PROCESS CONTROL for Investment Casting

ICI Regional Meeting

Montreal, Canada

June 19, 2019

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Who's ever been given a problem to solve?

1. Were you able to find the root cause?
2. Did you follow a process to solve it?
3. How long did it take?
4. Did the problem ever come back?

We've all seen this:

What could the problem be here?

- Flat Tire
- Out of Gas
- Car Accident
- Pulled Over
- Mechanical trouble
- Taking a phone call/texting
- Spilled food/drinks
- Upset Children

WE NEED MORE INFORMATION TO KNOW!

The 3P's of Process Control

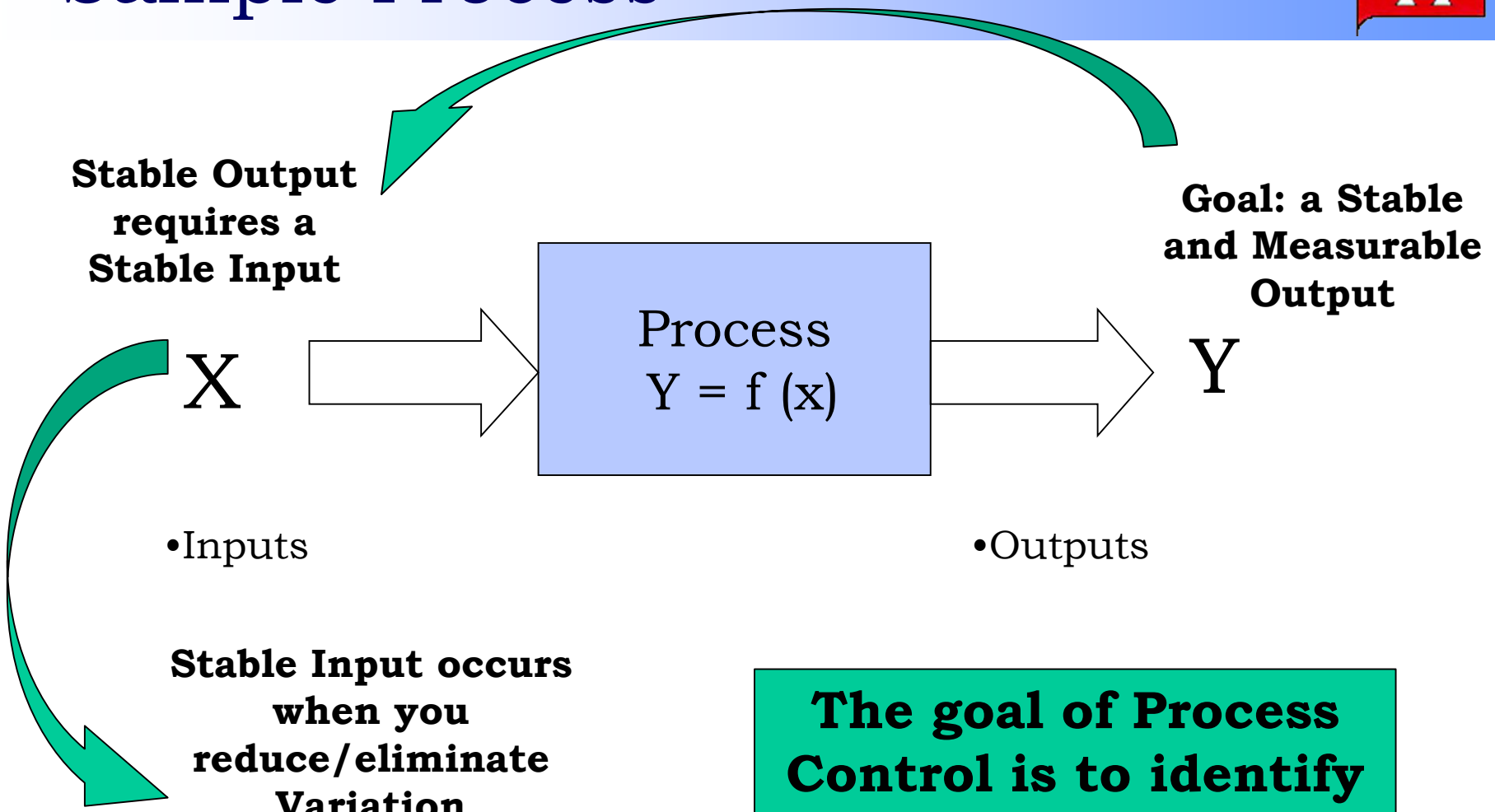
- The Purpose - to learn techniques and skills to apply in the context of the problem-solving process
- The Process – Tools will be introduced and applied through the simulation of a real-life problems
- The Payoff – You'll understand the problem-solving process, and how the process control tools are applied.

First Things First…

What exactly is a *process*?

"A unique combination of tools, materials, methods and people engaged in producing a measurable output."

Sample Process



The goal of Process Control is to identify and reduce sources of variation

Trust the Process

What exactly is Process *Control* then?

And why is it important?

Process Control is

Definition:

Activities involved in ensuring a process is predictable, stable, and consistently operating at the target level of performance with only normal (common cause) variation.

