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# Problem Solving: 5 Whys Root Cause Analysis

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# 5 Whys – goal and objectives

## Goal

Enable learners to understand and apply the 5 Whys methodology for root cause analysis in Problem Solving

## Objectives

- Explain the concept of the 5 Whys
- Create an effective Problem Statement
- Differentiate between Symptoms and Causes
- Differentiate between Specific and Systemic root causes
- Use the 5 Whys to identify a problem’s root cause(s)

# Target Audience

- NCGs (New College Grads), and new employees in technical roles
- Examples of roles at Micron that utilize these concepts:
  - Manufacturing Technician
  - Manufacturing Engineer
  - Process Technicians
  - Process Engineer
  - Equipment Technician
  - Equipment Engineer
  - Process Integration Technician
  - Process Integration Engineer
  - Product Engineer
  - Characterization Engineer
  - Yield Enhancement Engineer
  - Test Engineer
  - Probe Engineer
  - Reliability Engineer
  - Quality Engineer
  - Industrial Engineer

## Pro tip

Everyone interviewing at Micron can use this presentation to prepare for the interview by learning foundational information about memory. Check out the candidate guides for Engineering, Technician and Business roles.

- Micron engineering candidate guide
- Micron technician candidate guide
- Micron business candidate guide

# 5 Whys
# Root Cause Analysis
# Introduction

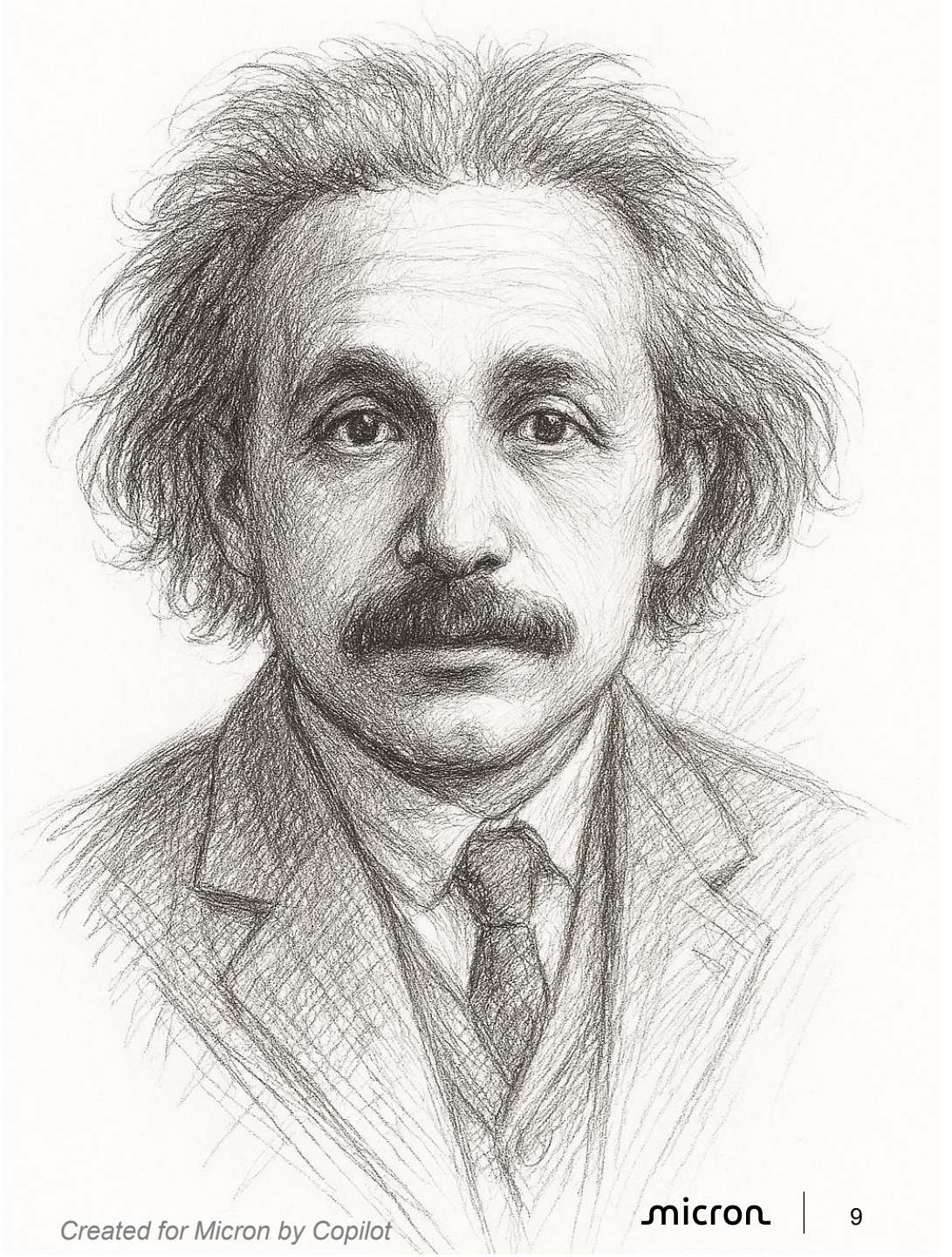
Hi, I’m Eliza Stack. I am an engineer at Micron, and I will be your learning guide through this module on 5 Whys Problem Solving. Welcome!

## Description

The 5 Whys technique is a problem-solving method used to explore the root cause of an issue by asking "why?" five times in succession. Each answer forms the basis of the next question, helping to peel away layers of symptoms and uncover the underlying problem. It's simple, yet powerful, and often used in quality improvement and lean methodologies.

"If I had an hour to solve a problem and my life depended on the solution, I would spend the first 55 minutes determining the proper question to ask, for once I know the proper question, I could solve the problem in less than 5 minutes. "

Frequently attributed to Albert Einstein



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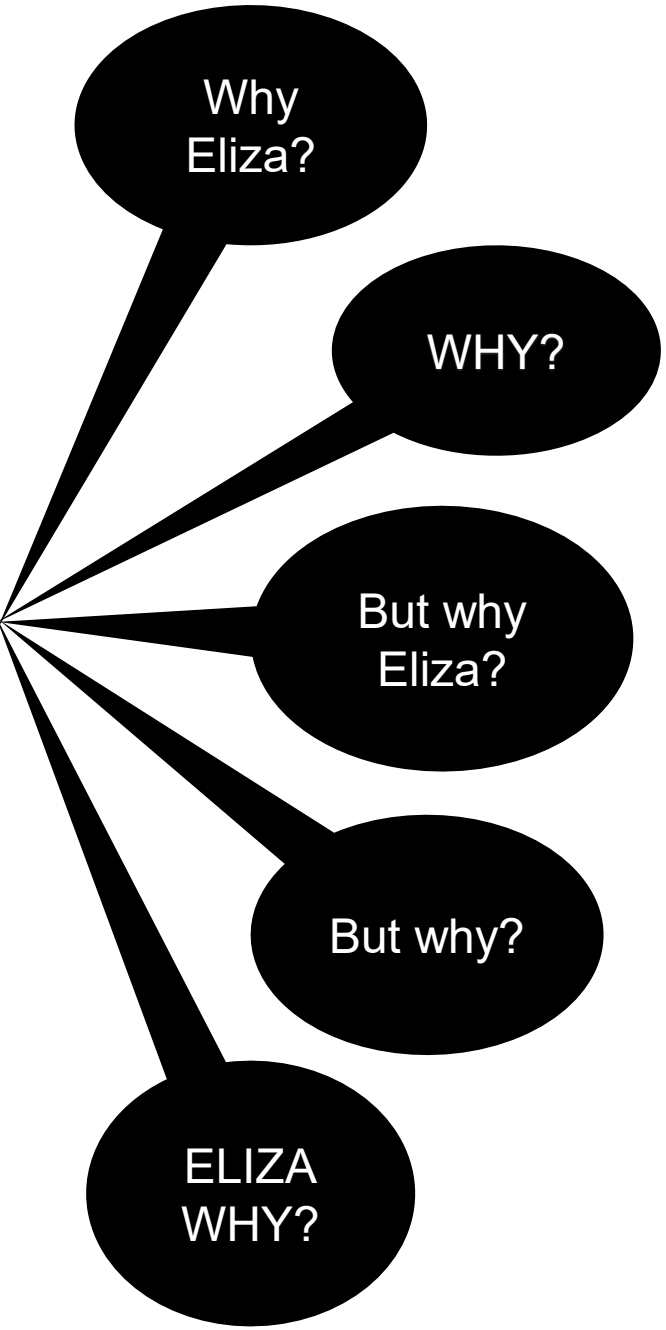



If you have spent any time with a young child, you have likely encountered a steady stream of "why" questions.

