set a Goal
    4. Root Cause Analysis
    5. Countermeasures
    6. Check Results
    7. Standardize & Follow Up

4 Types of Problem Situations



Type 3 – Target State



(Future) Ideal Situation

GAP

Acceptable (Current State) Situation

Normal Status

GAP

Current Situation

Type 3 - "Target State"

Type 2 - "Gap from Standard"

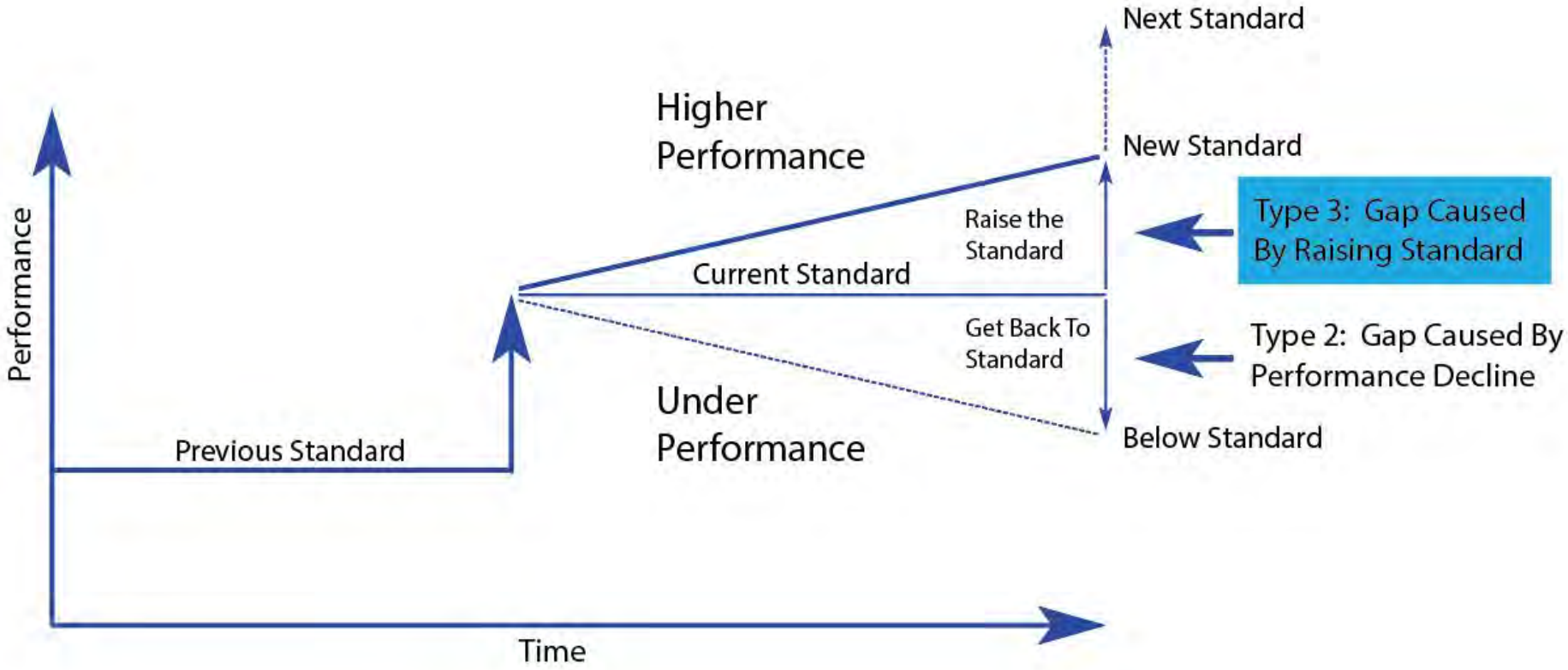
Kaizen Methods

改善方法

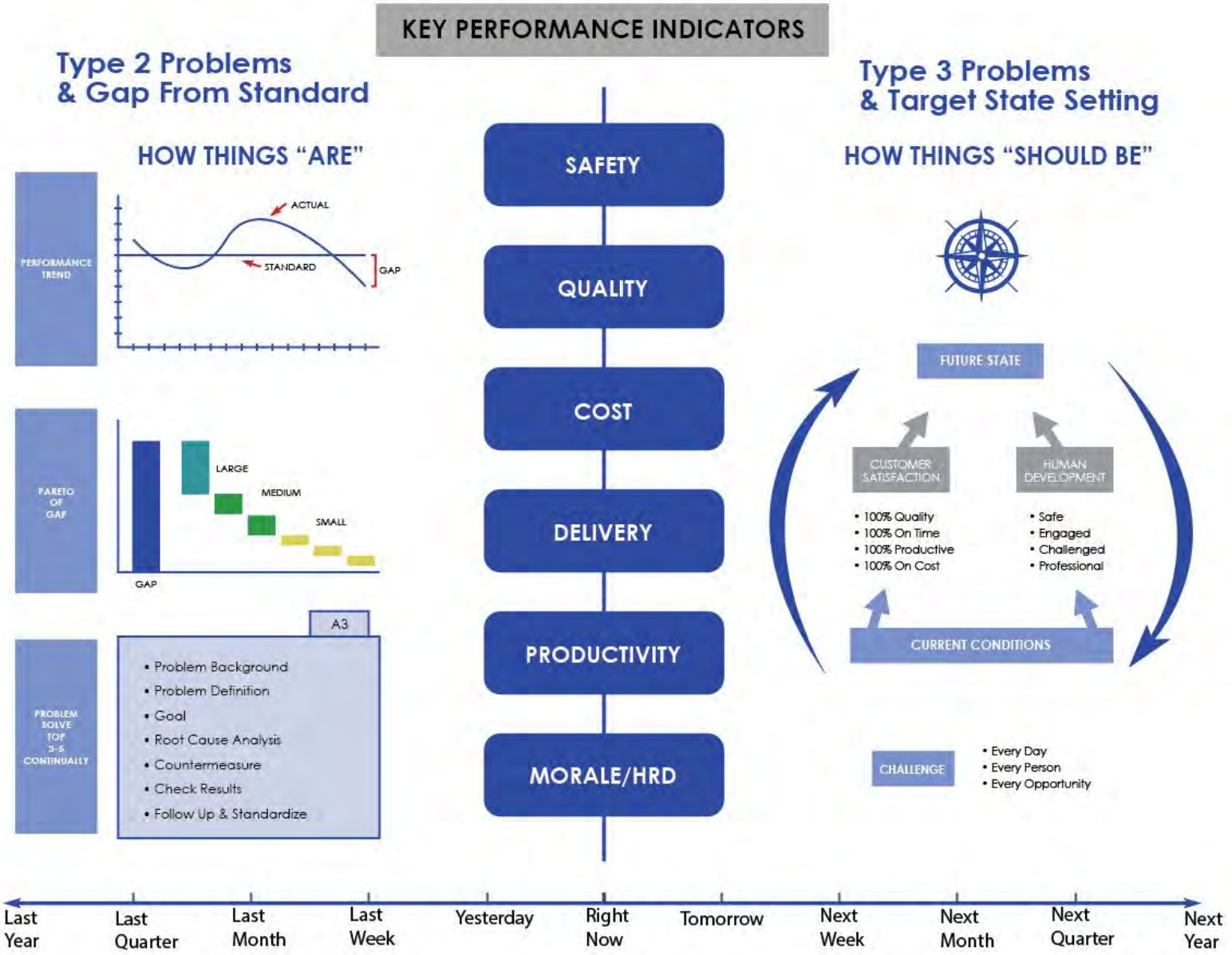
問題解決

Problem Solving

Type 3 – Raise the Bar



Target State Concept (Time Frame)



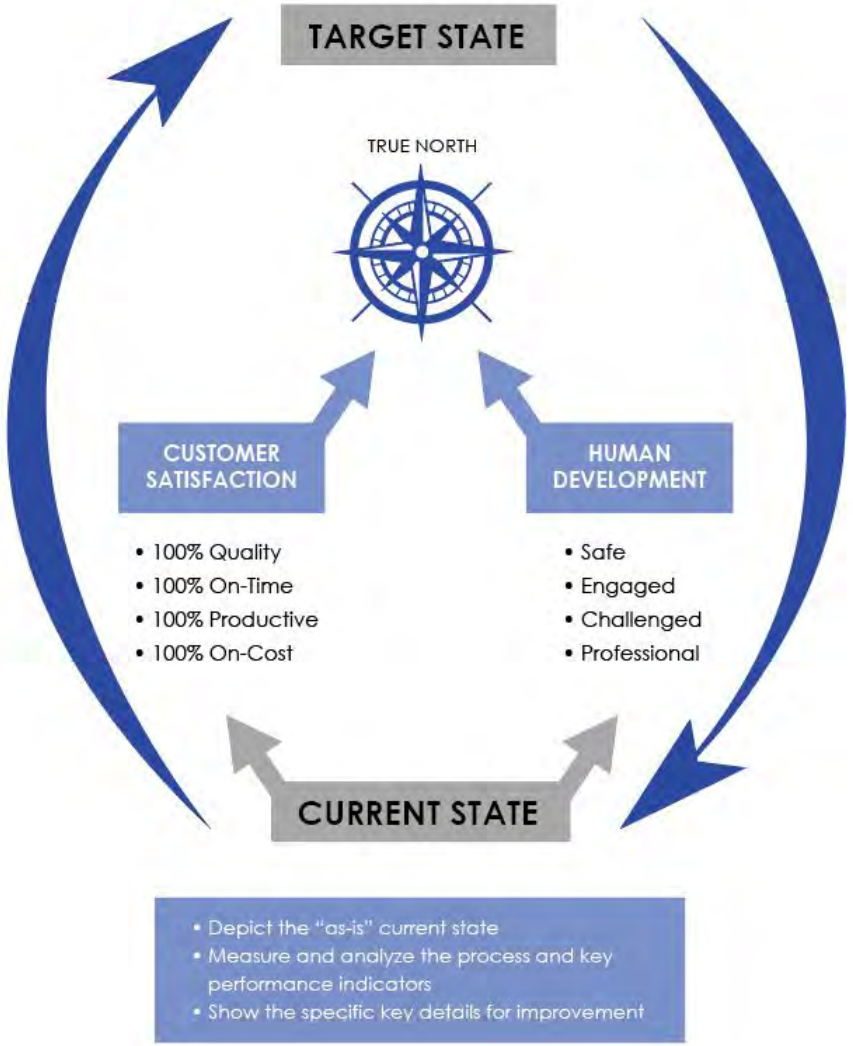
You Can Target State Anything!