Source: Business Dictionary.com

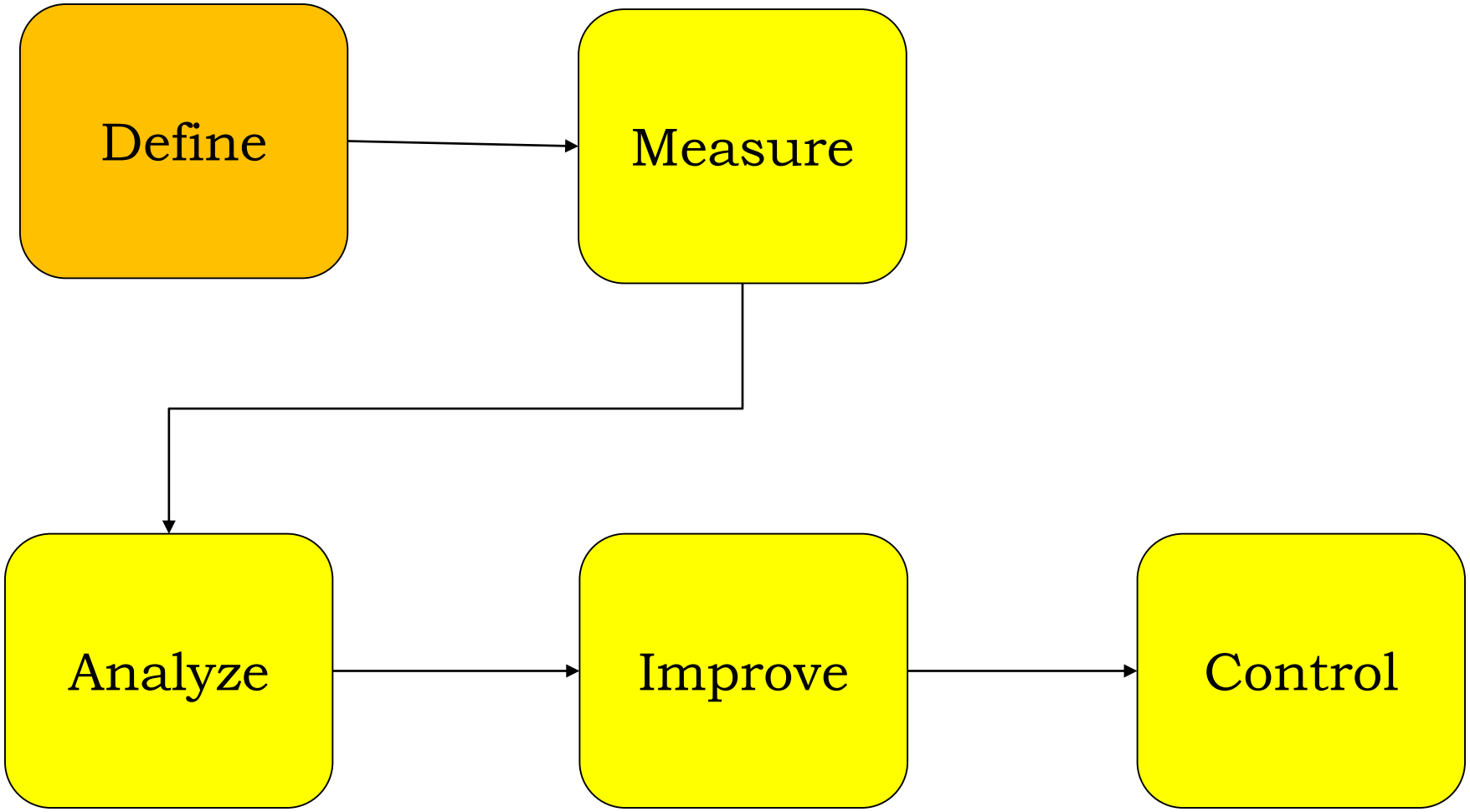
Why is it important?

A Controlled Process ensures:

1. Consistent, high quality products
2. Avoidance of costly mistakes
3. Easy detection if “out of control”
4. A safe working environment
5. Customer confidence

To control any process, we must first understand the problem solving method

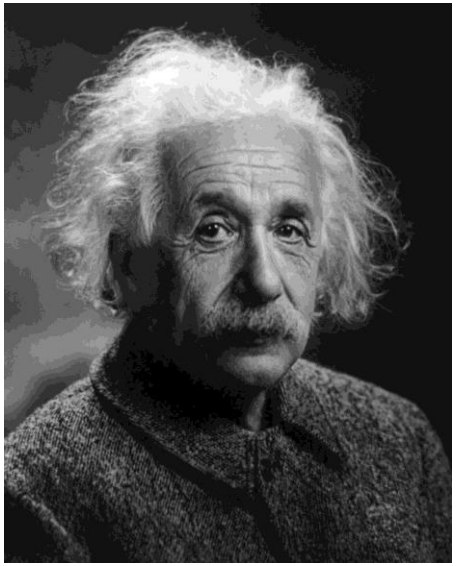
Process Control Problem Solving Phases



Problem Solving Phases – Define

The DEFINE phase is simply about *defining the problem*.

This is done with a *well crafted problem statement*.



"If I had an hour to solve a problem, I'd spend 55 minutes thinking about the problem and 5 minutes thinking about solutions." — **Albert Einstein**