You have already experienced the 5 Whys!

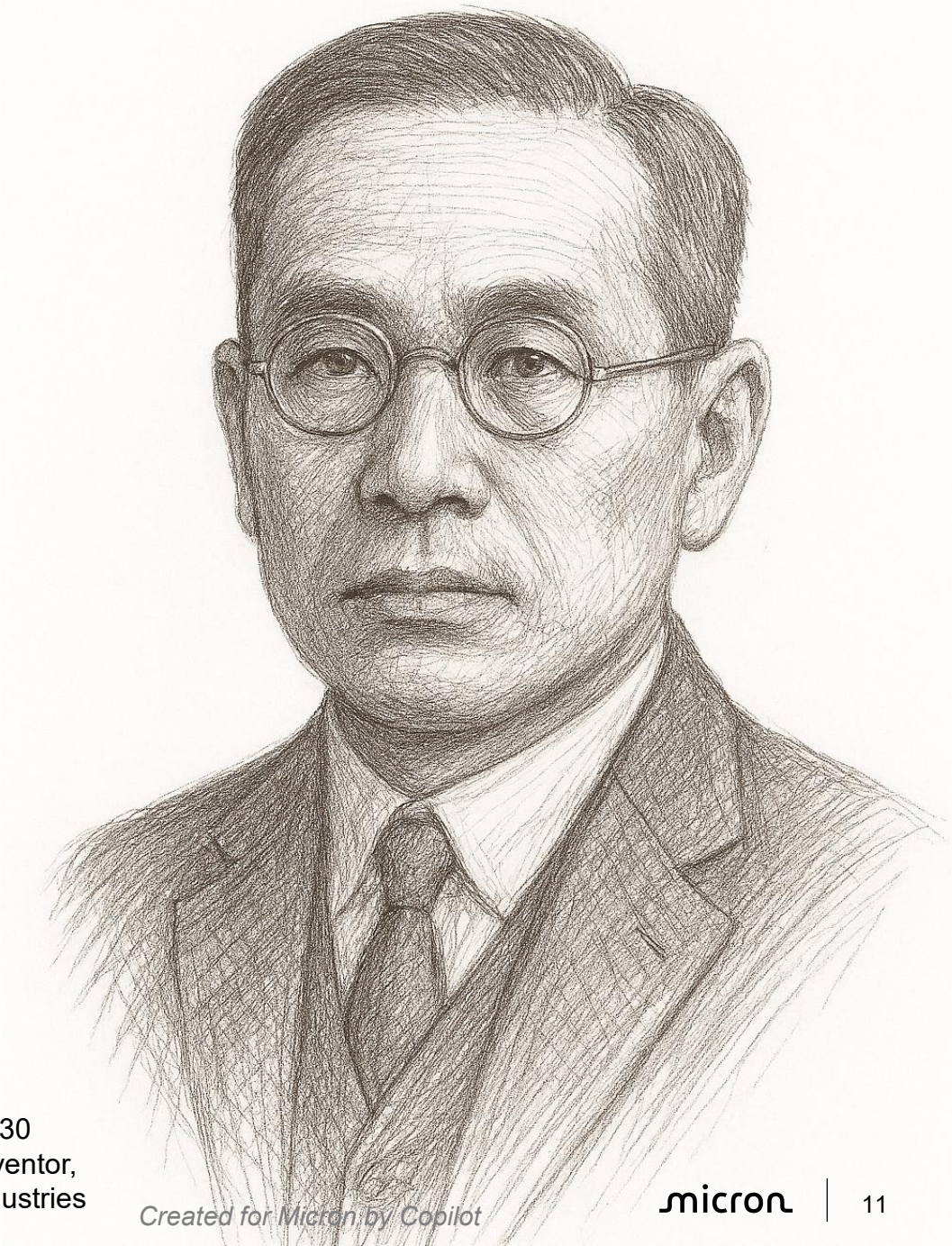
In this short training you will learn the steps to stay organized so you can find the root cause(s) faster!

# 5 Whys Technique

The 5 Whys is a Problem-Solving method that is often used in business and manufacturing to identify the root cause of a problem.

Based on Sakichi Toyoda's philosophy of Genchi Genbutsu "Go and See"

(Going to the source to find facts, solve problems, and make decisions)



Sakichi Toyoda, 1867 -1930
Japanese industrialist, inventor, and founder of Toyota Industries

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# Problem Solving
## 5 Whys Root Cause Analysis

Washington D.C., United States of America
Case Study – Jefferson Memorial

# Jefferson Memorial Example

## Problem Statement:

The Jefferson Memorial in Washington, D.C. was crumbling. A falling block of cement almost seriously injured a tourist. No other nearby monuments were having the same problem.

# Why 1
# Why was the Jefferson Memorial crumbling?

It was found that the soap used to wash the monument was mixing with jet fuel from the nearby airports, causing the building to degrade quickly. Additionally, the monument was being washed very frequently, and the soap was especially strong.

# Why 2

## Why was the building being washed so often and with such a strong soap?

There were a lot of pigeon droppings on the monument.

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# Why 3
# Why were there so many pigeons there?

The pigeons were attracted to the many spiders on the monument.

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# Why 4
# Why were there so many spiders?

The spiders were drawn, in turn, by the prevalence of midges – tiny little sand flies that come out at dusk.

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# Why 5
# Why were there so many midges?

Midges were attracted to the building's lighting, which was turned on early at dusk.

# 5 Whys Summary Table

| | |
|---|---|
| Why 1 | **Why was the building crumbling?** |
| | The soap used to wash the monument was mixing with jet fuel from the nearby airports, causing the building to degrade quickly. Additionally, the monument was being washed very frequently, and the soap was especially strong. |
| Why 2 | **Why was the building being washed so often with such a strong soap?** |
| | There were a lot of pigeon droppings on the monument. |
| Why 3 | **Why were there so many pigeons there?** |
| | The pigeons were attracted to the many spiders there. |
| Why 4 | **Why were there so many spiders?** |
| | The spiders were drawn, in turn, by the prevalence of midges – tiny little sand flies that come out at dusk. |
| Why 5 | **Why were there so many midges?** |
| | Midges were attracted to the building's lighting, which was turned on early at dusk. |

"Therefore" is a way to validate the 5 Whys by working backward.

Root cause: Lighting was turned on early at dusk, *therefore* attracting the midges, which *therefore* attracted the spiders, which *therefore* attracted the pigeons, which *therefore* caused droppings, that were *therefore* cleaned very frequently with a strong soap that mixed with jet fuel droplets from planes flying to nearby airports.

## Solution Approach

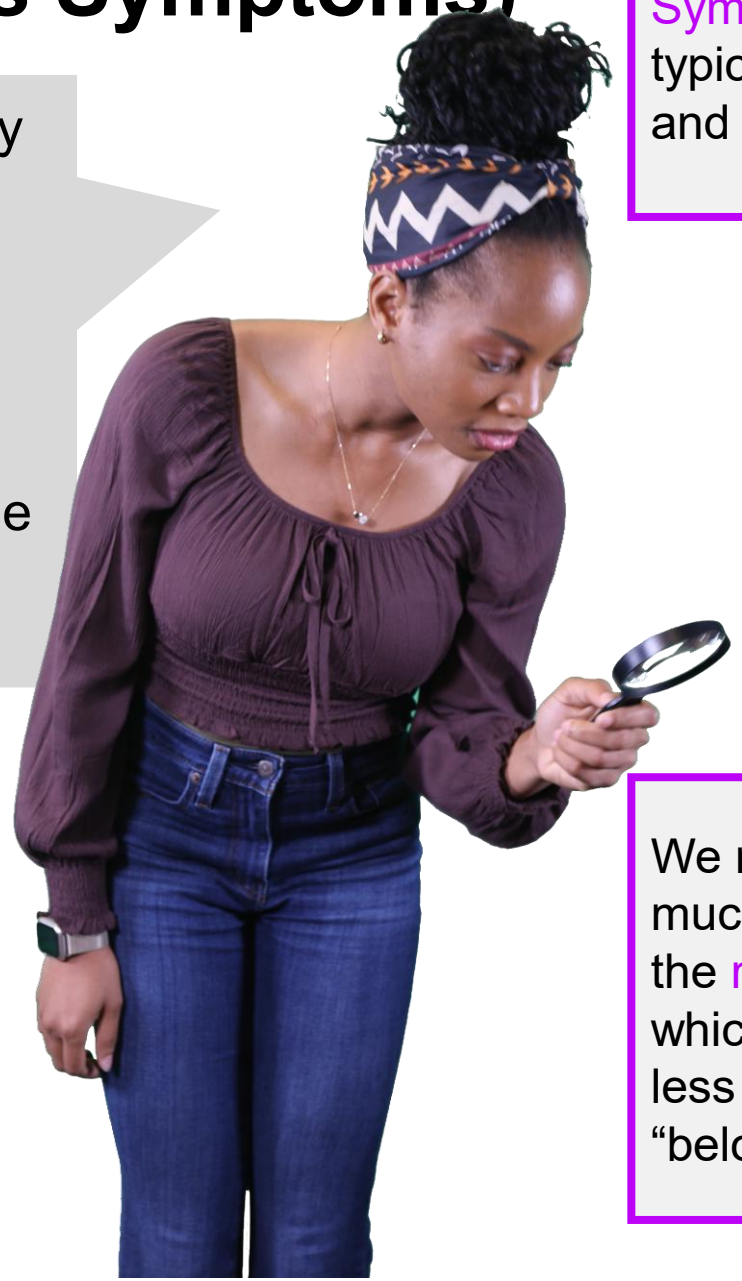
Changing the soap used to clean the monument seemed like a sensible solution. But would that take care of the root cause?

