

MINITAB & Six Sigma

Hong Kong Society for Quality

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Presented By

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Agenda

- **Introduction to Six Sigma**
- **Minitab History and Products**
- **DMAIC Methodology**
- **MINITAB and MQC Tools**
- **Tutorials (time permitting)**
- **Questions**

Statistics & Six Sigma

Six Sigma is a methodology that aims to remove variation from any process. It is a data driven program that is focused on financial return.

Successful Six Sigma practitioners must have strong communication and quantitative skills. They must have excellent process knowledge and need to apply to appropriate tools. Statistics is one of the key tools used in Six Sigma.

Statistics & Six Sigma

Good statistical software is essential tool for a successful Six Sigma initiative

- Takes away “hand” calculations - reduces the chances for error
- Must be intuitive – practitioners are not usually statisticians
- Allow for exploration – must offer a well-rounded suite of tools
- Clear and consistent presentation of results

Why MINITAB?

MINITAB has been the standard for global Six Sigma operations since the mid 1990's

- Developed in 1972 to teach introductory statistics, designed for non-statisticians
- Began developing for quality in the late 80's
- Strong customer focus and support
- Developing translated product
- Developing companion products

Minitab Products

MINITAB Release 14

- Statistical software

Minitab Quality Companion

- Process Improved Soft Tools

Minitab Quality Trainer

- Multimedia training tool available in 2005

DMAIC Model

Define

- Where are your current problems and opportunities?
- What do your customers require & want?

Measure

- Where is your process currently?

Analyze

- What are the sources or variation?

Improve

- What can make the process better?

Control

- How do you ensure your improvements last?

Define

- Determine the process to be improved
- Identify your customers
- Identify your problems and scope

Measure

- Determine the extent of problem
- Identify your inputs & outputs (X's & Y's)
- Measure it

MQC

- Project Charter
- C&E Matrix
- Critical To Matrix
- FMEA
- Brainstorming
- Process Mapping
- Data Collection Plan

MINITAB

- Pareto
- Gage R&R
- Control Charts
- Capability Analysis
- Graphics

Analyze

- Screen potential causes
- Identify sources or root causes of problem
- Draw Conclusions

MINITAB

- Gage R&R
- Hypothesis Tests
- ANOVA
- Correlation
- Regression
- Capability Analysis
- Graphics
- DOE

Improve

- Identify what improvements to implement
- Determine optimal settings
- Confirm results



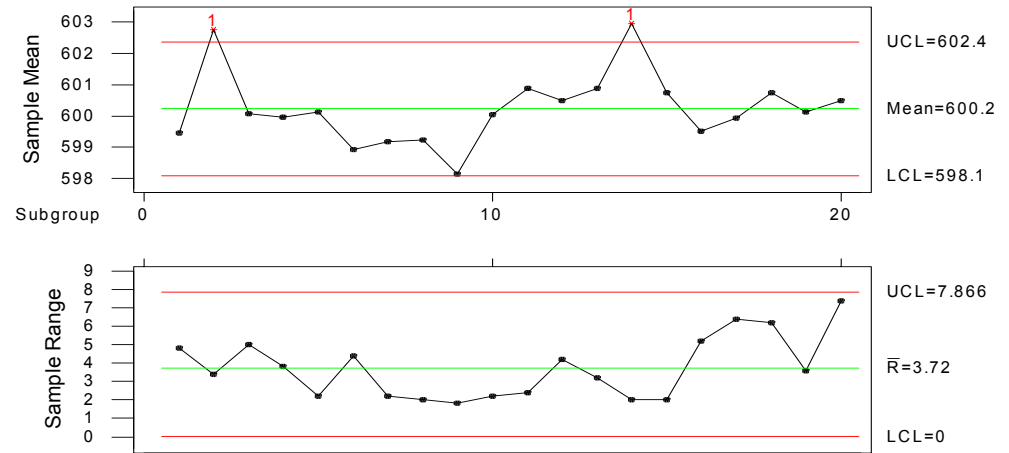
MINITAB

- Gage R&R
- Hypothesis Tests
- ANOVA
- Regression
- Graphics
- Capability Analysis
- Response Optimizer
- DOE

Control

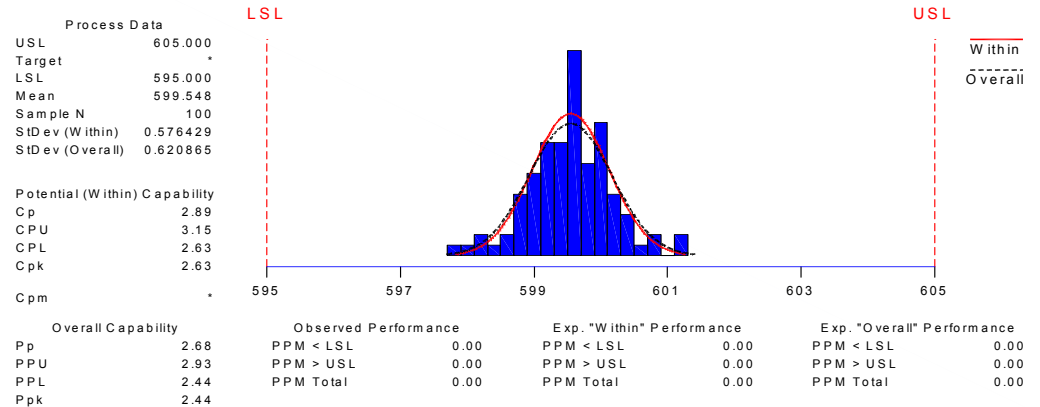
- Sustain the gains
- Permanent change

Xbar/R Chart for Tech Support



- Control Charts
- Capability Analysis

Process Capability Analysis for Sales



Tutorials

Download Meet MINITAB for free from

www.minitab.com/downloads/

- Data is included in MINITAB – SHIPPINGDATA.MTW
- Emphasis on Analyze, Improve, Control phases of Six Sigma

Questions?

Our technical support staff is also available to help you whether you have purchased or are considering buying MINITAB. Please contact them at <http://customer.minitab.com>.

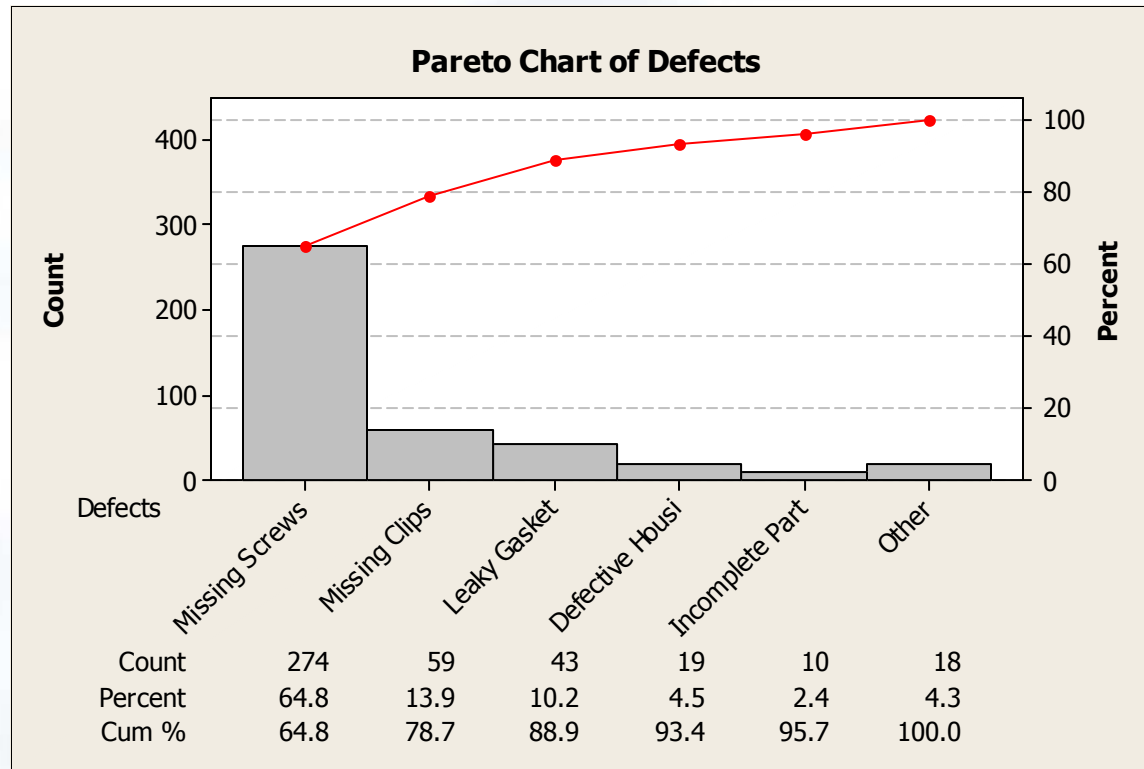
Thank you!