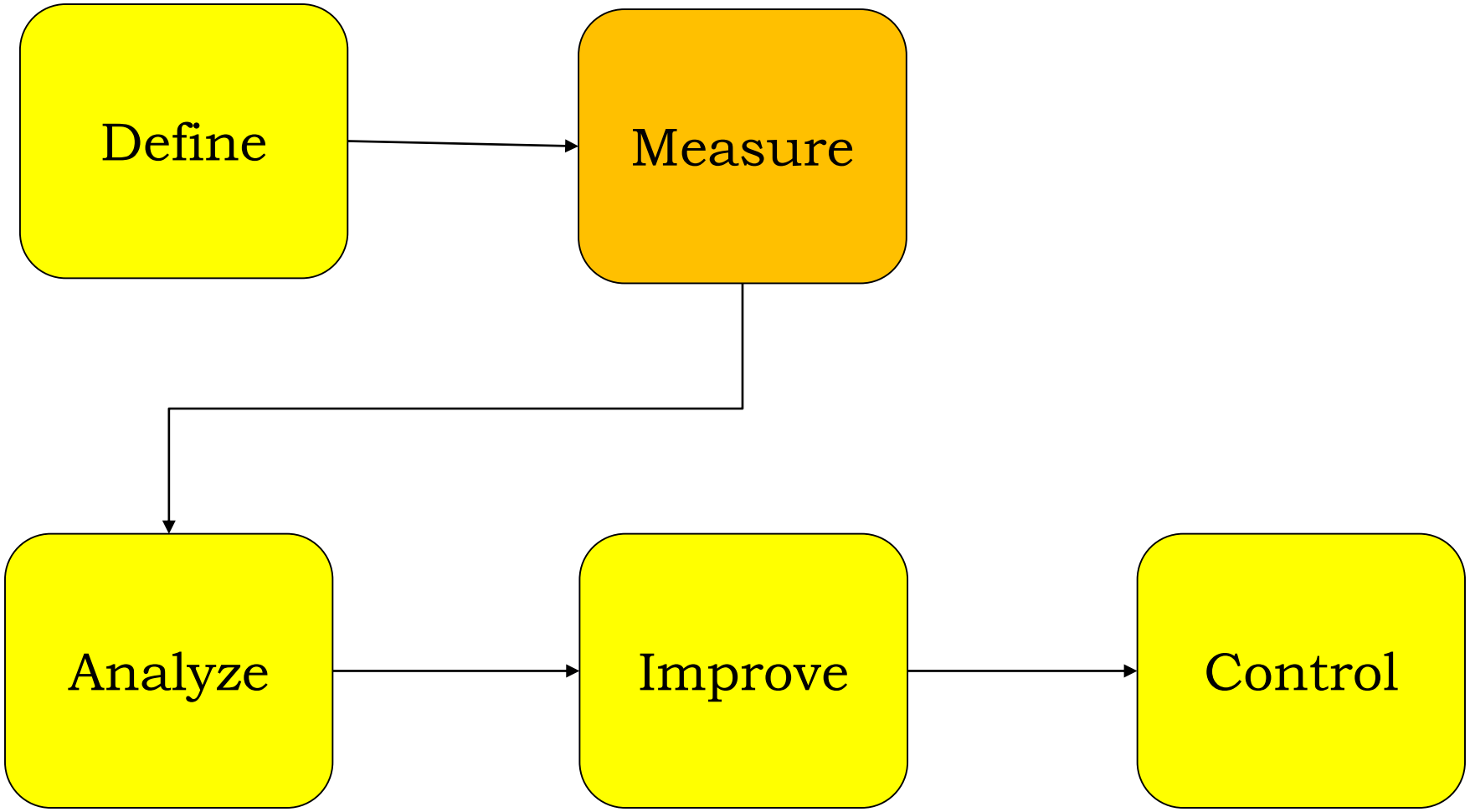
What Makes a Good Problem Statement?

A *good* problem statement will

1. Define the PROBLEM
2. Include a MEASUREMENT method for the problem
3. Define the customer REQUIREMENTS
4. Define the current CAPABILITY to produce to these requirements
5. Define the GOAL
6. Define WHEN it will be completed
7. Determine the WORTH of correcting the problem

Is this Project Worth Doing?

Process Control Problem Solving Phases



Problem Solving Phases – Measure

In the MEASURE phase we are *measuring the problem.*

In this phase we need to learn everything we can about the problem. The problem is the *key output variable (KOV)* we are trying to improve.

- Where do you get the data?
- Is the output objectively measurable?
- Is the data used to measure the output reliable?
- Based on the data, what is a realistic goal?

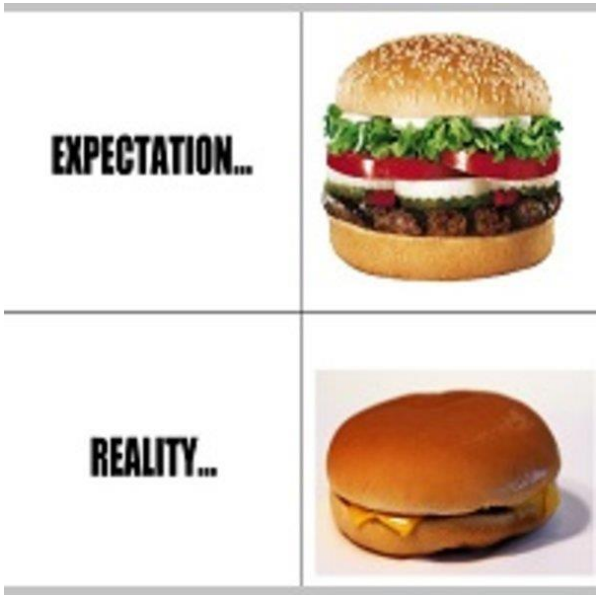
Is our Problem Statement still valid?