- Products
- Processes
- Services
- Sports
- Metrics

But you have to think
and not just copy…

Two Types of Thinking

Target State Improvement Steps



1	BACKGROUND
2	CURRENT STATE DEFINITION
3	CURRENT STATE ANALYSIS
4	GOALS
5	TARGET STATE DEFINITION
6	IMPLEMENTATION PLAN
7	CHECK RESULTS
8	FOLLOW-UP & STANDARDIZE

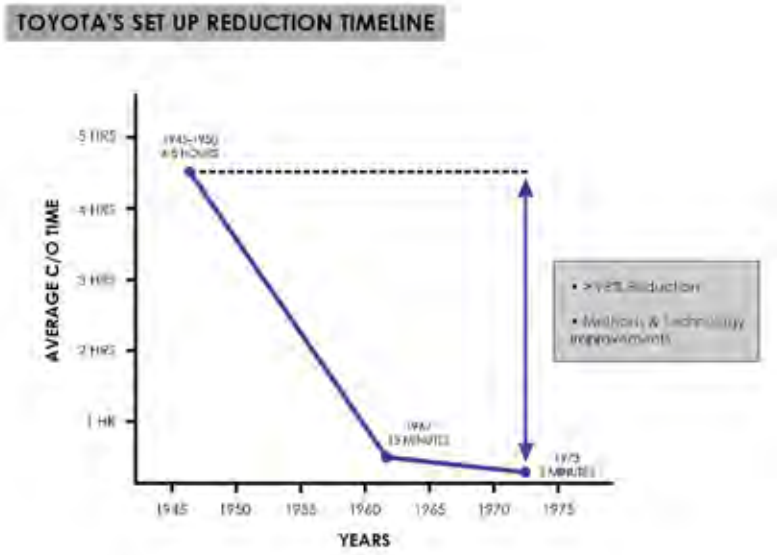
Process Example SMED Example

Dedicated Press
Part A

Dedicated Press
Part B

Dedicated Press
Part C

3 Dedicated Machines
No Flexibility
Each 30% Utilization
Make lots of inventory!



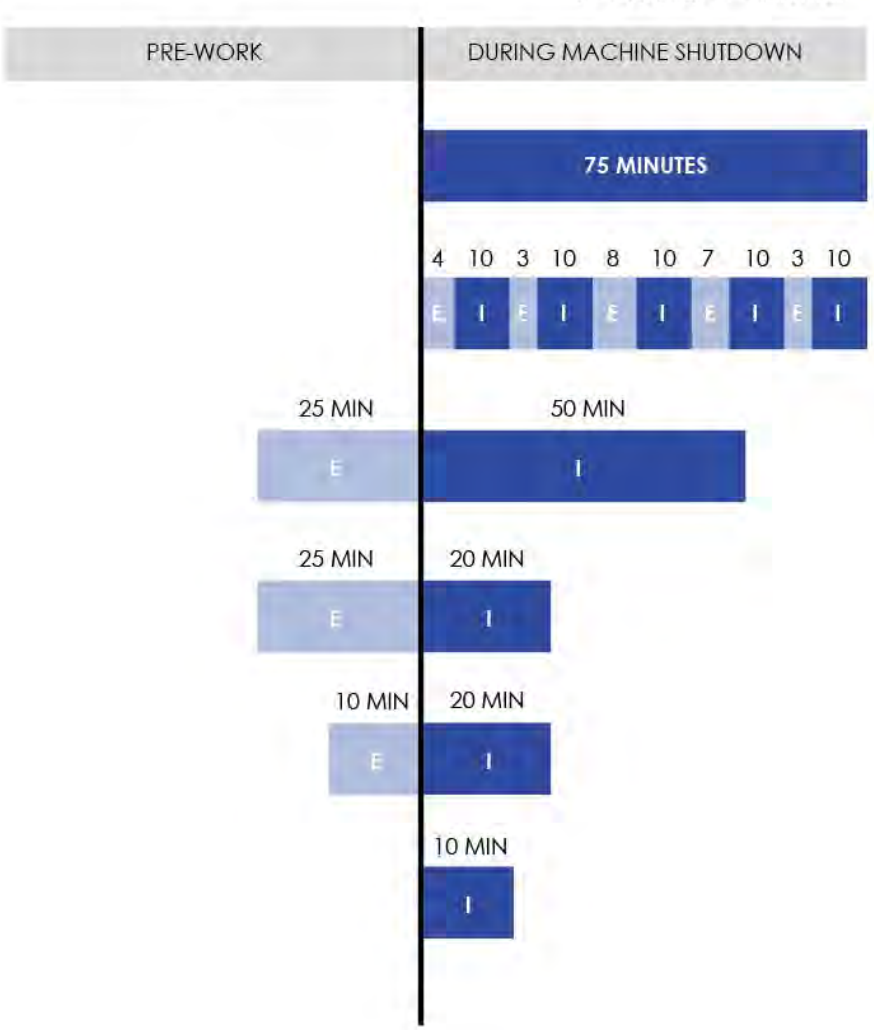
Flexible Press
Parts A, B, & C

1 Machine / 3+ Tools
Change Over Flexibility