An additional corrective action explored: Turn the lights on at a later time to minimize midges!

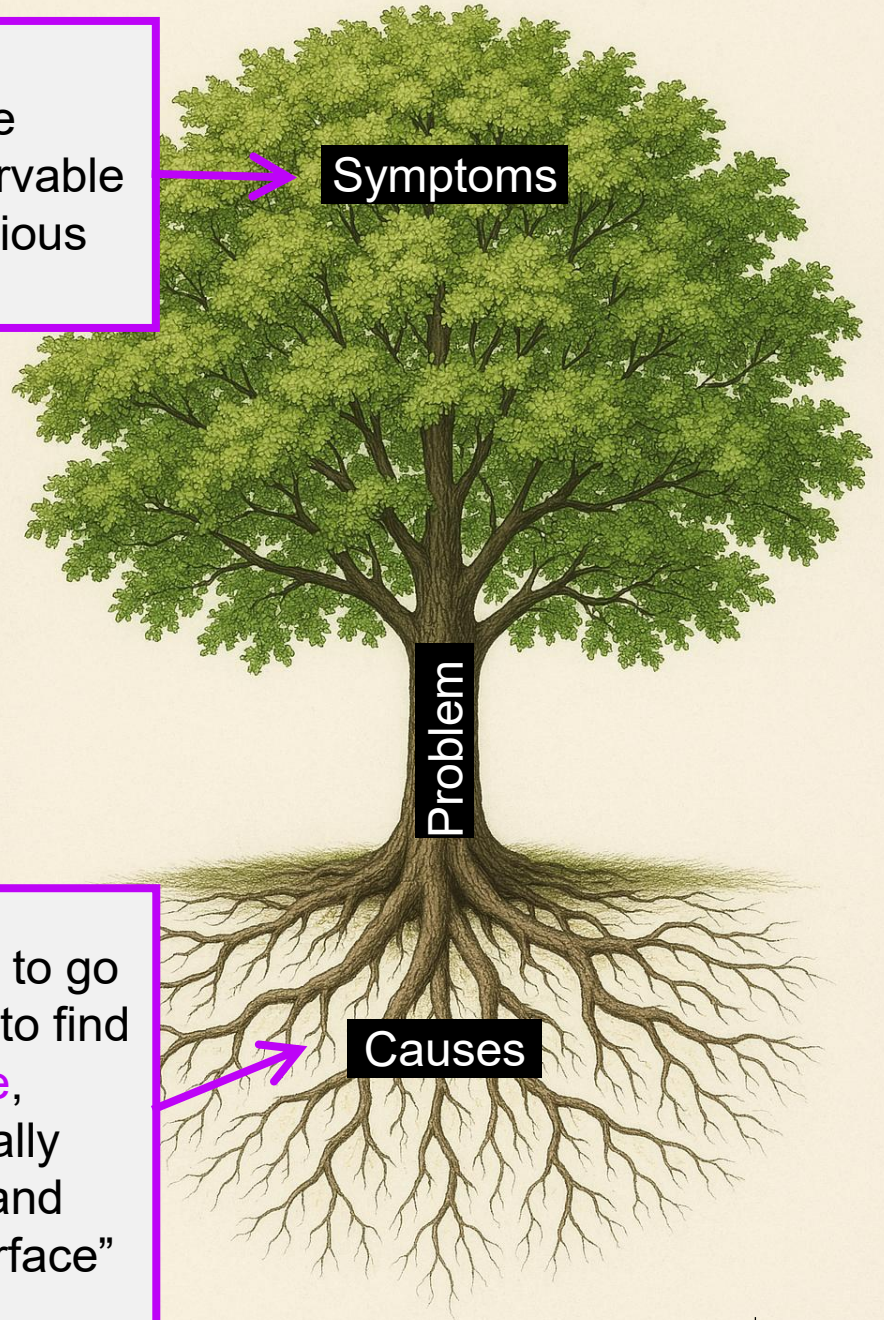
# Types of Root Cause

# Root Cause (vs Symptoms)

Trees are a great analogy to help understand the difference between root cause and symptoms. Symptoms are what we can see and experience. The underlying root cause may be invisible, just like the roots of this tree!



Symptoms are typically observable and more obvious




We may have to go much deeper to find the root cause, which is typically less obvious and “below the surface”

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# Root Cause (vs Symptoms)

Let's look back at the Jefferson Memorial problem.

In the original problem statement, we said the building was crumbling. Is the "building crumbling" a symptom or the root cause?

The building was observed to be "crumbling". This was a *symptom* of the much deeper problem: The midges' attraction to the building's lighting was the root cause.

# Semiconductor Manufacturing

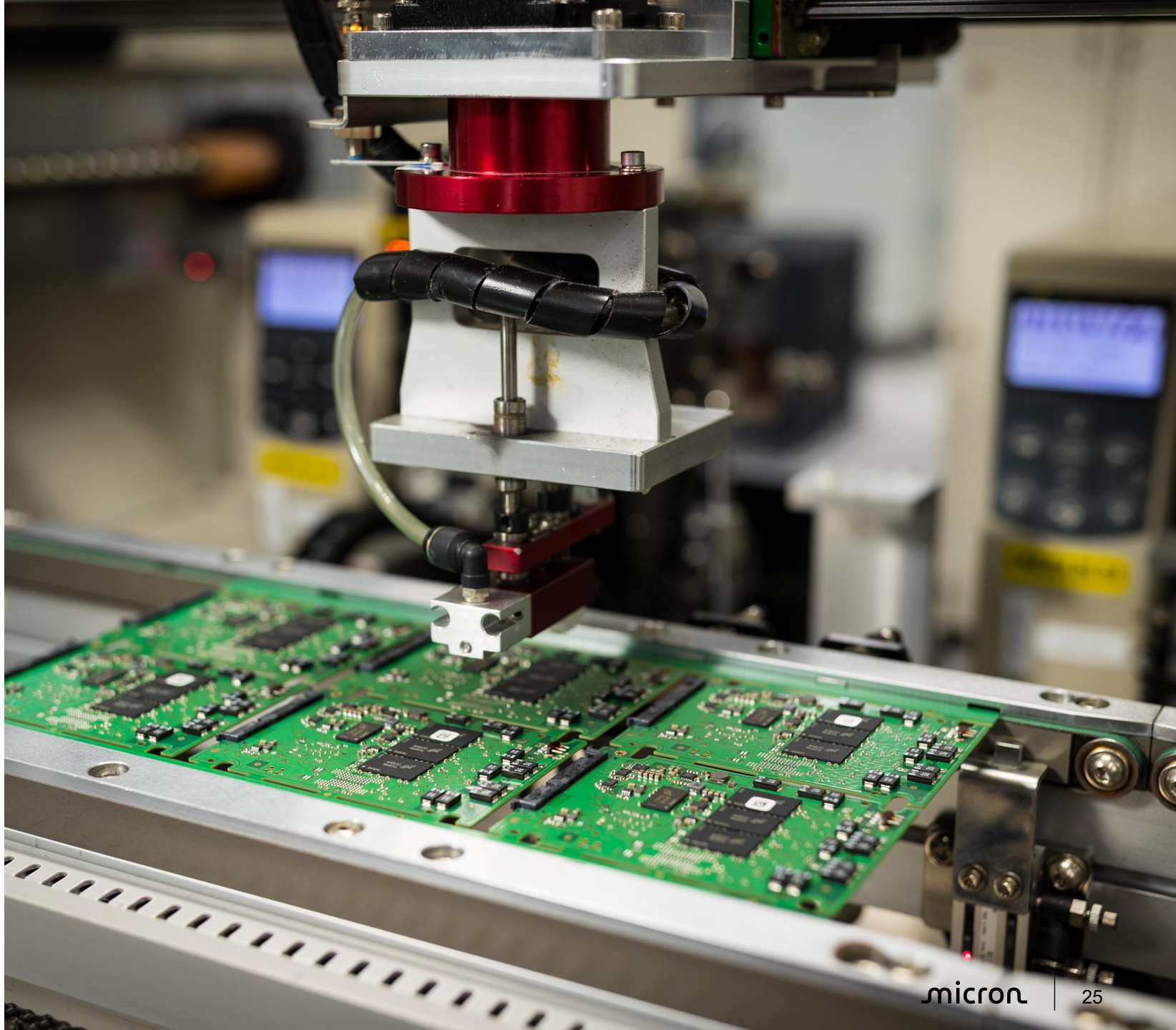
## 5 Whys Case Study

Angstrom Electronics Incorporated
Case Study – Elkhorn Production Line

# Problem on the Elkorn Production Line

Fred is the production manager at Angstrom Electronics Inc.