Linked Pages

MINITAB Release 14 – Pareto Chart

Identify Potential Root Causes



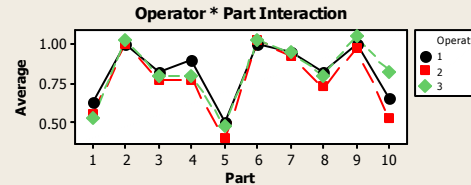
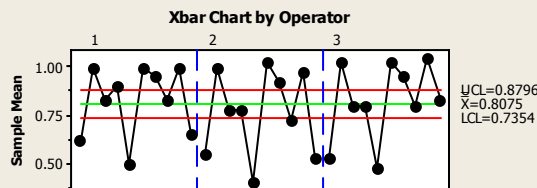
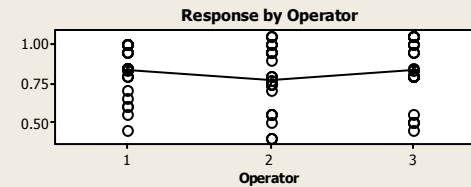
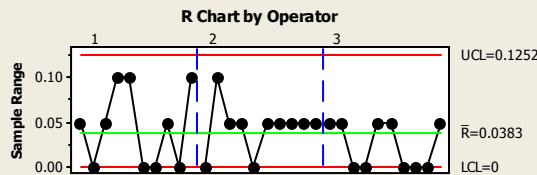
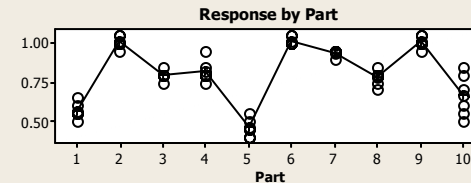
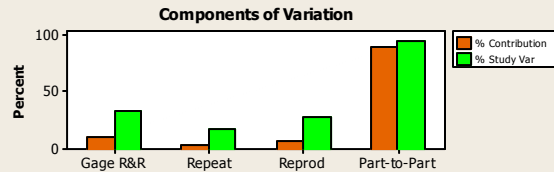
MINITAB Release 14 – Gage R&R

Measurement Systems Analysis

Gage R&R (ANOVA) for Response

Gage name: Line #2
Date of study: 10/20/2003

Reported by: Shift #2
Tolerance:
Misc:



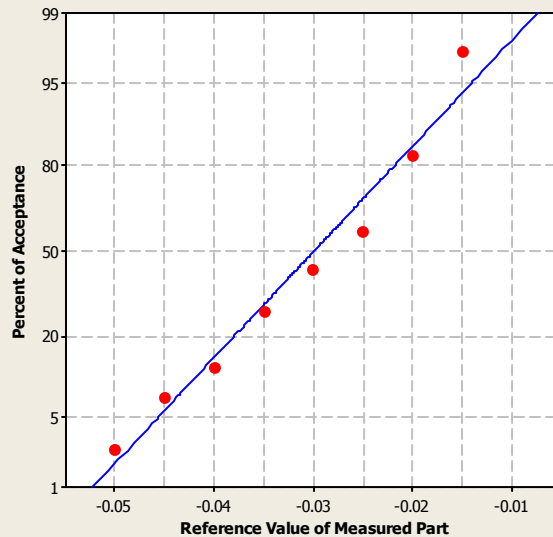
MINITAB Release 14 – Attribute Gage Study for Acceptances

Measurement Systems Analysis

Attribute Gage Study (Analytic Method) for Acceptances

Gage name:
Date of study:

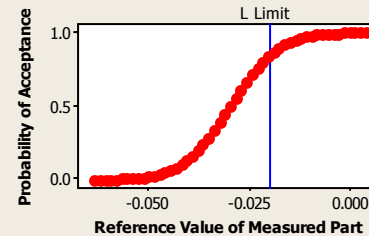
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Tolerance:
Misc:



Bias: 0.0097955
Pre-adjusted Repeatability: 0.0494705
Repeatability: 0.0458060

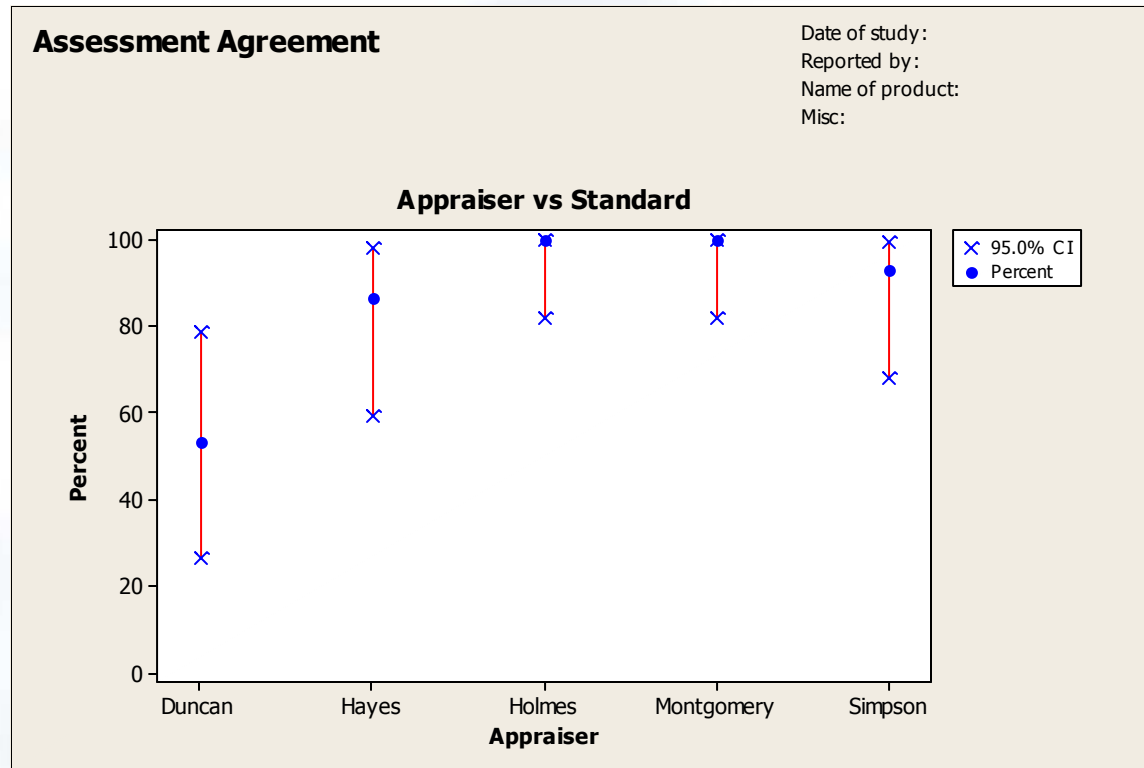
Fitted Line: $3.10279 + 104.136 * \text{Reference}$
R - sq for Fitted Line: 0.969376

