POKA-YOKE EXAMPLES

Section 2
Assembly Errors

**Example 57**

- **Process:** Tightening nuts
- **Problem:** Missing washers
- **Solution:** Modify nut driver so nuts can't be tightened if washer is missing
- **Key Improvement:** Tool modified to guarantee correct processing

**Description of Process:** Nuts were tightened using an automatic nut driver.

**Before Improvement:**

It was possible to tighten the nuts even if their washers were missing, and checking for the washers relied on worker vigilance. Defects occurred when nuts were tightened with their washers missing.

**After Improvement:**

A stopper was built into the nut driver. If the washer is missing, the bolt strikes the stopper and prevents the driver from tightening the nut. Missing washers are completely eliminated. Note: For this poka-yoke to work, variations in length of the bolt must be very carefully controlled.
**Example 61**

**Process:** Mounting cases on thick-film hybrid ICs

**Problem:** Cases mounted backwards

**Solution:** Interference pin designed into case

**Key Improvement:** Part modified to guarantee correct positioning

**Description of Process:** Cases are mounted onto thick-film hybrid ICs.

**Before Improvement:**
It was difficult to tell from the outer appearance of the case which direction the case was to be mounted.

**After Improvement:**
A boss was designed into the inside of the case as an interference pin to prevent the case from being mounted in reverse. Defects due to mounting the case wrong are completely eliminated, and 100 percent accuracy in mounting the cases is achieved.

![Diagram](Diagram.png)
**Example 63**

**Process:** Mounting circuit boards into assemblies  
**Prevent Error:**  
**Shutdown:**  
**Problem:** Missing mounting holes in circuit boards  
**Detect Error:** X  
**Control:** X  
**Solution:** Detecting pins installed in circuit board inspection step  
**Alarm:**  
**Key improvement:** Jig modified to detect defective parts

**Description of Process:** Circuit boards are inspected, then later mounted into assemblies.

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**Before Improvement:**

Sometimes circuit boards could not be mounted into their assemblies because screw holes had not been drilled in them. The workers in earlier processes relied on visual checks to determine whether screw holes had been drilled.

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**After Improvement:**

Detecting pins were installed on the jig used for checking the circuit boards after wiring. Circuit boards without the proper holes cannot be mounted on the jig. All circuit boards that lack mounting holes are now detected before they are sent on to assembly.
Example 68

Process: Testing plastics
Problem: Setup errors on testing machine
Solution: Setup templates for each type of plastic tested
Key Improvement: Gage used for inspection

Description of Process: A number of different types of plastic batches are tested using a testing machine. It is necessary to set up the conditions, such as temperature, time, and pressure, differently for each type of plastic.

Before Improvement:

Errors sometimes occurred when the operators misread the scales or the instruction documents. Therefore, deviations sometimes occurred in the tests, and it was often necessary to repeat the tests to confirm the results.

After Improvement:

Transparent templates for setting the conditions were prepared for each different type of plastic. When beginning operations, the operator first checks the type of plastic to be tested, then takes the appropriate template out of the case and attaches it to the instrument panel. The template is marked with the correct settings for each of the dials and instruments on the instrument panel, ensuring that testing is done according to the proper procedures.
**Example 74**

**Process:** Tightening nuts

**Problem:** Insufficient torque caused by drops in pneumatic pressure

**Solution:** Air pressure sensor

**Key Improvement:** Operation tied to value of critical physical quantity

**Description of Process:** Nuts are tightened with a specified torque with a power wrench driven by pneumatic pressure supplied throughout the factory.

<table>
<thead>
<tr>
<th>Before Improvement:</th>
</tr>
</thead>
<tbody>
<tr>
<td>If air pressure dropped during tightening, no warning of the problem was given, and the conveyor continued to move. Therefore, bolts were tightened with insufficient torque.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>After Improvement:</th>
</tr>
</thead>
<tbody>
<tr>
<td>An air pressure meter was installed in the air line. A lamp blinks, an alarm rings, and the conveyor stops if the air pressure drops below a critical point.</td>
</tr>
</tbody>
</table>
Example 83

Process: Assembly
Problem: Wrong parts mounted
Solution: Automatic parts bin
Key Improvement: Selection of parts automated

Description of Process: On an assembly line the model is changed several times a day, and to shorten the time required for model changes, the parts for all the models are stored next to the assembly line.

Before Improvement:
The parts were kept in open boxes and sometimes the operators mounted the wrong parts inadvertently.

After Improvement:
A rotating parts rack was made, with one delivery outlet. When the selection button is pressed for a particular model, only the parts needed for that model are delivered. It is impossible to take out parts for other models, even accidentally.
**Example 90**

Process: Mounting dial pointer

Prevent Error: X

Problem: Pointer mounted upside down

Detect Error: Control: X

Solution: Improve jig

Key Improvement: Jig modified to guarantee correct positioning

**Description of Process:** A pointer, pointer boss, and washer are mounted to a dial shaft. The pointer is unpainted and it is difficult to tell its front from its back.