On Monday morning, Fred arrives at work to discover that the “Elkhorn” production line—responsible for 24/7 manufacturing to fulfill a critical customer shipment—is unexpectedly down.



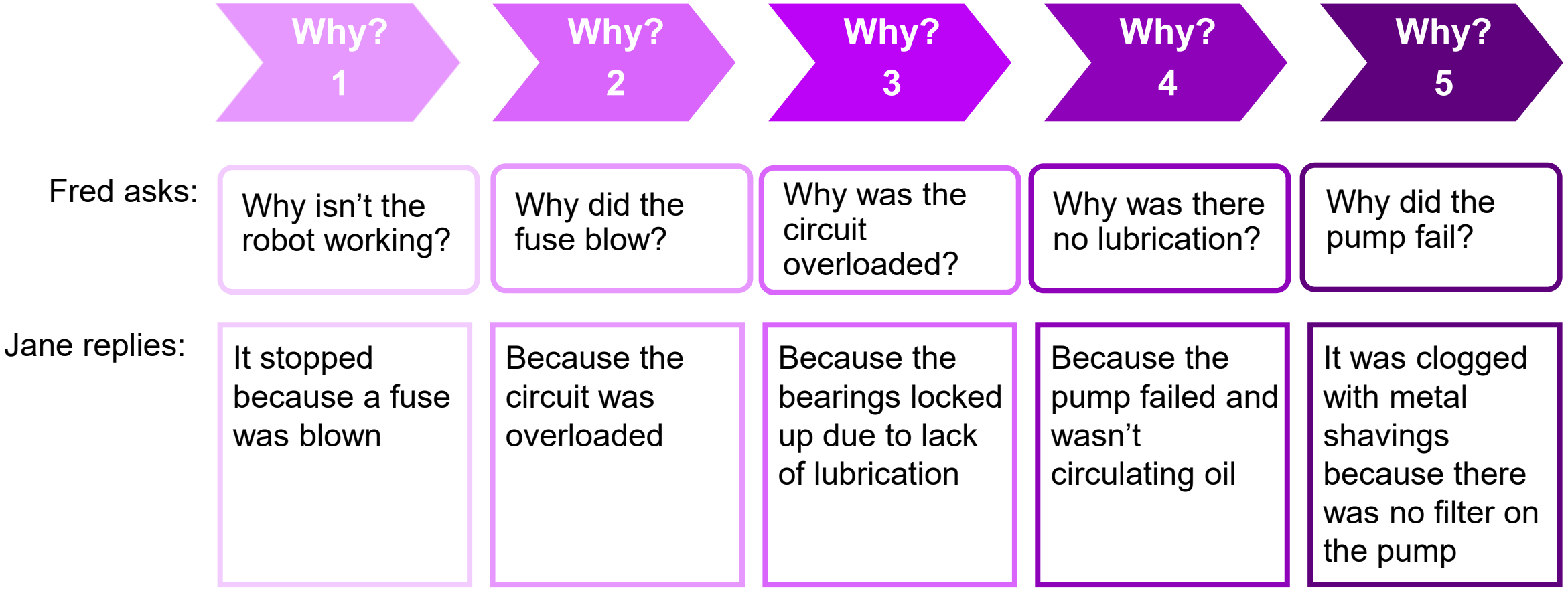
# Problem Statement

The 24x7 “Elkhorn” production line is down and no longer manufacturing product.

Fred asks, “Why is the production line down?”

Jane, the senior maintenance technician tells Fred, “because the main parts-handling robot isn’t working since Sunday night”

# The main parts-handling robot is down causing the production line to halt since Sunday night.



# 5 Whys Summary Table

| | |
|---|---|
| **Problem Statement** | **The main parts-handling robot is down causing the production line to halt since Sunday night.** |
| Why 1 | **Why isn't the main parts-handling robot working?** |
| | It stopped because a fuse was blown. |
| Why 2 | **Why did the fuse blow?** |
| | The circuit was overloaded. |
| Why 3 | **Why was the circuit overloaded?** |
| | The bearings locked up due to lack of lubrication |
| Why 4 | **Why was there no lubrication?** |
| | The pump failed and wasn't circulating oil |
| Why 5 | **Why did the pump fail?** |
| | It was clogged with metal shavings because there was no filter on the pump |

# Systemic root cause reflection

In the prior example the Elkhorn line was down, and the root cause was identified as “there was no filter on the pump”

The corrective action or solution was to replace the pump and filter to bring the line back up.

But…will replacing the pump and filter prevent the problem from reoccurring?

# Systemic root cause reflection

The investigation may not be over. There may be more “Why” questions to ask. For example: Why wasn’t there a filter in the oil pump?

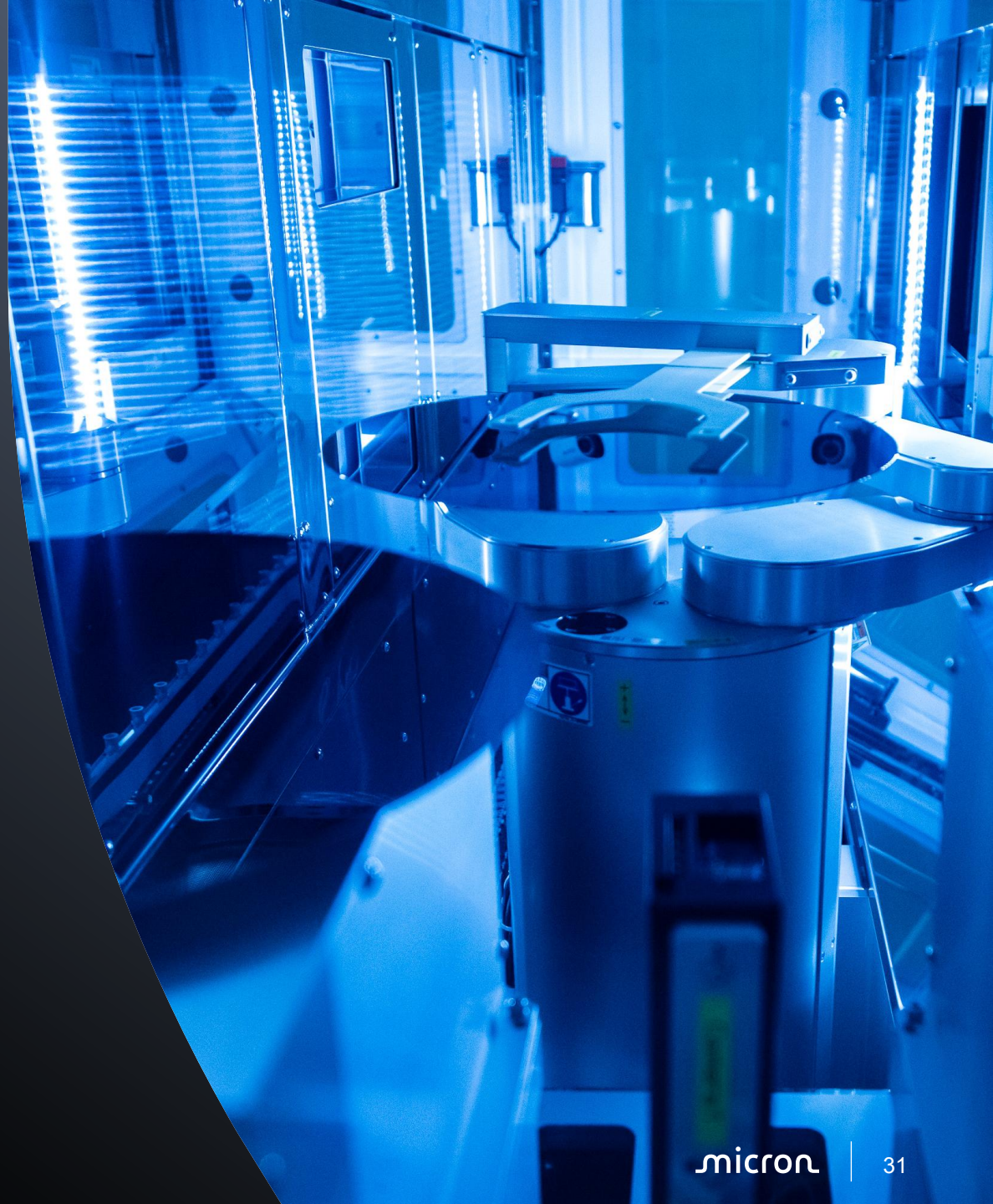
This will get us closer to what is called a “Systemic root cause”.

