# THE LEAN ENGLISH PODCAST

Podcast 3: Six Sigma

Part 2

# MEASURE PHASE

Purpose: Collect data to establish the baseline performance of the process.

Output: Verified, reliable baseline data that quantifies the problem.

Deep dive:

- Basic Statistics
- Process Maps
- Data Collection Plan

# STATISTICS BASICS

| | |
|---|---|
| Types of data and measurement scales | • Understanding how different data types are analyzed will help with the data collection |
| Sampling and data collection methods | • The more samples the better, but costs must be considered<br>• "Garbage in, garbage out" |
| Descriptive statistics | • Population or historical data that we use as a baseline for comparing with our performance AFTER a solution |
| Inferential statistics | • When dealing with samples, we often make inferences when we compare them to population data |
| Graphical methods | • Many types of analysis are better understood when they are represented graphically |

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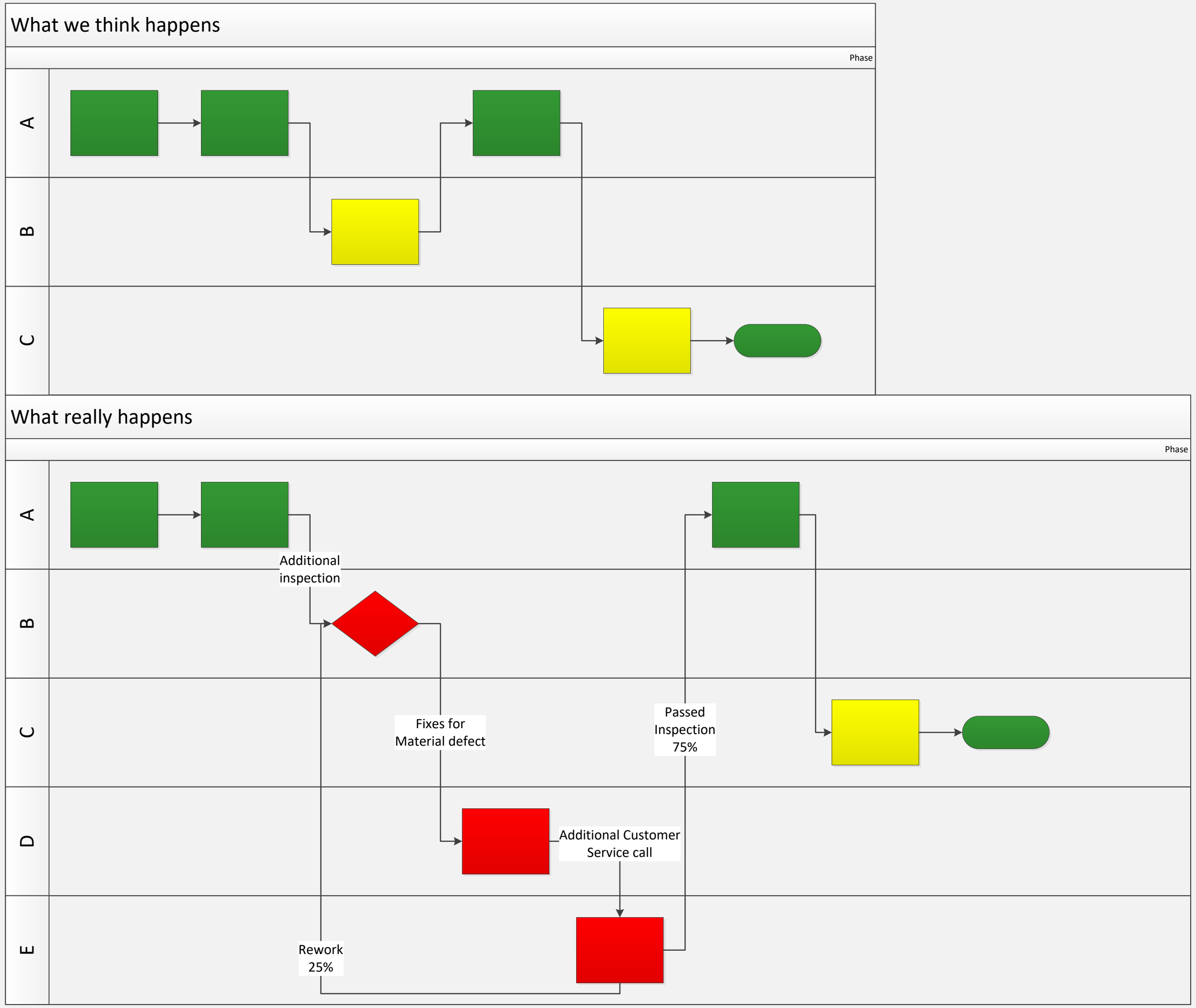
# CURRENT STATE PROCESS MAP




