Toyota Kaizen Methods

Steps for Continuous Improvement
Learning Session Outline

• Background

• 4 Types of Problem Situations

• Type 3 – Target State Improvement
  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

• 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
Other Background - Stuff
Western Influences:
Mass Production & moving conveyor lines
Scientific Principles Of Management
Standardization Of Parts
Many Others....

Various parties and key individuals involved over a long period of time
20th Century & Problem Solving

1896
Frederick W. Taylor's scientific management principles
John Dewey Reflective Thinking

1900s
TWI Methods during WWII
U.S. DOD standard MIL-P-1629 Failure Modes Effects Analysis

1910s
Walter A. Shewhart's control chart
Vilfredo Pareto introduces 80/20 concept in Italy

1920s

1930s

1940s
Lean problem solving methods
Six sigma methods
Design thinking routines

1950s
Sarasohn & Protzman
CCS Course in Japan & 5 step problem solving
Deming SPC lectures & Deming Wheel in Japan
JUSE PDCA Cycle
Juran Quality Management & Handbook in Japan
TRIZ / TIPS

1960s
U.S. DOD 8D Method
Kepner Tregoe Rational Analysis Methods

1970s
JUSE 7 QC Tools
6 step problem solving & shop floor QC circle activities

1980s
Alex F. Osborn establishes brainstorming routines for creative problem solving
Ronald A. Fischer Design of Experiments
Shewhart cycle of specify, produce & inspect

1990s

2000s

General Inputs:
Scientific Method & Critical Thinking Routines
4 Types of Problem Situations

Type 1: Troubleshooting
- Immediate corrective action oriented with limited root causal emphasis

Type 2: Gap from Standard
- Rapid occurrence oriented with strong root causal emphasis

Type 3: Target Setting
- Future oriented with a new target state emphasis and creative solutions

Type 4: Innovation Oriented
- Future oriented with a more open ended view for problem resolution

- diagram showing the relationship between problem complexity and time to resolve.
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
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
  - Immediate corrective action oriented with limited root causal emphasis

- **Type 2**: Gap from Standard
  - Rapid occurrence oriented with strong root causal emphasis

- **Type 3**: Target Setting
  - Future oriented with a new target state emphasis and creative solutions

- **Type 4**: Innovation Oriented
  - Future oriented with a more open ended view for problem resolution

The diagram maps these types along two dimensions: complexity of the problem and time to resolve.
Type 3 – Target State

Acceptable (Current State) Situation

Normal Status

(GAP)

(Future) Ideal Situation

(GAP)

Type 2 - “Gap from Standard”

Problem Solving

問題解決

改善方法

Kaizen Methods

Type 3 - “Target State”
Shop Floor Management Board
Type 3 – Raise the Bar

- Previous Standard
- Current Standard
- Higher Performance
- Under Performance
- New Standard
- Next Standard

Type 3: Gap Caused By Raising Standard
Type 2: Gap Caused By Performance Decline
PS vs TS Comparison

**KEY PERFORMANCE INDICATORS**

**Type 2 Problems & Gap From Standard**

**HOW THINGS “ARE”**

**Type 3 Problems & Target State Setting**

**HOW THINGS “SHOULD BE”**

- SAFETY
- QUALITY
- COST
- DELIVERY
- PRODUCTIVITY
- MORALE/HRD

**FUTURE STATE**
- CUSTOMER SATISFACTION
  - 100% Quality
  - 100% On Time
  - 100% Productive
  - 100% On Cost
- HUMAN DEVELOPMENT
  - Safe
  - Engaged
  - Challenged
  - Professional

**CURRENT CONDITIONS**
- CHALLENGE
  - Every Day
  - Every Person
  - Every Opportunity

**Problem Scoping** & Case Commun/Case

- Problem Background
- Problem Definition
- Goal
- Root Cause Analysis
- Countermeasure
- Check Results
- Follow Up & Standardize

**Timeline**
- Last Year
- Last Quarter
- Last Month
- Last Week
- Yesterday
- Right Now
- Tomorrow
- Next Week
- Next Month
- Next Quarter
- Next Year
Thinking Patterns

TWO KINDS OF THINKING

Critical Thinking
- analytic
- convergent
- vertical
- probability
- judgment
- focused
- objective
- answer
- left brain
- verbal
- linear
- reasoning
- yes but

Creative Thinking
- generative
- divergent
- lateral
- possibility
- suspended judgment
- diffuse
- subjective
- an answer
- right brain
- visual
- associative
- richness, novelty
- yes and
You Can Target State (Kaizen) Anything!

