MINITAB Applications in Six Sigma

Agenda

13:00-13:30 Registration

13:30-14:20 MSA-MINITAB

14:20-14:30 Break

14:30-15:20 SPC-MINITAB

15:20-15:30 Break

15:30-16:20 Case study (Healthcare & Banking)

16:20-16:30 Q&A

July 14, 2006 in Taipei

MSA-MINITAB

Application in
(Measurement Systems Analysis, MSA)

Measuring System.

What is a Measuring System?

- The measuring device (Repeatability)
- The person who is taking the measurement (Reproducibility)

Measurement Process

- The ideal measurement system produce *"true"* measurements every time
- Quality of the measurement system is characterized by *statistical properties*
- Properties
  - Must be in *Statistical Control*
  - *Variability must be small* compared to product *specifications*
  - *Variability must be small* compared *process variation*

Basic Model

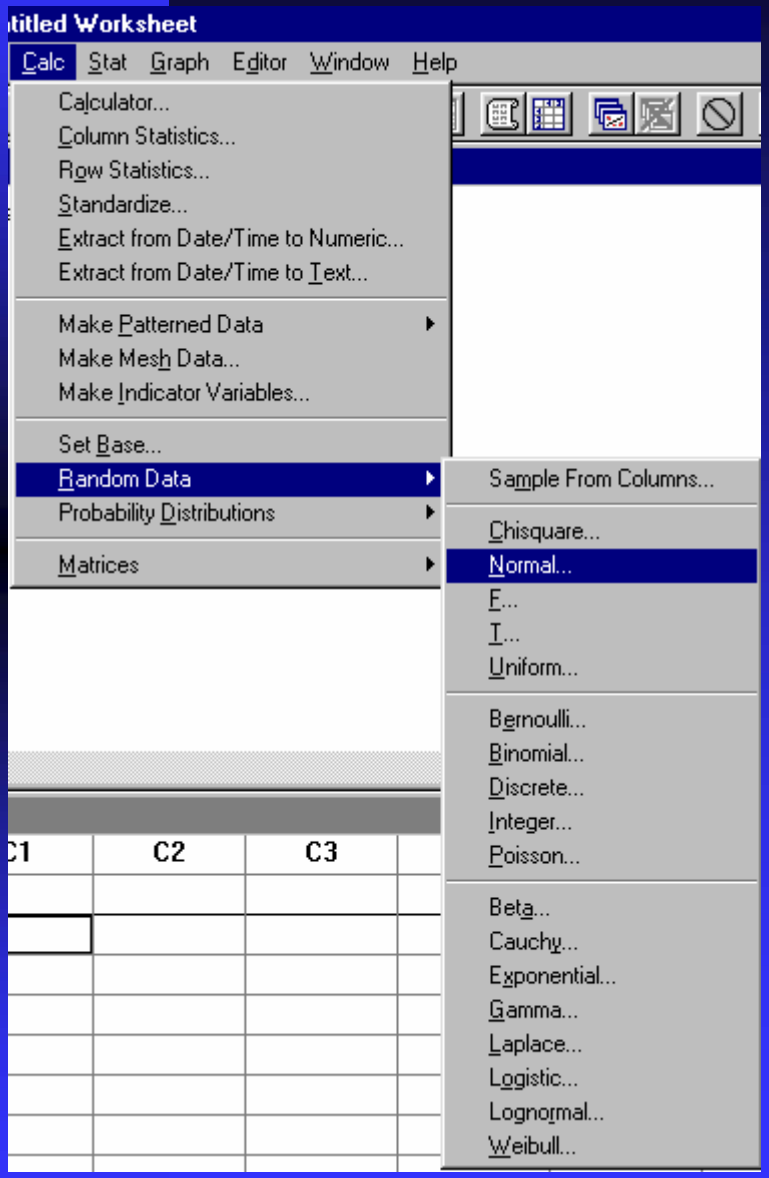
$$\sigma^2_{\text{Total}} = \sigma^2_{\text{Product}} + \sigma^2_{\text{Measurement System}}$$

The Total Variation is equal to the real product variation plus the variation due to the measurement system

Minitab Exercise
Capability and Measurement Error

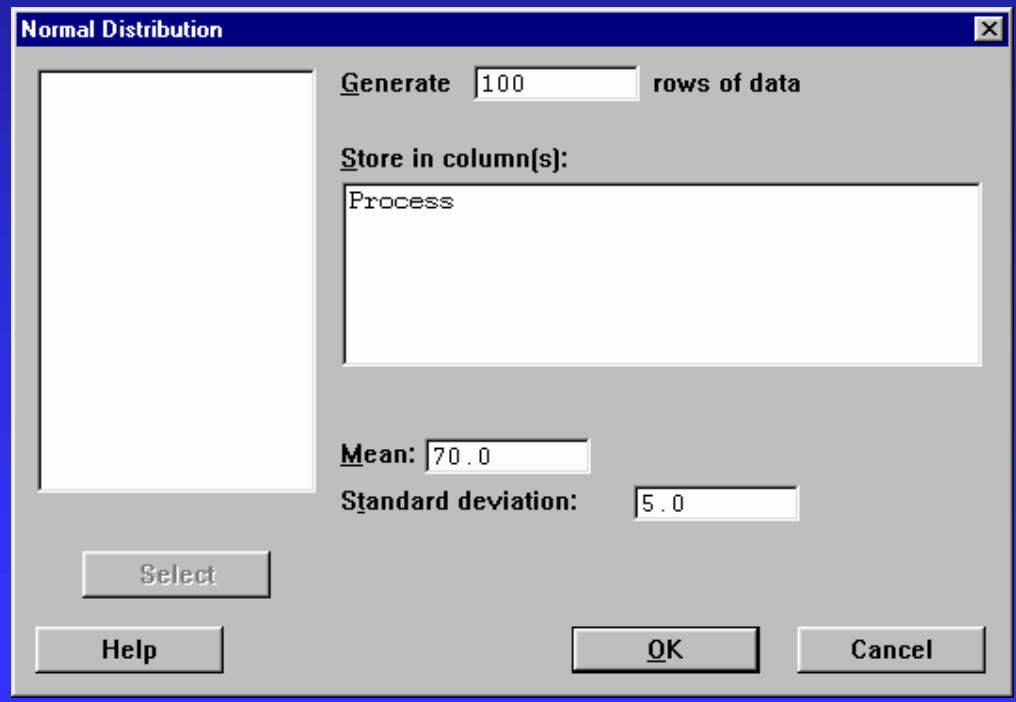
- Assume we have a process that has an actual *sigma of 5 units* and a *mean of 70 units*
- Also assume we have a measurement system that has the same measurement error as the process - *sigma of 5 units*
- Let's use Minitab to simulate the effect of measurement error on process capability

Exercise - Continued

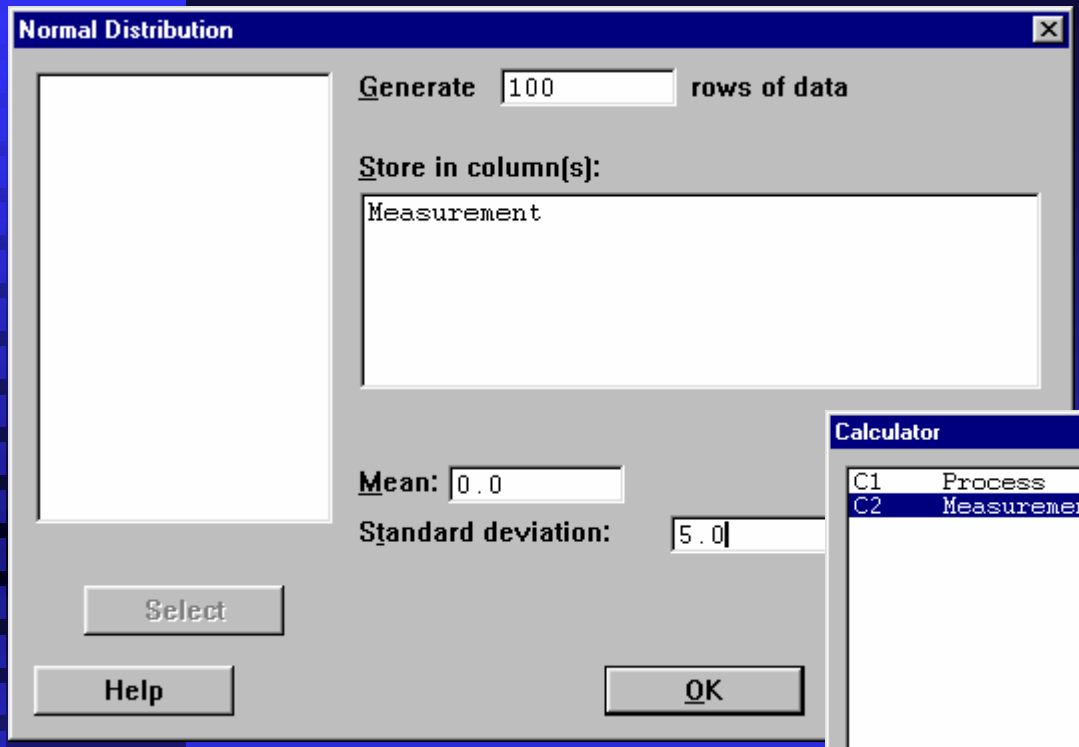


- Follow these methods to create data to fit our process model:

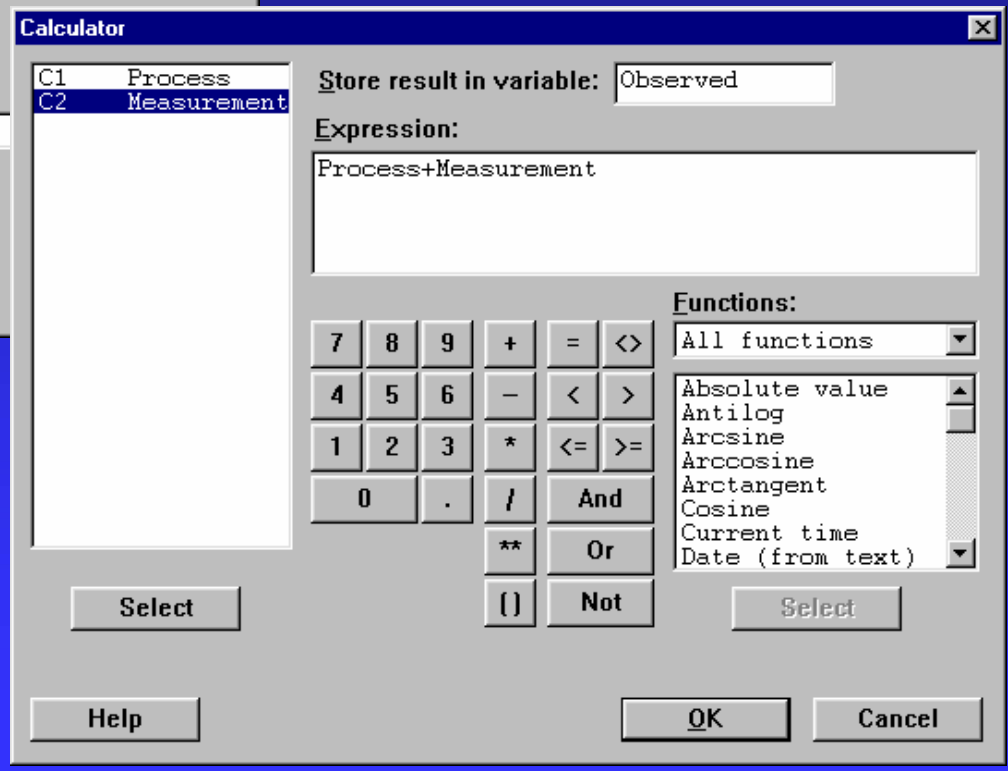
Creates a random normal distribution



Exercise - Continued



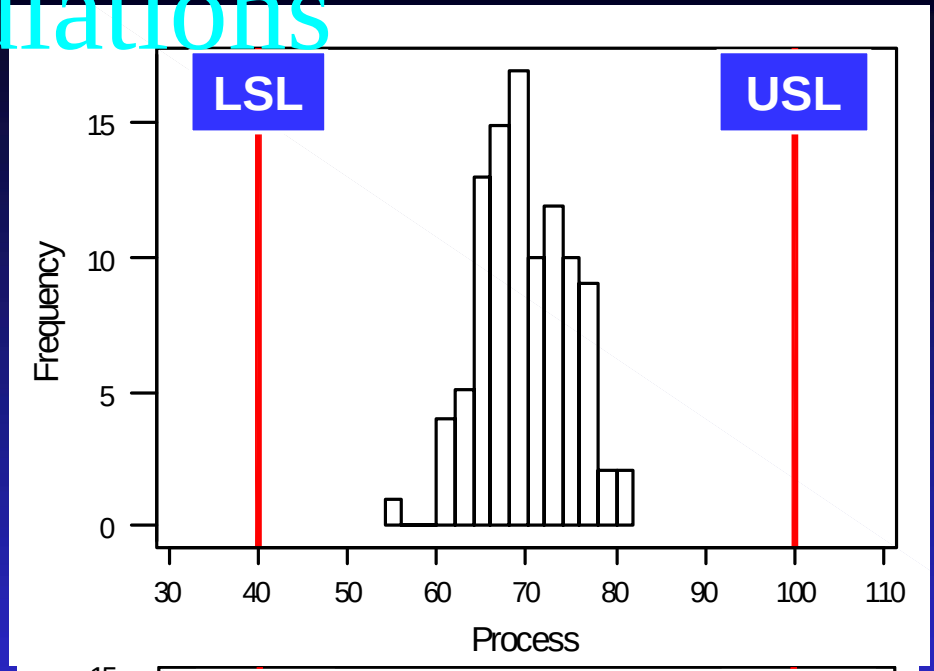
What value should we use for the mean of the measurement error?



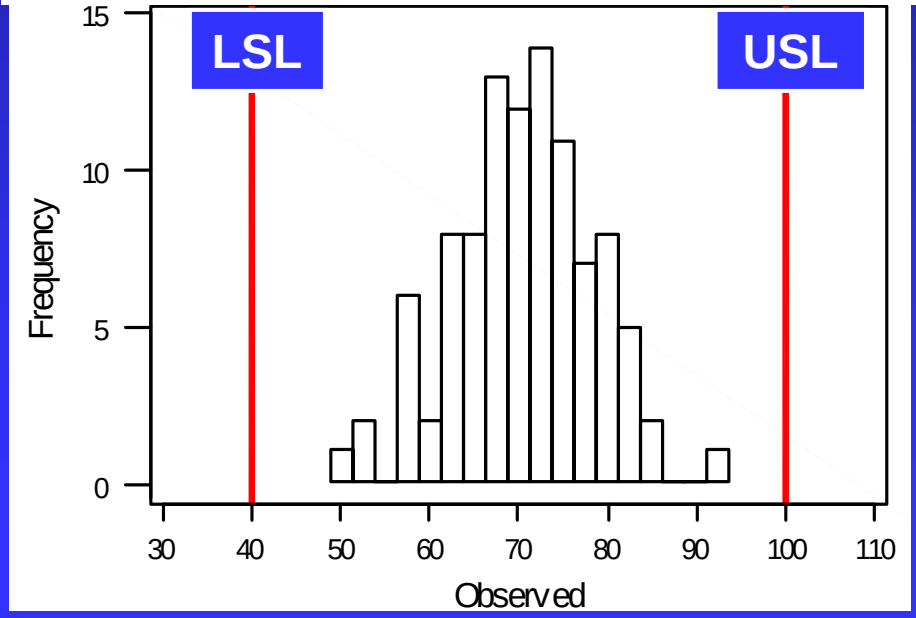
Calculate observed process behavior.

Results of Simulations

Actual process variation - *No* measurement error



Observed process variation - *With* measurement error



Effects of Measurement Error

Averages

Accuracy

$$\mu_{total} = \mu_{product} + \mu_{measurement}$$

Measurement System Variability - Determined through "R&R Study"

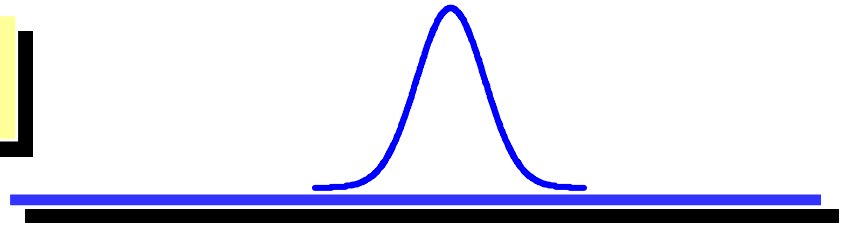
Variability

Precision

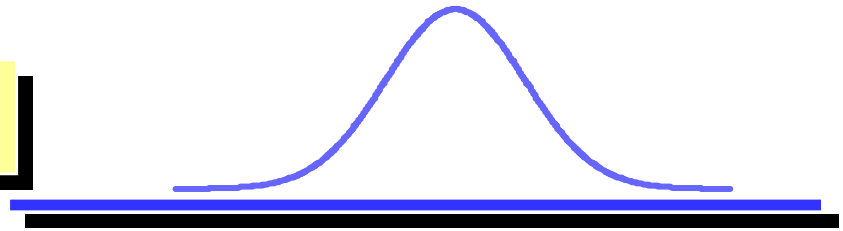
$$\sigma^2_{total} = \sigma^2_{product} + \sigma^2_{measurement}$$

Sources of Variation

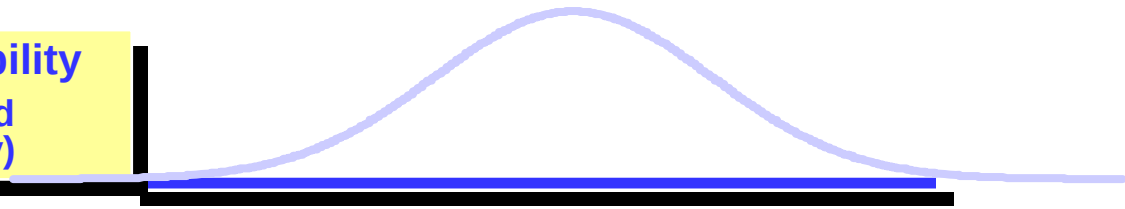
Product Variability
(Actual variability)