- A critical step in the Measure phase is to map and measure the current state as there may be a significant disconnect between what we think happens and what actually happens.
- A popular way to represent a process is through a cross functional swim lane map.
- That is why it is essential to perform a Gemba walk instead of assuming or taking someone’s word for it.

# DATA COLLECTION PLAN

- Performance Measure – The process step we wish to investigate.
- Operational Definition – How the step is defined and scoped.
- Data Source – Do we trust the source if we are not collecting it?
- Sample Size – How many items will we measure during our collection?
- Who Will Collect The Data – The person responsible for the collection.
- When Will Data Be Collected – The date/time the data will be collected.
- How Will Data Be Collected – Will we get the data from a computer or manually?
- Other Data that Should Be Collected At The Same Time – for future reference.

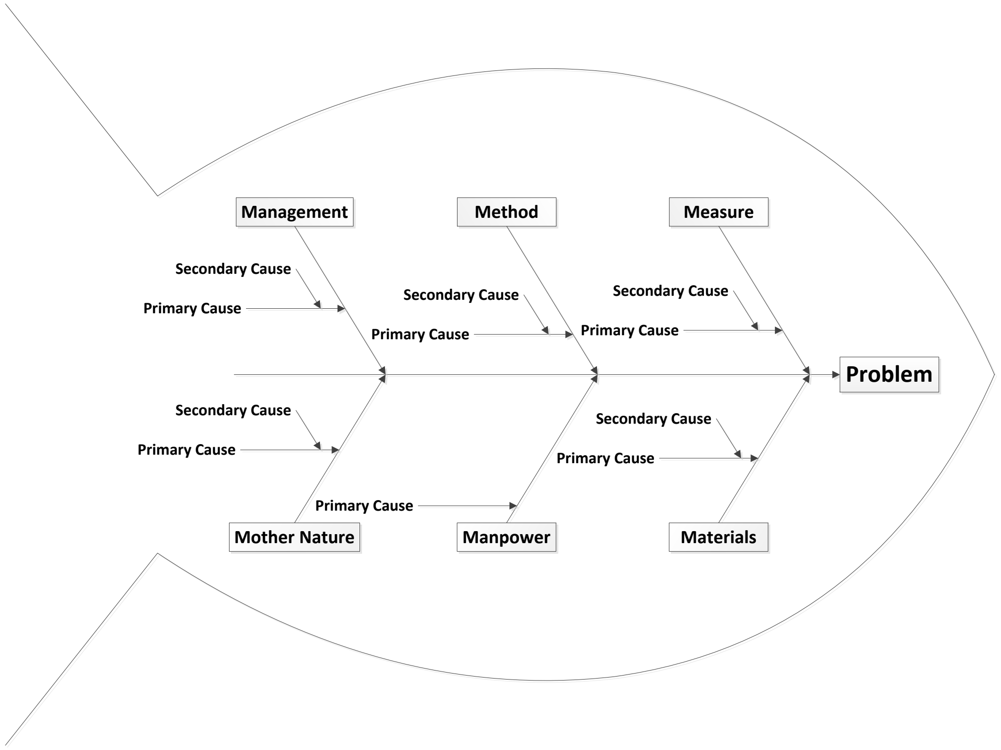
# ANALYZE PHASE

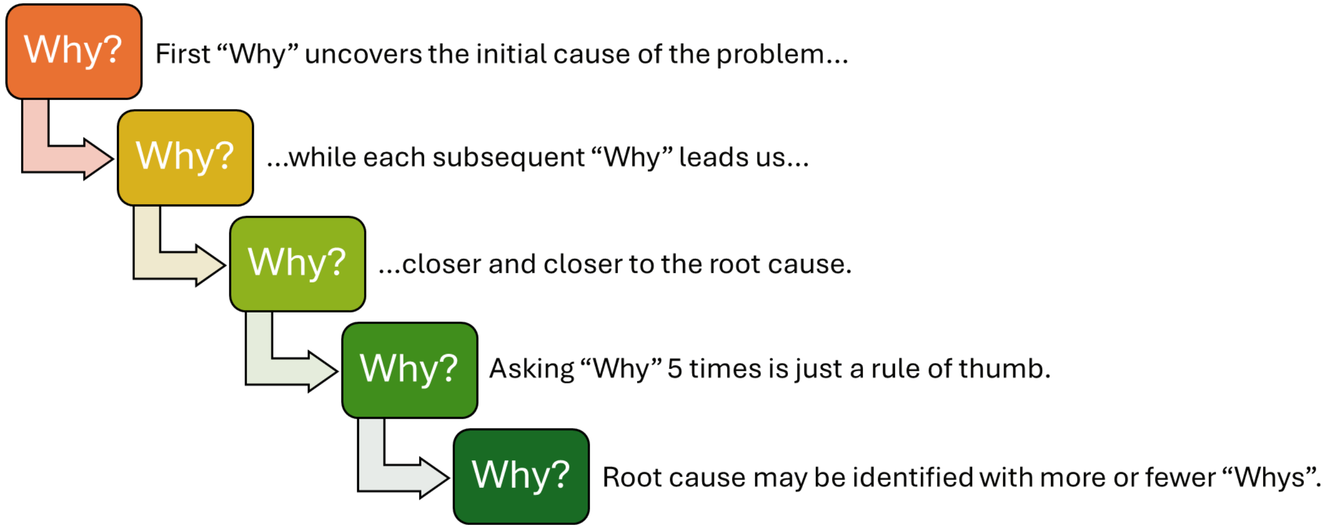
Purpose:  Discover what causes the problem and why it occurs.

Output: Validated root causes of the problem, supported by data (not assumptions).

Deep dive:

- Cause and Effect Diagrams
- Hypothesis Testing




# CAUSE AND EFFECT DIAGRAMS

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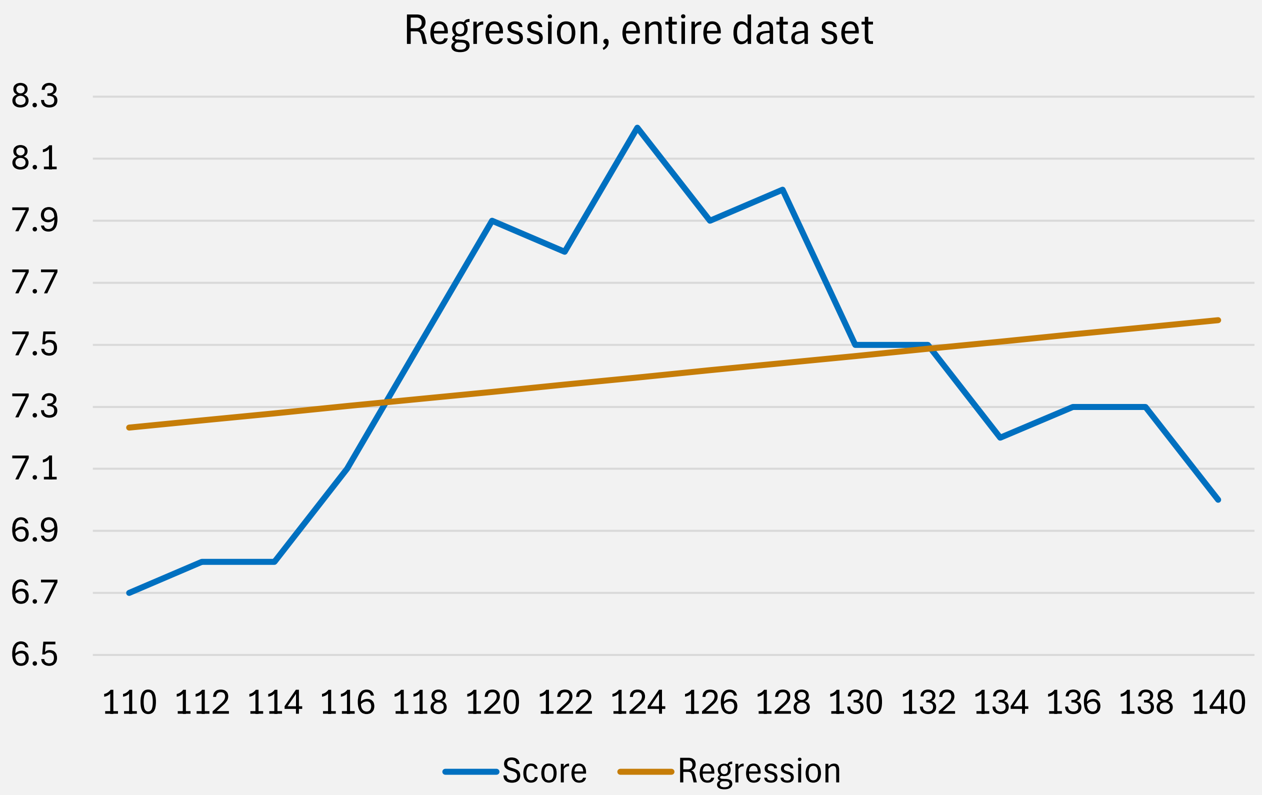
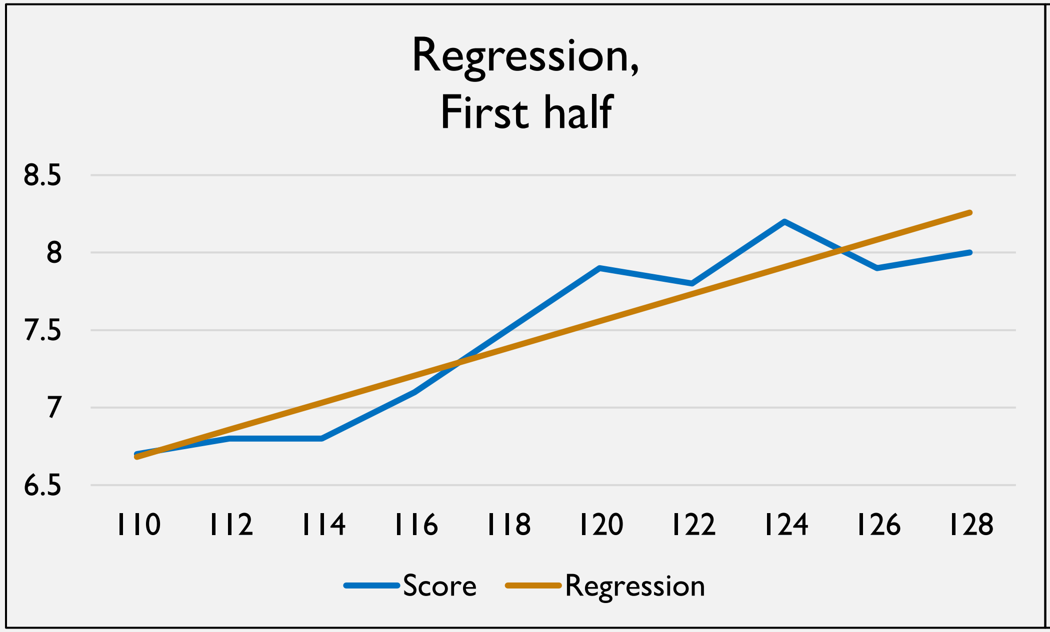
# REGRESSION ANALYSIS