- Products
- Processes
- Services
- Sports
- Metrics

But you have to think and not just copy...
Value Stream Example

Multiple process flow depiction with emphasis on lead time reduction
Stamping Process 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

**TOYOTA'S SET UP REDUCTION TIMELINE**

- > 98% Reduction
- Methods & Technology Improvements

- 1945-1950: 4-6 HOURS
- 1962: 15 MINUTES
- 1973: 3 MINUTES
Software Server Example

Traditional Dedicated Server Model

Unix
Customer 1

Linux
Customer 2

Windows
Customer 3

With the traditional dedicated server, the customer often ends up paying for CPU, Disk and Memory that will never be used.

VPS Model

Customer 1

Customer 2

Customer 3

By running multiple virtual servers on a single piece of hardware, CPU, Disk and Memory resources are utilized more effectively, driving down costs – this can benefit some customers.

3 Dedicated Servers
Each 30% utilized
No flexibility
Stranded resources

1 Virtual Server
Now 90% utilized
Flexibility
Less waste

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...
Sports Simplification Example

**NO-HUDDLE OFFENSE**

- Whistle ends previous play.
- Players stop action & get up. Officials set ball.
- Return to Huddle
- Coaches communicate play call.
- Play called in huddle by quarterback.
- Players travel to position.
- Offense in position for next play

- Whistle ends previous play.
- Players stop action & get up. Officials set ball.
- Players travel to position.
- Offense in position for next play
- Coaches communicate play call.

**Time reduction**
**Tempo enhancement**
**Alignment simplification**
**Multiple plays single formation**
Target State Improvement Steps

### Target State

- **True North**
- **Customer Satisfaction**
  - 100% Quality
  - 100% On-Time
  - 100% Productive
  - 100% On-Cost
- **Human Development**
  - Safe
  - Engaged
  - Challenged
  - Professional

### Current State

- Depict the “as-is” current state
- Measure and analyze the process and key performance indicators
- Show the specific key details for 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
Background Situation

Purpose:
Provide context
Bigger picture
Relevant information
Logic for next sections
Current State Definition

Dedicated Press
Part A, B, C

Dedicated Press
Part D, E, F

Dedicated Press
Part G, H, I

Zero safety incidents
100% On-Time Delivery
<1% Scrap
Satisfied customers
No major problems...

...However

- 3 Dedicated Machines
- Each 30% Utilization
- Minimal Flexibility
- 3 Underutilized Operators
- 75 Minute Changeover
Goal Setting

3 Consideration Points:
- From What Level
- To What Level
- By When

SMART Concept:
- Specific
- Measurable
- Actionable
- Relevant / Realistic
- Time Bound
Goal Setting

Utilization

- Current Level: 30%
- New Target: 90%
- Date: July 15th, 2016

Changeover Time

- Current Level: 75 minutes
- New Target: 10 minutes
- Date: July 15th, 2016

Improve utilization
From 30% to 90%
By July 15th, 2016

Reduce Set Up Time
From 75 Minutes to 10 Minutes
By July 15th, 2016
Current State Analysis

Dedicated Press Part A, B, C

Dedicated Press Part D, E, F

Dedicated Press Part G, H, I

Analysis – Break it down

Quantify – Measure

Detail – Get specific facts
Two Types of Thinking

Critical Thinking
- analytic
- convergent
- vertical
- probability
- judgment
- focused
- objective
- answer
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- possibility
- suspended judgment
- diffuse
- subjective
- an answer
- right brain
- visual
- associative
- richness, novelty
- yes and
Idea Generation

Lateral Thinking
- Random Stimulation
- Unrelated Ideas
- Other People's Views

Vertical Thinking
- Osborn's Checklist
- Related Ideas
- Futuring

The Brainstorming Process

Free Association
(Unstructured Idea Generation)
Brainstorming is a group creativity technique by which efforts are made to find a conclusion for a specific problem by gathering a list of ideas spontaneously contributed by its members. The term was popularized by Alex Faickney Osborn in the 1953 book Applied Imagination.

Four Rules:
1) Seek quantity
2) Suspect judgement
3) Free association / wild ideas
4) Combine and improve ideas
Osborn / SCAMPER Checklist

- Rearrange
- Substitute
- Combine
- Adapt
- Modify
- Eliminate
- Put to other use
<table>
<thead>
<tr>
<th>Item</th>
<th>Meaning</th>
<th>Example Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>Substitute</td>
<td>What can you use instead?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>What components could change?</td>
</tr>
<tr>
<td>C</td>
<td>Combine</td>
<td>What can you add or put together?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>What can be combined into one?</td>
</tr>
<tr>
<td>A</td>
<td>Adapt</td>
<td>What can meet other needs?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>What can this also possible do?</td>
</tr>
<tr>
<td>M</td>
<td>Modify / Magnify / Minimize</td>
<td>What if you alter in some fashion?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>What if you make it larger?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>What if you make it smaller or lighter?</td>
</tr>
<tr>
<td>P</td>
<td>Put to other uses</td>
<td>What other uses might this serve?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>How might it benefit somewhere else?</td>
</tr>
<tr>
<td>E</td>
<td>Eliminate</td>
<td>What can be eliminated or taken away?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>What can be omitted?</td>
</tr>
<tr>
<td>R</td>
<td>Reverse / Rearrange</td>
<td>What if something was rearranged?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>What if something was reversed?</td>
</tr>
</tbody>
</table>

