Introduction

All manufacturing processes display some level of _______ or inherent capability

A manufacturing processes output can be used to understand and maintain:

• Process Capability (PC)
• Quality Control (QC)

Statistical and analytical tools are used for both Process Capability and Quality Control studies

Proactive vs Reactive quality control

Proactive vs Reactive Quality Control

[Diagram showing proactive and reactive quality control processes]
Process Capability & Quality Control

Process Capability (PC)

The ability to hit what you are aiming at within tolerance limits
Manufacturing process capability is determined by measuring the output of the process
Process Capability (PC) focuses on the __________________________

Quality Control (QC)

Quality Control (QC) is based on examining the product to determine if the processing meets design specifications
The objective is to root out and eliminate problems that cause defective products during production
Quality Control (QC) focuses on the __________________________ of the process

Determining Process Capability

The objective of a Process Capability Study is to determine the inherent nature or tendency of the process compared to the desired specifications
Two factors establish the ______ or __________ of a process:

Aim of the process (Accuracy)

Variability of the process (Precision)

- Assignable Causes - Can be eliminated
- Non-Assignable Causes - Can’t be eliminated (Inherent to process)

<table>
<thead>
<tr>
<th>Assignable Causes</th>
<th>Non-Assignable Causes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple Machines</td>
<td>Material Variation</td>
</tr>
<tr>
<td>Operator Blunders</td>
<td>Operator Variability</td>
</tr>
<tr>
<td>Defective Material</td>
<td>Vibration / Chatter</td>
</tr>
<tr>
<td>Tool Wear</td>
<td>Machine Wear</td>
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</tbody>
</table>

Process Capability Studies

Important to analyze output of process under “normal” conditions
Six steps in determining Process Capability (PC)

- Design the Experiment
- Define the Inspection Method
- Determine the Sample Size
- Control the Input Material
- Design the Data Sheets
- Run Process & Collect Data

Terminology & Output from a Process Capability (PC) Study

- Population - Total number of parts produced under the conditions specified
- Sample - A specified limited size taken from the population
- Histogram or Frequency Distribution - Plot of the data
- Run Chart - Plot of a quality characteristic as a function of time
- Process Mean (X bar prime) - True mean of the distribution
- Standard Deviation (sigma prime) - Measure of process spread or variability
- Process Capability - Defined by ± 3 Standard Deviations
- Natural Capability Limits - Defined as Process Mean ± 3 Standard Deviations
Elements of a Process Capability Study

Figure 12-2  Page 248

Frequency Distribution or Histogram

Figure 12-3  Page 249

Run Chart or Diagram

Figure 12-5  Page 251

Plot of a quality characteristic as a function of time
Process Capability Study Results

Process Capability (PC) Studies answer 2 questions

1. Does the process have the ability to meet specifications?
   • Determined by calculating a process capability index ($C_p$)
   • $C_p = \frac{\text{Tolerance Spread}}{\text{Process Capability}}$
   • A $C_p$ value $\geq 1.33$ is considered good

2. Is the process centered with respect to the nominal?
   • A mismatch or bias value ($D$) is determined
   • $D = \frac{\text{Calculated Process Mean} - \text{Specified Nominal}}{1/2 \text{Tolerance Spread}}$

Taguchi Methods

Type of PC analysis used to determine which input parameters have the greatest effect on process

- More sophisticated analysis
- Develops a test array to determine sensitivity of inputs to variability
- How the analysis is designed
  - High influence parameters are set to minimal levels to reduce variability
  - Low influence parameters are then used to adjust the process aim
- Objective is to dampen the effect of the causes of variability in order to reduce the total process variability
Inspection & Quality Control (QC)

Quality Control (QC) is based on examining the product to determine if the processing meets design specifications.

Important to know & maintain the quality of individual parts in virtually all manufacturing.

Inspection is the function that controls quality.

Level of Inspection

- No Inspection (Inspect nothing assume everything is good)
- 100 % Inspection (Inspect every part)
- Sampling (Inspect some of the parts)
  - Statistical Process Control (SPC)

Statistical Process Control (SPC)

Utilizes statistical methods to make decisions about the whole population based on the quality of the sample.

Basic SPC techniques:

- (Frequency Plots) - Used to classify the range and distribution of measurements with respect to design specifications
- Charts - Used to measure variables and monitor the output of a process by sampling
  - X-Bar (Mean) Chart - Tracks the aim (accuracy) of the process
  - R (Range) Chart - Tracks the variability (precision) of the process
  - Sigma Charts - Used with large sample sizes

Histogram Example

[Histogram showing frequency distribution with frequency counts and class intervals for diameter measurements.]

Figure 12-4  Page 250
Sampling Errors

2 Types of decision errors are possible with sampling

- Type I Error - Process is right / Sampling indicates something is wrong
- Type II Error - Process is wrong / Sampling indicates process is right

For a given sample size, reducing the chance of one type of error increases the chance of the other

Increasing Sample Size > Reduces Chance of Error > Increases Cost of Inspection

Variations from the standard are due to __________ or ______________ (Chance) causes

Statistical Process Control (SPC) helps detect assignable cause variations so corrective action can be taken.
Correcting Quality Problems

• Read Section 12.4 Pages 264 - 270
• Everyone in the company has to be responsible for quality
• Process Capability (PC) & Quality Control (QC) are tools that allow informed decisions about the quality levels of products produced
• Inspect to prevent defects rather than inspecting to find defects
• Find a defect > Determine the cause > Take corrective action

Chapter 12 - Process Capability and Quality Control

• Difference between Process Capability (PC) and Quality Control (QC) and the fundamental aspects of each
• Awareness of the “nature” of a process and the influence of variability (precision) and aim (accuracy)
• Basic concept, objectives, and results of a process capability study
• Understand the key elements of a histogram or frequency distribution
• Relationship of inspection to quality control and the tools used to collect and manage quality data
• General concept of quality control charts
• Purpose of fishbone diagram
• Fundamental concept of Total Quality Control (TQC)

Review Questions: ___________________________