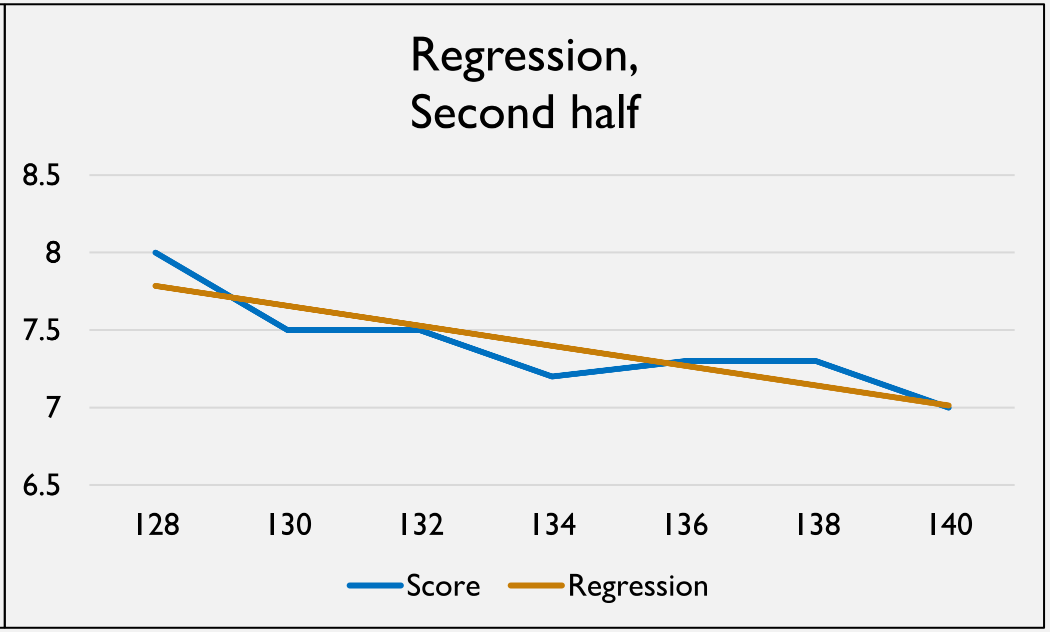
- Regression analysis tests whether an input variable, like butter, has an influence on an output variable, like customer satisfaction.
- At 110 grams, the customers gave the croissants an average score of 6.7, but the model expected a score of about 7.3.
- Throughout the graph, the regression formula does not do a very good job of prediction, even though we intuit that there is a relationship present.



# TWO REGRESSION TESTS

- We can see that if we perform 2 tests, one for the scores before 124 grams and one for the scores after, we can fit two formulas that offer good predictability.
- The amount of butter is truly related to the customers' scores, just not in a linear way through all possible inputs.
- For the project's purposes, the right amount seems to be between 124 and 128 grams.



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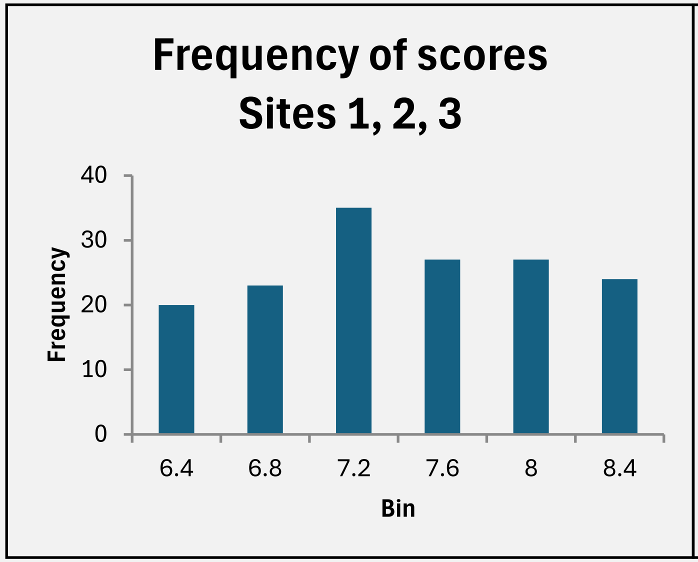
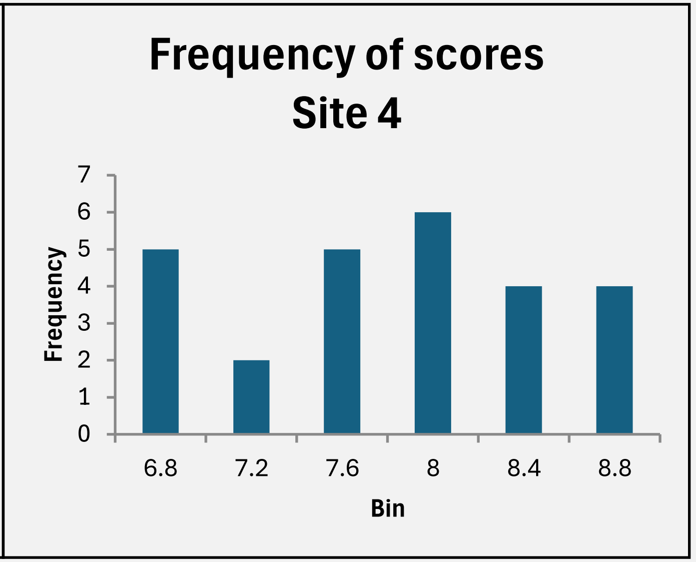
# HYPOTHESIS TESTING