Problem Solving Phases – Measure

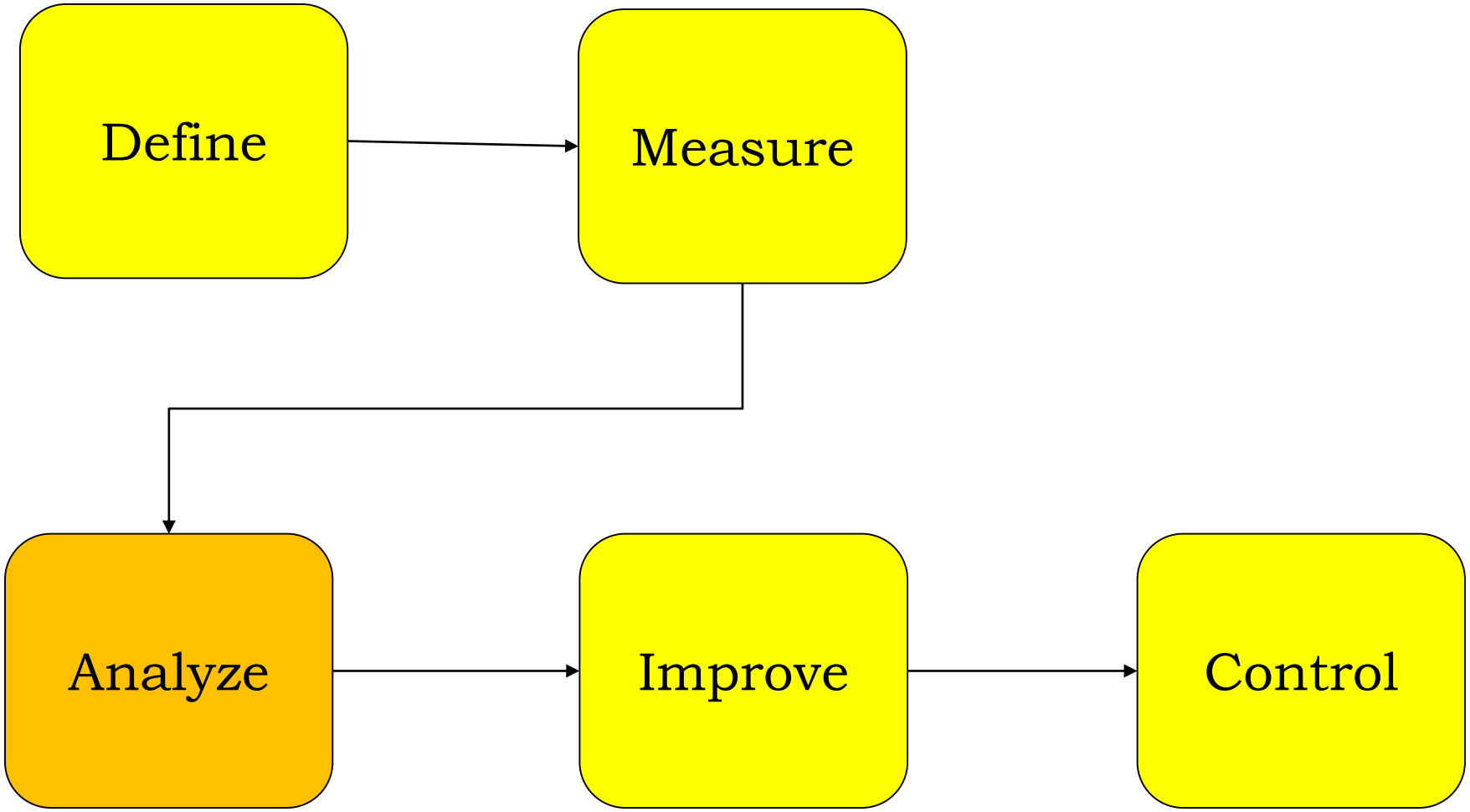
Can you think of a time you made a decision based on bad data?

What was the outcome?

How could the outcome have been improved if the data used to make the decision was “better”?



Process Control Problem Solving Phases



Problem Solving Phases – Analyze

In the ANALYZE phase the focus is on identifying all potential *Key Input Variables (KIV)*.

What is an *Input Variable*?

Any *input* to an operation that could *vary*.

A *key* input variable has direct or indirect effect on the Key Output.

There are many input variables but only a few have an effect on the Output.

Do KIVs meet our selection criteria?

How do we determine all Input Variables?

With the use of:

1. A detailed ***Process Flow Diagram*** for the area of interest

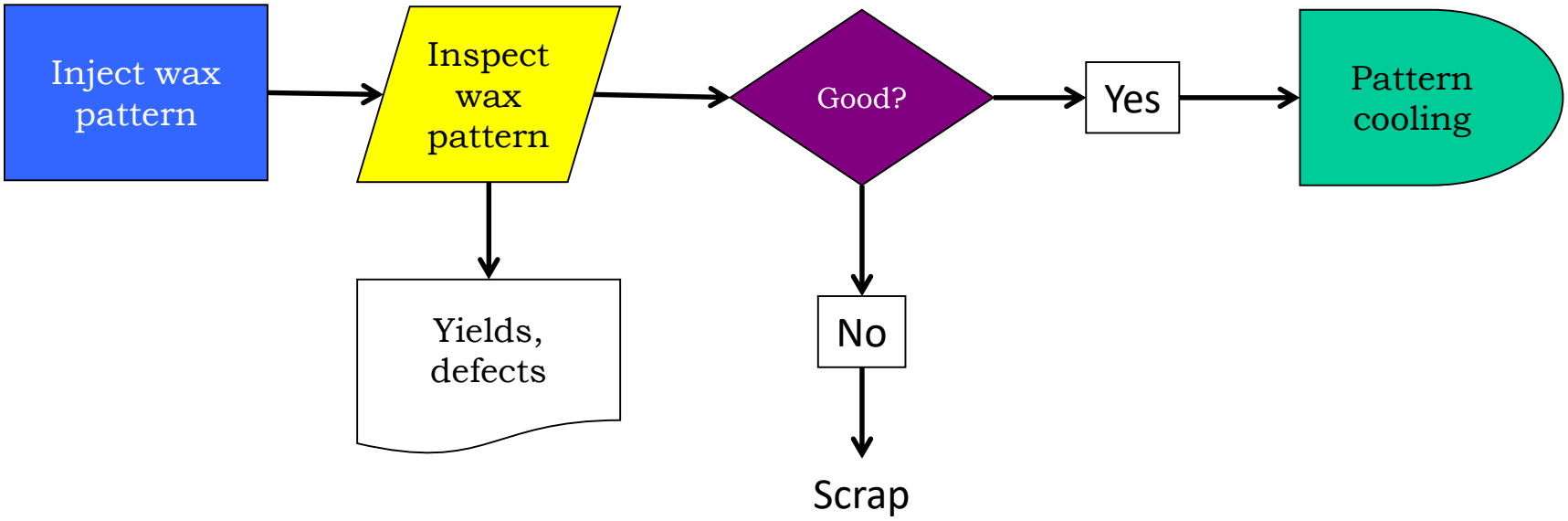
2. A list of ***hypotheses*** for the cause of the issue