**Before Improvement:**

Although workers were very careful when assembling, they sometimes mistook the back for the front and mounting errors occurred. The defects were discovered after painting at the final assembly stage.

**After Improvement:**

A cutout was made in the bottom die used for mounting the pointer. The cutout makes it impossible to mount the pointer upside down.
**Example 139**

<table>
<thead>
<tr>
<th>Process:</th>
<th>Testing integrated circuits (ICs)</th>
<th>Prevent Error:</th>
<th>Shutdown:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem:</td>
<td>Defective ICs placed in &quot;good&quot; box after testing</td>
<td>Detect Error: X</td>
<td>Control: X</td>
</tr>
<tr>
<td>Solution:</td>
<td>Electromechanical sorting based on results of testing</td>
<td>Alarm:</td>
<td></td>
</tr>
</tbody>
</table>

**Key Improvement:** Chute modified to sort out defective parts

**Description of Process:** An IC tester is used to measure the characteristic values of ICs against reference values. Those matching the reference values are put into a "good" box, while those deviating from the reference values are placed in a "defective" box.

**Before Improvement:**

Because of operators' errors, some of the defective ICs were placed in the box with the ICs that tested good. When these ICs were used by customers, the company received complaints.

**After Improvement:**

A sorting device was developed as shown in the drawing. The gate to the "defective" and "good" boxes moves according to whether the IC has tested good or defective. The operator merely places the IC in the chute after testing and the chute itself decides which box to put the IC in. Mix-ups between defective and good items are eliminated.
### Example 145

**Process:** Mounting capacitors on circuit boards  
**Polarity defects**  
**Prevent Error:** X  
**Shutdown:**  
**Detect Error:**  
**Control:** X  
**Alarm:**

**Solution:** Change circuit board design guidelines  
**Key improvement:** Procedure modified to guarantee correct processing

**Description of Process:** Capacitors are inserted in printed circuit boards.

<table>
<thead>
<tr>
<th>Before Improvement:</th>
<th>After improvement:</th>
</tr>
</thead>
</table>
| The circuit board designers were free to design the boards as they liked regarding capacitor polarity. The result was that the direction of polarity was completely random. Workers had to exercise extreme vigilance to ensure that capacitors were inserted correctly, but as the number of parts in the circuit boards increased, the incidence of incorrect insertion increased as well. | The guidelines for circuit board design were changed to require that the polarities of all capacitors are aligned on one axis of the board:  
1. the polarities were all aligned on either the X or the Y axis (better);  
2. the polarities were all aligned in one direction (best). Although the result restricts circuit design in some ways, faulty insertion is prevented, and defects are eliminated. |

![Diagram of capacitor insertions](image-url)
Example 151

Process: Mounting components on circuit boards

Problem: Polarity defects

Solution: Make parts asymmetrical

Key Improvement: Part modified to guarantee correct positioning

Description of Process: Electronic parts are inserted into printed circuit boards and soldered. Almost all the electronic parts have polarities. If they are mounted with the wrong polarity, they will not operate correctly.

Before improvement:

It was possible to mount many of the parts backwards. If insertion errors were discovered at inspection, the parts had to be removed and resoldered. This entailed considerable time and expense.

After improvement:

The key to improvement is to make it impossible to mount the parts with the wrong polarity. Several strategies may be used. If the legs of the part are made different lengths and corresponding holes are made in the mounting jig, the part cannot be mounted backwards. Another method is to vary the spacing between the legs and the holes in the circuit board so that the part fits into the holes in only one orientation.

strategy 1

<table>
<thead>
<tr>
<th>part</th>
<th>printed circuit board</th>
</tr>
</thead>
<tbody>
<tr>
<td>+</td>
<td>part can be mounted incorrectly</td>
</tr>
</tbody>
</table>

increase length of leg

hole in jig

part cannot be inserted in the wrong direction

strategy 2

<table>
<thead>
<tr>
<th>part</th>
<th>printed circuit board</th>
</tr>
</thead>
<tbody>
<tr>
<td>+</td>
<td>part can be inserted only in correct direction</td>
</tr>
</tbody>
</table>

shift position of hole and leg slightly
Example 163

Process: Assembly
Problem: Missing parts
Solution: Count parts to make sure the right number have been installed
Key Improvement: Number of parts used compared with number of parts required

Description of Process: In the assembly process there are several parts, such as small gears, that are mounted behind other parts.

Before improvement:
Because the parts were hidden, it was difficult to determine if they actually were there and not omitted. Often detection was possible only by dismantling the unit. Workers in previous processes where the small parts were still visible were supposed to check that the parts were installed. However, the check was often overlooked, and products with missing parts were sent on, and some even were sent out onto the market.