- We use hypothesis tests to see if the data prove if the impact of the variable is statistically significant or merely coincidence.
- The company has 3 bakeries and recently opened a $4^{th}$,. They want to test their hypothesis that the average scores from the new store are different from the old stores.
- We perform a T-Test and compare the data. Although they look similar, the test's P-value of 0.00 tells us there is very little chance the average scores are the same.




| | ***Sites 1, 2, 3*** | ***Site 4*** |
|---|---|---|
| Mean | 7.22 | 7.66 |
| Variance | 0.38 | 0.45 |
| Observations | 156 | 26 |
| Pooled Variance | 0.39 | |
| df | 180 | |
| t Stat | -7.10 | |
| P(T<=t) two-tail | 0.00 | |
| t Critical two-tail | 1.97 | |

# IMPROVE PHASE

Purpose:  Generate, test, and implement solutions that address root causes.

Output:  Proven solutions that eliminate or reduce root causes and improve performance metrics.

Deep dive:

- Brainstorming and TIPS
- Design of Experiments

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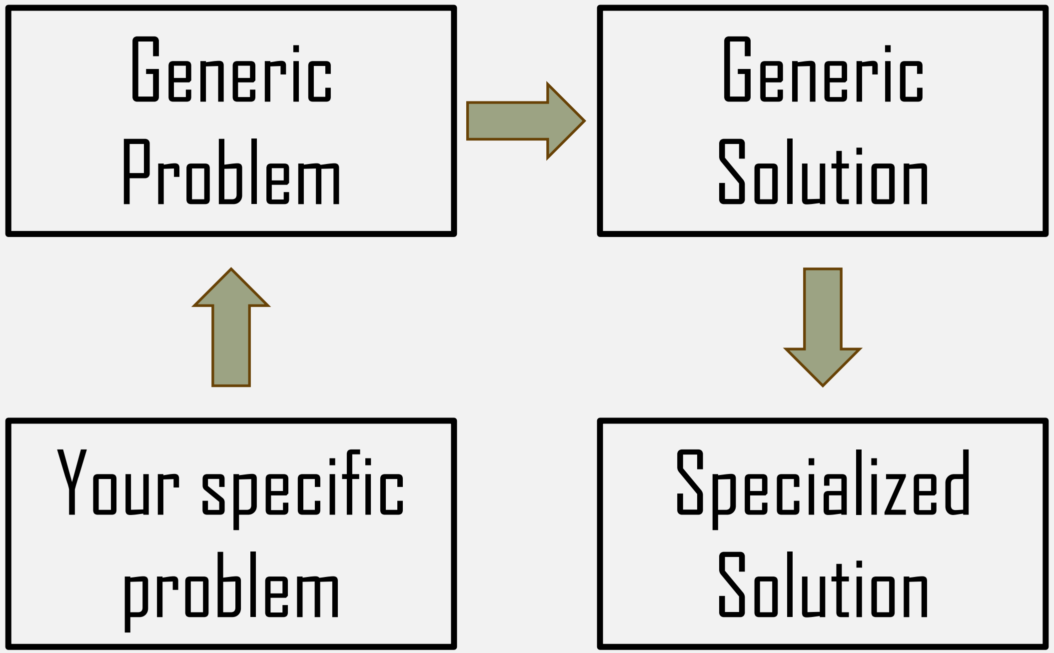
# BRAINSTORMING SOLUTIONS

- Brainstorming sessions should include the entire team and any Subject Matter Experts (SMEs) that have intimate knowledge of the process.
- The team maps the impact points, identifies possible solutions and begins creating plans for implementation.
- The Project Champion is briefed at the end of the meeting and determines the course of action.

This Theory of Inventive Problem-Solving model is another way to generate solutions.



