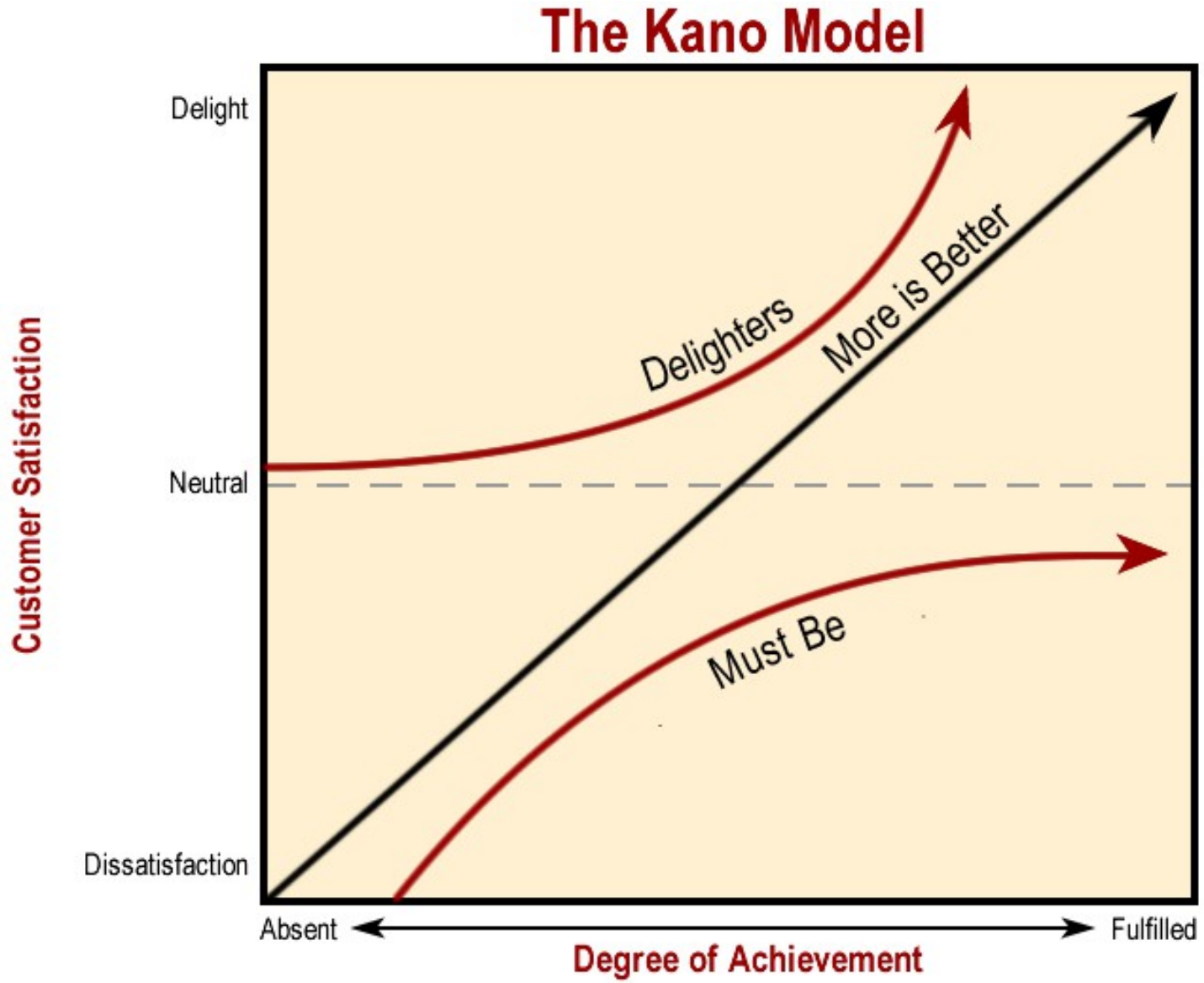
INTRODUCTION TO LEAN SIX SIGMA

WHAT IS QUALITY?


The Kano Model
Delight
Neutral
Dissatisfaction
Customer Satisfaction
Delighters
More is Better
Must Be
Absent
Fulfilled
Degree of Achievement

Objectives

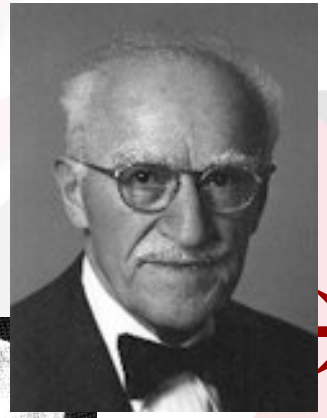
- Define Six Sigma
- Provide a brief history of Six Sigma
- Discuss the benefits of a Six Sigma deployment
- Introduce the DMAIC problem solving process
- Discuss roles and responsibilities in a Six Sigma deployment

