Poka Yoke
(Mistake Proofing)
Scope of Presentation

- Introduction
- Defects & Costs
- Waste Management
- Zero Defect Quality (ZDQ)
- Understanding Process Errors
- Four Elements of ZDQ
- Seven Steps To Poka-Yoke Attainment
- Poka-Yoke Methods
- Summary
Why is “Zero Defects” an Important Concept?

Key Element in our capability to implement Kaizen- Lean Manufacturing Systems.
No need for “just in case” inventories
Allows company to make only what the customer needs.
Why Kaizen

- Data Driven Methodology to Magnify Impact of Process Improvement
- Apply Control Techniques to Eliminate Erosion of Improvements
- Proceduralize/Standardize Improvements for Improved Maintenance of Critical Process Parameters

CPI Projects Emphasize Control and Long Term Maintenance

Kaizen
- Use Small Teams to Optimize Process Performance by Implementing Incremental Change
- Apply Intellectual Capital of Team Members Intimate with Process

Kaizen Projects Emphasize Incremental Improvements
Why is “Zero Defects” an Important Concept?

Maintain Customer Satisfaction & Loyalty

Happy Customers mean more sales!
Why is “Zero Defects” an Important Concept?

COST

There is always a cost associated with manufacturing defects!
Costs of Defects?

Does it cost more to make processes better?  NO

Making processes better leads to reduced:

- Rework
- Scrap
- Warranty costs
- Inspection costs
The 1-10-100 rule states that as a product or service moves through the production system, the cost of correcting an error multiplies by 10:

<table>
<thead>
<tr>
<th>Activity</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Order entered correctly</td>
<td>$ 1</td>
</tr>
<tr>
<td>Error detected in billing</td>
<td>$10</td>
</tr>
<tr>
<td>Error detected by customer</td>
<td>$100</td>
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</table>

Dissatisfied customer shares the experience with others the cost is $1000.
Introduction

Defects & Costs

Waste Management

Zero Defect Quality (ZDQ)

Understanding Process Errors

Four Elements of ZDQ

Seven Steps to Poka-Yoke Attainment

Poka-Yoke Methods

Summary
Why is “Zero Defects” an Important Concept?

Key Element in our capability to eliminate waste.

- Defects
- Misused resources
- Inventories
- Untapped Resources
- Motions
- Delays
- Processes
What is Waste?

Everything we do that costs something without adding value to the product

Our objective > Value added = Maximum

Non-Value Added = Minimum
The nine types of waste

- Overproduction
- Delays (waiting time)
- Transportation
- Process
- Inventories
- Motions
- Defective products
- Untapped resources
- Misused resources
Elimination of Waste

The Method

1. Identify waste
2. Check and measure results
3. Search for causes
4. Implement continuous improvement

Identify waste

Check and measure results

Search for causes

Implement continuous improvement
Elimination of Wastes and Continuous Improvement

The Approach

- Elimination of wastes
- KAIZEN
- Continuous Improvement

The Means

- One piece flow
- SMED
- Visual Controls
- Workplace Organization
- Kanban
- Standard Work
- Process Control
- Total Productive Maintenance
- Poka-Yoke

The Strategy

• Leadtime
• Costs
Quality
the
First Time
What is a Zero Defect Quality System (ZDQ)?

A quality concept to manufacture ZERO defects & elimination of waste associated with defects!

“ZERO” is the goal!
What is a Zero Defect Quality System (ZDQ)?

Based on a discipline that defects are prevented.

Control the process so that defects are impossible!
What is a Zero Defect Quality System (ZDQ)?

No Finger Pointing. Operators and Machines will sometimes make mistakes.

Find ways to keep errors from becoming defects!
What is a Zero Defect Quality System (ZDQ)?

A Method for Mistake-Proofing (Poka-yoke) a process.

ZDQ assures that defects are not shipped!
How ZDQ Makes Work Easier

Mistake-Proof or Poka-yoke the process!

Recognize that it is natural for people to make mistakes.
How ZDQ Makes Work Easier

Mistake-Proof or Poka-yoke the process!

Not noticing that an error is made or a machine is not functioning does not make a person stupid or foolish.
How Do We Achieve ZDQ?