Measurement Variability



Total Variability
(Observed variability)



Two General Kinds of Data

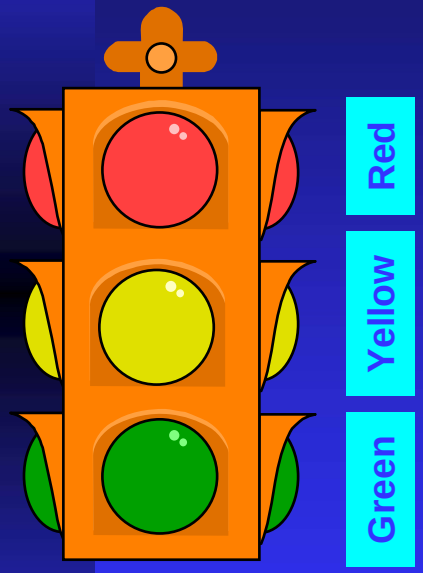
ATTRIBUTE - Discrete, Counted Data

Ex: 1, 2, 3, 4 etc…
Good/Bad, Go/NoGo, Pass/Fail
Machine 1 , 2 , 3 ...

VARIABLES - Continuous, Measured Data

Ex: Weight = 10.2 Lbs
Thickness = 11.211 inches

GR&R Metrics



Red

Yellow

Green

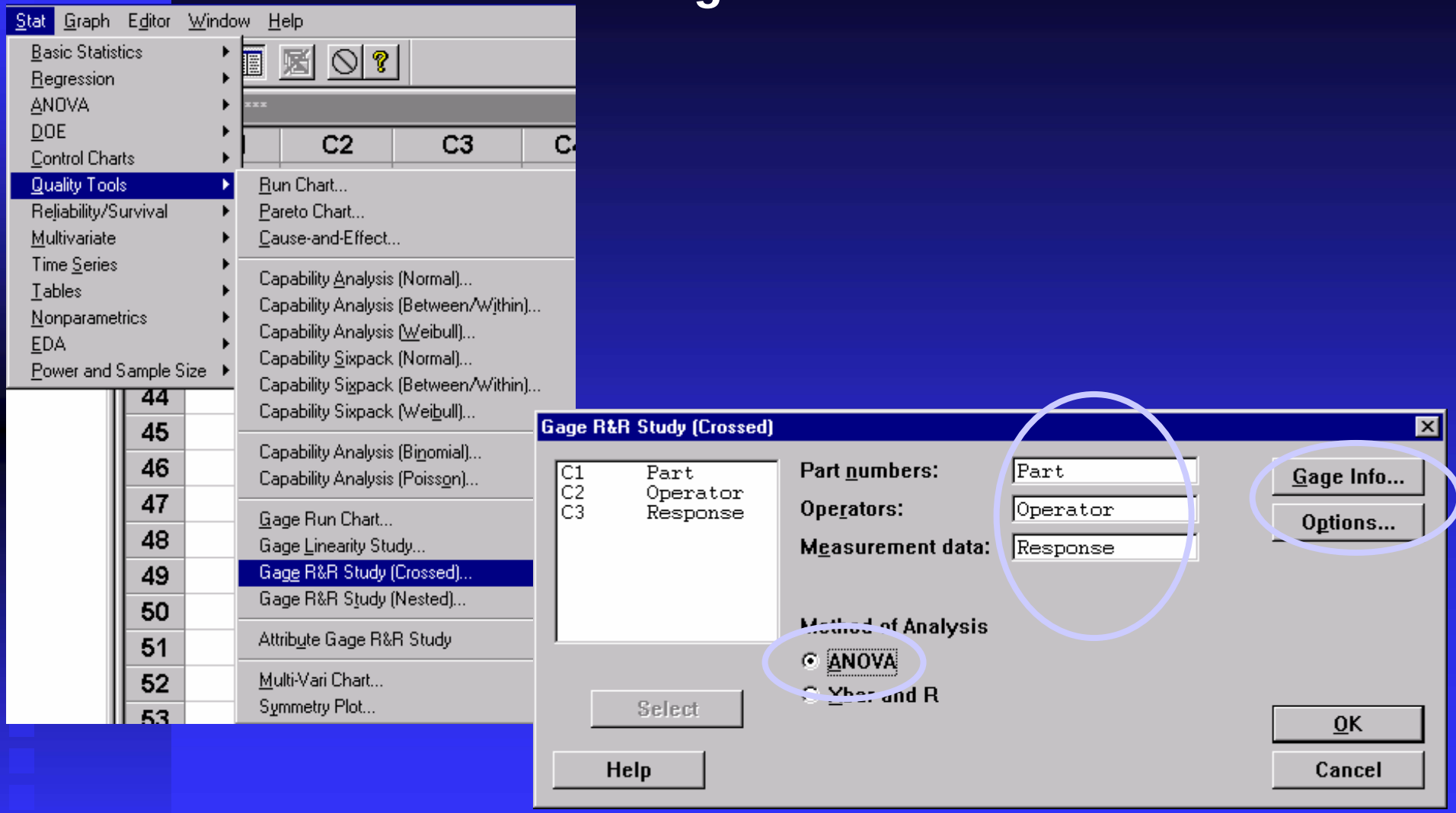
P/T Ratio	%R&R
30%	30%
10%	15%

Main Question - Is my measurement system okay to use on my project?

MSA Exercise

Part	Operator	Response
1	1	0.65
1	1	0.60
2	1	1.00
2	1	1.00
3	1	0.85
3	1	0.80
…	…	…

Minitab - Gage R&R Studies



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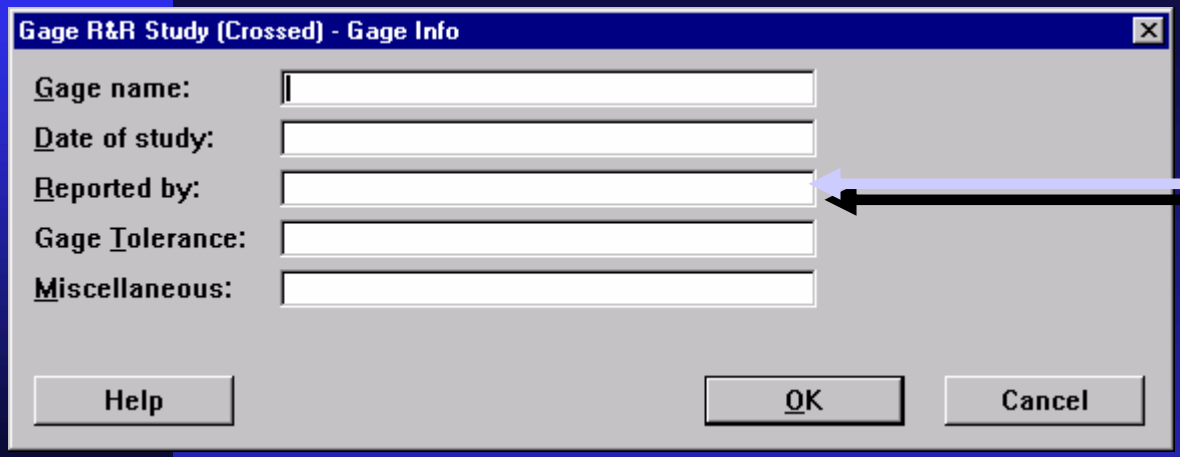