90% Utilization
Run more JIT style

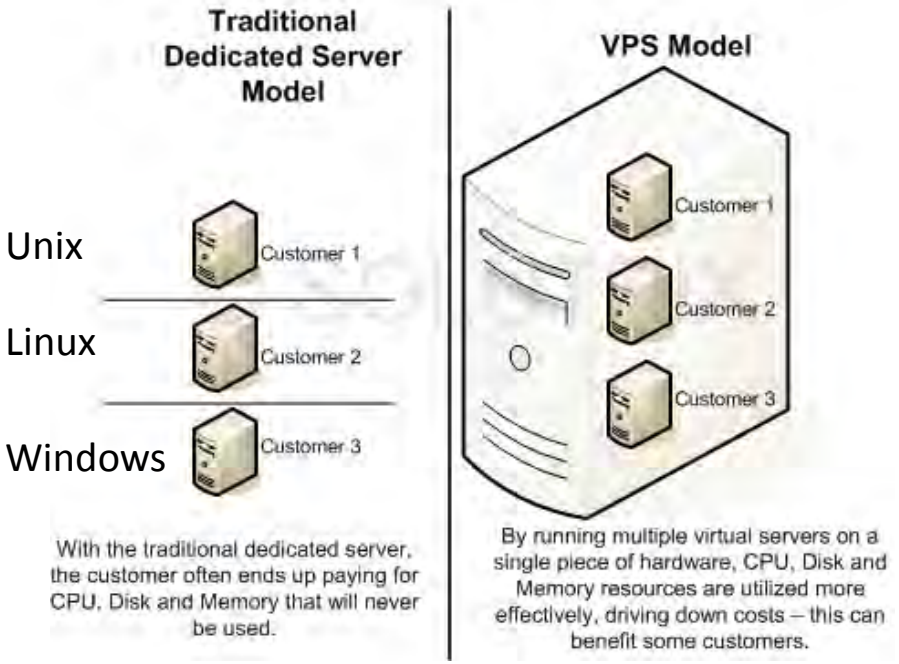
Set Up Reduction

METHODS: CHANGEOVER REDUCTION STEPS

1. Measure total time required for changeover. Video tape is best.
2. Identify internal versus external elements and calculate individual times
3. Take the external elements and make sure they are done before the machine stops
4. Reduce and eliminate the internal elements (i.e. adjustments & fastener items in particular)
5. Reduce the time required for external elements
6. Standardize and improve the new procedure over time



Software Example



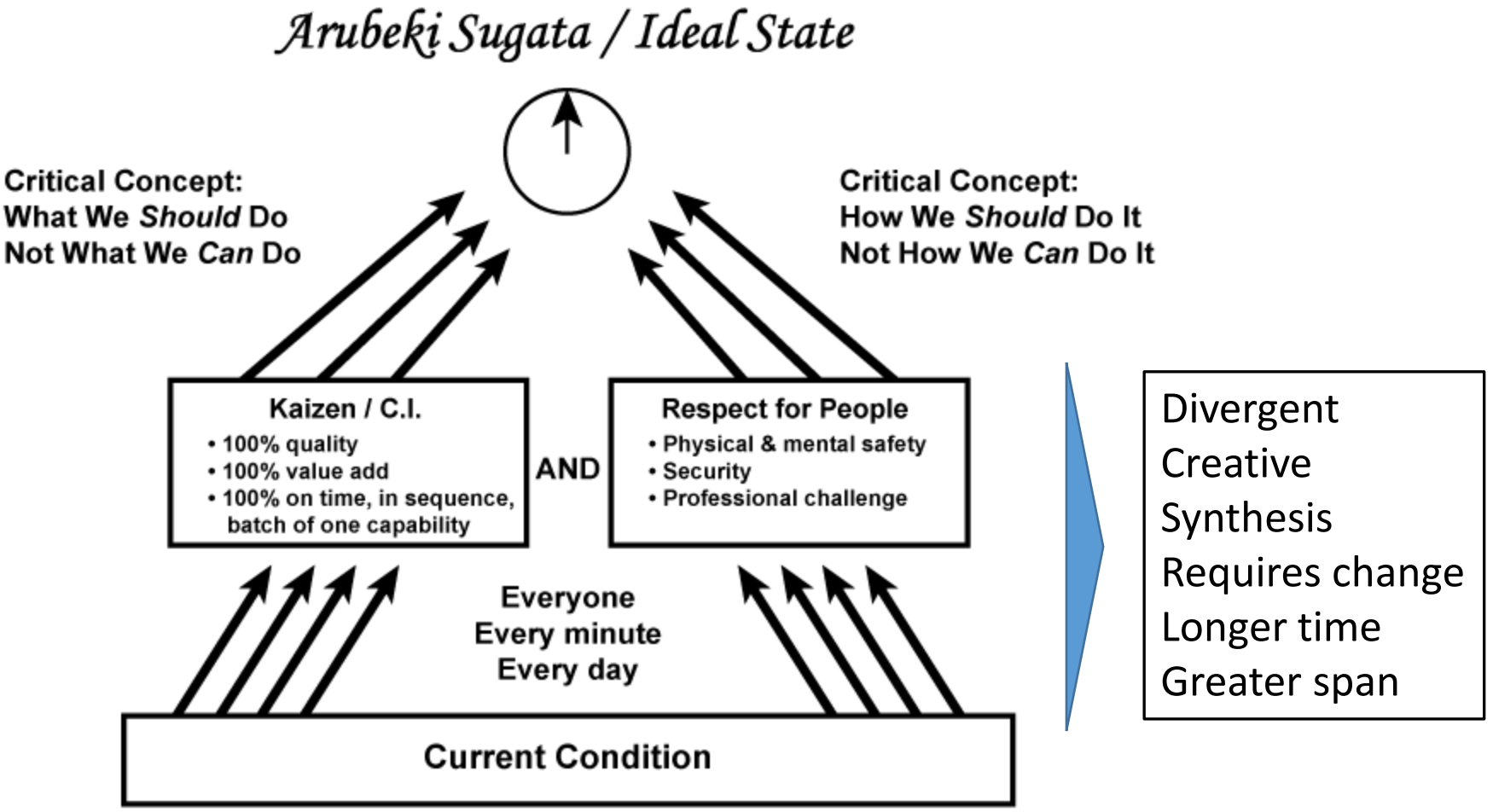
Same basic principle as SMED in die exchange…