Mistake-Proof or Poka-yoke the process!

Errors never become defects!

No finger pointing after the fact. No mandate to do better next time.
Poka-Yoke results in Quality of Processes

Transformation = Quality production the 1st time

Inspection….eliminated ???

Transport

Storage

Delay/wait

Dedicated lines

One piece flow

Quality the 1st time → Cost → Leadtime
Relationship between processes and quality defects.

• Almost any business activity can be considered a process.

• Production processes involve the flow of material. Machining, assembly, and packaging are typical production processes.

• Business processes involve the flow of information. Financial planning, purchasing & order entry are typical business processes.

• All processes have the potential for defects. Hence, all processes offer a opportunity for the elimination of defects and the resultant quality improvement.
In order to reduce quality defects and stop throwing away money, we must understand the process and its relationship to other business processes. Identify the inputs and outputs of the process. Know who are the suppliers to and customers of the process. And reduce the variation of the process.
What Causes Defects?

Process Variation From

1. Poor procedures or standards.
2. Machines.
3. Non-conforming material.
4. Worn tooling.
5. **Human Mistakes.**

Except for human mistakes these conditions can be predicted and corrective action can be implemented to eliminate the cause of defects.
What Causes Defects?

Human Mistakes

Simple errors—the most common cause of defects—occur unpredictably.

The goal of ZDQ is zero! Make certain that the required conditions are in place and controlled to make acceptable product 100% of the time.
Ten Types of Human Mistakes

- Forgetfulness
- Misunderstanding
- Wrong identification
- Lack of experience
- Willful (ignoring rules or procedure)
- Inadvertent or sloppiness
- Slowliness
- Lack of standardization
- Surprise (unexpected machine operation, etc.)
- Intentional (sabotage)
## Relationship of Defects & Human error

<table>
<thead>
<tr>
<th>Causes of defects</th>
<th>Human errors</th>
<th>Intentional</th>
<th>Misunderstanding</th>
<th>Forgetful</th>
<th>Misidentification</th>
<th>Amateurs</th>
<th>Willful</th>
<th>Inadvertent</th>
<th>Slowness</th>
<th>Non-supervision</th>
<th>Surprise</th>
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<tr>
<td>Missed operations</td>
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<td>Errors in part set-up</td>
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<tr>
<td>Improper equipment set-up</td>
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<tr>
<td>Improper tools and jigs</td>
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- **highly correlated**
- **correlated**
The 4 Components of ZDQ

ZDQ functions by combining four elementary components:

1. Point of Origin Inspection
2. 100 % Audit Checks
3. Immediate Feedback
4. Poka-Yoke
The 3 basic approaches to inspection of processed product are:

Judgement/Standard Inspection

Informative Inspection

Point of Origin Inspection

The first two approaches are widely used and considered traditional.

Only Point of Origin Inspection actually eliminates defects.
Point of Origin Inspection

Focus on prevention, not detection.

One of the 4 basic elements of ZDQ.

Differs from Judgement and Informative:

- Catches errors
- Gives feedback before processing
- No risk of making more defective product

May include: Switches that detect miss-fed parts

- Pins that prevent miss-feeding
- Warning lights
- Sound signals

By combining Check and Do in the ZDQ approach; the Doing is controlled so it cannot be wrong 100% of the time!

Process with Zero Defects

Detect Error

Feedback/Corrective Action
### ZDQ/Check and Do/Point of Origin Inspection

**Point of Origin Inspection**

- **Check for optimum process conditions** before processing is done and errors can be made.
- **Instant feedback.**
- **Corrections made before defects occur.**

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| Number of Profitable Firms | 158,210,171,178,242 |
| Number of Unprofitable Firms | 103,638,794,42 |
| Aggregate Pre-Tax Earnings of Profitable Firms | 2,807,4,300,3,482,10,970,18,470 |
| Aggregate Pre-Tax Earnings of Profitable Firms | (2,183),(428),(663),(3,388),(989) |
| Revenues | $43,541 $59,338 $50,789 $152,499 $183,706 |
| Revenues | $43,018 $55,467 $47,979 $144,918 $166,224 |
| Expenses | $1,832 $1,927 $1,499 $183,706 |
| Expenses | $2,342,225 |
| After-Tax Profit/Loss | 102,638,794,42 |
| After-Tax Profit/Loss | 1,832,4,927,11,362 |
| Assets | 2,680,452,2,342,225,2,562,618,2,680,452,2,342,225 |
| Capital & Subordinations | 150,319,139,721,146,179,150,319,139,721 |
100% Audit Checks

Point of Origin Inspection on every piece.

