Where R You in Your Quality Journey?

An Introduction to Process Improvement and the R Computing Environment

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Process Improvement Models

- Why use a process improvement model?
- Introduce 2 popular process improvement models
- Case Study
- Using R as part of process improvement

Why Use a Process Improvement Model?

- The process improvement model defines a strategy to:
  - Identify opportunities for improvement
  - Facilitates engagement & “buy-in”
  - Models simplify complex problems into manageable pieces
- Plan Do Study Act: PDSA
- Define Measure Analyze Improve Control: DMAIC
- Parallels between these 2 popular models

PDSA compared to DMAIC

PDSA	DMAIC
Plan - Do	Define - Measure
Study	Analyze
Act	Improve - Control

PDSA:

- it's continuous, it's built into process control (SPC, SQC)
- it can also be used as a project framework

DMAIC:

- defines the stages of the targeted process improvement project
- improvement tools & methods are often associated with each stage
- the tools & methods can (and are) used in process control

Define: Pipe Fittings & RK Mechanical

- Problem Statement: Many pipe “spools” did not fit the pre-defined dimensions.

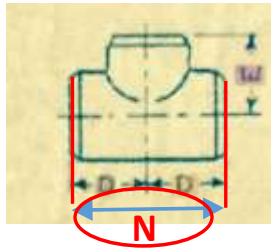
Define: Hypothesis & Course of Action

- Hypothesis: Assuming pipe is cut to the correct length, could the variation in the purchased parts (flanges, tees, elbows, etc.) be the cause?
- Course of Action: Measure critical-to-quality dimensions on random parts over an extended period of time and evaluate.

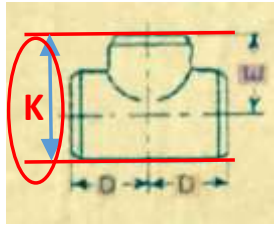
Measure: Pipe Fitting Data

1. Define the dimensions to be measured
   Example:

    1. Determine the dimensions to be measured on each type of part:
        a. Full Size Tee's
            i. 2 X "D" or face to face ("N" = 2*"D")



Face to Back ("K")

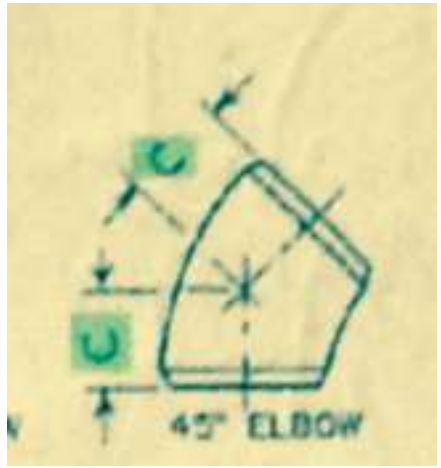


Measure: Pipe Fitting Data

2. Determine other data to be collected at the same time:
    a. Date
    b. Time
    c. Manufacturing Country
    d. Part Size
    e. Part Type
    f. Fitter – MSA??

Analyze: What are the Specifications?

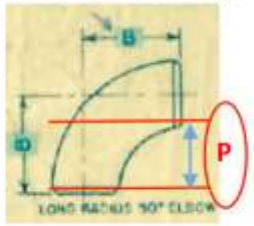
- Pulled together from several sources
  - *The Pipe Fitters Blue Book*, W. V. Graves
  - *Pipe Fitters Handbook*, ANVIL® International
  - www.weldbend.com
  - www.engineeringtoolbox.com/ansi-steel-pipes-d_306.html
- Used calculations to derive some specifications



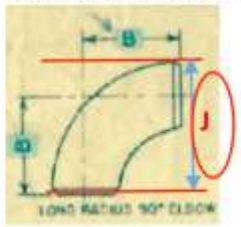
Analyze: Exploring the Dataset

- RStudio
- PipeFittingsCapStudy.R
- Pipe Fittings Capability Study.docx

a. 90° long radius elbows
   i. Face to Lower Height ("P"



   ii. Face to Height ("J")



Analyze: Variation

- Variation is…
  - Measured by variance: σ^2
  - Variance is additive

- What are we seeing when we analyze the data?