A IAG Test of Bias = 0 vs not = 0
T DF P-Value
6.70123 19 0.0000021



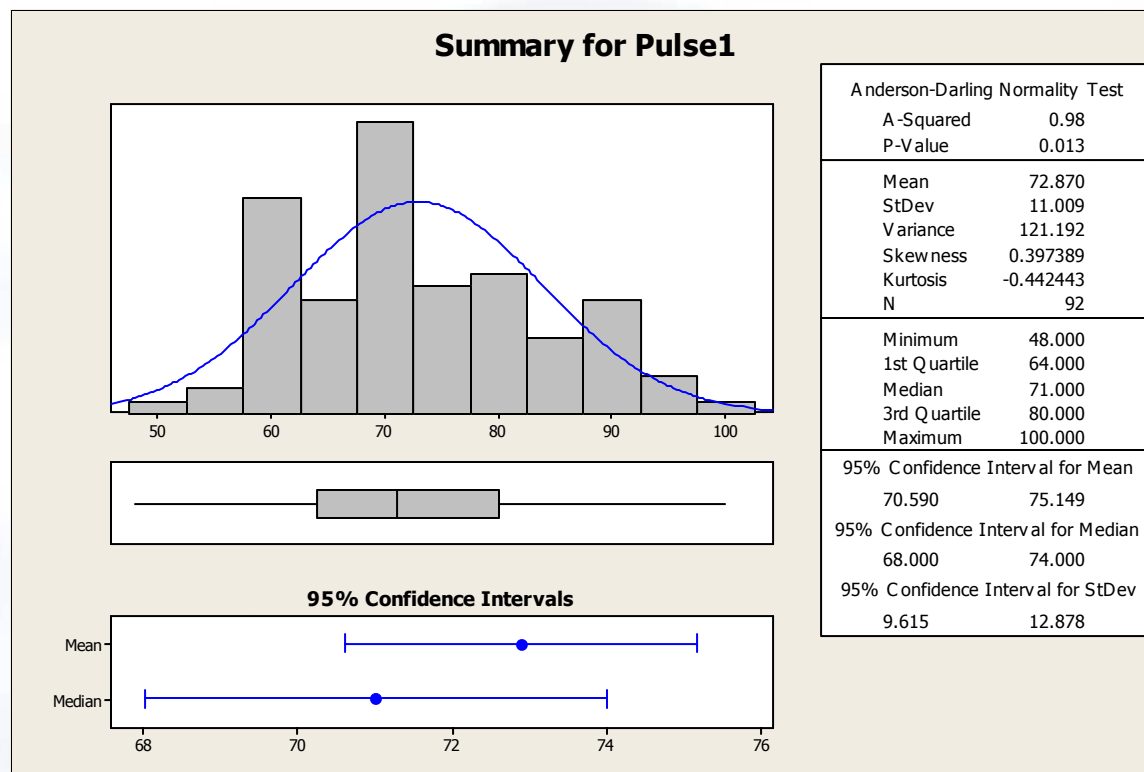
MINITAB Release 14 – Attribute Agreement Analysis

Measurement Systems Analysis of Appraisers



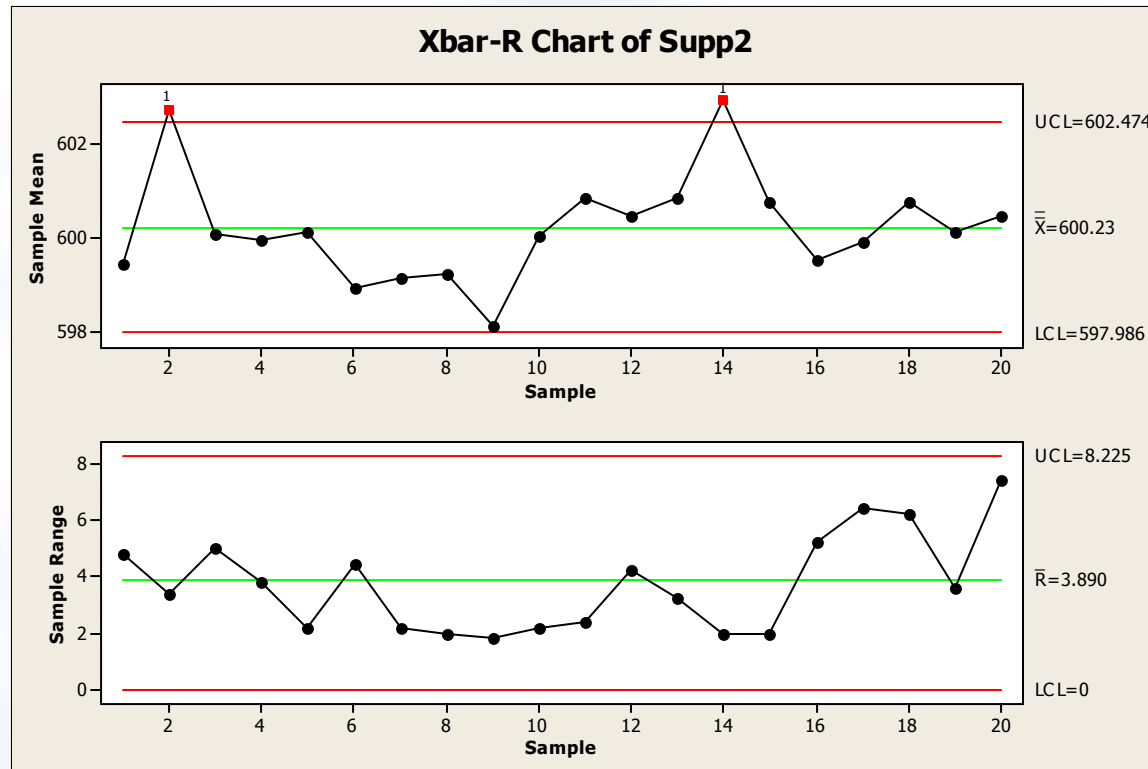
MINITAB Release 14 – Graphing Techniques

Descriptive Statistics



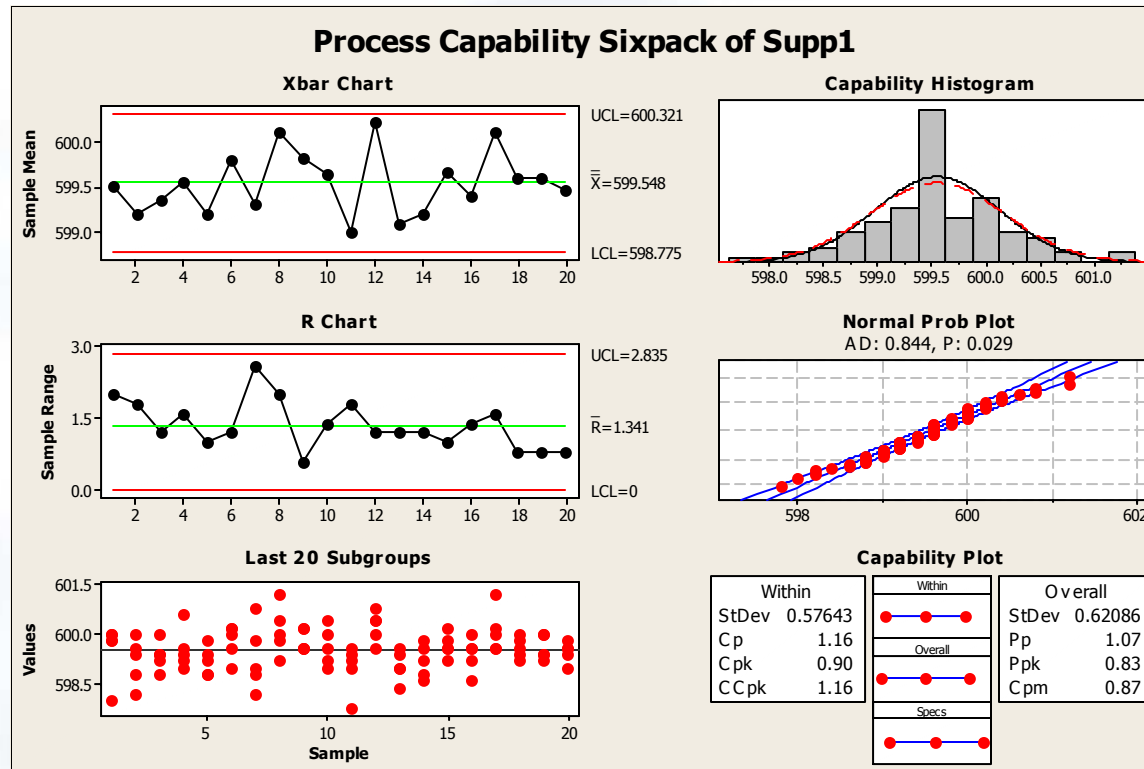
MINITAB Release 14 – Control Charts

Is your process in control?



MINITAB Release 14 – Capability Analysis (Sixpack)

How Capable is your process?