General Info

On Your Study

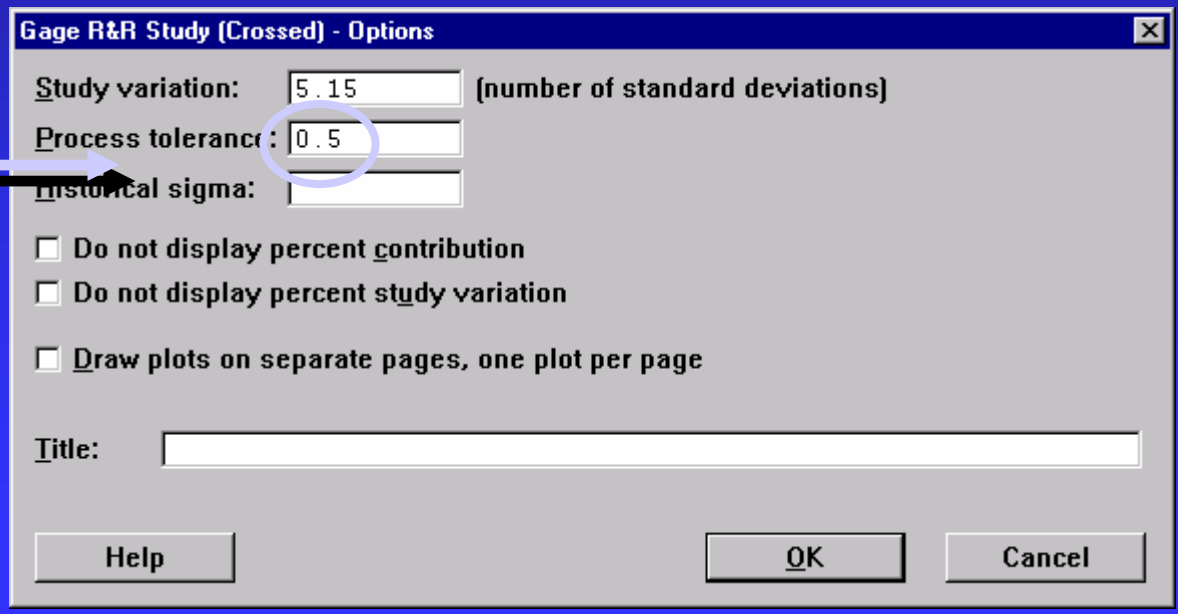
GAGE Options

If There Is A

Tolerance For

This Part -

Put It Here

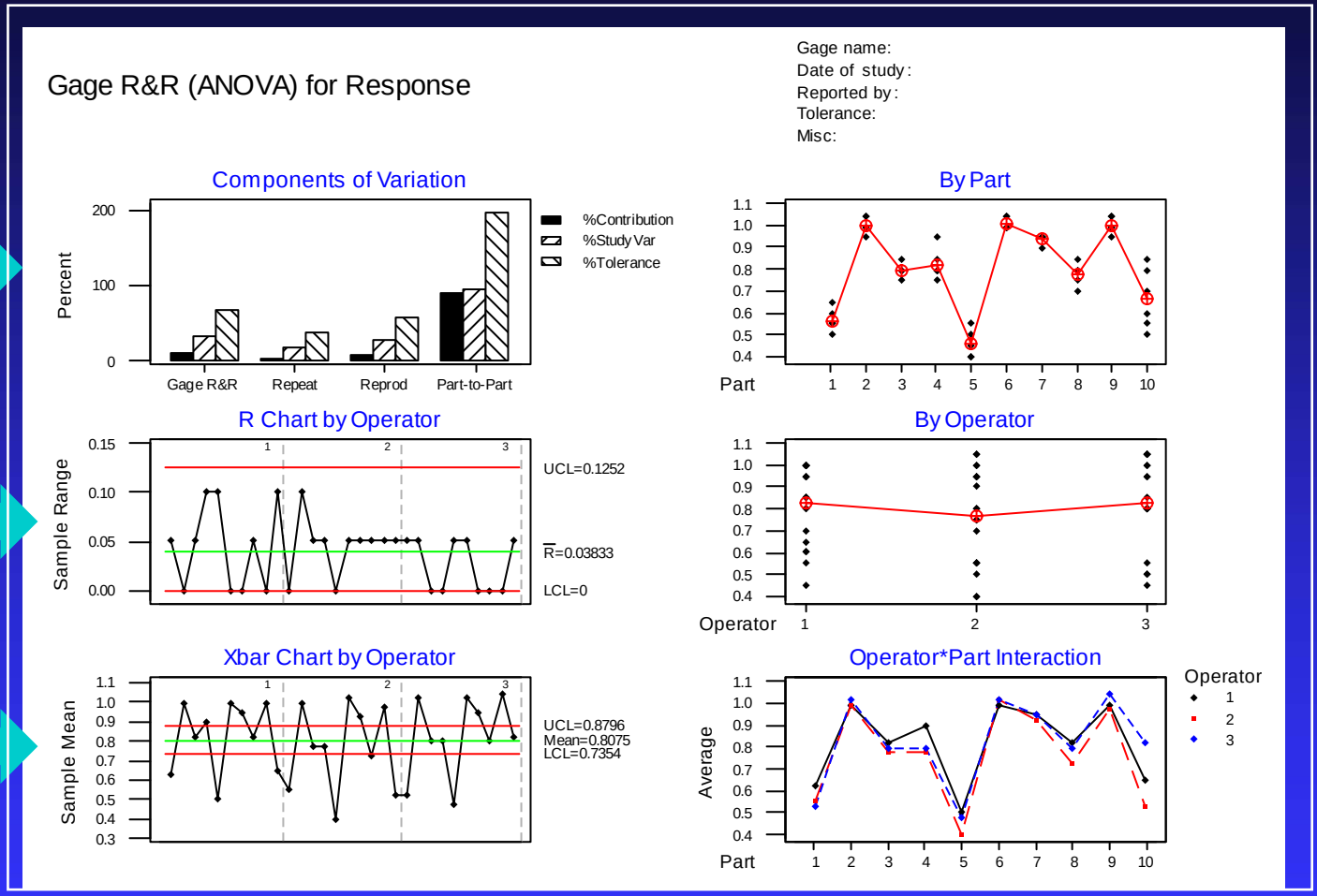


Minitab - Output

%R&R &
P/T Ratios

Gives Us The 1st
Look At
Discrimination

Expected To
Be Out of Control



Graphical View
Of Results

Minitab - Output

Gage R&R

Source	StdDev (SD)	Study Var (5.15*SD)	% R&R %Study Var (%SV)	%P/T %Tolerance (SV/Toler)
Total Gage R&R	0.066615	0.34306	32.66	68.61
Repeatability	0.035940	0.18509	17.62	37.02
Reproducibility	0.056088	0.28885	27.50	57.77
Operator	0.030200	0.15553	14.81	31.11
Operator*Part	0.047263	0.24340	23.17	48.68
Part-To-Part	0.192781	0.99282	94.52	198.56
Total Variation	0.203965	1.05042	100.00	210.08

Number of Distinct Categories = 4

What decision do we make?

%P/T

Best case: 10% Acceptable: 30%

% R&R

As a target, look for %R&R < 30%

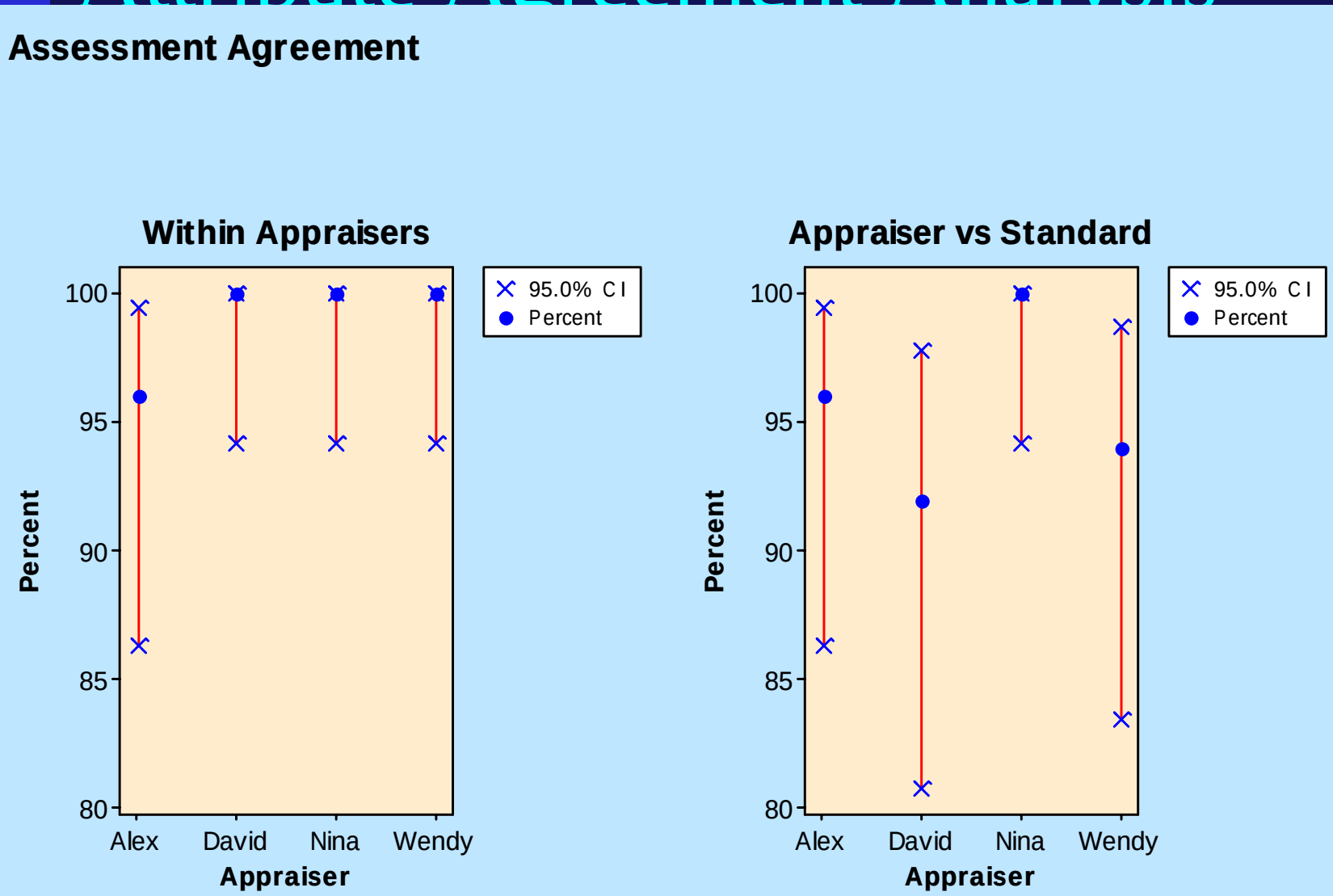
Reducing recruiting costs

- Due to high costs and significant time needed to screen resumes submitted electronically, the team decides to evaluate the screening process for resumes submitted via the web.
- Think about the response. Resumes are evaluated by team members- what type of data is this?