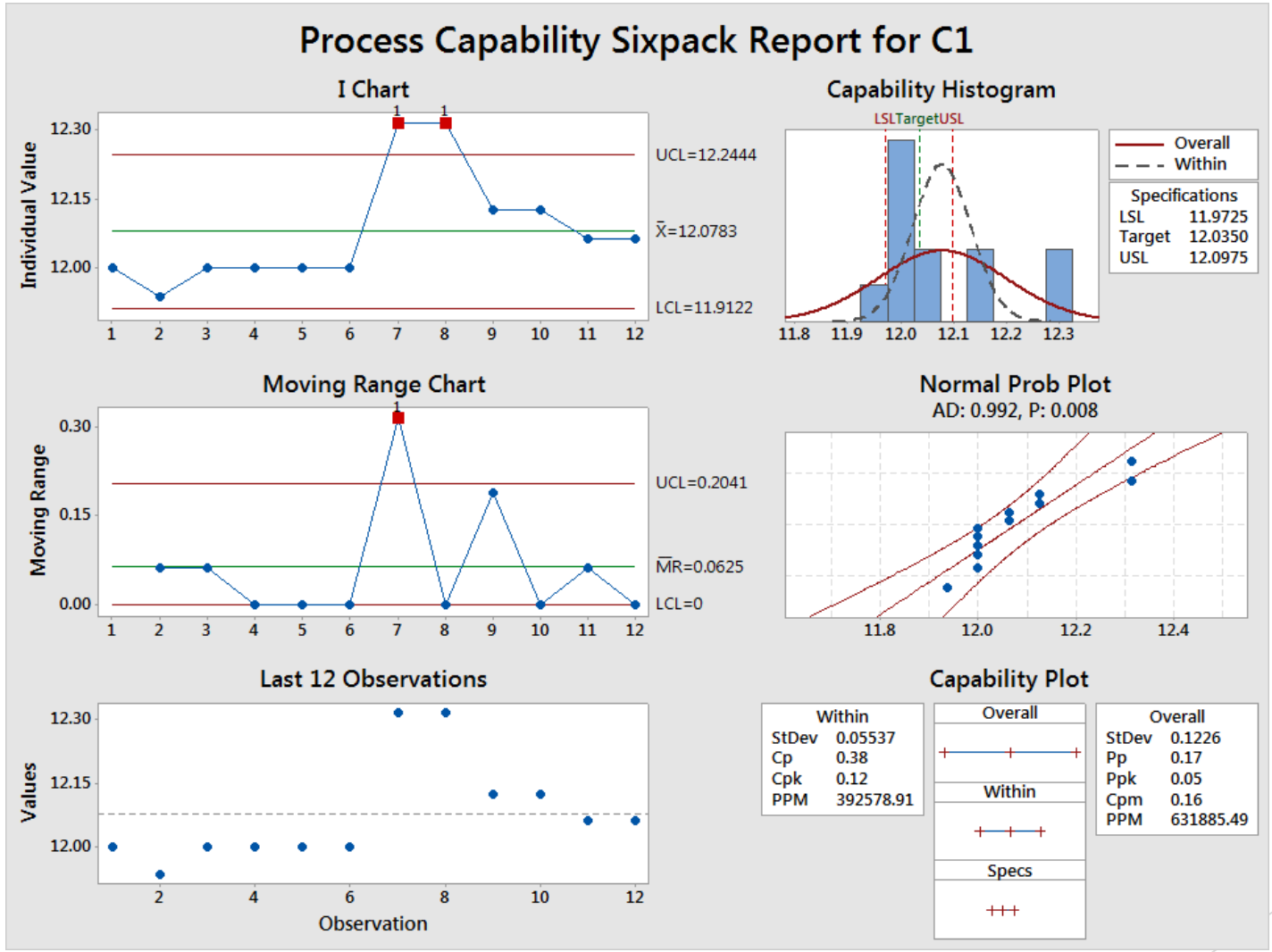
  - What we see: $\sigma^2_T = \sigma^2_{Gage} + \sigma^2_{Parts} + \sigma^2_{Unknown}$

  - Measurement error: $\sigma^2_{Gage} = \sigma^2_{Repeatablity} + \sigma^2_{Reproducibility}$ → "Gage R&R"