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# DESIGN OF EXPERIMENTS

- We use experiments to tell us if a new solution makes a significant impact toward fixing our problem, or if our current method can be improved in some way.
- A designed experiment saves the company time by ensuring that each level of each variable is properly assigned to a run, that the results are properly measured and that the best solution is identified.

| Run | Butter | Time | Temp | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|---|---|
| 1 | 80% | 18 | 190 | 8.4 | 8.6 | 8.4 | 8.2 | 8.2 |
| 2 | 80% | 18 | 205 | 8.6 | 8.9 | 8.6 | 8.5 | 8.8 |
| 3 | 80% | 20 | 190 | 8.6 | 8.4 | 8.2 | 8.3 | 8.5 |
| 4 | 80% | 20 | 205 | 7.8 | 8 | 8.1 | 7.9 | 7.7 |
| 5 | 70% | 18 | 190 | 7.4 | 7.6 | 7.4 | 7.2 | 7.4 |
| 6 | 70% | 18 | 205 | 7.5 | 7.6 | 7.2 | 7 | 7.5 |
| 7 | 70% | 20 | 190 | 7.8 | 7.5 | 7.6 | 7.4 | 7.2 |
| 8 | 70% | 20 | 205 | 7.1 | 6.9 | 6.8 | 7.2 | 7.1 |

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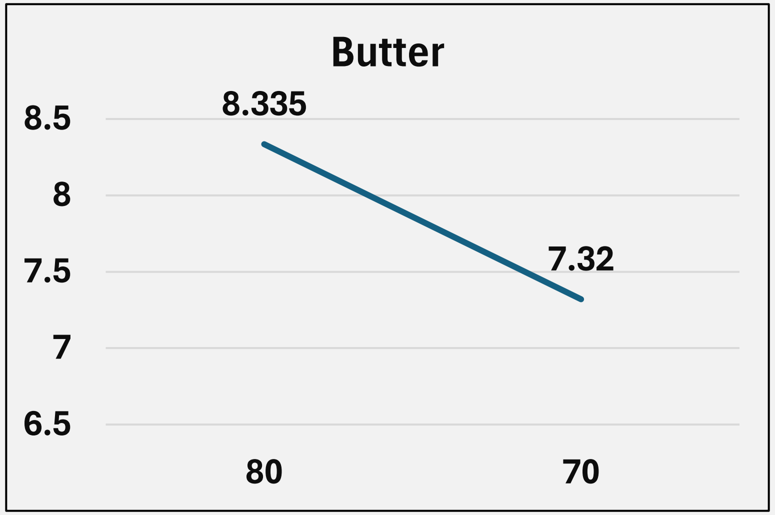
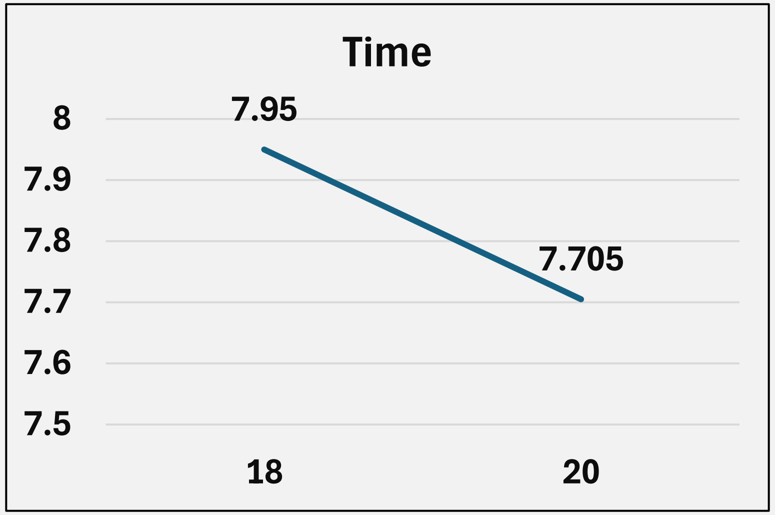
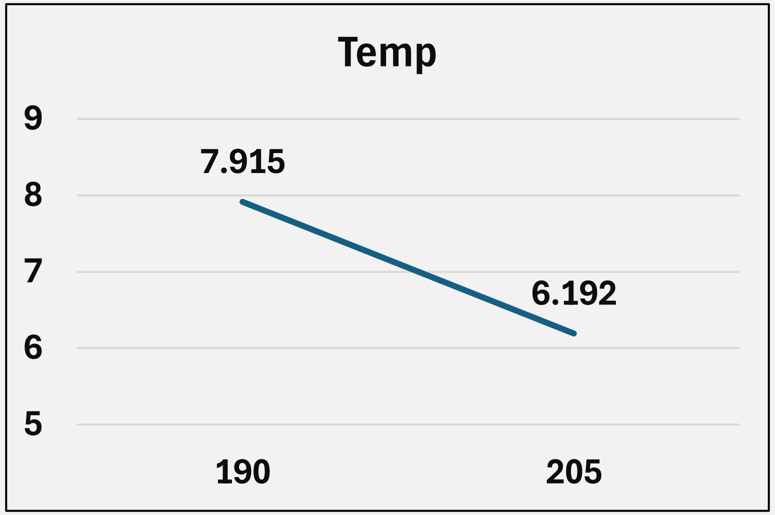
# MAIN EFFECTS CHARTS