The second of the 4 basic elements of ZDQ.

Differs from SQC inspection:

- Does not rely on sampling
- Prevents defects
- Does not assume defects will statistically occur

100% Audit checks everything on the line!
Quick Feedback

Error correction as soon as possible

The third of the 4 basic elements of ZDQ.

Differs from traditional inspection approaches that:

Correct problems after the process

Address the problem when errors are already defects

In some cases never identify an error has occurred

ZDQ sends the operator a signal and alarms the person that an error has happened!

ZDQ Inspections = Immediate Feedback
1.) Quality Processes - Design “Robust” quality processes to achieve zero defects.

2.) Utilize a Team Environment - leverage the teams knowledge, experience to enhance the improvement efforts.

3.) Elimination of Errors - Utilize a robust problem solving methodology to drive defects towards zero.

4.) Eliminate the “Root Cause” of The Errors - Use the 5 Why’s and 2 H’s approach.

5.) Do It Right The First Time - Utilizing resources to perform functions correctly the “first” time.

6.) Eliminate Non-Value Added Decisions - Don’t make excuses-just do it!

7.) Implement an Incremental Continual Improvement Approach - implement improvement actions immediately and focus on incremental improvements; efforts do not have to result in a 100% improvement immediately.
Poka-yoke

Mistake-proofing systems
The fourth of the 4 basic elements of ZDQ.
Does not rely on operators catching mistakes
Inexpensive Point of Origin inspection
Quick feedback 100% of the time

Most Poka-yoke devices are sensor or jig devices that assure 100% compliance all the time!

"The machine shut down. We must have made an error!"
What is Poke-yoke?

A method that uses sensor or other devices for catching errors that may pass by operators or assemblers.

Poka-yoke effects two key elements of ZDQ:

**Identifying the defect immediately (Point of Origin Inspection)**

**Quick Feedback for Corrective Action**

How effective the system is depends on where it is used: **Point of Origin** or **Informative Inspection**.

Poka-yoke detects an error, gives a warning, and can shut down the process.
Poka-yoke

Poke-yoke and Point of Origin Inspections (Proactive Approach):
A fully implemented ZDQ system requires Poka-yoke usage at or before the inspection points during the process.

Poka-yoke will catch the errors before a defective part is manufactured 100% of the time.
Poka-yoke and Informative Inspection (Reactive Approach):

- Check occurs immediately after the process.
- Can be an operator check at the process or successive check at the next process.
- Not 100% effective, will not eliminate all defects.
- Effective in preventing defects from being passed to next process.

Although not as effective as the Source inspection approach, this methodology is more effective than statistical sampling and does provide feedback in reducing defects.
Poka-yoke Systems Govern the Process

Two Poka-Yoke System approaches are utilized in manufacturing which lead to successful ZDQ:

1. Control Approach
   Shuts down the process when an error occurs.
   Keeps the “suspect” part in place when an operation is incomplete.

2. Warning Approach
   Signals the operator to stop the process and correct the problem.
Control System

Takes human element out of the equation; does not depend on an operator or assembler.

Has a high capability of achieving zero defects.

Machine stops when an irregularity is detected.

“There must have been an error detected; the machine shut down by itself!”
Warning System

Sometimes an automatic shut off system is not an option. A warning or alarm system can be used to get an operator's attention.

Below left is an example of an alarm system using dials, lights and sounds to bring attention to the problem.

Color coding is also an effective non automatic option.

“I’m glad the alarm went off, now I’m not making defects!”
Methods for Using Poka-yoke

Poka-yoke systems consist of three primary methods:

1. Contact
2. Counting
3. Motion-Sequence

Each method can be used in a control system or a warning system.

Each method uses a different process prevention approach for dealing with irregularities.
A contact method functions by detecting whether a sensing device makes contact with a part or object within the process.