Discussion point. What might be some possible Systemic root causes? Possible discoveries:

- There is no established Preventive Maintenance (PM) procedure for the pump
- If there is an established PM procedure, maybe it wasn’t followed correctly
- Maybe the maintenance technician didn’t know there was a PM procedure or wasn’t trained correctly

Getting to the Systemic root cause will take more work. But, unless that Systemic root cause is found and corrected, this problem will likely happen again.

# 5 Whys in Semiconductor Manufacturing



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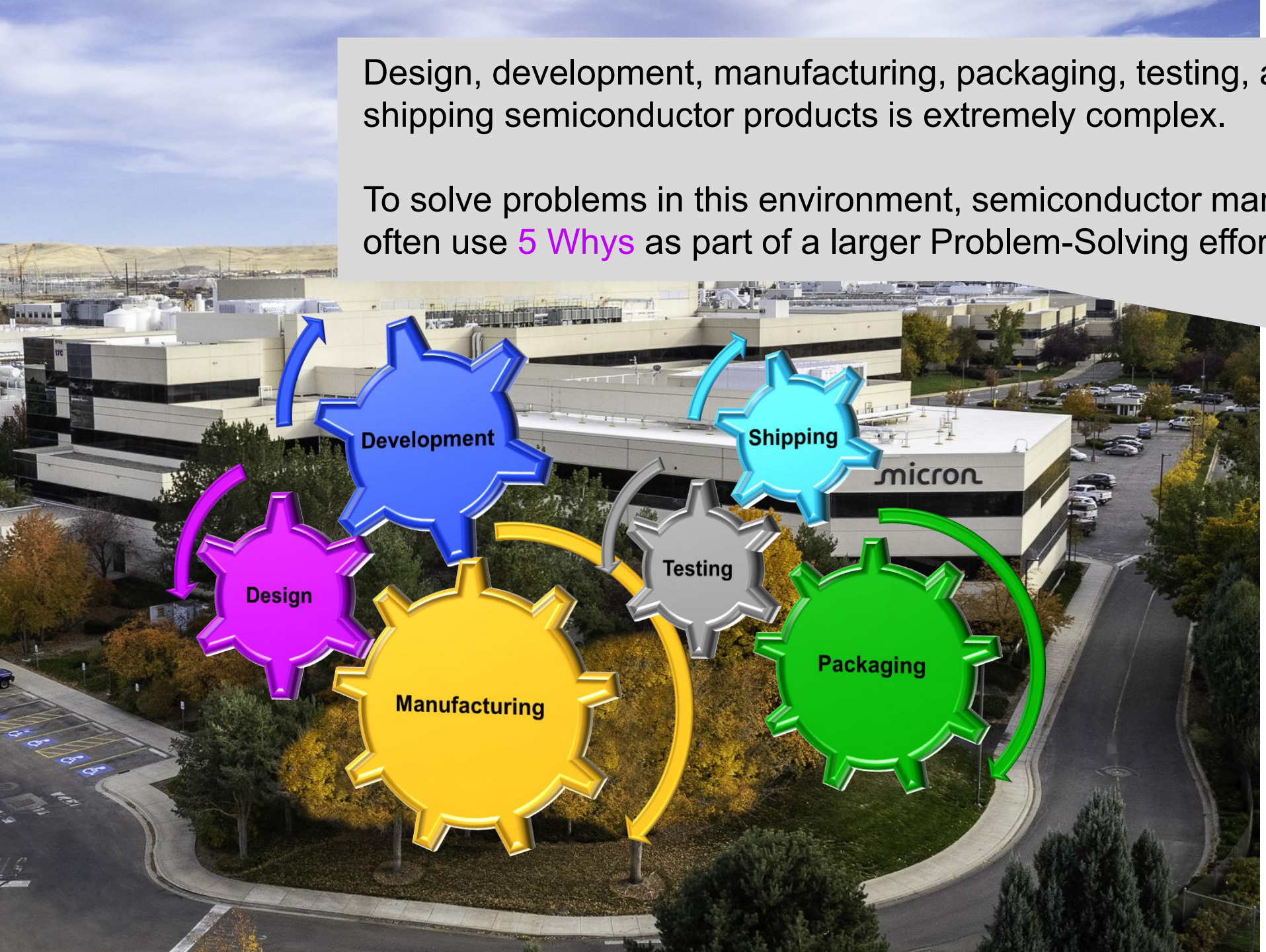
Design, development, manufacturing, packaging, testing, and shipping semiconductor products is extremely complex.

To solve problems in this environment, semiconductor manufacturers often use 5 Whys as part of a larger Problem-Solving effort.




# 8D Problem Solving

D1 Form Team → D2 Describe Problem → D3 Contain Symptoms → D4 Find and Verify Root Causes → D5 Define and Select Corrective Actions → D6 Implement Corrective Actions → D7 Prevent System Problems → D8 Final Discussion

5 Whys may be used as part of comprehensive Problem-Solving methodologies, such as 8D

8D is an industry-standard Problem-Solving methodology.

8D is used for getting to root cause of a problem, and for implementing corrective actions, preventing the problem from happening again, and protecting the customer through the entire process.

# 5 Whys In Semiconductor Manufacturing

**Deviations**

- When something has gone wrong in the manufacturing process.
- Can lead to problems such as poor cost performance, die that must be scrapped, downgrades or increased cycle time.

5 Whys can be used to explore:
Why did a deviation occur?

**Audit**

- Formal reviews of an organization's processes to determine whether industry, customer, and internal requirements are being met and drive continuous improvement. Various types of Audits: customer, certification, internal, etc.

5 Whys can be used to explore:
Why did we receive an audit finding?

**Non-performing metrics**

- Metrics that are not improving at the desired pace or are worsening
- Each department (research & development, manufacturing, testing, quality, etc.) will have different metrics to gauge how they are performing