3. Using a structure brainstorming session, fill the funnel with potential High Level Causes

4. Narrow down the list of Variables using a ***Cause and Effect*** matrix

Process Flow Diagram Example

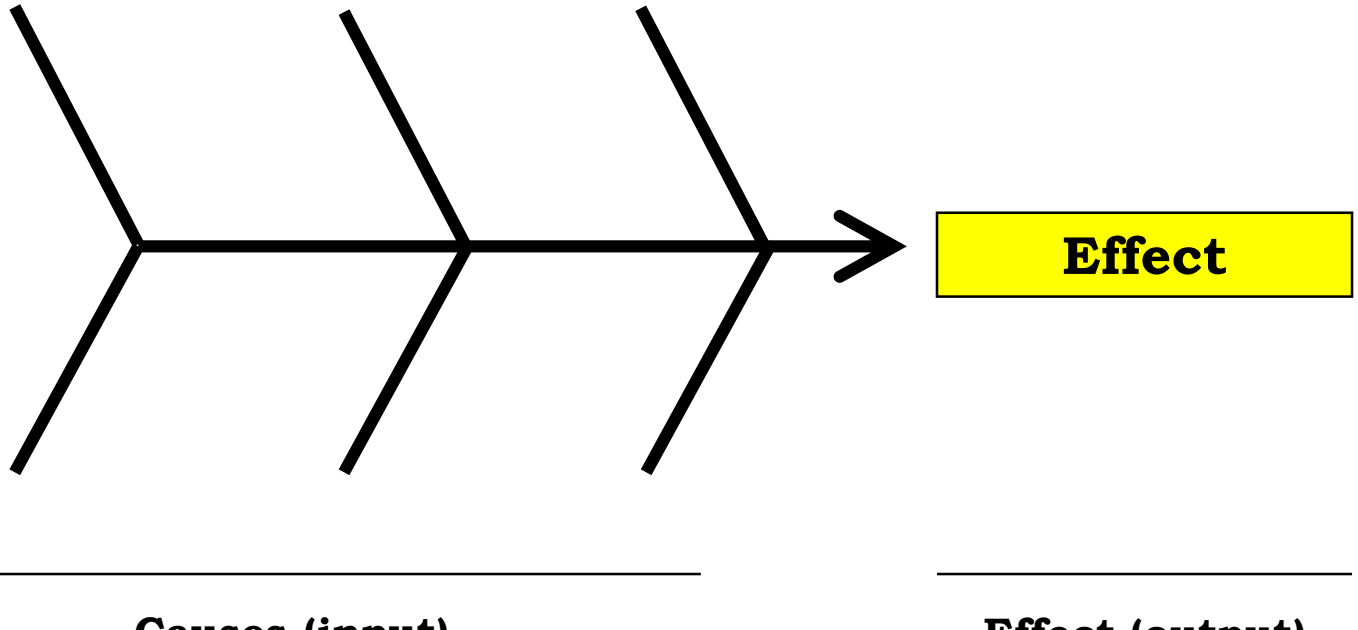
A ***Process Flow Diagram*** is a visual representation of the steps in a process. It uses standardized shapes that represent different types of operations.