An example of a physical contact method is limit switches that are pressed when cylinders are driven into a piston. The switches are connected to pistons that hold the part in place. In this example, a cylinder is missing and the part is not released to the next process.
Physical Contact Devices

Limit Switches

Toggle Switches
Energy Contact Devices

Photoelectric switches can be used with objects that are translucent or transparent depending upon the need.

**Transmission method:** two units, one to transmit light, the other to receive.

**Reflecting method:** PE sensor responds to light reflected from object to detect presence.

If object breaks the transmission, the machine is signaled to shut down.
An example of a contact device using a limit switch. In this case the switch makes contact with a metal barb sensing its presence. If no contact is made the process will shut down.
Contact Methods

Do not have to be high tech!

Passive devices are sometimes the best method. These can be as simple as guide pins or blocks that do not allow parts to be seated in the wrong position prior to processing.

Take advantage of parts designed with an uneven shape!

A work piece with a hole a bump or an uneven end is a perfect candidate for a passive jig. This method signals to the operator right away that the part is not in proper position.
Counting Method

Used when a fixed number of operations are required within a process, or when a product has a fixed number of parts that are attached to it.

A sensor counts the number of times a part is used or a process is completed and releases the part only when the right count is reached.

In the example to the right a limit switch is used to detect and count when the required amount of holes are drilled. The buzzer sounds alerting the operator that the appropriate amount of steps have been taken in the process.
Another approach is to count the number of parts or components required to complete an operation in advance. If operators find parts leftover using this method, they will know that something has been omitted from the process.

“I have an extra part. I must have omitted a step!”
The third poka-yoke method uses sensors to determine if a motion or a step in a process has occurred. If the step has not occurred or has occurred out of sequence, the sensor signals a timer or other device to stop the machine and signal the operator.

This method uses sensors and photo-electric devices connected to a timer. If movement does not occur when required, the switch signals to stop the process or warn the operator.
Motion-Sequence Method

In order to help operators select the right parts for the right step in a process the “sequencing” aspect of the motion-step method is used. This is especially helpful when using multiple parts that are similar in size and shape.

In this example, each step of the machine cycle is wired to an indicator board and a timer. If each cycle of the machine is not performed within the required “time” and “sequence”, the indicator light for that step will be turned on and the machine will stop.
Types of Sensing Devices

Sensing devices that are traditionally used in poka-yoke systems can be divided into three categories:

1. Physical contact devices
2. Energy sensing devices
3. Warning Sensors

Each category of sensors includes a broad range of devices that can be used depending on the process.
Physical Contact Sensors

These devices work by physically touching something. This can be a machine part or an actual piece being manufactured.

In most cases these devices send an electronic signal when they are touched. Depending on the process, this signal can shut down the operation or give an operator a warning signal.
**Touch Switch**

Used to physically detect the presence or absence of an object or item—prevents missing parts.

Used to physically detect the height of a part or dimension.
Energy Sensors

These devices work by using energy to detect whether or not a defect has occurred.

- Fiber optic
- Photoelectric
- Vibration
Warning Sensors

Warning sensors signal the operator that there is a problem. These sensors use colors, alarms, lights to get the workers attention!

These sensors may be used in conjunction with a contact or energy sensor to get the operators attention.

Color Code

Lights connected to Micro switches & timers
To prevent mistakes, develop error proofing devices 
POKA-YOKE 
to avoid (yokeru) inadvertent errors (poka)

- Checklists
- Dowel and locating pins
- Error & alarm detectors
- Limit or touch switches
- Detectors, readers, meters, counters
Two types of error proofing devices

POKA-YOKE

- **Control** - eliminates the possibility of a mistake to occur (automatic machine shutdown)

- **Warning** - signals that a mistake can occur (blinking light, alarm, etc.)
3 Rules of POKA-YOKE

- Don’t wait for the perfect POKA-YOKE. Do it now!
- If your POKA-YOKE idea has better than 50% chance to succeed…Do it!
- Do it now….improve later!
Some examples of POKA-YOKE devices

- Attached gas cap
- Gas pump nozzle
- Polarized electrical plug and socket
- Disc brake pad warning noise
THANK YOU