Key here is not the time change over aspect but the software ability to act and host multiple server types…

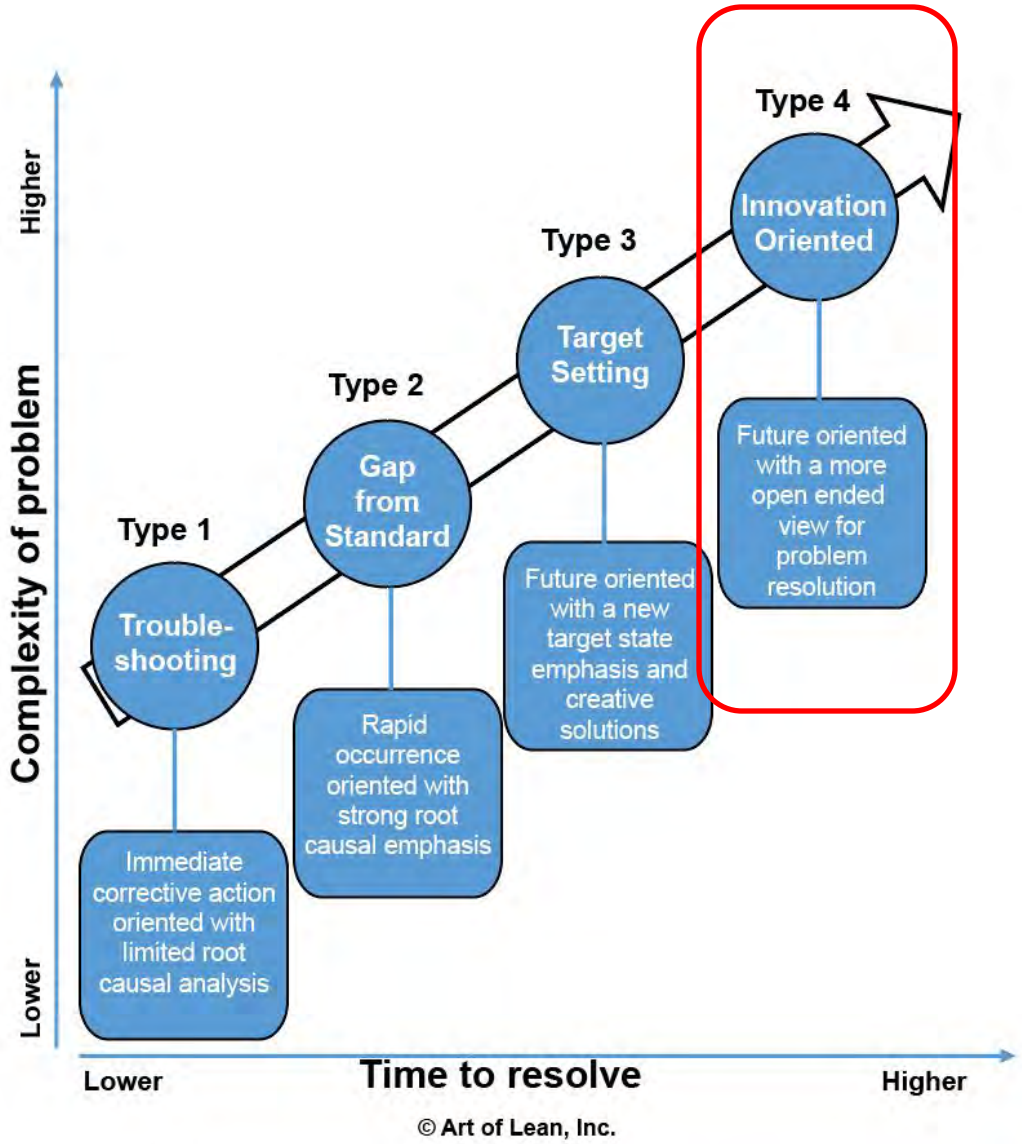
3 Dedicated Servers
Each 30% utilized
No flexibility
Stranded resources