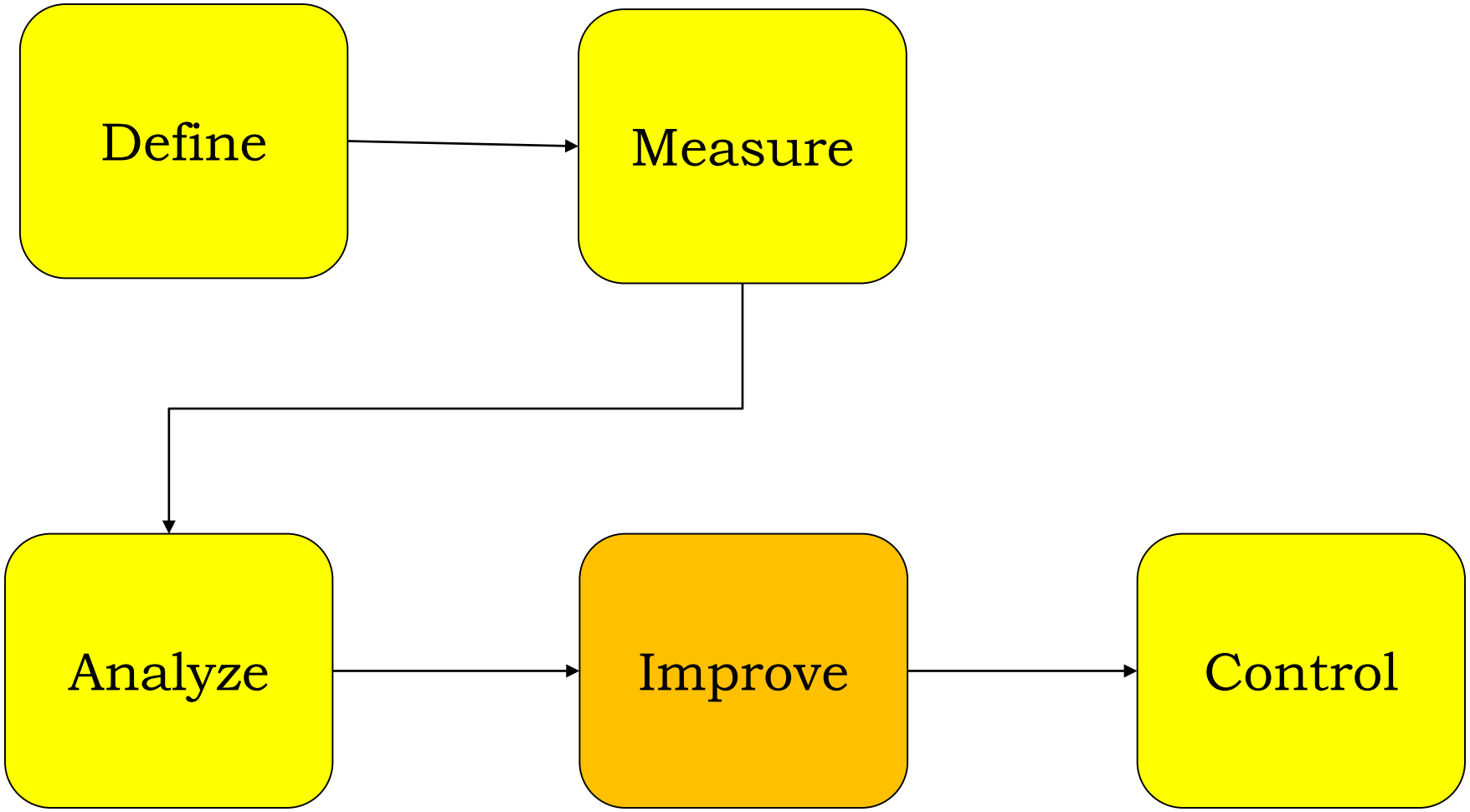
Cause and Effect Diagram Example

A Cause and Effect diagram, also known as a fishbone or Ishikawa diagram, is used to reveal the reasons behind a problem.

This diagram is used in brainstorming sessions to help identify all of the likely **causes** of the problem (**effect**).



Process Control Problem Solving Phases



Problem Solving Phases – Improve

Now that we have a list of *Key Input Variables*, we need to determine which impact our *Key Output Variables*.

This is done by:

- Conducting **screening tests** to determine the relationship of the most promising input variables to the Key Output
  - Single or Multi-Factor testing

- Conduct **optimization testing** to discover the ideal settings for each Key Input
  - High and Low testing conditions

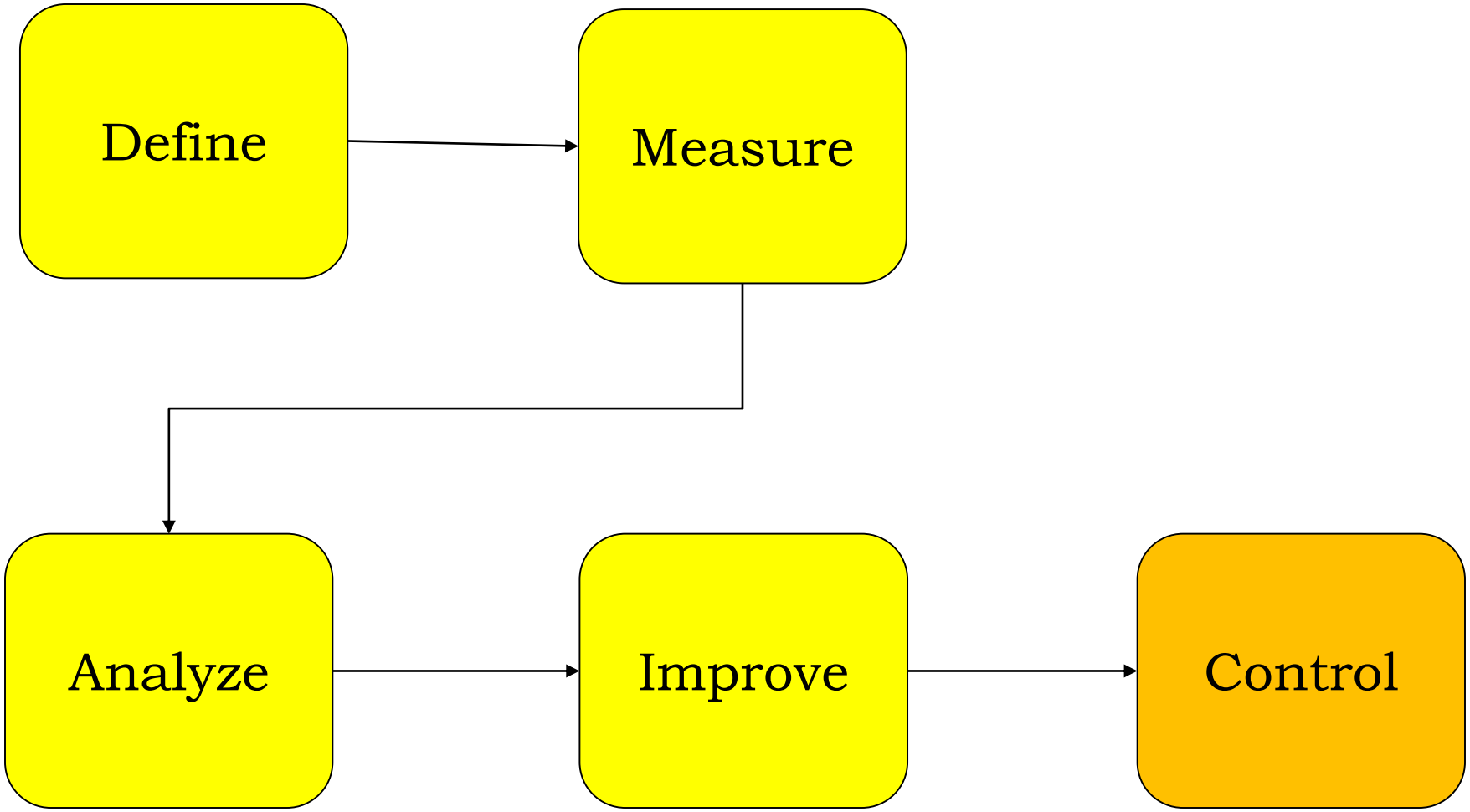
Is the Process Capable of Meeting Project Goals?