Attribute Agreement Analysis

- Binary response- Pass/Fail.
- A resume either proceeds to the next level or not.
- 4 people are responsible for screening resumes. Each is presented with 50 resumes, randomly selected and already judged to be either a pass or fail.

Attribute Agreement Analysis



MSA - Summary

- Introduce *Measurement Systems Analysis*
- Define basic measurement terms
- Outline procedure for performing a Gage Study (Measurement Systems Analysis)

SPC-MINITAB

Application in
(Statistical Process Control, SPC)

The Way We Manage Data - Today

SPC

S = Statistical techniques used to examine process variation

P = Process, ANY Process

C = Controlling the process through active management

Control Chart Methods
Where Did It Come From ?

- 1920's - Western Electric / Dr. Walter Shewhart
- Used to identify Controlled & Uncontrolled Variation
  - Controlled: Common Cause or Inherent Variation
  - Uncontrolled: Special Cause or Assignable Variation
- Uses Control Charts as main tool

Types of Variation "Common vs. Special"

COMMON CAUSE

- Is present in every process
- Is produced by the process itself (the way we do business)
- Can be removed and/or lessened but requires a fundamental change in the process

A process is Stable, Predictable, and In-Control when only Common Cause Variation exists in the process

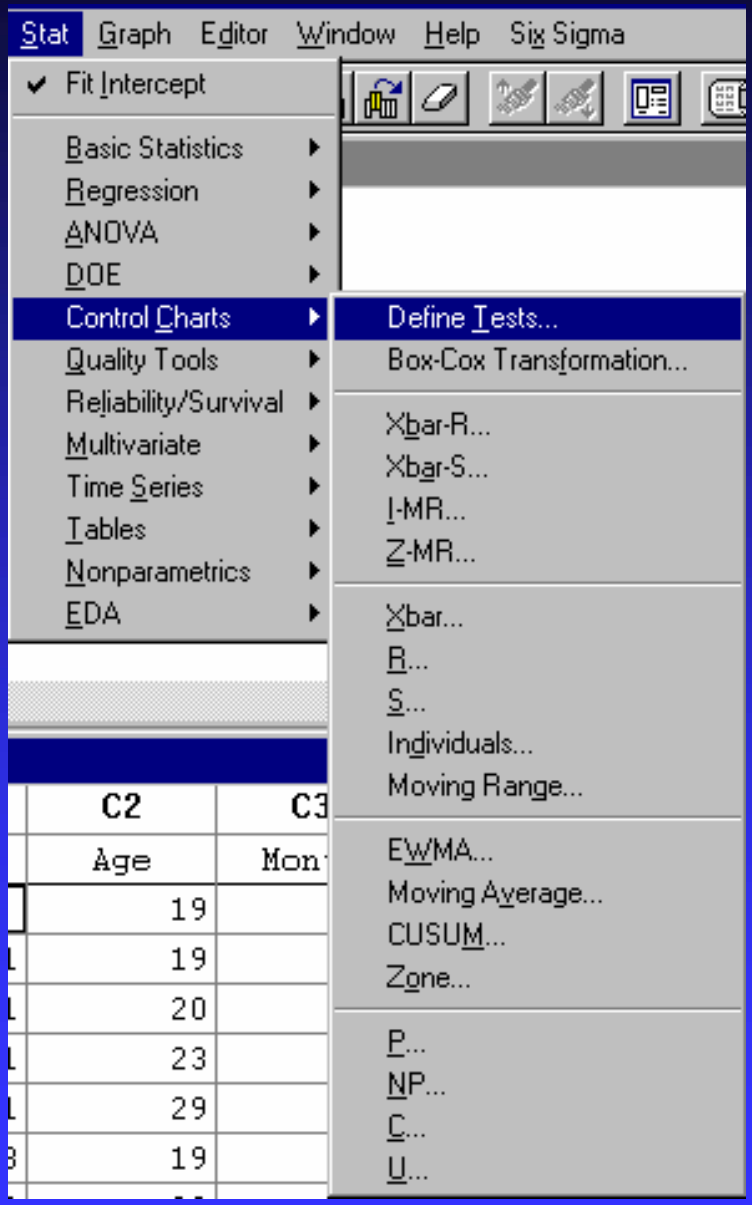
Types of Variation "Common vs. Special"

SPECIAL CAUSE

- Unpredictable
- Typically large in comparison to Common Cause variation
- Caused by unique disturbances or a series of them
- Can be removed/lessened by basic process control and monitoring

A process exhibiting Special Cause variation is said to be Out-of-Control and Unstable

Minitab - Control Charts



Key Component - Control Charts

UCL = Upper Control Limit / LCL = Lower Control Limit

Process Control Tests

A set of standard tests have been created to help identify SPECIAL CAUSE events in our processes

We use the phrase "Out of Control" when a test (or rule) has been broken.

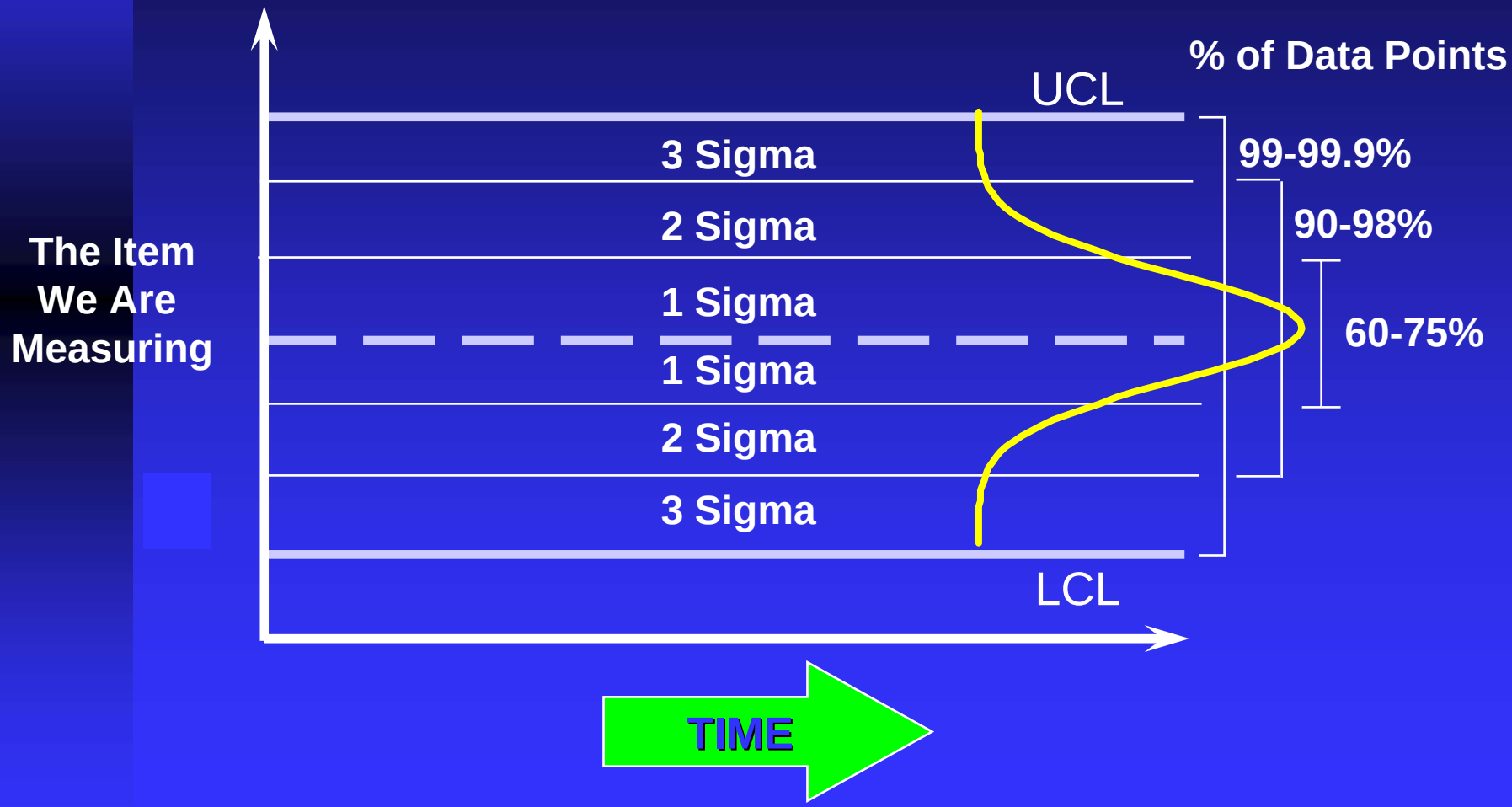
The tests we suggest:

- **Pattern rule:** If you see a pattern, the process is out of control

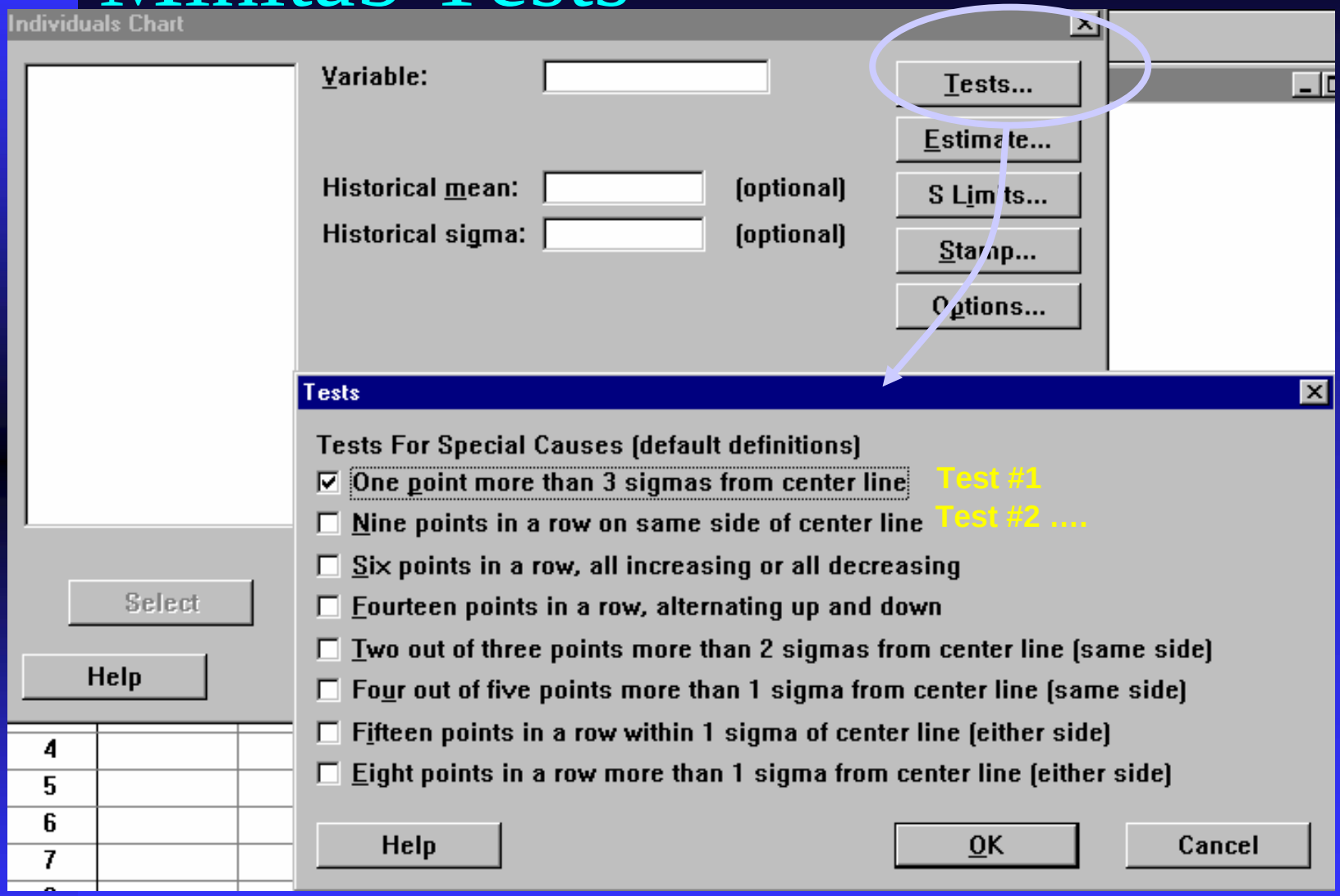
This means something "unusual" has happened -

Go check it out!!

Rules of Standard Deviation
"Where should the data lie?"

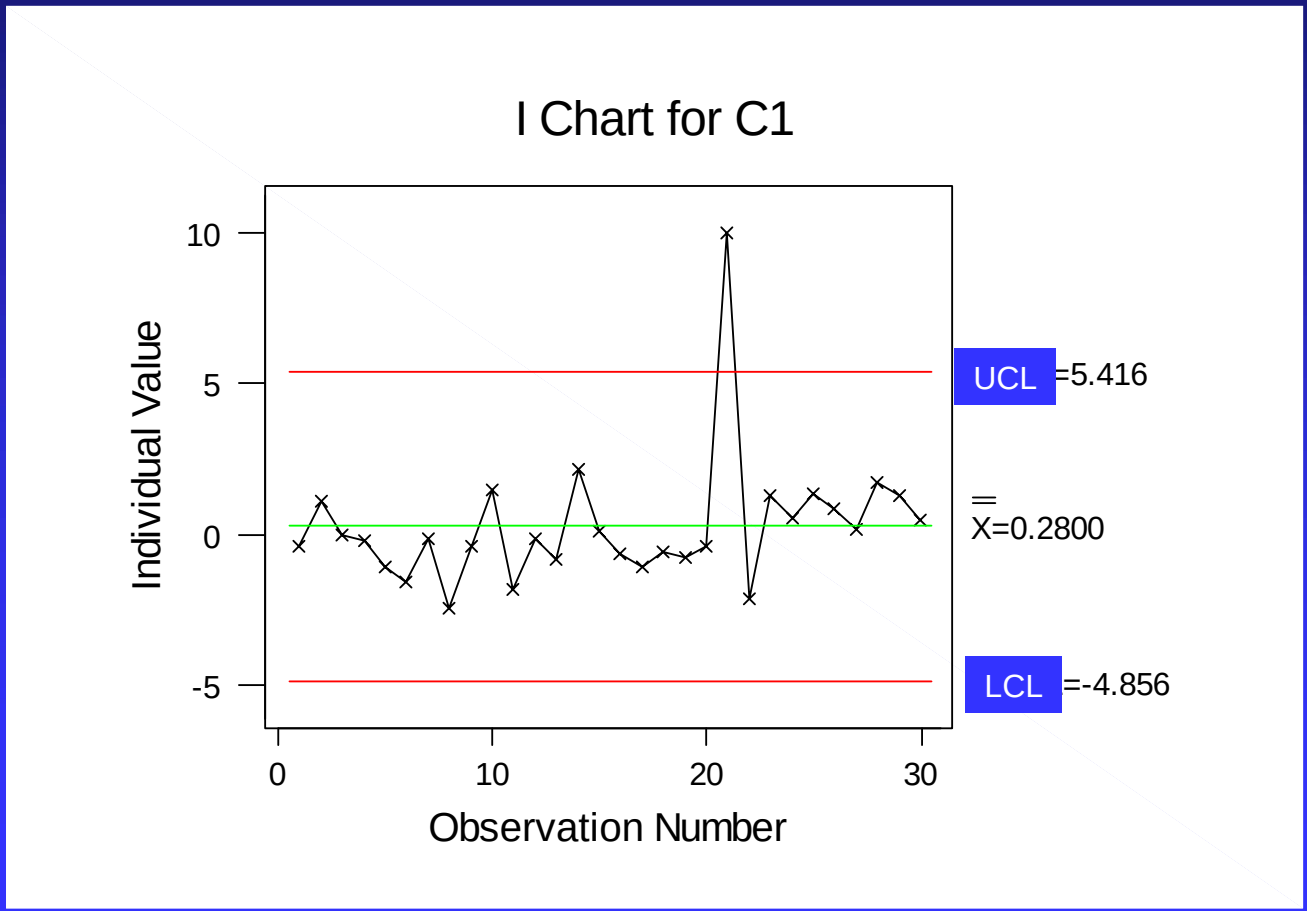


Minitab Tests



In Control or Out of Control ? _____

If out of Control, which rule(s) is broken or condition(s) is present?