Project Charter – (Form Tool)

Minitab Quality Companion - [Project Charter: Includes business case, problem and goal statements, project scope, milestones, roles and responsibilities, comm]

File Edit View Form Collaborate Window Help

Project: Call Center Issues

Project Information

Leader:	Joe Paterno
Master Black Belt:	Joe Gibbs
Project Start:	4 / 2 /2003
Project End:	11/30/2003
Cost of Poor Quality:	Unavailable

Team Members

Sponsor:	Technical Support
Black Belt:	Lavar Arrington
Master Black Belt:	Joe Gibbs
Subject Matter Experts:	
Patrick Ramsey	Rod Gardner
Jon Jansen	Chris Sammuels
Laverenous Coles	Larry Johnson
Michael Haynes	Jimmy Kennedy

Process Start/Stop

Start Point:

Stop Point:

Project Time Frame

Milestone:	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Date:	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

Process Importance

We are losing existing and new customers due to our bad cusotmer services standards.

Process Problem

Approximately 65% of the time customers are not staying on the line long enough to answer their calls causing bad cusotmer service.

Process Goals

Reduce the number of customers that hang up before call is answered by 50%. Stretch goal of 80%.

Process Measurements

Measured in seconds. The length a customer wait on the phone before their call is answered.

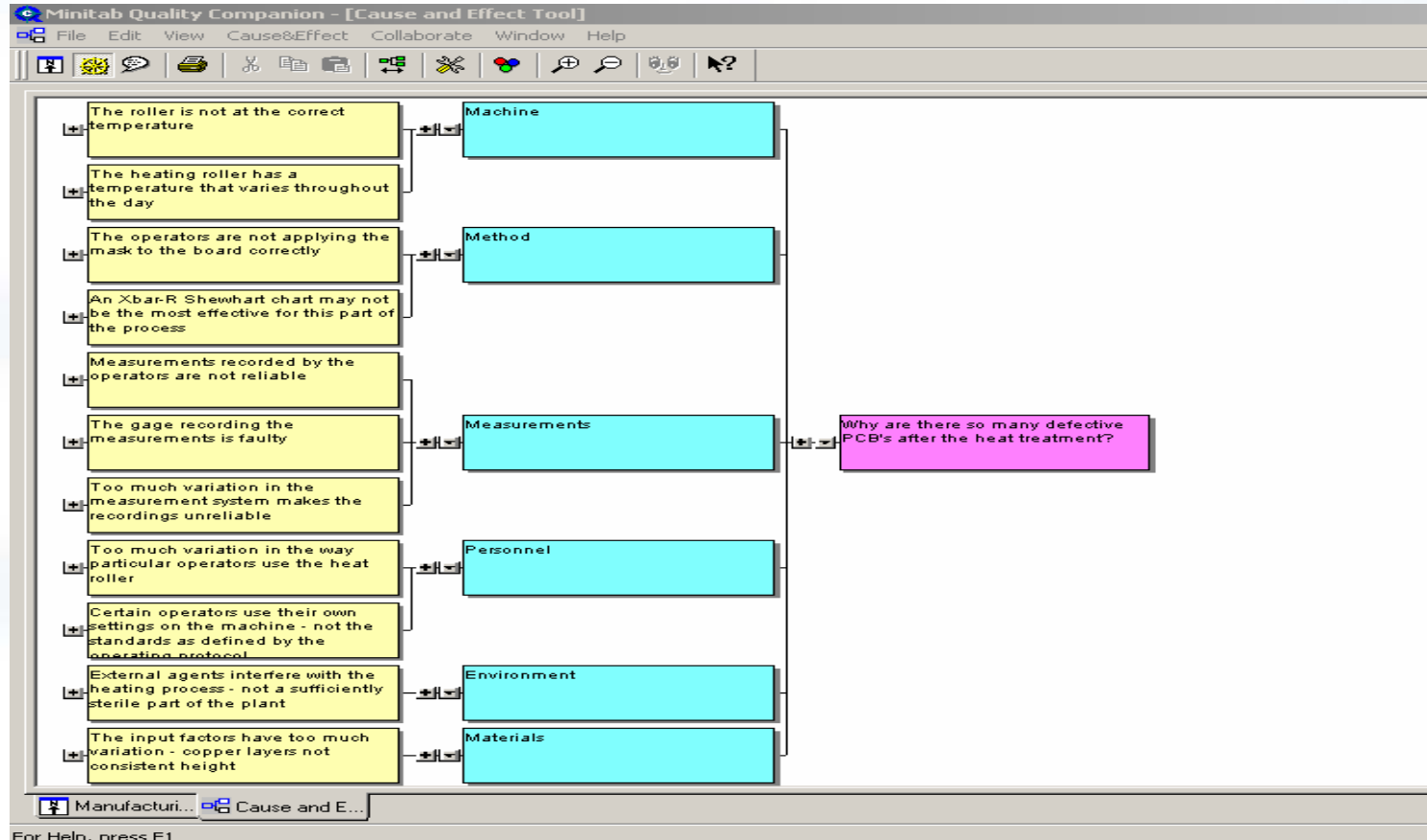
QC1.QCP Project Chart...

For Help, press F1

NUM

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Cause and Effect Diagram



FMEA – (Form Tool)

Minitab Quality Companion - [Failure Modes and Effects Analysis]

File Edit View Form Collaborate Window Help

What are we examining? Failure Modes Failure Effects Severity Failure Causes Occurrence Detectability Current Controls

What is the process step? How can the process fail? What happens if rock a failure occurs? 1 to 10 What could cause a failure? 1 to 10 1 to 10 1 to 10 What are the current methods to prevent failure? R

What are we examining?	Failure Modes	Failure Effects	Severity	Failure Causes	Occurrence	Detectability	Current Controls
What is the process step?	How can the process fail?	What happens if rock a failure occurs?	1 to 10	What could cause a failure?	1 to 10	1 to 10	What are the current methods to prevent failure? R
Collecting Bill to Information	Missing address information	Invoice does not reach person who should pay	6	Sales does not ask right questions or customer provides wrong information.			None; Sales request for billing address
Collecting Bill to Information	Inaccurate contact information	Invoice does not mail to correct department or contact	6	No confirmation of accurate billing contact information.			None; Sales will process with as long as there is any bill to address.
Verify tax exemption status	Don't collect tax exemption certificate	Taxes are applied and payment is short or delinquent	5	Sales does not check ship to state			None
Verify tax exemption status	We don't collect tax exemption certificate	Taxes are applied and payment is short or delinquent	5	Customer does not show tax exemption status			Sales person asks for verification
Verify tax exemption status	Not following process	Taxes are applied and payment is short or delinquent	5	Order entered and tax exemption is not set to finance for entry into taxware			Tax Exemption procedure
Verify tax exemption status	Tax exemption status is not in ONYX	Taxes are applied and payment is short or delinquent	5	No linkage between taxware, softax and onyx.			None
Verify tax exemption status	Tax exemption status is not in ONYX	Taxes are applied and payment is short or delinquent	5	Sales person not checking crystal report and assuming customer is tax exempt.			None
Entering order into Softax	Enter order under wrong customer.	Taxes are applied and payment is short or delinquent	5	When company purchases annual license through reseller, order is entered under reseller so tax			None
Collecting/Entering Purchase Order Number	Incorrect PO Number	Customer can not match invoice to PO so they do not pay.	7	Sales person enters wrong po number on ONYX order form			None
Collecting/Entering Purchase Order Number	Incorrect PO Number	Customer can not match invoice to PO so they do not pay.	7	Sales person enters wrong po number in the SOFTRAX			Sales Ass is to ask to verify order form with attached purchase order.
Collecting/Entering Purchase Order Number	Incorrect so PO Number	Customer can not match invoice to PO so they do not pay.	7	Order does not have PO Number			Ask customer if there is a po number. If not last name is used.
Collecting/Entering Purchase Order Number	Incorrect so PO Number	Customer can not match invoice to PO so they do not pay.	7	We do not receive hardcopy purchase order (E-mail or phone)			If there is no PO number from customer, last name is used.
Freight charges are applied in SOFTRAX	Freight charges are applied without customer's knowledge	Invoice are not paid on time or are short	5	Invoice total does not match PO total because of freight			Assumption of customer agrees with Minitab's terms.
Entering order into ONYX	Wrong price break extended. Ex: purchase 2nd copy within 30 days \$905 instead of \$1195	Invoice is not paid on time or is short	5	Wrong price entered into ONYX			None

Collections ... Failure Mode...