You've Solved the Problem!

So now you're done, right?!?

WRONG!!!!

Process Control Problem Solving Phases



Problem Solving Phases – Control

In the CONTROL phase we establish methods to *sustain the gains*.

An effective control system focuses on two aspects:

1. ***Prevent*** the problem from occurring.
2. ***Detect*** when a problem has occurred.

Types of CONTROL methods include:

1. Process Documentation
2. Monitoring
3. Reaction Plans
4. Training

1. Process Documentation

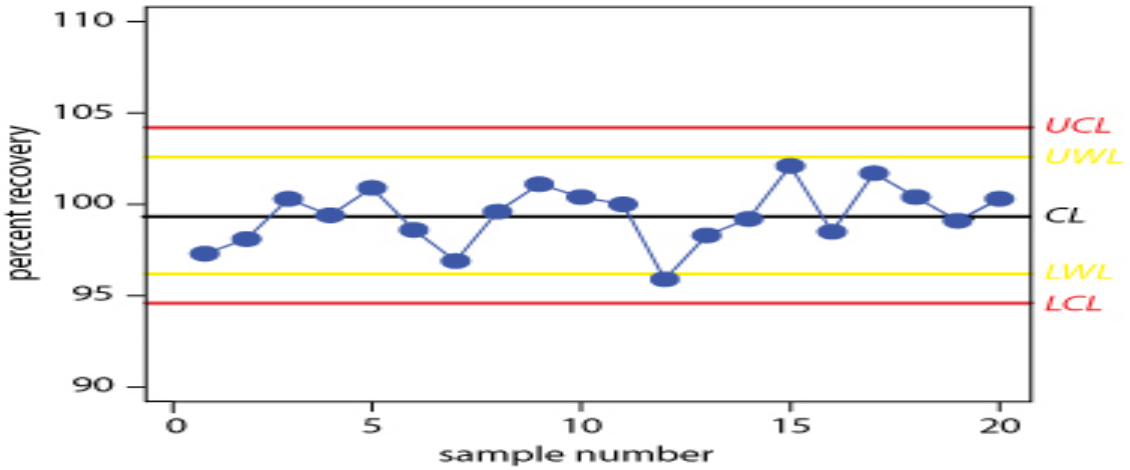
What documents are used to establish process consistency?

- Generic Instructions
- Part Specific Instructions
- Calibration and Maintenance
- Standard Work
- Checklists

2. Monitoring

Monitoring systems will ***detect*** when the Key Input Variables are out of control