**Others concepts to consider:**
Simplify?
Error proof?
Standardize?
Synchronize?
Lighter?
Faster?
Efficient?
## 5W & 1H Improvement Q’s

### THE 5W & 1H QUESTIONS OF IMPROVEMENT

<table>
<thead>
<tr>
<th><strong>WHO?</strong></th>
<th>1. Who does the work?</th>
<th>2. Who is doing it?</th>
<th>3. Who should be doing it?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4. Who else can do it?</td>
<td>5. Who else should do it?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6. Who is doing it with any form of waste, overburden, or inefficiency?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>WHAT?</strong></th>
<th>1. What is the purpose or need?</th>
<th>2. What is actually being done?</th>
<th>3. What should be done?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4. What else can be done?</td>
<td>5. What else should be done?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6. What is being done with any form of waste, overburden, or inefficiency?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>WHERE?</strong></th>
<th>1. Where is the work to be done?</th>
<th>2. Where is it actually done?</th>
<th>3. Where should it be done?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4. Where else can it be done?</td>
<td>5. Where else should it be done?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6. Where is there any form of waste, overburden, or inefficiency?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>WHEN?</strong></th>
<th>1. When is the work to be done?</th>
<th>2. When is it actually done?</th>
<th>3. When should it be done?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4. What other time can it be done?</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5. What other time should it be done?</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6. When is there any form of waste, overburden, or inefficiency?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>WHY?</strong></th>
<th>1. Why is it done this way?</th>
<th>2. Why is it actually done this way?</th>
<th>3. Why should it be done?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4. Why do it then at all?</td>
<td>5. Why do it that way and not another way?</td>
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<tr>
<td></td>
<td>6. Why is there any form of waste, overburden, or inefficiency in the process?</td>
<td></td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>HOW?</strong></th>
<th>1. How is the work to be done?</th>
<th>2. How is it actually done?</th>
<th>3. How should it be done?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4. How else can it be done?</td>
<td>5. How to eliminate, combine, rearrange or simplify?</td>
<td></td>
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<tr>
<td></td>
<td>6. How to better improve any form of waste, overburden, or inefficiency in the process?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Set Up Reduction Time Analysis

<table>
<thead>
<tr>
<th>NO.</th>
<th>MAIN SET UP (WORK ELEMENTS)</th>
<th>TIME STUDY</th>
<th>CATEGORY</th>
<th>IMPROVEMENT POINT</th>
<th>IMPROVEMENT IDEA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>START</td>
<td>END</td>
<td>TOTAL</td>
<td>INT.</td>
</tr>
<tr>
<td>1</td>
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<td>2</td>
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</tbody>
</table>

Analyze

Quantify

Details
# Set Up Reduction Time Analysis

## Methods: Changeover Reduction Steps

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Measure total time required for changeover. Video tape is best.</td>
</tr>
<tr>
<td>2</td>
<td>Identify internal versus external elements and calculate individual times</td>
</tr>
<tr>
<td>3</td>
<td>Take the external elements and make sure they are done before the machine stops</td>
</tr>
<tr>
<td>4</td>
<td>Reduce and eliminate the internal elements (i.e., adjustments &amp; fastener items in particular)</td>
</tr>
<tr>
<td>5</td>
<td>Reduce the time required for external elements</td>
</tr>
<tr>
<td>6</td>
<td>Standardize and improve the new procedure over time</td>
</tr>
</tbody>
</table>

---

### Pre-Work

- **E = External** • **I = Internal**

<table>
<thead>
<tr>
<th>Time</th>
<th>E</th>
<th>I</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 MIN</td>
<td>E</td>
<td>I</td>
</tr>
<tr>
<td>10 MIN</td>
<td>E</td>
<td>I</td>
</tr>
<tr>
<td>10 MIN</td>
<td>E</td>
<td>I</td>
</tr>
<tr>
<td>10 MIN</td>
<td>E</td>
<td>I</td>
</tr>
<tr>
<td>30 MIN</td>
<td>E</td>
<td>I</td>
</tr>
</tbody>
</table>