The History of Quality Improvement

Pre-Industrial Revolution: Craftsmen Guilds

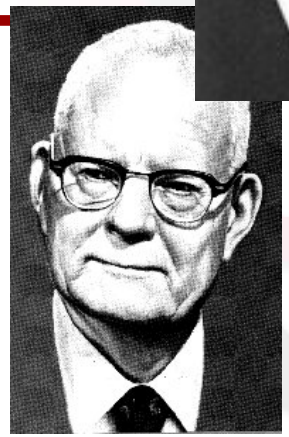
Ford's First Assembly Line 1913

Deming's and Juran's principles of quality are welcomed in Japan 1950's

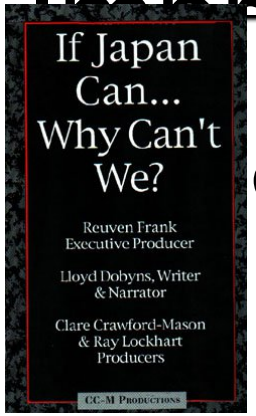


1880's Taylor's methods Of Scientific Management adopted by industry.

Shewhart introduces the control chart 1924



The History of Quality Improvement



If Japan Can, Why Can't We featuring Deming airs on NBC
1980

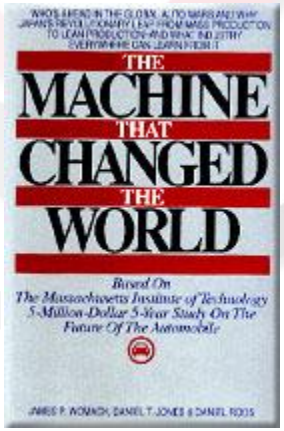
Malcolm Baldrige National Quality Award issued
1988

ISO 9000:2000 mandates executive involvement in quality

First International Conference on Quality held in Japan. Feigenbaum uses the phrase "total quality"
1969

Motorola "invents" Six Sigma
1986

Womack, Jones & Roos coin the phrase "Lean Manufacturing" in their book The Machine that Changed the World
1990