- Alarming
- Audits
- Control Charts, Run Charts



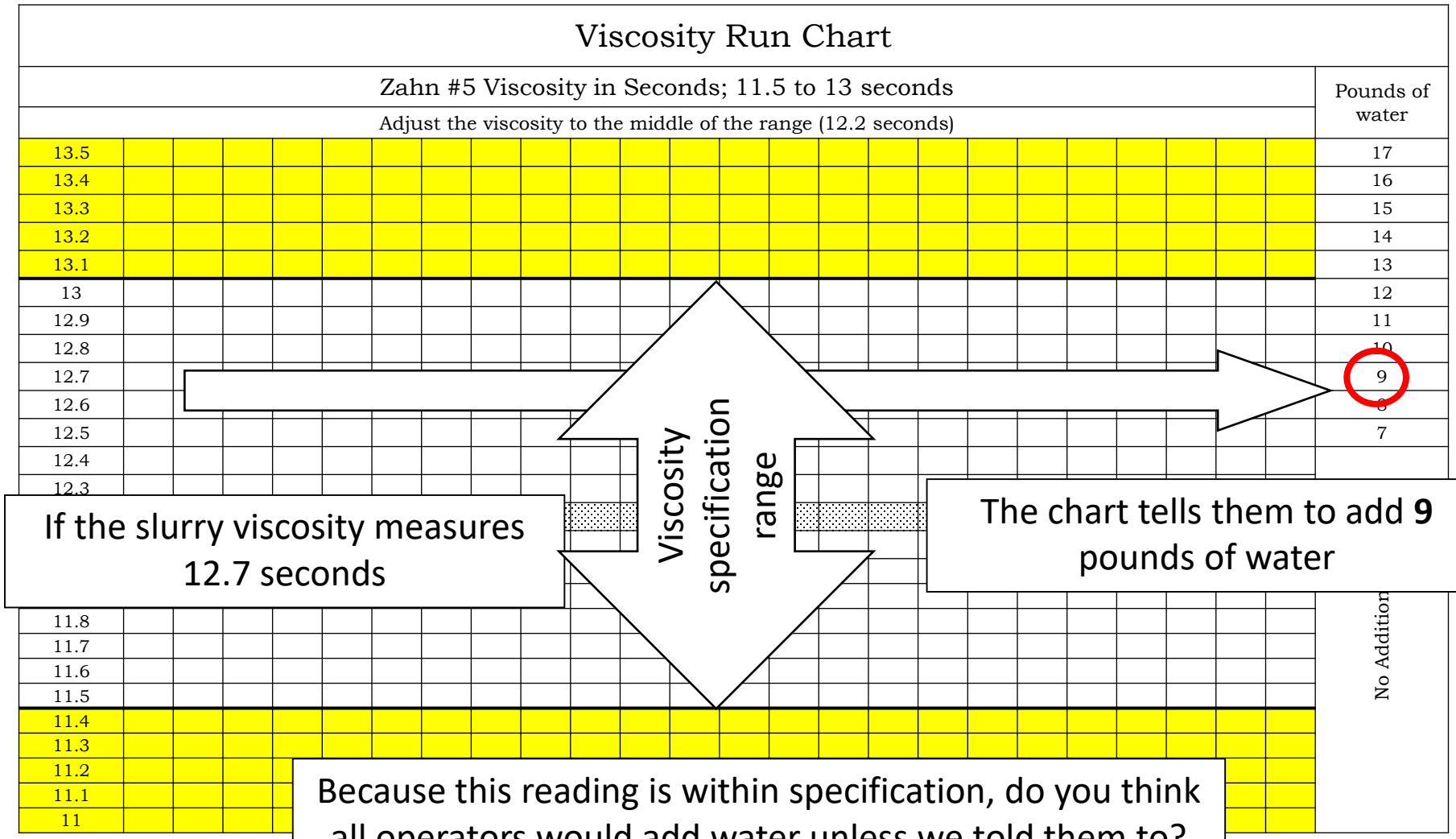
3. Reaction Plans

A reaction plan is a ***predefined*** procedure for reacting to a outcome. It can be simple or complicated. Examples include:

1. Adjusting slurry viscosity
2. Troubleshooting bubbles in wax patterns
3. Quarantining parts

Reaction plans can be very effective when included in a control chart or a decision diagram!

3. Reaction Plan Example



4. Training

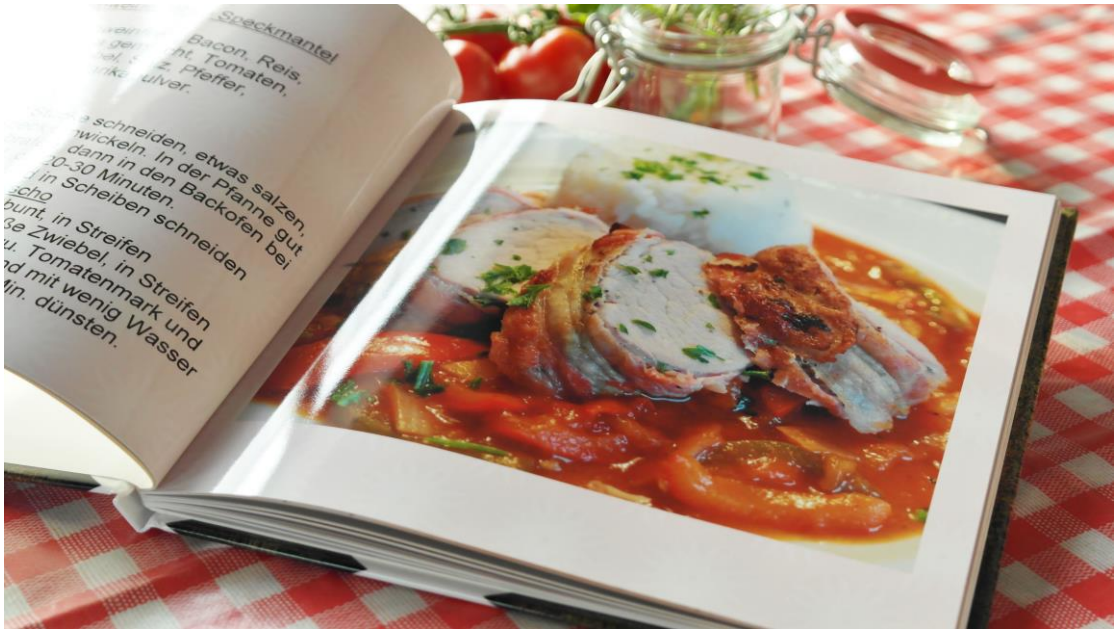
An effective training system **must**

1. Quickly and effectively train associates in new tasks or skills
2. Prevent quality and safety issues
3. Provide a path for associate development
4. Provide training status for each associate

4. Training

The *best* training methods include the use of:

- Job Instructions
- Operator Evaluation Forms
- Qualification Matrices



4. Training – Qualification Matrix

Training order

Employees

Name	Robot Helper		Vacuum Dip Operator		Handline Operator		Robot Operator	
Bill	1	2	1	2	1	2	1	2
	4	3	4	3	4	3	4	3
Fred	1	2	1	2	1	2	1	2
	4	3	4	3	4	3	4	3
Jack	1	2	1	2	1	2	1	2
	4	3	4	3	4	3	4	3
Joe	1	2	1	2	1	2	1	2
	4	3	4	3	4	3	4	3

Summary

The use of process controls help with…

- Reducing scrap & rework
- Improving production predictability
- Developing skills and knowledge of everyone
- Serving our customer
- Making more money!

ICI Process Control Course

Goal:

To teach students to apply process control tools in an investment casting foundry in order to solve a problem and prevent it from reoccurring

- Learn how to reduce variability in your foundry
- Hands-on experience applying process control tools
- Identify process areas which cause variation

"Many times the main difference between *mediocre* and world class manufacturing is effective and meaningful Process Control"