1 Virtual Server
Now 90% utilized
Flexibility
Less waste

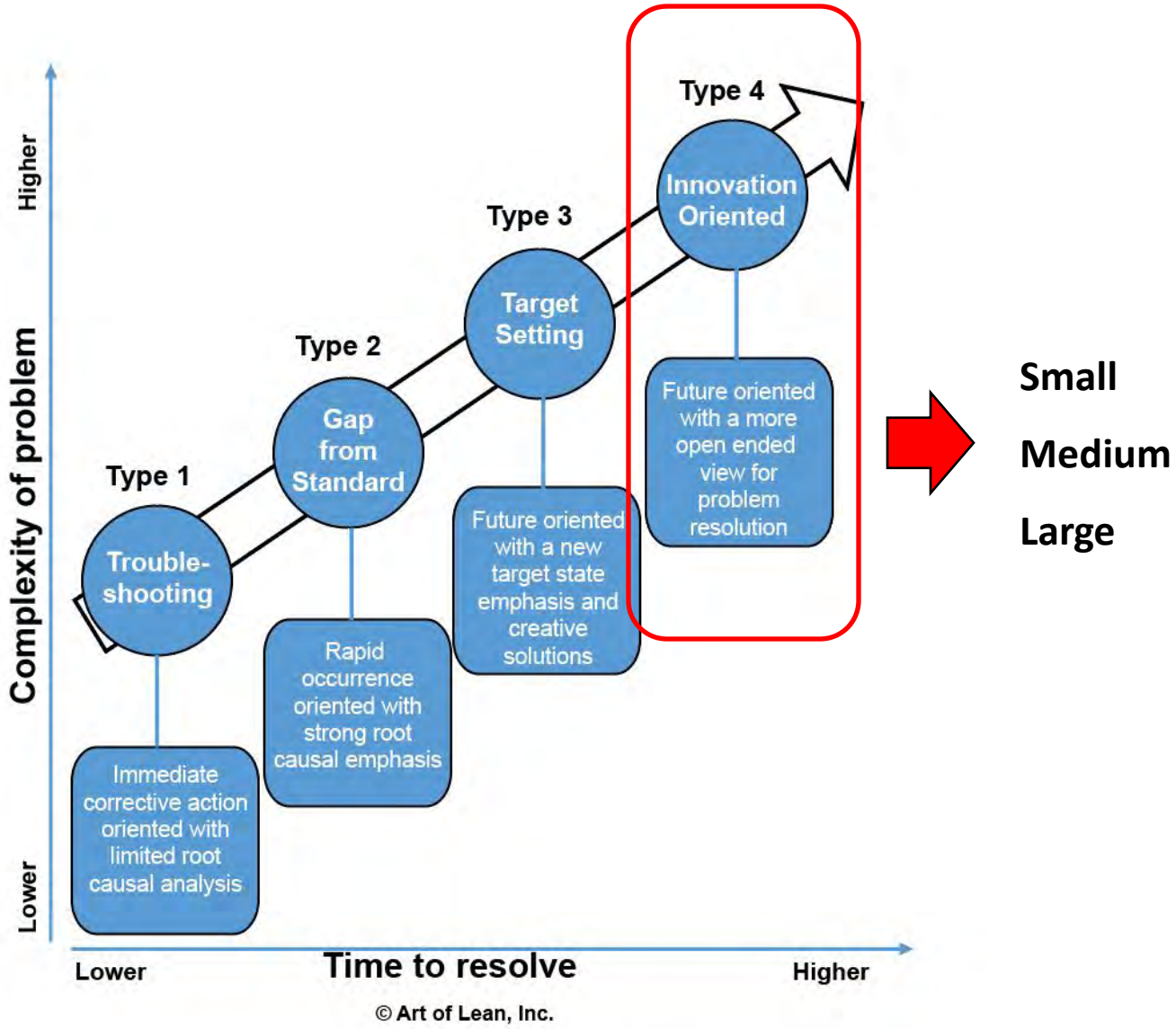
Type 3 – Target State Summary



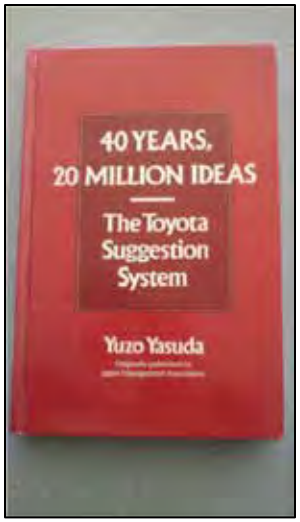
4 Types of Problem Situations



4 Types of Problem Situations



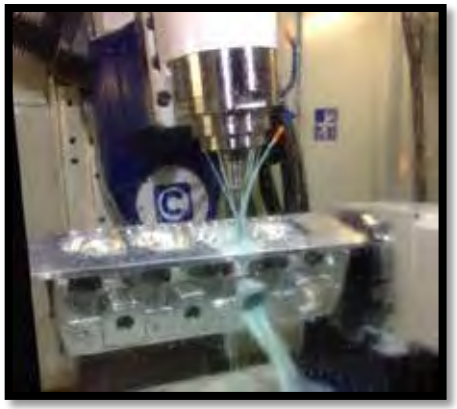
Toyota Suggestion System 1951

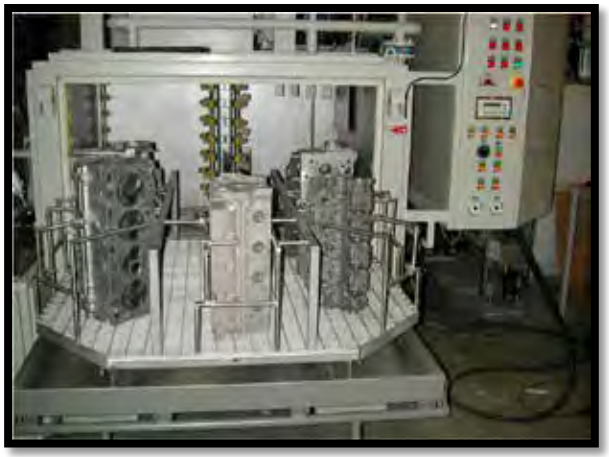


The system was introduced by Managing Director Eiji Toyoda in 1951 when it became clear during the post Second World War economic recovery that Toyota's production facilities needed improvement. Toyoda took the idea of TCISS (the creative ideas suggestion system) from a Ford Motor Company plant which he had visited in July 1950.