For Help, press F1

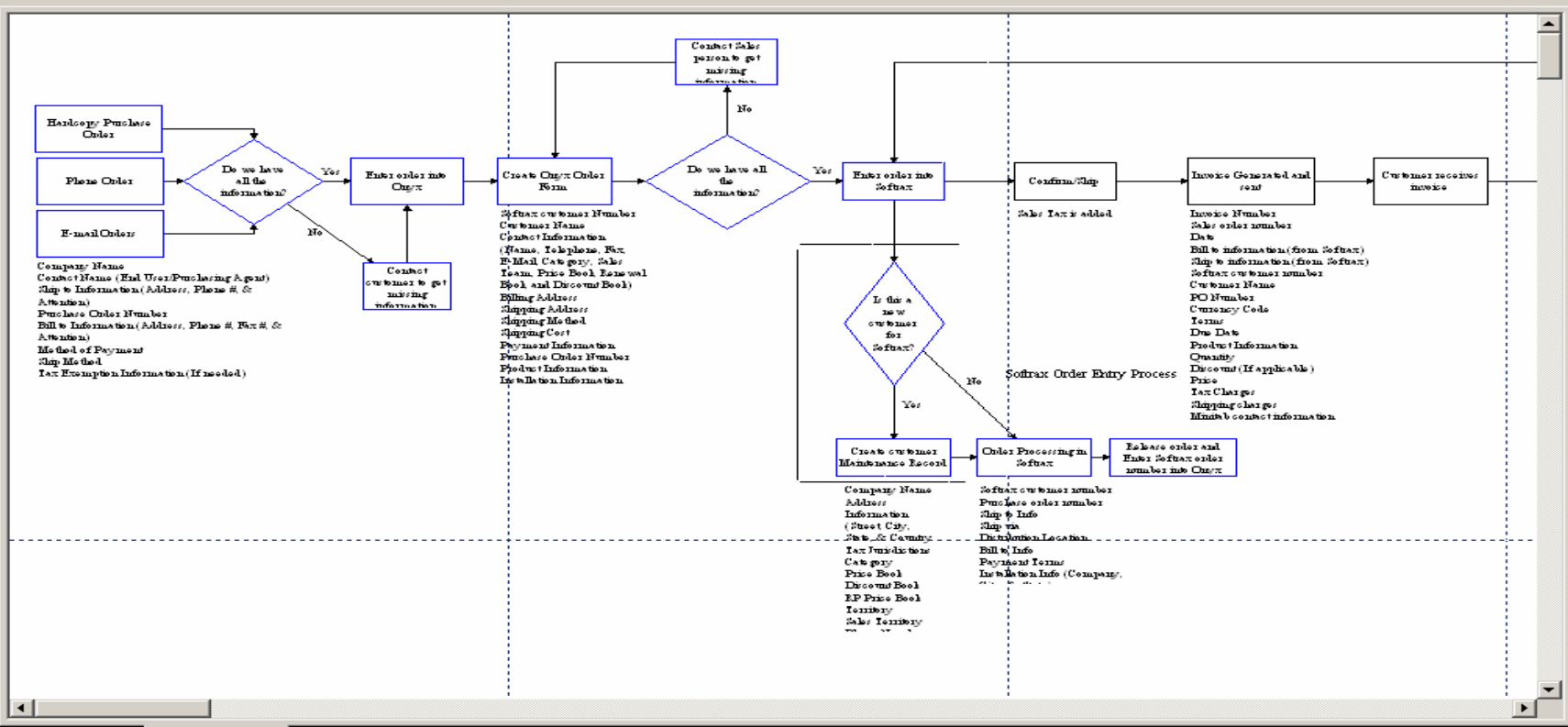
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Process Mapping Tool

Minitab Quality Companion - [Order Process Map]

File Edit View Flowchart Collaborate Window Help



```

    graph LR
      Start([Start]) --> Input[Handtype/Purchase Order, Phone Order, E-mail Order]
      Input --> D1{Do we have all the information?}
      D1 -- No --> C1[Contact customer to get missing information]
      C1 --> E1[Enter order into CRM]
      D1 -- Yes --> E1
      E1 --> C2[Create CRM Order Form]
      C2 --> D2{Do we have all the information?}
      D2 -- No --> C3[Contact Sales person to get missing information]
      C3 --> E2[Enter order into Softpak]
      D2 -- Yes --> E2
      E2 --> C4[Confirm/Ship]
      C4 --> I1[Invoice Generated and sent]
      I1 --> R1[Customer receives invoice]
      E2 --> D3{Is this a new customer for Softpak?}
      D3 -- No --> E2
      D3 -- Yes --> C5[Create customer Maintenance Record]
      C5 --> E3[Order Processing in Softpak]
      E3 --> E4[Release order and Enter Softpak order number into CRM]
      E4 --> E2
  
```

Handtype/Purchase Order, Phone Order, E-mail Order

Company Name
Contact Name (End User/Purchasing Agent)
Ship to Information (Address, Phone #, & Attention)
Purchase Order Number
Bill to Information (Address, Phone #, Fax #, & Attention)
Method of Payment
Ship Method
Tax Exemption Information (if needed)

Do we have all the information?

Yes

No

Enter order into CRM

Create CRM Order Form

Softpak customer number
Customer Name
Contact Information (Name, Telephone, Fax, E-Mail, Category, Sales Team, Price Book, Escrow and Ship and Discount Book)
Billing Address
Shipping Address
Shipping Method
Shipping Cost
Payment Information
Purchase Order Number
Product Information
Installation Information

Do we have all the information?

Yes

No

Enter order into Softpak

Confirm/Ship

Sales Tax is added

Invoice Generated and sent

Invoice Number
Sales order number
Date
Bill to information (from Softpak)
Ship to information (from Softpak)
Softpak customer number
Customer Name
PO Number
Currency Code
Terms
Due Date
Product Information
Quantity
Discount (if applicable)
Price
Tax Charges
Shipping charges
Minitab contact information

Customer receives invoice

Is this a new customer for Softpak?

Yes

No

Softpak Order Entry Process

Create customer Maintenance Record

Company Name
Address Information (Street City, State & Country)
Tax Jurisdiction
Category
Price Book
Discount Book
EP Price Book
Territory
Sales Territory

Order Processing in Softpak

Softpak customer number
Purchase order number
Ship # Info
Distribution Location
Bill to Info
Payment Terms
Installation Info (Company, ...)

Release order and Enter Softpak order number into CRM

NUM

For Help, press F1

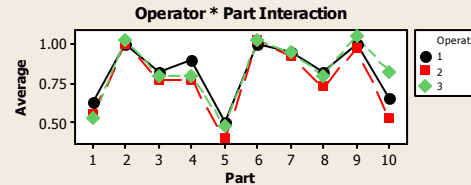
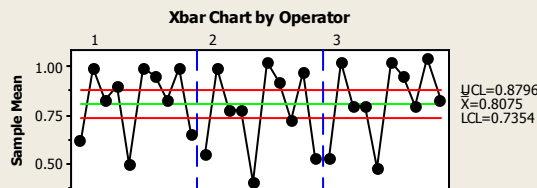
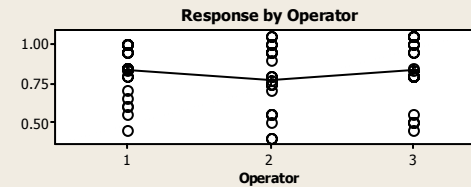
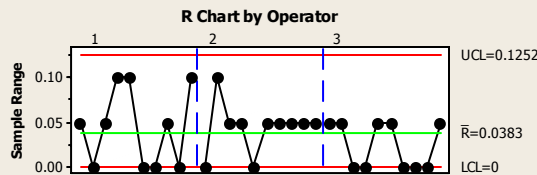
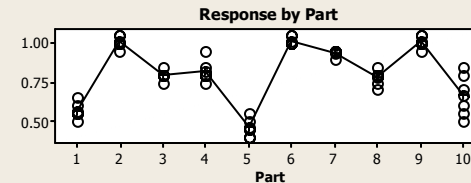
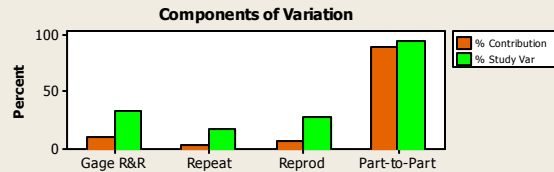
Start | I... | O... | S... | M... | I... | Si... | M... | D... | M... | Desktop >> | 2:32 PM