In Control or Out of Control ? _____

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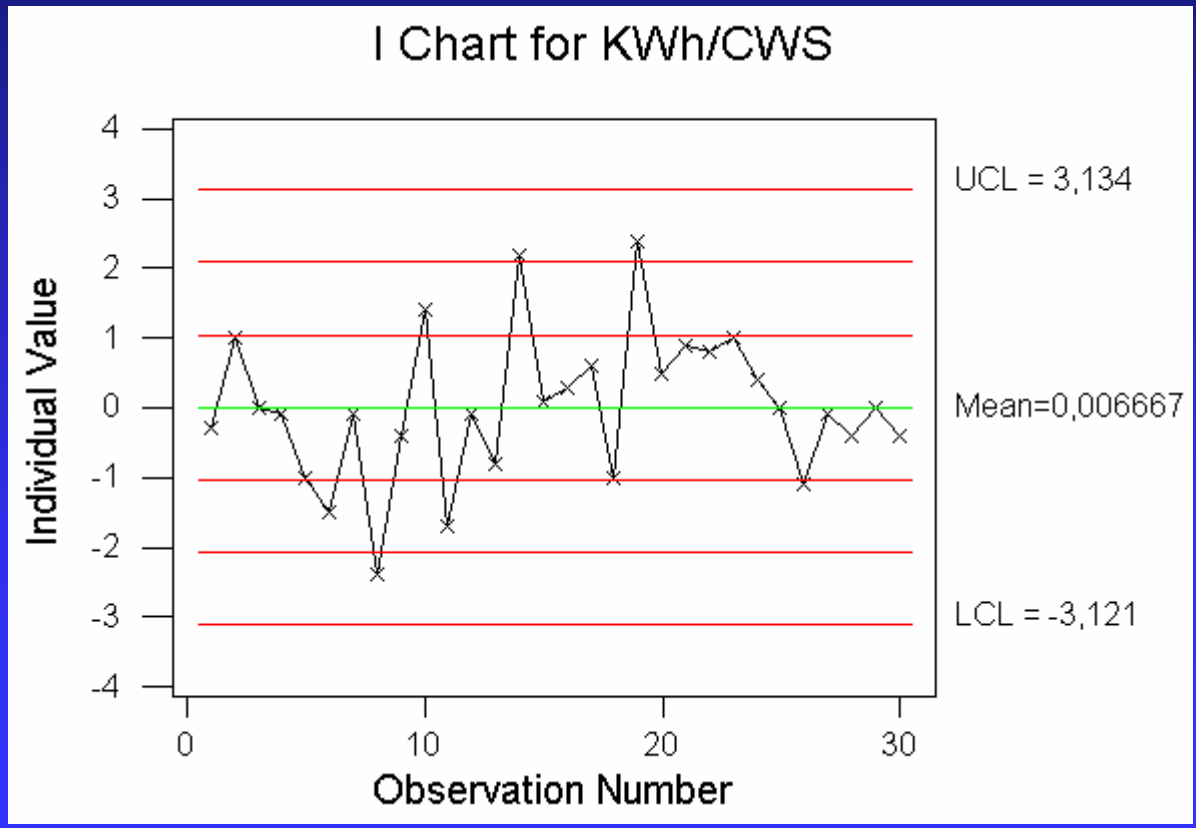
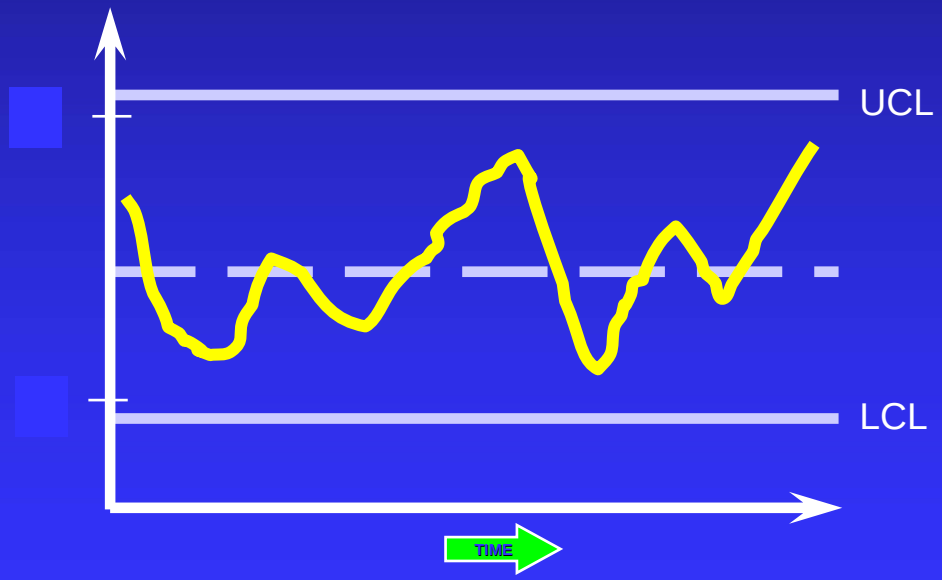
_____



Control Limits vs. Specification Limits

If a point falls beyond the upper or lower *control* limit does this mean we are making a defect for the customer?



Control Limits vs. Specification Limits

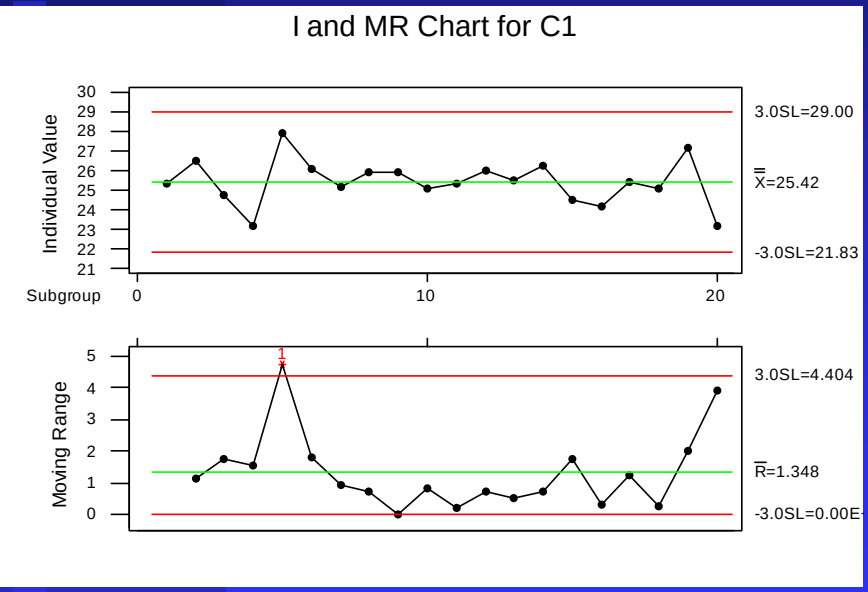
- Process Control Limits are calculated based on data from the process itself
- They are based on +/- 3σ *(99.73% of the process variation is expected to fall between these limits)*
- Product Specification Limits ***ARE NOT*** found on the control chart
- Understanding how the process matches up against customer requirements ***IS*** important to know

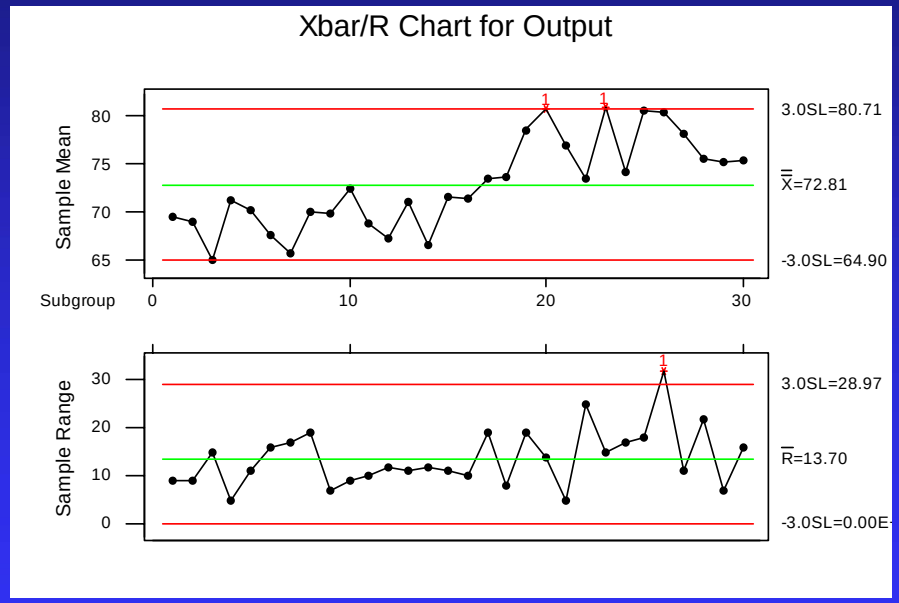
To determine how the process performs to Customer Expectations, a *Process Capability Study* is required