### During Machine Shutdown

- **75 Minutes**

<table>
<thead>
<tr>
<th>Time</th>
<th>E</th>
<th>I</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 MIN</td>
<td>E</td>
<td>I</td>
</tr>
<tr>
<td>20 MIN</td>
<td>E</td>
<td>I</td>
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<tr>
<td>10 MIN</td>
<td>E</td>
<td>I</td>
</tr>
<tr>
<td>10 MIN</td>
<td>I</td>
<td></td>
</tr>
<tr>
<td>10 MIN</td>
<td>I</td>
<td></td>
</tr>
</tbody>
</table>

---

*Note: The chart shows the distribution of external (E) and internal (I) tasks across different stages of the changeover process.*
Target State Definition

From:
Dedicated Press
Part A, B, C
Dedicated Press
Part D, E, F
Dedicated Press
Part G, H, I

To:
Flexible Press
Parts A, B, C, D, E, F, G, H, I
On Demand / Any Sequence

3 Dedicated Machines
3 Operators
No Flexibility
Each 30% Utilization
75 Minute C/O

1 Machine / 9+ Tools
1 Operator
Change Over Flexibility
90% Utilization
10 Minute C/O
<table>
<thead>
<tr>
<th>What Item</th>
<th>Who’s Responsible</th>
<th>Due Date</th>
<th>Expected Outcome</th>
<th>Status Review (June 25th IPR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eliminate bolts &amp; switch to clamps</td>
<td>Tom M.</td>
<td>June 20th</td>
<td>Time savings of 28 minutes</td>
<td>Complete. First trial showed 9 minute gain.</td>
</tr>
<tr>
<td>Preheat dies</td>
<td>Jeff R.</td>
<td>June 16th</td>
<td>Time savings of 22 minutes First part quality</td>
<td>Complete. First trial showed 10 minute gain.</td>
</tr>
<tr>
<td>Standardize hoses, manifold connectors, &amp; quick disconnect</td>
<td>Kathy L.</td>
<td>June 25th</td>
<td>Time savings of 8 minutes</td>
<td>Complete. First trial showed 11 minute gain.</td>
</tr>
<tr>
<td>Create set up cart &amp; 5S tool board</td>
<td>Tom M.</td>
<td>June 22nd</td>
<td>Time saving of 7 minutes</td>
<td>Complete. First trial showed 5 minute gain.</td>
</tr>
<tr>
<td>Alignment aids for die insertion</td>
<td>Jeff R.</td>
<td>June 16th</td>
<td>Work simplification &amp; visual management</td>
<td>Confirmed easier die insertion.</td>
</tr>
<tr>
<td>Create new work instructions</td>
<td>Kathy L.</td>
<td>June 26th</td>
<td>Training document</td>
<td>Not complete yet.</td>
</tr>
<tr>
<td>Train all operators across 3 shifts</td>
<td>Kathy L.</td>
<td>June 30th</td>
<td>Same result each shift</td>
<td>Pending completion of new work instruction.</td>
</tr>
</tbody>
</table>
Check Results

Utilization

<table>
<thead>
<tr>
<th>%</th>
<th>Previous Level</th>
<th>New Target</th>
<th>Actual Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>90</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>80</td>
<td></td>
<td></td>
<td></td>
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<td>70</td>
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<td>10</td>
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</tbody>
</table>

Changeover Time

<table>
<thead>
<tr>
<th>Min.</th>
<th>Previous Level</th>
<th>New Target</th>
<th>Actual Results</th>
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Did not achieve goal yet.
Small gap or problem remains.
Follow up & resolve

Successfully achieved goal.
Will focus on sustainment.
Follow up & sustain
Follow Up & Standardize

STANDARDIZE & FOLLOW UP

- CREATED GAP
- NEW STANDARD
- IMPROVEMENT TREND

How to sustain?

- WORK INSTRUCTIONS
- FORMS
- CHECKLISTS
- AUDITS
- SPARE PARTS
- TRAINING
- COMMUNICATION
- MANUALS
Type 3 – Target State Summary

Arubeki Sugata / Ideal State

Critical Concept: What We Should Do
Not What We Can Do

Critical Concept: How We Should Do It
Not How We Can Do It

Kaizen / C.I.
- 100% quality
- 100% value add
- 100% on time, in sequence, batch of one capability

Respect for People
- Physical & mental safety
- Security
- Professional challenge

Everyone
Every minute
Every day

Current Condition

AND

Divergent
Creative
Synthesis
Requires change
Longer time
Greater span
Session Summary

• Type 1 & 2 Problem Solving: Defense
• Type 3 & 4 Problem Solving: Offense
• Type 3 Key Success Factors
  ➢ Challenge, Courage, & Creativity
  ➢ Openness to exploration
  ➢ PDCA Loop iteration
  ➢ Rapid experimentation
  ➢ Learning by doing
• Good luck on your improvement journey!
Appendix