MINITAB Release 14 – Gage R&R Measurement Systems Analysis

Gage R&R (ANOVA) for Response

Gage name: Line #2
Date of study: 10/20/2003

Reported by: Shift #2
Tolerance:
Misc:



MINITAB Release 14 – Hypothesis Testing & Graphics

Graphical and Statistical Analysis of Data

Two-Sample T-Test and CI: BTU.In, Damper

Two-sample T for BTU.In

Damper	N	Mean	StDev	SE Mean
1	40	9.91	3.02	0.48
2	50	10.14	2.77	0.39

Difference = μ (1) - μ (2)

Estimate for difference: -0.235250

95% CI for difference: (-1.450131, 0.979631)

T-Test of difference = 0 (vs not =): T-Value = -0.38 P-

Value = 0.701 DF = 88

Both use Pooled StDev = 2.8818

Test and CI for Two Proportions

Sample	X	N	Sample p
1	537	1000	0.537000
2	778	1000	0.778000

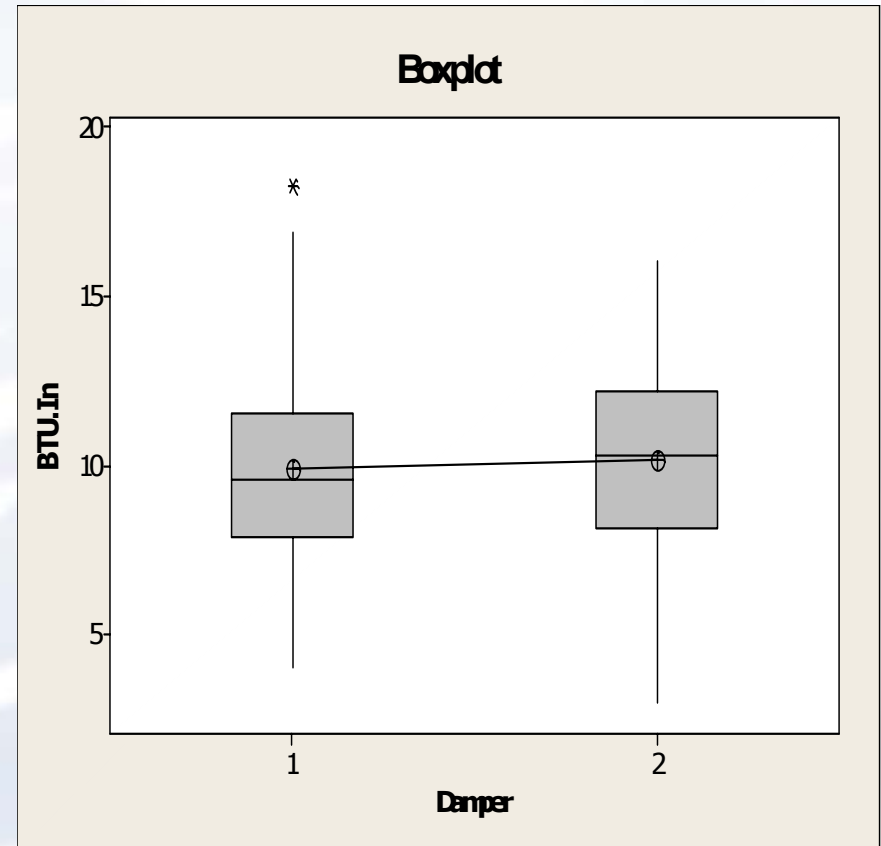
Difference = p (1) - p (2)

Estimate for difference: -0.241

95% CI for difference: (-0.281232, -0.200768)

Test for difference = 0 (vs not = 0): Z = -11.74 P-Value

= 0.000



MINITAB Release 14 – ANOVA & Graphics

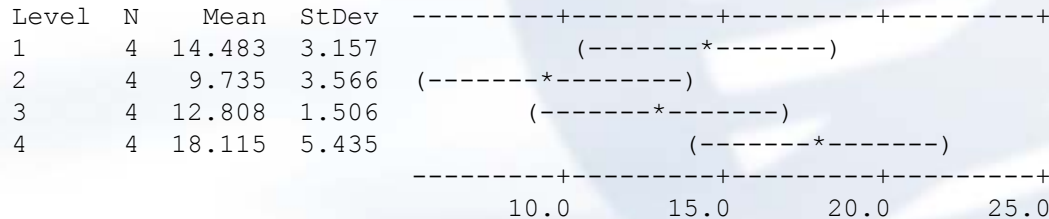
Graphical and Statistical Analysis of Data

One-way ANOVA: Durability versus Carpet

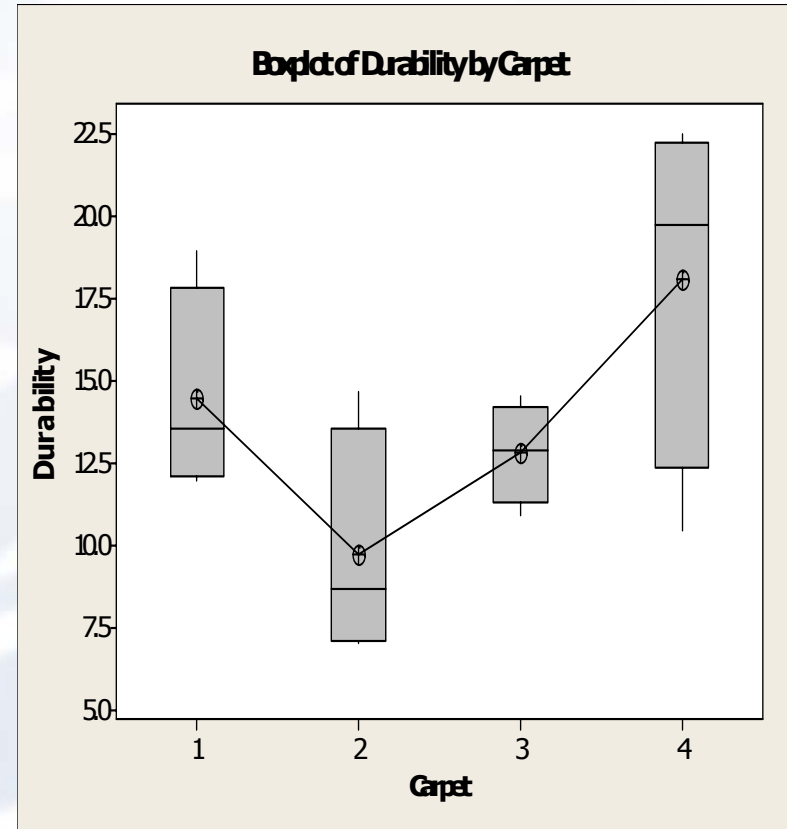
Source	DF	SS	MS	F	P
Carpet	3	146.4	48.8	3.58	0.047
Error	12	163.5	13.6		
Total	15	309.9			