Although the TCISS offered incentives to employees, the real value of the system was that it provided motivation to employees by focusing on their skills and creativity. The TCISS systemized the practices that had been customary since the time of Toyota Motor Corporation founder Kiichiro Toyoda: respecting opinions from production and sales and conducting spontaneous on-site inspections while simultaneously inviting suggestions for improvements.

Washer Process Innovation





Entry View

Front View

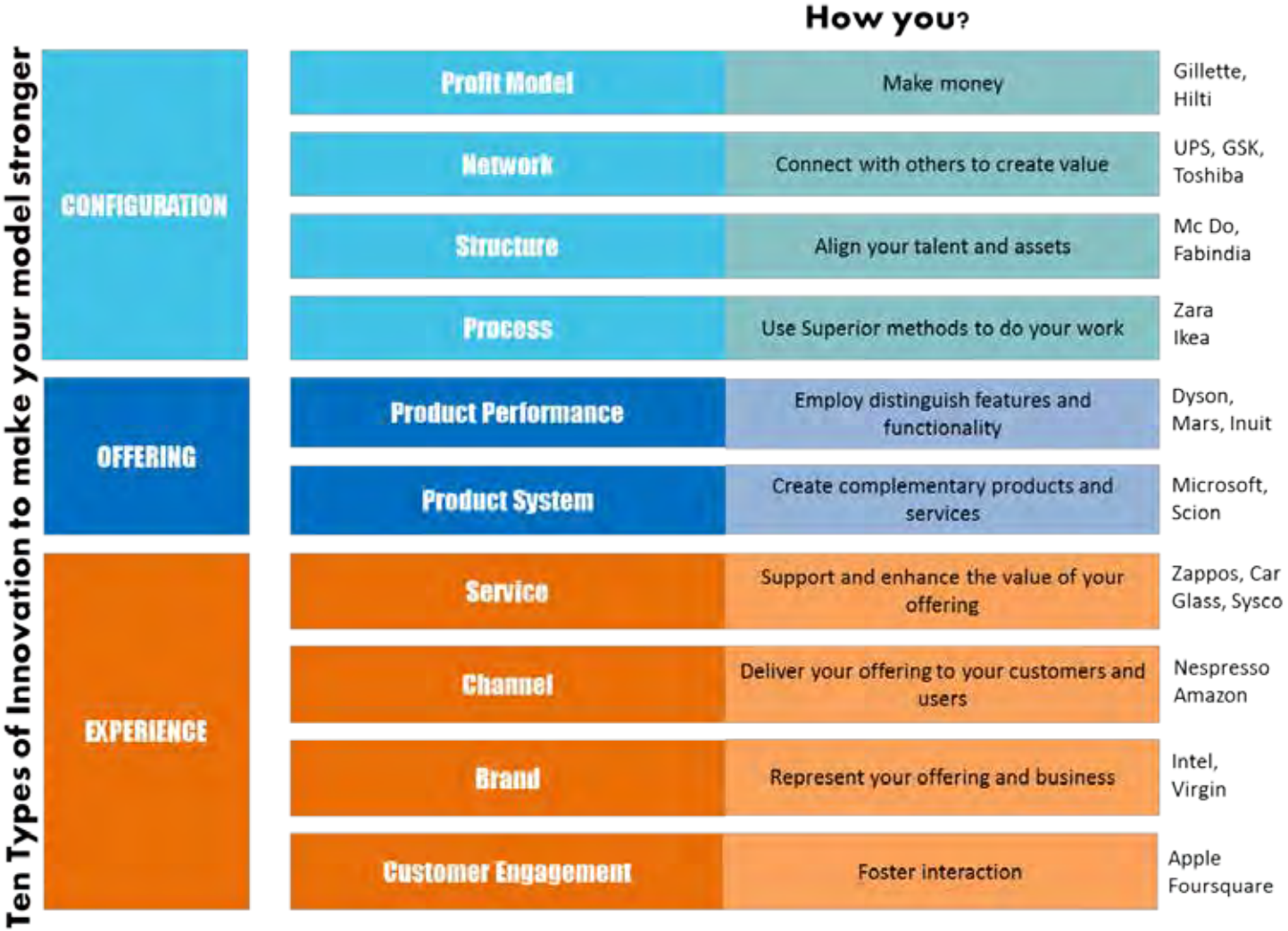
Employee Improvement Idea

- “It occurred to me that the thought of putting the cylinder head through a large box shaped industrial washer was inherently a bad idea…blasting it from the outside with dozens of high pressure nozzles only pushed some cutting chips, dirt, and contaminants father into the holes and ports, etc.”