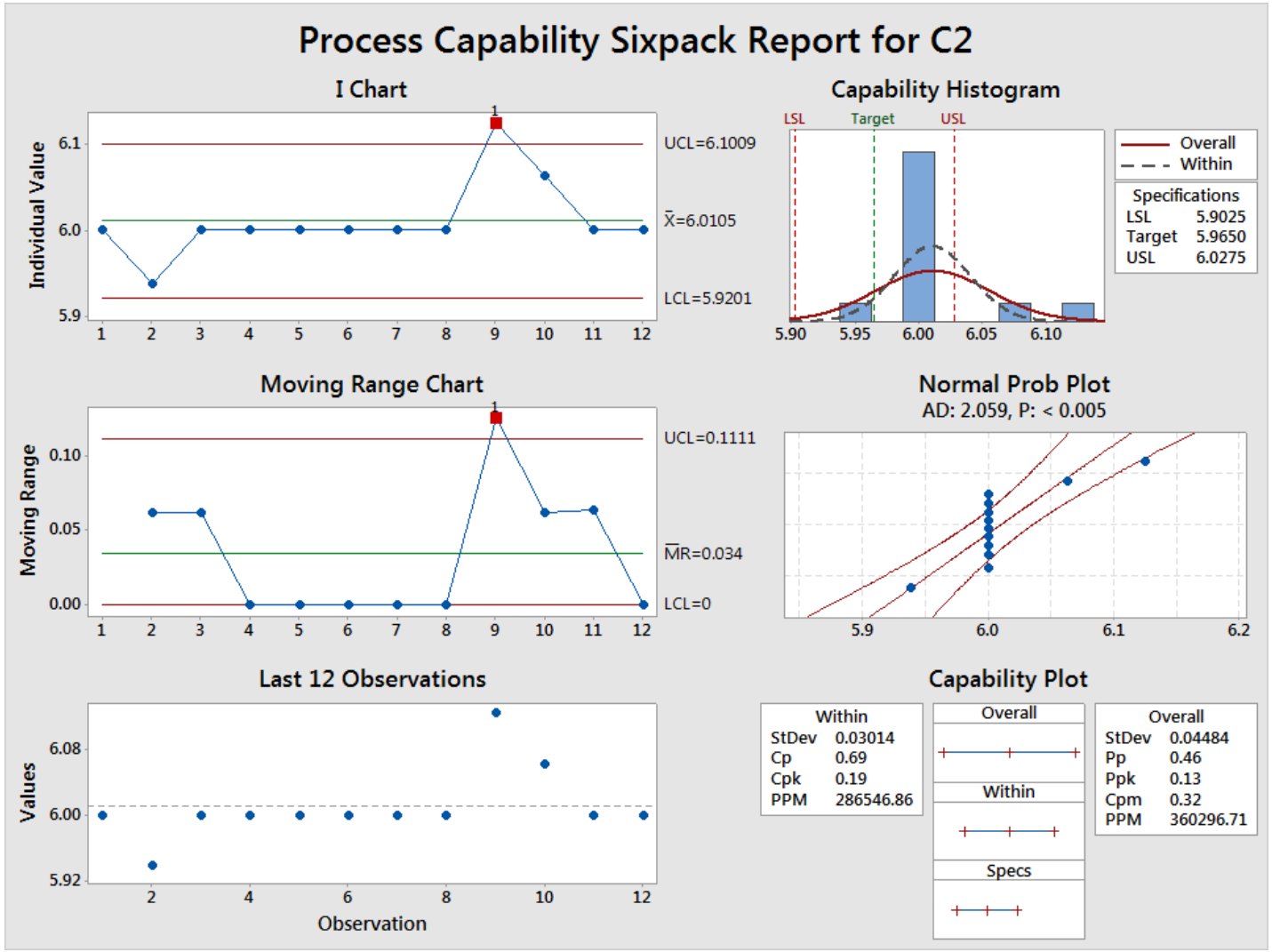
Analyze: Pipe Fitting Dimensional Capability

- MINITAB – PROCESS CAPABILITY
- WHY MINITAB?

Process Capability: Dimension J



Process Capability: Dimension P



Improve: Pipe Fittings

- First- Measurement Analysis
  - Observed that Fitters measured the same parts in different ways
  - Chunky data- need better measurement discrimination
  - Really out of control?
  - Improve the measurement system

- Second- Involve the suppliers
  - What are their specifications?
  - Where did they get them?
  - Involve suppliers in Round #2?
  - Can we identify the supplier on the part?

R Pros & Cons

- R Statistical Computing Environment
  - +Flexible
  - +Statistical Analysis is iterative & interactive
  - +The latest statistical procedures are supported
  - -Statistical procedure needs to be defined if not already in CRAN
- Statistical Analysis Software Packages (Minitab, SPSS, JMP, etc)
  - +Statistical analyses are already defined
  - +Copious output
  - -Less user engagement and understanding of the analysis
  - -Less engagement leads to “number crunching”

Background about R

- Developed at Bell Labs
- R provides a wide variety of **statistical** (linear and nonlinear modelling, classical statistical tests, time-series analysis, classification, clustering, …) and **graphical techniques**, and is highly extensible. The S language is often the vehicle of choice for research in statistical methodology, and **R provides an Open Source route** to participation in that activity.
- an effective data handling and storage facility,
- a suite of operators for calculations on arrays, in particular matrices,
- a large, coherent, integrated collection of intermediate tools for data analysis,
- graphical facilities for data analysis and display either on-screen or on hardcopy, and
- a well-developed, simple and effective programming language which includes conditionals, loops, user-defined recursive functions and input and output facilities.

- Source: https://www.r-project.org/about.html