- A quick view of the main effects charts show that there is a difference between the average scores for butter, time and temperature factors.
- The croissants made with butter with 80% fat received higher scores on average, as did croissants that baked for 18 minutes at 190 degrees.



# CONTROL PHASE

Purpose: Ensure that the gains are maintained over time.

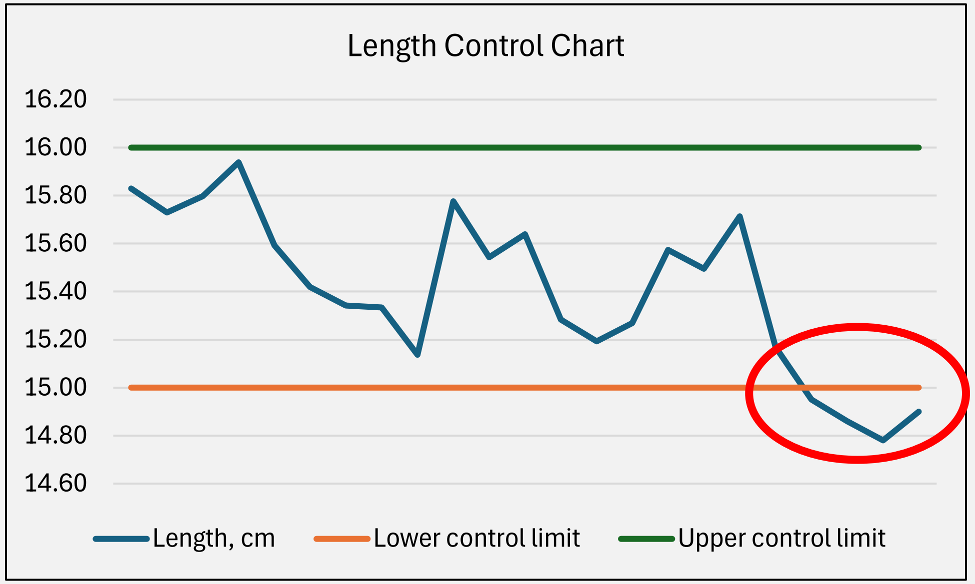
Output: A stable, sustainable process with controls to prevent regression.

Deep dive:

- Process Monitoring
- Standard Operating Procedures

# PROCESS MONITORING

- Statistical process control (SPC) is the use of statistical analysis and graphics to monitor and understand the variation in process performance.
- Control plans are generated during the Control phase to provide instructions on how to properly monitor new processes and respond to "out of limit" performance.




**Control / Response Plan**

| Process (x) and Outcome (y) Indicators | Unit of Measure | Target | Control Limit | Process Owner | System/ Source | What to Check? |
|---|---|---|---|---|---|---|
| Enter "y" metric to be monitored | | | | | | |
| Enter "$x_1$" metric to be monitored | | | | | | |
| Enter "$x_2$" metric to be monitored | | | | | | |

# STANDARD OPERATING PROCEDURES

Standard Operating Procedures outline the process steps in detail in accordance with business policies.

These files are the ideal form of documentation to ensure sustainability of the improvements.

The Process Owner and Process SMEs should help author the SOPs, while the entire team should validate them.

Care should be given to write them in the language most easily understood by the user, with graphics and visual cues to make comprehension immediate.

# CLOSING THE PROJECT

- To formalize the end of the project, after the Control tollgate meeting, the team should meet with the Process Owner and workers to "hand over" responsibility for the change and the solution.
- This will ensure that any questions about the new process are answered and the team members can return to their jobs without worry.
- The team should also celebrate with a party, and leadership should publish the project's results throughout the company.
- This will promote and raise awareness of the benefits of Six Sigma projects.

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