- “It also occurred to me that just dunking the cylinder head into a series of 55 gallon sized dunk tanks via a robotic arm would work better. Plunging action into the tank with an agitator style of motion would drop the chips and contaminants out with less time, energy, cost, maintenance, and higher end quality…”

Prius, Lexus, & Mirai

Type 4 – Vision / Innovation



Doblin: 10 Types of Innovation: The Discipline of Building Breakthroughs

5 Why Example Revisited

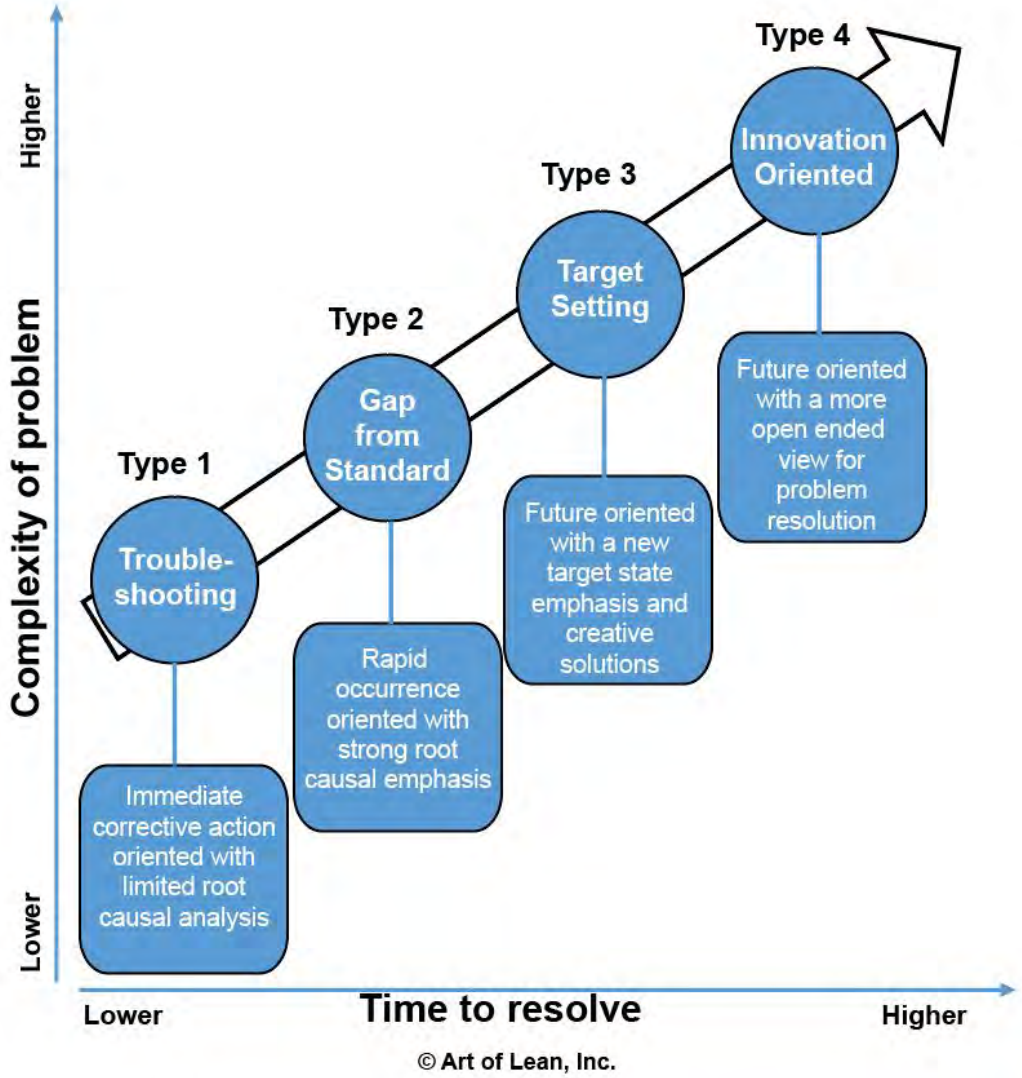
Situation: A machine tool has stopped working halting production.

1) "Why did the machine stop working?"
    - "Because the machine overloaded blowing the fuse in the control panel."
2) "Why did the overload condition result?"
    - "Because there was insufficient lubrication to the spindle bearing."
3) "Why was there insufficient spindle bearing lubrication?"
    - "Because there was insufficient lubrication drawn up by the pump."
4) "Why was there insufficient lubrication draw by the pump?"
    - "Because the pump shaft was worn and rattling."
5) "Why was the pump shaft worn?"
    - "Because there was no strainer on the lubrication device inlet port, and small metal cutting chips entered the system causing damage."

5 Why Revisited

- Type 1 - Troubleshoot cutting chips by daily cleaning and maintenance of the machine for immediate relief.
- Type 2 – Put the strainer on the inlet port in the previous example for recurrence prevention.
- Type 3 – Evacuate the cutting chip better by breaking the cutting chips smaller, with better coolant systems, chip breakers, and better tooling conditions. Also improve machine guards and tank covers for a more creative solution.
- Type 4 – Tooling innovation, chip formation optimization, cutting condition innovation, washer process redesign, and upstream die casting optimization for process innovation. Material and product innovation are also possible angles.

4 Types of Problem Situations



4 Types & Benkei Analogy

Benkei

Kaoru Ishikawa

The term "7 QC tools" is named after the seven tools of Musashibo Benkei the famous warrior monk. Benkei owned seven weapons which he used to win all his battles. Similarly from my own experience you will find that you will be able to solve 95% of the problems you face if you properly use the 7 QC tools.

Professor Emeritus
University of Tokyo

Baka / バカ / 馬鹿

馬鹿の一つ覚え
[ばかのひとつおぼえ,
baka no hitotsu-oboe

A fool remembers only one thing

A fool knows only one way of doing things

Session Summary

- Benkei versus Baka analogy and be careful of experts who only know one way
- Each type has a different cadence and focal point
- Learning by doing is key for all four types
- Reflection after doing is key as well. However you can’t just “think” your way to improvement
- Problem solving, innovation and improvement require perspiration and willingness to fail more than once

Appendix