5 Whys can be used to explore:
Why are we under-performing in an area?

# Semiconductor Manufacturing

## Four Steps towards a good 5 Whys Analysis

Angstrom Electronics Incorporated
Case Study 2 – Machine #3

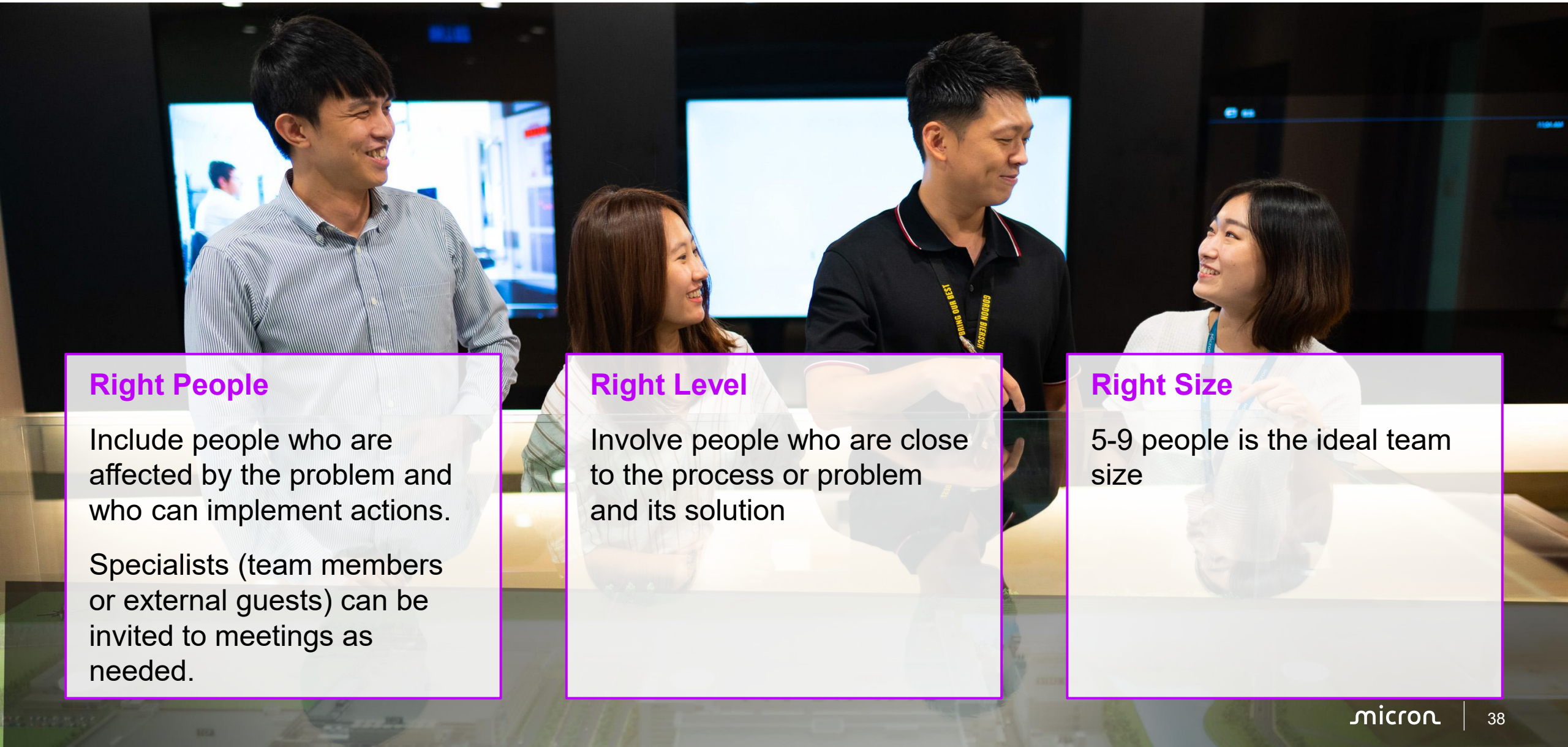
# How to Conduct a good 5 Whys Analysis

| Steps | | Purpose |
|---|---|---|
| 1 | Create a cross-functional team | To get to root cause of complex engineering problems, we need diversity of thought |
| 2 | Write a clear and concise problem statement | The more problems you solve, the more you realize that it all starts with a very clear statement of the problem |
| 3 | Ask “why” until Specific and Systemic root cause(s) are identified | It might only take 3 whys, or it might take 10, but keep asking why until you get to the Systemic root cause |
| 4 | Verify why statements using “therefore” and root cause | As an example – lights at the Jefferson Memorial were turned on early at dusk, **therefore** insects were attracted to the lights. |

# Step 1: Create a cross-functional team

Getting to the root cause of complex problems in the semiconductor manufacturing domain will almost always require a team effort!

# Create a cross-functional team



### Right People

Include people who are affected by the problem and who can implement actions.

Specialists (team members or external guests) can be invited to meetings as needed.

### Right Level

Involve people who are close to the process or problem and its solution

### Right Size

5-9 people is the ideal team size

# Step 2: Write a clear problem statement

# Why do we need a Problem Statement?

A clear problem statement ensures all team members/stakeholders share the same understanding of the issue.

**A good problem statement typically addresses:**

**What?**

What exactly is the issue? (e.g., which part, process, or product?)

**When?**

When did it occur? How often?

**Where?**

Where did it happen? (e.g., location, line, workstation)

**How much?**

How many items are affected? How severe is the impact?

**No Solution Yet!**

Don’t jump to solutions—define the problem first.

# The Problem with Problem Statements

"The problem with problem statements is that hardly anyone knows how to correctly formulate a problem statement and instead they put a lot of information there in place of sound arguments and justification for action, and people would be better off leaving the writing of problem statements to professionals."

**Can you find any problems with this statement?**

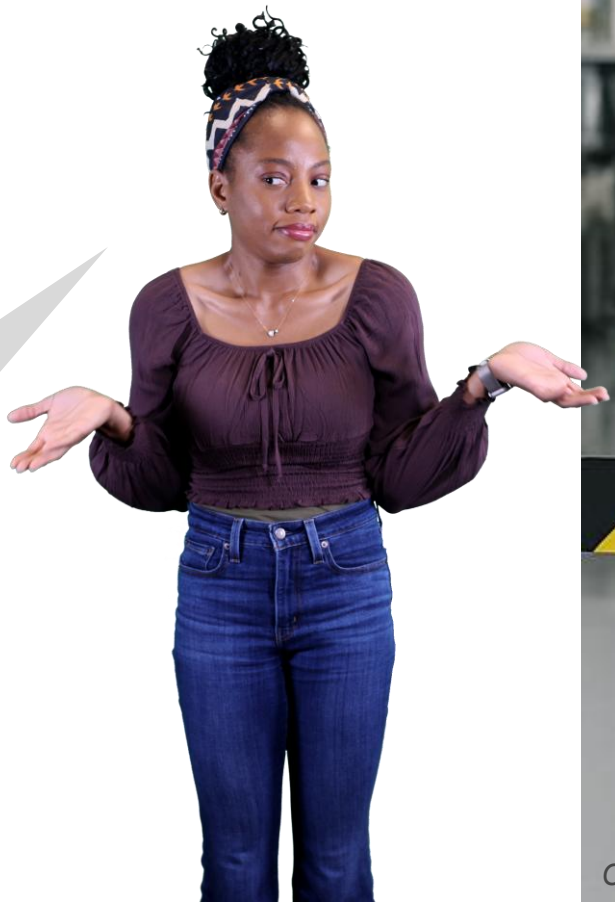
Poor Problem Statements…
1. Assign a cause
2. Contain the solution
3. Are based on conjecture or belief rather than fact
4. Are too long
5. Do not describe actual current condition or problem condition
6. Do not describe the ideal or desired condition
7. Are not measurable
8. Are unclear
9. Are not specific
10. Refer to issues outside of the scope of the actual problem

# Accident in Front of Machine #3

Alex, a machine operator on the Elkhorn production line, was walking past Machine #3 when they suddenly slipped and fell. The incident happened on Monday morning, May 5 at 6:15 am, right at the start of the shift, and was witnessed by several colleagues. Fortunately, Alex was not injured, but the fall highlighted a safety concern in the area.

The shift manager reported this problem statement:

“An operator slipped and fell. They need to maintain better cleanliness in the area.”



Is this a good problem statement?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# Let’s refine the problem statement

Let’s ask these questions:

- What?
- When?
- Where?
- How much (or how many)?

Let’s not offer a solution.

**Poor Problem Statement**

“An operator slipped and fell. They need to maintain better cleanliness in the area.”

**Revised Problem Statement**

“An operator slipped and fell on the floor Monday, May 5, at 6:15 am when slipping on a puddle in front of Machine #3.”

# Step 3: Ask “why” until Specific and Systemic root cause(s) are identified

# Accident in Front of Machine #3

An operator slipped and fell on the floor Monday, May 5, at 6:15 am when slipping on a puddle in front of Machine #3.

| Why? | Why? | Why? | Why? | Why? | Why? |
|---|---|---|---|---|---|
| Why did the operator fall? | Why was there a puddle on the floor? | Why was Machine #3 leaking oil? | Why did the seal deteriorate and crack? | Why was the incorrect seal used? | Why did the buyer purchase the incorrect seal? |
| The operator slipped on a puddle on the floor, near Machine #3. | Machine #3 was leaking oil. | A seal in the machine had deteriorated and cracked. | The seal was made with material not suitable for the application. | The buyer purchased the incorrect seals from a secondary supplier for a lower price. | The service manual did not specify what kind of seal was needed. |