After improvement:
The parts that will be necessary for a given run of products are counted out beforehand and given to the worker. If some of the parts are still on hand after the planned number of products have been assembled, or if there are not enough parts, it is immediately clear that there is an abnormality. This method of checking prevents units with missing parts from being sent out onto the market.
Example 164

Problem: Omitted items  Detect Error:
Solution: Automatic parts boxes interlocked with line movement  Control:
Key Improvement: Selection of parts automated

Description of Process: The operator mounts a set of parts onto a workpiece on an assembly line.

Before Improvement:
Correct assembly relied entirely on worker vigilance. If the worker was fatigued or stepped away from the line for a moment, some of the parts in the set were often omitted.

After Improvement:
Special parts containers were made to prevent operators from omitting parts during assembly. When the worker opens the lid and takes out a part, a limit switch is actuated and a light is turned on. A stopper on the line allows the part to move to the next station only after all the appropriate lights have turned on (or all the parts have been assembled). This completely eliminates defective units with missing parts.
**Example 177**

<table>
<thead>
<tr>
<th>Process:</th>
<th>Inspection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prevent Error:</td>
<td></td>
</tr>
<tr>
<td>Shutdown:</td>
<td></td>
</tr>
<tr>
<td>Problem:</td>
<td>Inspection labels omitted</td>
</tr>
<tr>
<td>Detect Error:</td>
<td>X</td>
</tr>
<tr>
<td>Control:</td>
<td></td>
</tr>
<tr>
<td>Solution:</td>
<td>Testing jig for detecting presence of labels</td>
</tr>
<tr>
<td>Alarm:</td>
<td>X</td>
</tr>
<tr>
<td>Key Improvement:</td>
<td>Tool used to detect defective parts</td>
</tr>
</tbody>
</table>

**Description of Process:** The worker responsible for testing hose assemblies for pressure-resistance attaches inspection labels after the inspections and then packs the products into boxes.

<table>
<thead>
<tr>
<th>Before Improvement:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correct labeling depended on the worker's vigilance, and the labels were sometimes omitted.</td>
</tr>
</tbody>
</table>

![Inspection label](image1)

labeled product

<table>
<thead>
<tr>
<th>After Improvement:</th>
</tr>
</thead>
<tbody>
<tr>
<td>A jig was developed that tests for the presence of labels. A circuit on the jig is activated when a workpiece is placed on it. If there is no label on the workpiece, current passes through it and a buzzer sounds to alert the worker. If a workpiece is not set in place within a certain time, an alarm interlocked with the line speed rings to prevent omissions of testing.</td>
</tr>
</tbody>
</table>

![Diagram of jig with labels and buzzer](image2)
Operations Errors

• Example 202

Process: Turning
Prevent Error: X
Shutdown: X

Problem: Chuck key not removed before operation of the lathe
Detect Error:
Control:
Alarm:

Solution: Interlock lathe power switch with chuck key storage rack
Key Improvement: Tool modified to protect operator from danger

Description of Process: Workers chuck workpieces into a metal turning lathe, then return the chuck key to its storage rack before starting the lathe. The worker can be injured if the chuck key is not removed from the chuck before the lathe is started.

Before Improvement:
It was possible to start the lathe while the chuck key was still in the chuck.

After Improvement:
A limit switch was installed in the chuck key storage rack to detect the presence of the chuck key. The limit switch is interlocked with the power switch for the lathe so the lathe cannot be started if the chuck key has not been returned to the rack. In addition, a red lamp comes on when the chuck key is off the storage rack.
**Example 208**

**Process:** Attaching printed labels to cassette decks

**Problem:** Labels attached upside down

**Solution:** Change shape of label and area it is attached to

**Key improvement:** Part modified to guarantee correct positioning

**Description of Process:** Labels for the push-button functions are attached to cassette decks.

<table>
<thead>
<tr>
<th>Before improvement</th>
<th>After improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>The label was rectangular and could easily be stuck on upside down by mistake.</td>
<td>The shape of the label and the area to which it is attached was modified so the label cannot be attached upside down. Defects are completely eliminated and the design value of the cassette deck is increased.</td>
</tr>
</tbody>
</table>

![Before improvement diagram](image1.png)

![After improvement diagram](image2.png)
Example 215

Process: Wiring terminal boards
Problem: Wiring errors
Solution: One-touch wiring template
Key Improvement: Template used for assembly

Description of Process: Cables of many different sizes and colors are wired to a multipoint terminal board.

Before Improvement:
The workers followed a diagram mounted over the terminal board. Detects occurred because of misunderstandings, mix-ups, or oversights made when workers looked from the diagram to the wiring work.

After Improvement:
A wiring template was made that slides between the rows of terminals on the board. Samples of the correct wire for each terminal are attached to the template, and the worker can tell at a glance which terminal to connect with a particular wire.