S = 3.691 R-Sq = 47.24% R-Sq(adj) = 34.05%

Individual 95% CIs For Mean Based on Pooled StDev



Pooled StDev = 3.691



MINITAB Release 14 – Regression & Correlation

Determining Significant Factors

Regression Analysis: Score1 versus Score2

The regression equation is
 $\text{Score1} = -4.667 + 4.397 \text{ Score2}$

S = 0.572711 R-Sq = 95.7% R-Sq(adj) = 95.1%

Analysis of Variance

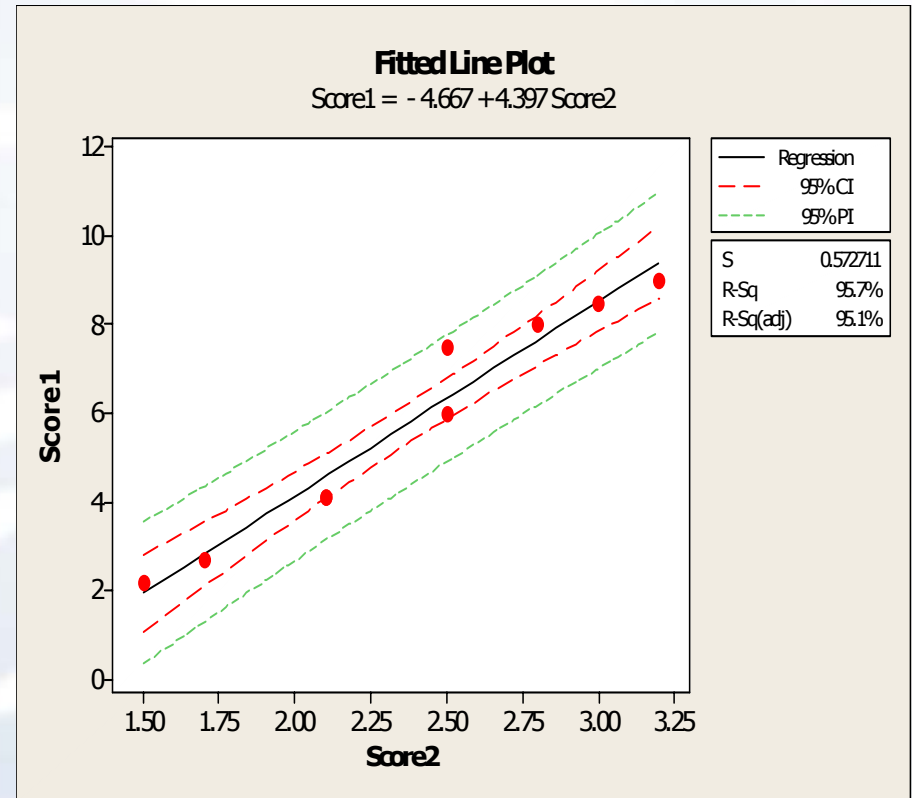
Source	DF	SS	MS	F	P
Regression	1	51.3529	51.3529	156.56	0.000
Error	7	2.2960	0.3280		
Total	8	53.6489			

Correlations: Verbal, Math, GPA

	Verbal	Math
Math	0.275	0.000
GPA	0.322	0.194
	0.000	0.006

Cell Contents: Pearson
 correlation

P-Value



MINITAB Release 14 – Design of Experiments (DOE)

Determining Significant Factors

Factorial Fit: Yield versus Block, Time, Temp, Catalyst

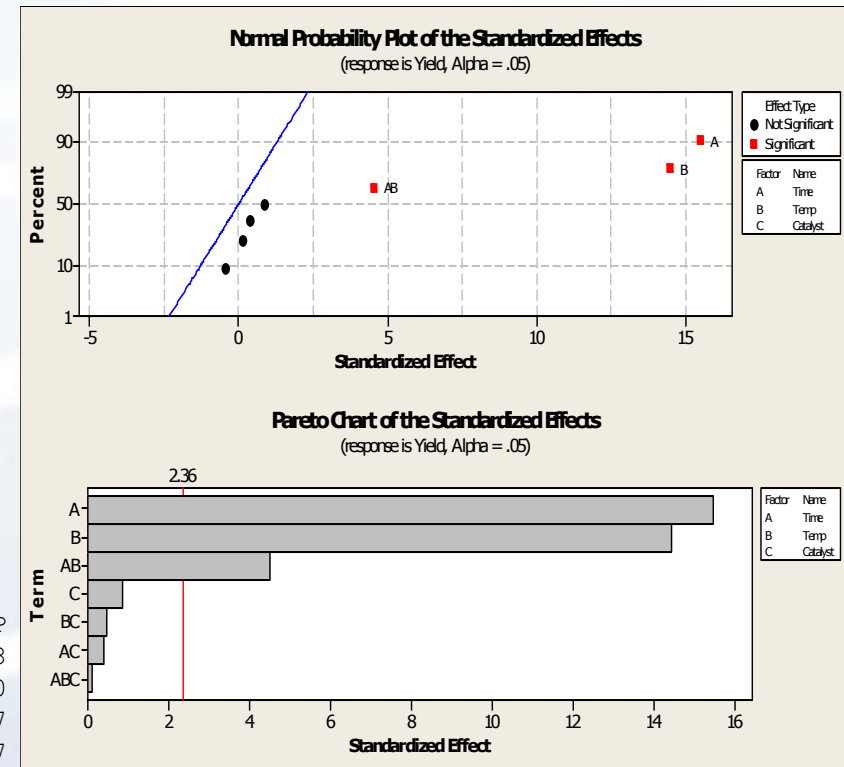
Estimated Effects and Coefficients for Yield (coded units)

Term	Effect	Coef	SE Coef	T	P
Constant		45.5592	0.09546	477.25	0.000
Block		-0.0484	0.09546	-0.51	0.628
Time	2.9594	1.4797	0.09546	15.50	0.000
Temp	2.7632	1.3816	0.09546	14.47	0.000
Catalyst	0.1618	0.0809	0.09546	0.85	0.425
Time*Temp	0.8624	0.4312	0.09546	4.52	0.003
Time*Catalyst	0.0744	0.0372	0.09546	0.39	0.708
Temp*Catalyst	-0.0867	-0.0434	0.09546	-0.45	0.663
Time*Temp*Catalyst	0.0230	0.0115	0.09546	0.12	0.907

S = 0.381847 R-Sq = 98.54% R-Sq(adj) = 96.87%

Analysis of Variance for Yield (coded units)

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Blocks	1	0.0374	0.0374	0.0374	0.26	0.628
Main Effects	3	65.6780	65.6780	21.8927	150.15	0.000
2-Way Interactions	3	3.0273	3.0273	1.0091	6.92	0.017
3-Way Interactions	1	0.0021	0.0021	0.0021	0.01	0.907
Residual Error	7	1.0206	1.0206	0.1458		
Total	15	69.7656				



MINITAB Release 14 – Hypothesis Testing & Graphics

Confirming Improvements

Two-Sample T-Test and CI: BTU.In, Damper

Two-sample T for BTU.In

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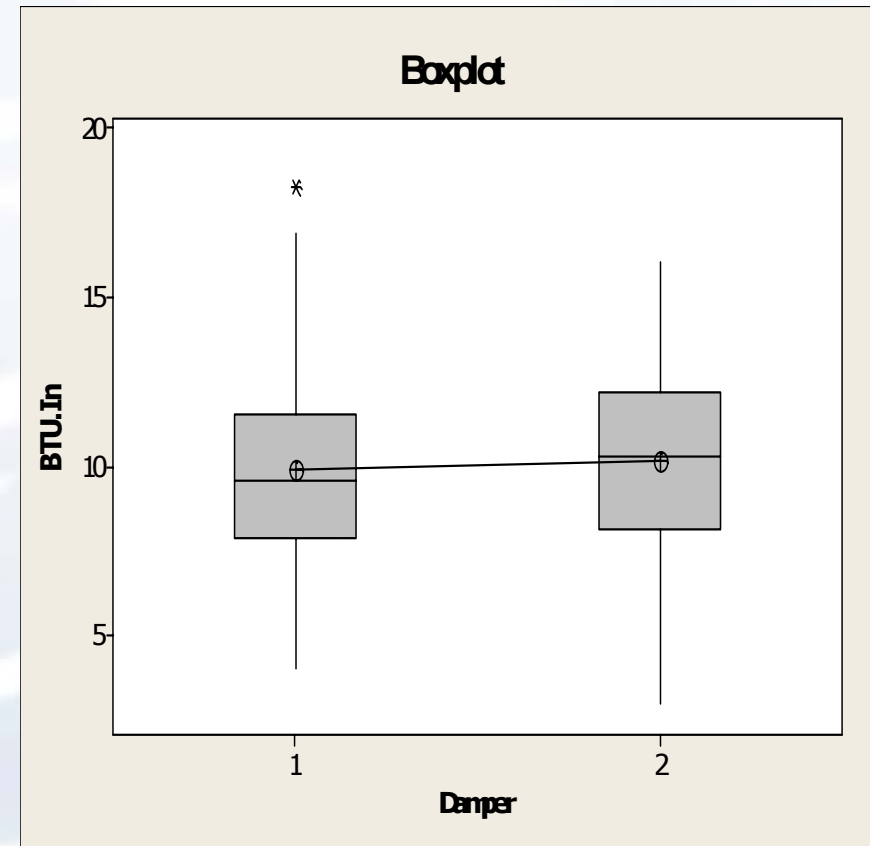
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MINITAB Release 14 – ANOVA & Graphics