Different Variables Control Charts

I-MR Individuals - Moving Range

X-Bar-R Average -Range Chart

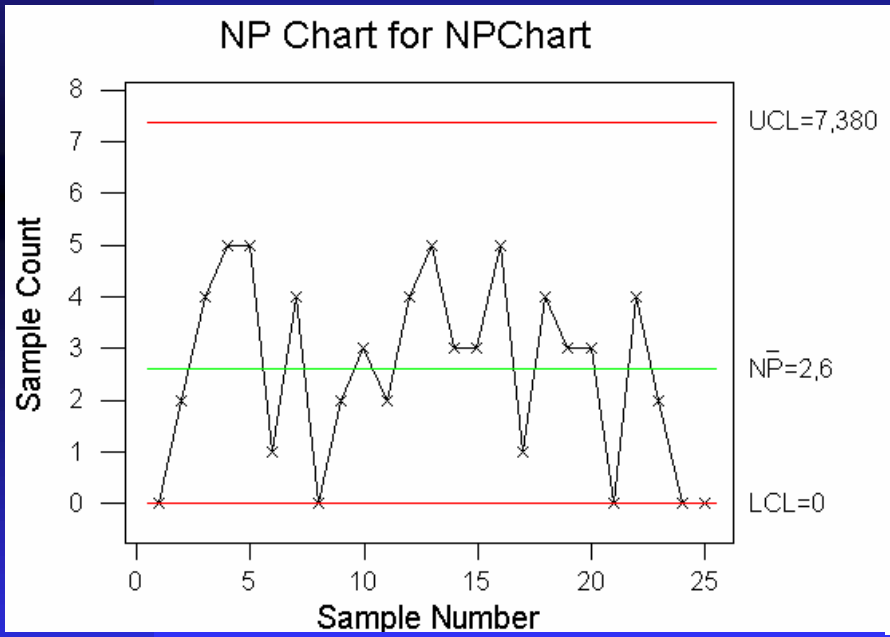


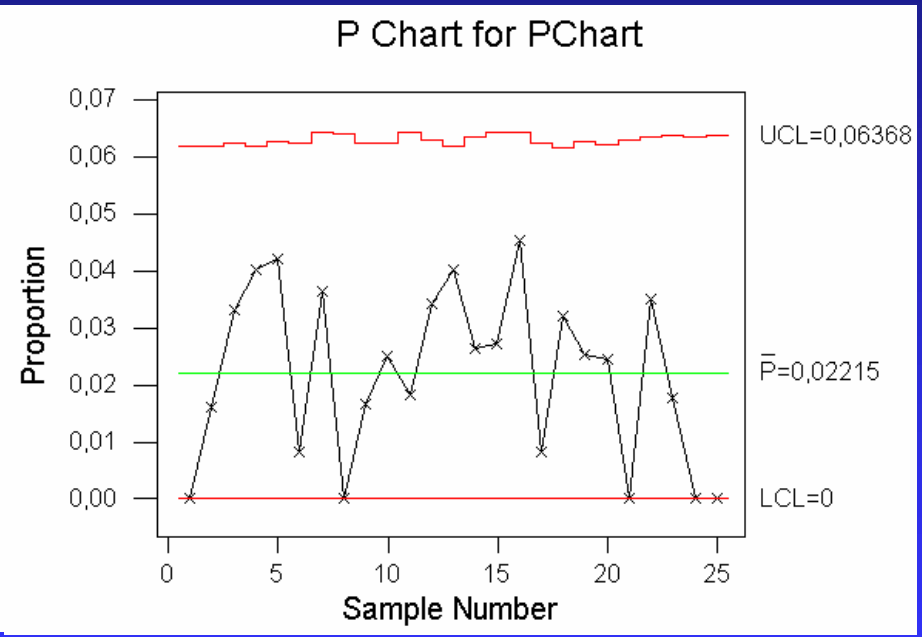


Different Attribute Control Charts: Defectives

NP Number of non-conforming units

P Proportion of non-conforming units

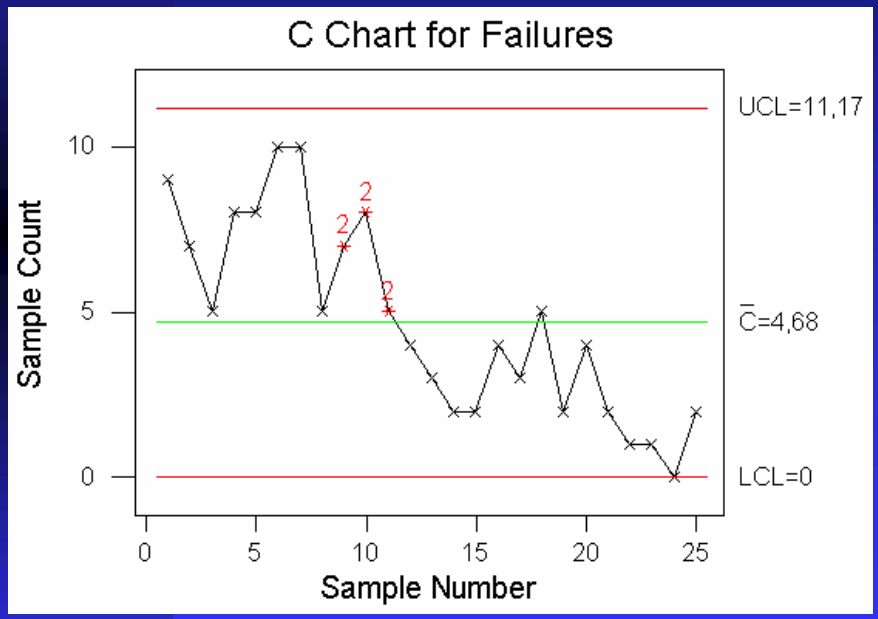


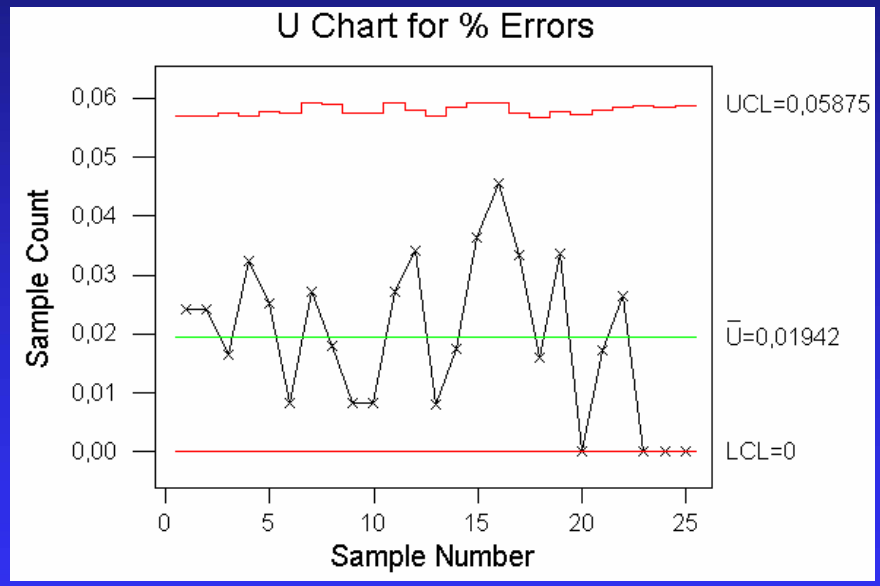


Different Attribute Control Charts : Defects

C Number of defects

U Number of defects per “unit”





Exercise: What Type of Control Chart?

1. # of typos per sales contract (C,U)
2. Number of notebooks with defects in monthly production (P)
3. % of defective vehicles in monthly production (I-MR,P)
4. Per accounts receivable, amount of time it takes to close it (I-MR_
5. Number of transmissions with defects per 100 built (NP)

Requirements for Effective Use of Control Charts

- Management ***MUST*** establish and support an environment that promotes proper action and support to the information collected on the control charts
- Control Charts are implemented ***ONLY*** on Key Processes on which improvement will bring benefit to the organization and/or the customer
- Data collected from the process is validated through the use of a ***CAPABLE*** measurement system

SPC - Summary

- Linked Control Chart Methods to the DMAIC roadmap
- Discussed different types of variation
- Introduced various Control Chart types
- Discussed the interpretation of Control Charts

Case study (Healthcare & Banking)

Healthcare industry

- MD Anderson Cancer Center (TX, USA)
  - 1998-2000
  - CT process re-arranged
  - Service capacity increased 28%

Healthcare industry _ City hospital of Taipei

- X-ray transparency delivery time< 30 mins
- KPIVs
  - No dedicated delivery personnel
  - No specific process
- MSA
  - Attribute data
- SPC
  - Control charts

Healthcare industry_ Local hospital in Taichung

- TQIP
- Unexpected return rate within 15 days-<1.8%
- MSA
  - Attribute data
- SPC
  - Control charts

Banking

1. Customer waiting time <12 mins
2. Money transfer process improvement

- Minitab tools used
  - Control Charts
  - MSA

Summary

- Process oriented
- Data driven with Minitab
- Innovation required
- Common language in project management

Q& A

Thank you

Control charts

- For data in subgroups:
  - subgroup means, Xbar Xbar
  - subgroup ranges, r R Chart
  - subgroup standard deviations, s S Chart
  - Xbar and r on same screen Xbar and R
  - Xbar and s on same screen Xbar and S
  - I chart, MR chart, and R chart for subgroups on the same screen I-MR-R/S (Between/Within)
- For individual observations:
  - individual observations Individuals
  - moving ranges Moving Range
  - individual observations and moving ranges on same screen I-MR
- For subgroup combinations:
  - exponentially weighted moving averages EWMA
  - moving averages Moving Average
  - cumulative sums CUSUM
  - individual observations or subgroup means according to their distance from the center line Zone
- For short runs:
  - standardized individual observations and moving ranges from short run processes Z-MR