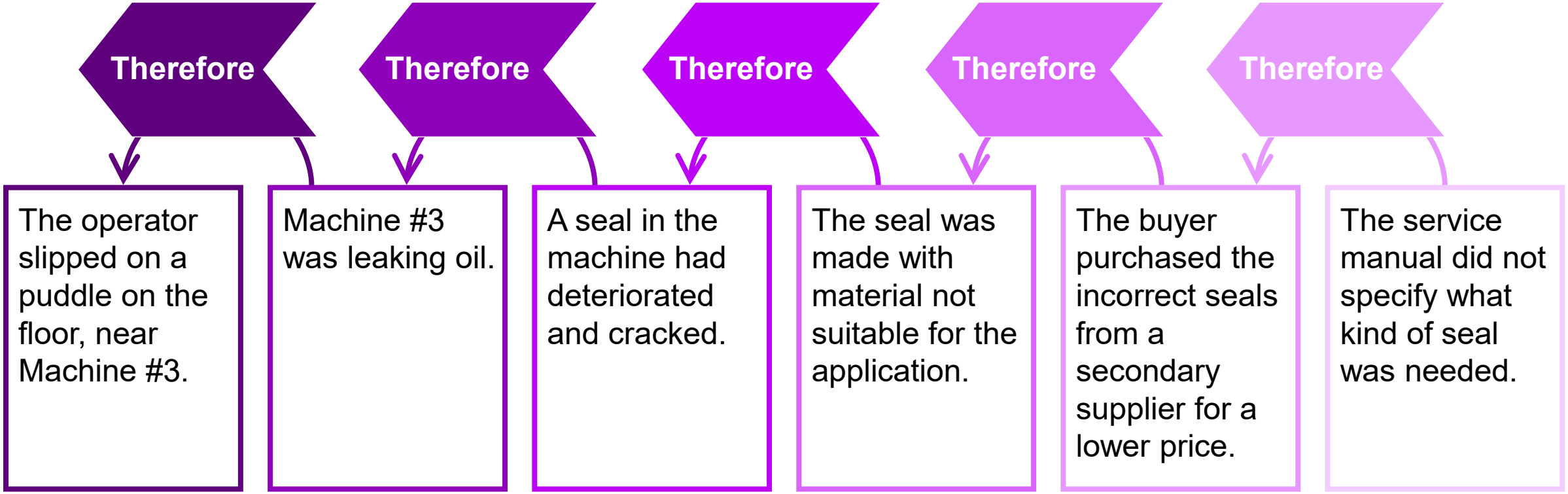
# 5 Whys Summary Table

| | |
|---|---|
| **Problem Statement** | **An operator slipped and fell on the floor Monday, May 5, at 6:15 am when slipping on a puddle in front of Machine #3** |
| Why 1 | **Why did the operator fall?** |
| | There was a puddle of oil on the floor |
| Why 2 | **Why was there a puddle on the floor?** |
| | Machine #3 was leaking oil |
| Why 3 | **Why was Machine #3 leaking oil** |
| | A seal had deteriorated and cracked |
| Why 4 | **Why did the seal deteriorate and crack?** |
| | The seal was made with material not suitable for the application |
| Why 5 | **Why was the incorrect seal used?** |
| | The buyer purchased the incorrect seal from a secondary supplier for a lower price |
| Why 6 | **Why did the buyer purchase the incorrect seal?** |
| | There was nothing in the service manuals specifying what kind of seal to purchase |

# Step 4: Verify why statements using “therefore” and root cause

# Accident in Front of Machine #3

An operator slipped and fell on the floor Monday, May 5, at 6:15 am when slipping on a puddle in front of Machine #3.



# Therefore Summary Table

| | |
|---|---|
| **Root Cause Statement** | **The service manual did not specify what kind of seal was needed.** |
| **Therefore 1** | The buyer purchased the incorrect seals from a secondary supplier for a lower price. |
| **Therefore 2** | The seal was made with material not suitable for the application. |
| **Therefore 3** | A seal in the machine had deteriorated and cracked. |
| **Therefore 4** | Machine #3 was leaking oil. |
| **Therefore 5** | The operator slipped on a puddle on the floor, near Machine #3. |

# Specific Root Cause

The Specific root cause directly addresses the technical failure that led to the incident and is generally actionable. In semiconductor manufacturing, Specific root cause is often related to design, operations, or dimensions and is typically traceable or controllable by the team doing the work.

Examples: tool wear or break, incorrect set up or procedure, process deviation, part design issue, etc.

**Specific Root Cause:**

The seal installed in Machine #3 was made from an incorrect material, which was not suitable for the operating conditions. This led to premature deterioration and cracking of the seal, causing oil to leak onto the floor.

→ Proposed solution: replace with the correct seal

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# Systemic Root Cause

Systemic root cause is the underlying cause that led to the problem and sub causes. The Systemic root cause could be anchored in processes, people, the environment, etc.

Examples: Normally Systemic root causes deal with lack of processes and procedures.

**Systemic Root Cause:**

The purchasing organization lacked proper documentation and specifications for purchasing seals for Machine #3.

→ Proposed solution: update documentation to describe the specific seal required for Machine #3


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# Semiconductor Manufacturing

## 5 Whys Analysis

Angstrom Electronics Incorporated
Case Study – Monarch 47L1 board failures

# Monarch 47L1 board failures

The yield* for Monarch 47L1 boards on production line 8 typically averages 99%. Currently, it has dropped to 74%, with the decline beginning during Tuesday's night shift. This sharp decrease in yield is reducing production capacity and driving up scrapped product.

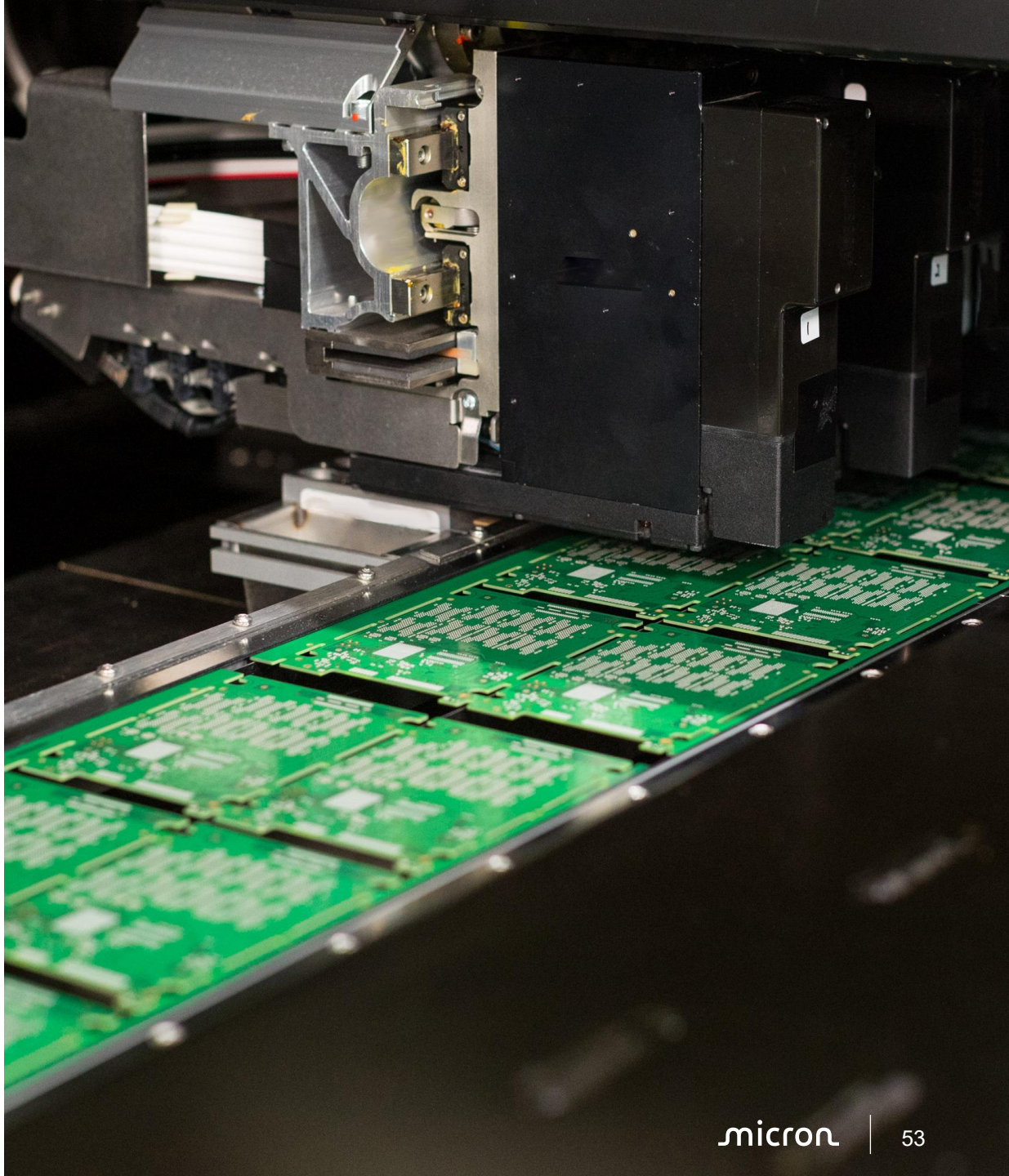
Desired level of performance → 99%

**Monarch 47L1 production line:**

- We expect 99% of 47L1 boards on line 8 to pass testing
- The yield rate has dropped to 74% with multiple test fails over the last 2 shifts