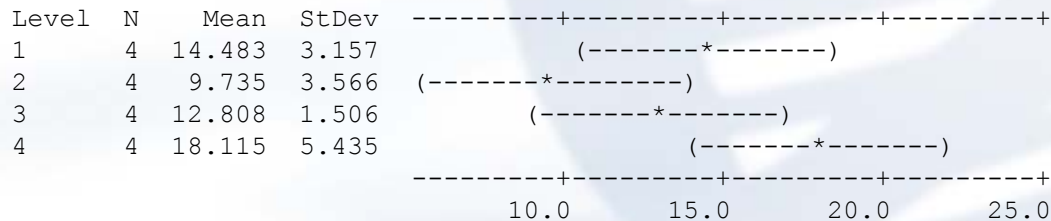
Confirming Improvements

One-way ANOVA: Durability versus Carpet

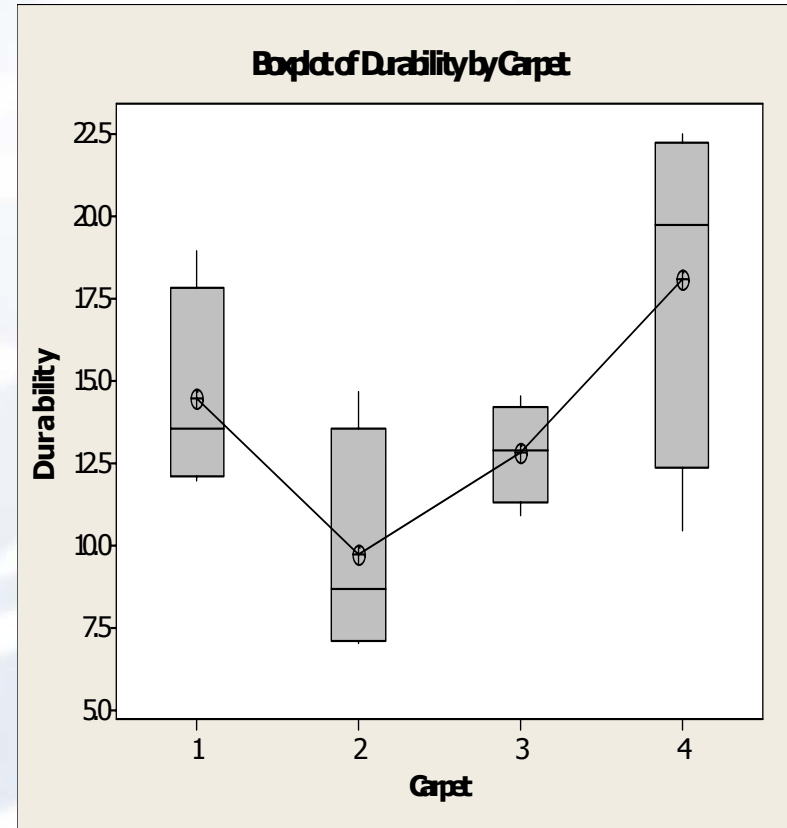
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Individual 95% CIs For Mean Based on Pooled StDev



Pooled StDev = 3.691



MINITAB Release 14 – Regression Prediction Methods

Regression Analysis: Score1 versus Score2

The regression equation is
 $\text{Score1} = -4.67 + 4.40 \text{ Score2}$

Predictor	Coef	SE Coef	T	P
Constant	-4.6674	0.8572	-5.44	0.001
Score2	4.3975	0.3514	12.51	0.000

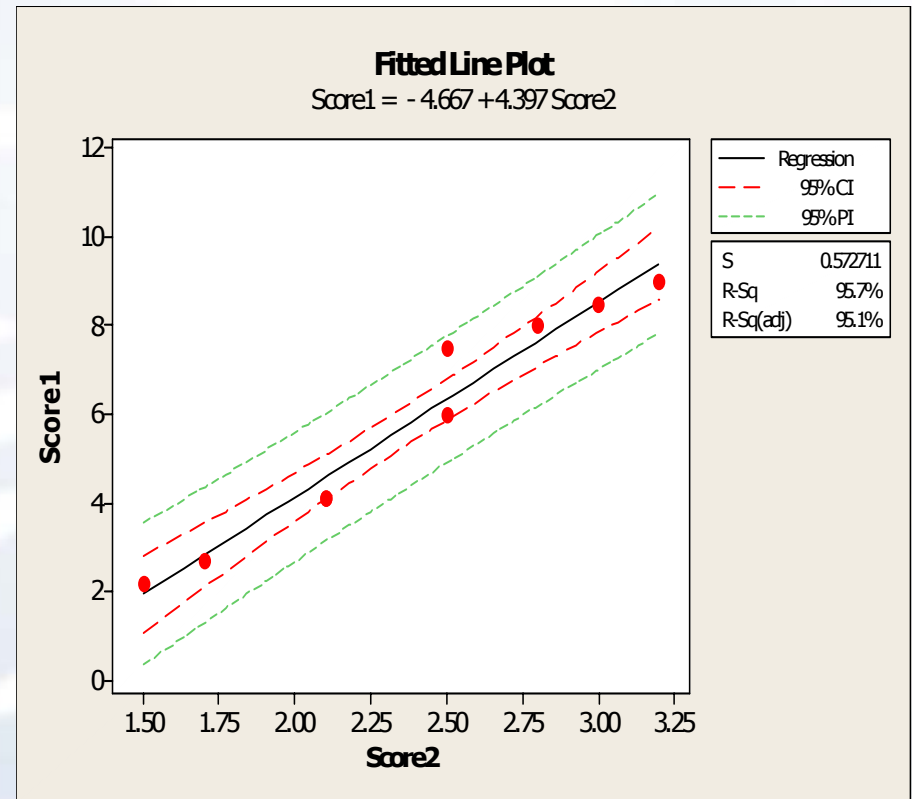
S = 0.572711 R-Sq = 95.7% R-Sq(adj) = 95.1%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	51.353	51.353	156.56	0.000
Residual Error	7	2.296	0.328		
Total	8	53.649			

Predicted Values for New Observations

Obs	Fit	SE Fit	95% CI	95% PI
1	4.567	0.214	(4.060, 5.074)	(3.121, 6.013)
2	1.929	0.363	(1.071, 2.787)	(0.326, 3.532)
3	2.808	0.305	(2.087, 3.530)	(1.274, 4.343)
4	6.326	0.196	(5.864, 6.789)	(4.895, 7.757)
5	8.525	0.290	(7.839, 9.212)	(7.007, 10.043)
6	4.567	0.214	(4.060, 5.074)	(3.121, 6.013)
7	9.405	0.346	(8.586, 10.224)	(7.822, 10.987)
8	7.646	0.242	(7.074, 8.217)	(6.176, 9.116)
9	6.326	0.196	(5.864, 6.789)	(4.895, 7.757)



MINITAB Release 14 – DOE & Response Optimizer

Determine Optimal Settings

Response Surface Regression: BeanYield vs Nitrogen, PhosAcid, Potash

Estimated Regression Coefficients for BeanYield

Term	Coef	SE Coef	T	P
Constant	10.4623	0.4062	25.756	0.000
Nitrogen	-0.5738	0.2695	-2.129	0.059
PhosAcid	0.1834	0.2695	0.680	0.512
Potash	0.4555	0.2695	1.690	0.122
Nitrogen*Nitrogen	-0.6764	0.2624	-2.578	0.027
PhosAcid*PhosAcid	0.5628	0.2624	2.145	0.058
Potash*Potash	-0.2734	0.2624	-1.042	0.322
Nitrogen*PhosAcid	-0.6775	0.3521	-1.924	0.083
Nitrogen*Potash	1.1825	0.3521	3.358	0.007
PhosAcid*Potash	0.2325	0.3521	0.660	0.524

S = 0.9960 R-Sq = 78.6% R-Sq(adj) = 59.4%

Analysis of Variance for BeanYield

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Regression	9	36.465	36.465	4.0517	4.08	0.019
Linear	3	7.789	7.789	2.5962	2.62	0.109
Square	3	13.386	13.386	4.4619	4.50	0.030
Interaction	3	15.291	15.291	5.0970	5.14	0.021
Residual Error	10	9.920	9.920	0.9920		
Lack-of-Fit	5	7.380	7.380	1.4760	2.91	0.133
Pure Error	5	2.540	2.540	0.5079		
Total	19	46.385				