Current level of performance → 74%

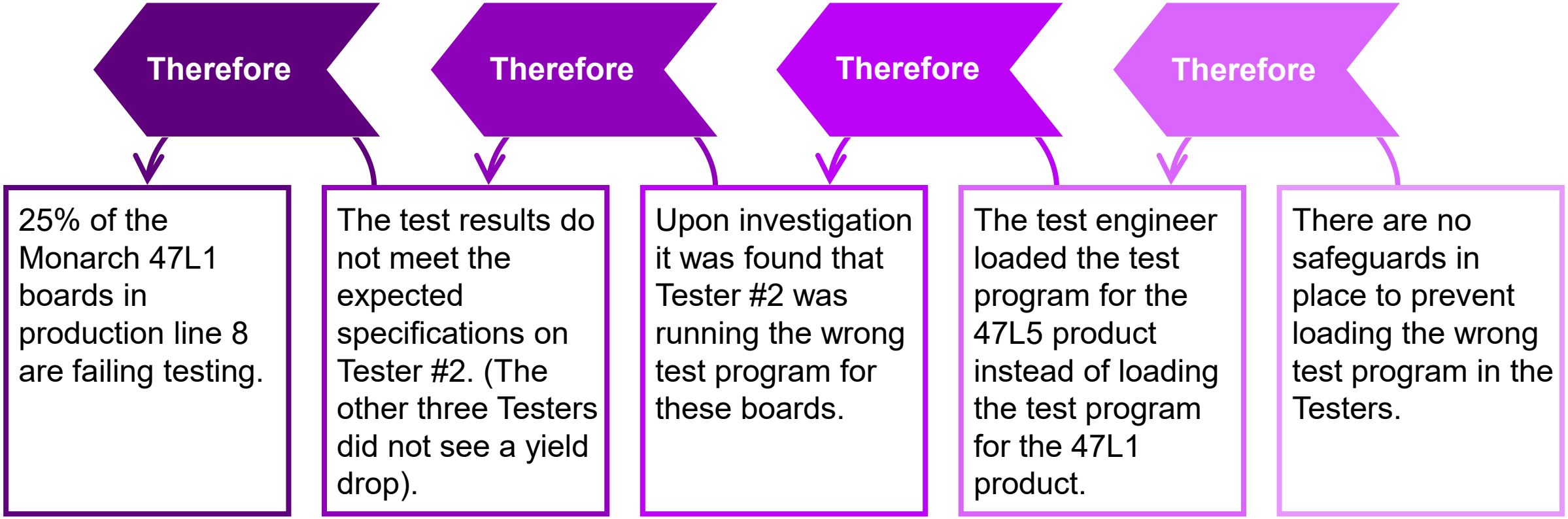
*Yield: percentage of units that meet quality standards



# Monarch Production Line low yield

| Why? | Why? | Why? | Why? | Why? |
|---|---|---|---|---|
| Why has the production line yield rate dropped? | Why are these boards failing testing? | Why are all 47L1 boards tested on Tester #2 failing? | Why was the test system running the wrong test program? | Why was the test engineer able to load the wrong program? |
| 25% of the Monarch 47L1 boards in production line 8 are failing testing. | The test results do not meet the expected specifications on Tester #2. (The other three Testers did not see a yield drop). | Upon investigation it was found that Tester #2 was running the wrong test program for these boards. | The test engineer loaded the test program for the 47L5 product instead of loading the test program for the 47L1 product. | There are no safeguards in place to prevent loading the wrong test program in the Testers. |

# Monarch Production Line low yield



# Root Causes

Monarch board example:

**Specific Root Cause:**

Monarch 47L1 boards were failing on Tester #2 because the Test Engineer loaded the wrong test program.

→ Proposed solution: loading the correct test program and re-test the 47L1 boards with the correct program

**Systemic Root Cause:**

The issue brought to light that there were inadequate processes for loading test codes in Testers

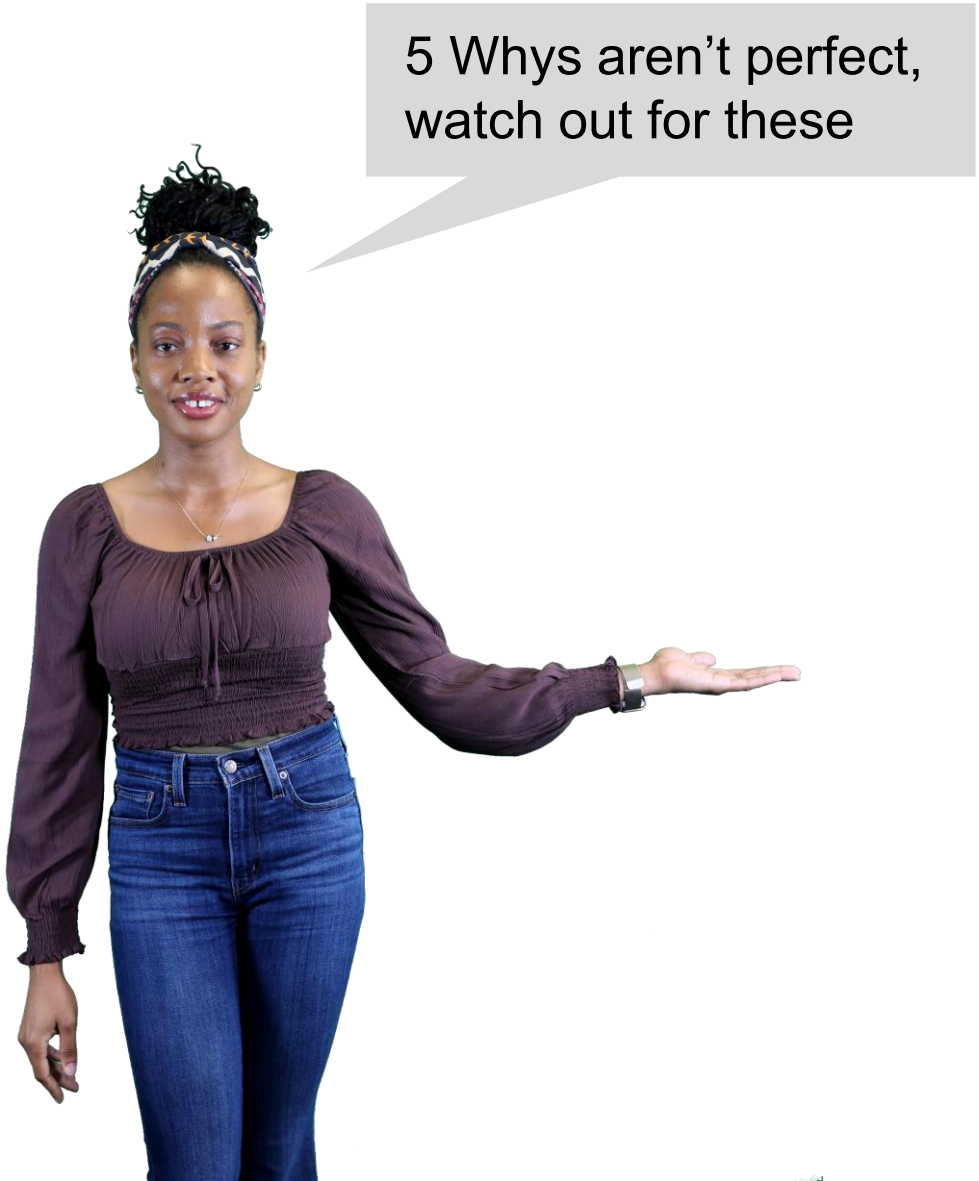
→ Proposed solution: A team was tasked with putting safeguards in place to prevent the problem from reoccurring

# Common Deviations in Semiconductor Industry

- Field failures
- Hardware issues
- Software issues
- Line down
- Operational errors
- Manufacturing defects
- Particle contamination
- Non-uniform film deposition
- Photolithography mask alignment issues
- Non-uniform etching
- Packaging related failures
- Reliability and use condition failures

# Limitations of 5 Whys Analysis

# Limitations of using 5 Whys




- Potential for Missing the Root Cause
- Oversimplification
- Skill-dependent
- Lack of Repeatability
- Confusion between Causal Factors and Root Causes
- Insufficient Rigor
- Bias and Subjectivity
- Over-reliance on Deduction

# Key Takeaways

- **Start with a clear, factual problem statement.** Avoid jumping to solutions or assigning blame.
- **Use the 5 Whys to move from symptoms to root causes.** Each “why” peels back a layer, revealing deeper issues.
- **Validate your findings by working backward (“therefore”).** For example: “The seal was incorrect, therefore it cracked, therefore oil leaked, therefore a puddle formed, therefore the operator fell.”
- **Address both Specific and Systemic root causes.** Fixing the immediate issue (the seal) is important, but so is improving processes (training, cleaning procedures, supplier specifications) to prevent recurrence.


Thank you for joining me in exploring the 5 Whys method! Wishing you success in defining your problem statements and uncovering the root cause to your challenges.

# Educator Hub

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