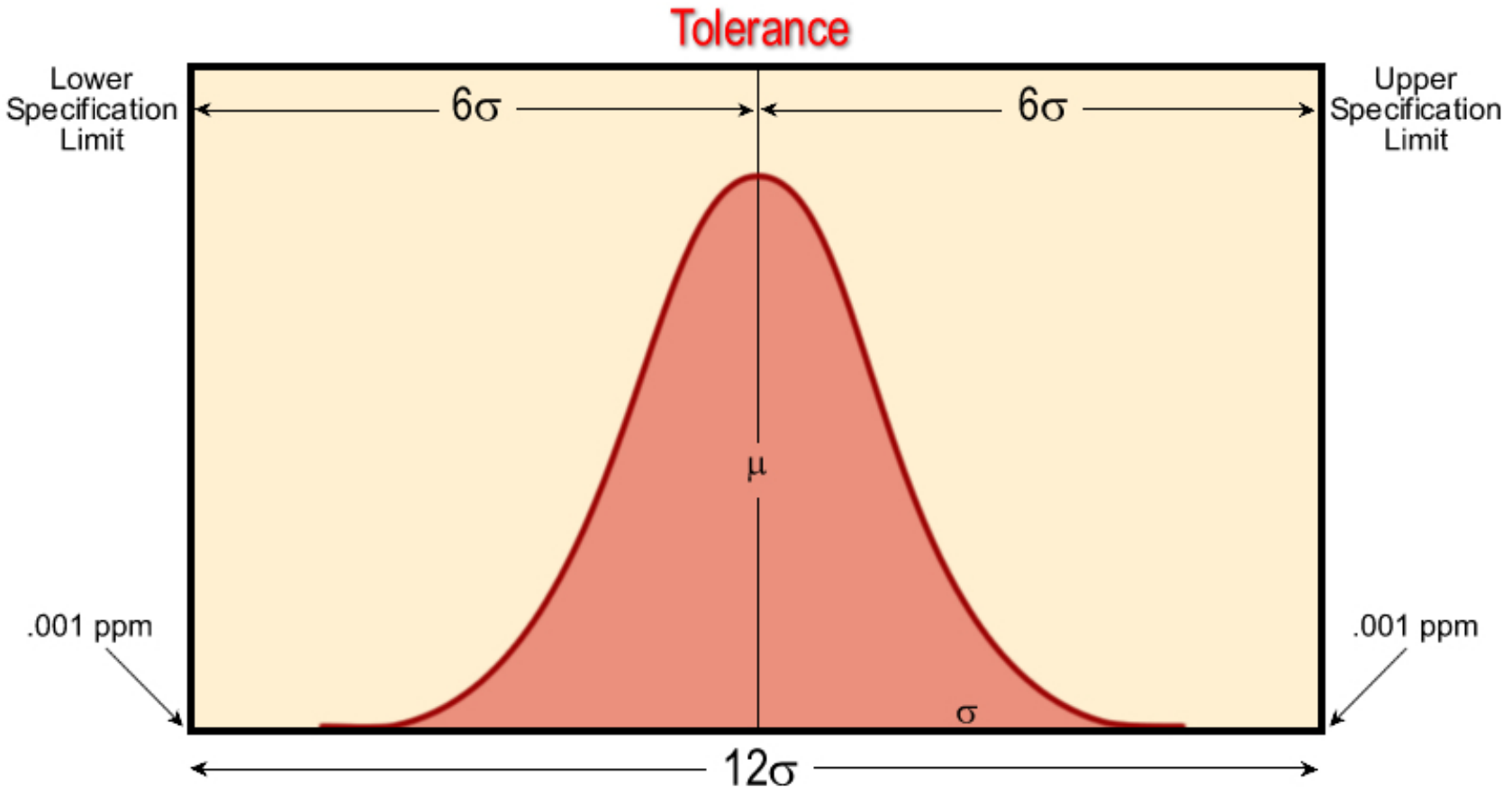


The History of Six Sigma

- In the 1980's, struggling with competition from foreign manufacturers and their own poor quality, Motorola's CEO, Bob Galvin, sets a goal of a 10 – fold improvement in 5 years.
- In 1987, Galvin launched the company wide "Six Sigma Quality Program" with the goal to reach a quality standard of 3.4 defects per one million opportunities (DPM).
- Motorola won the inaugural Baldrige National Quality

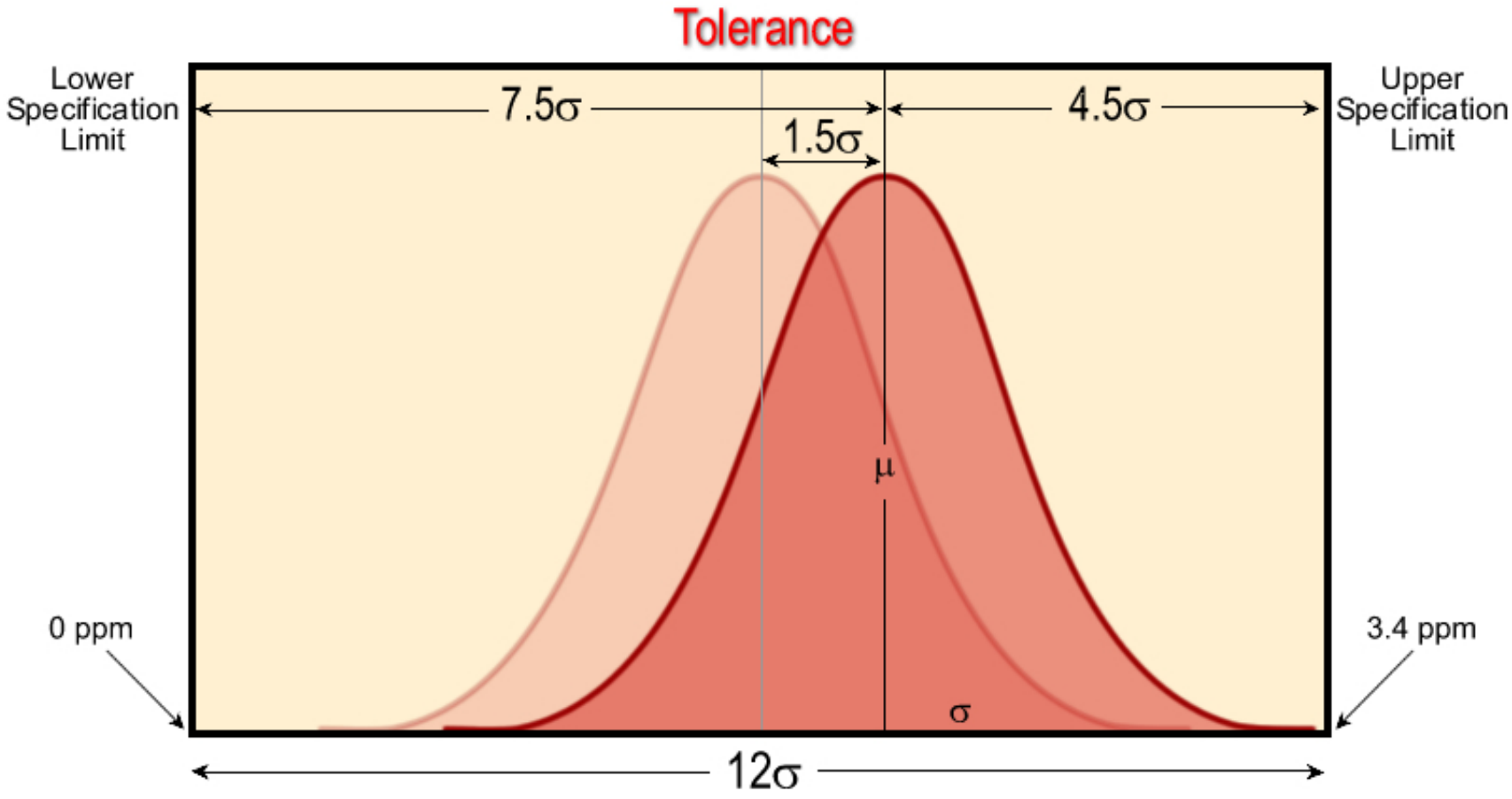
Motorola's Original Definition

Static Process (With No Shift in Process Average)



Motorola's Original Definition

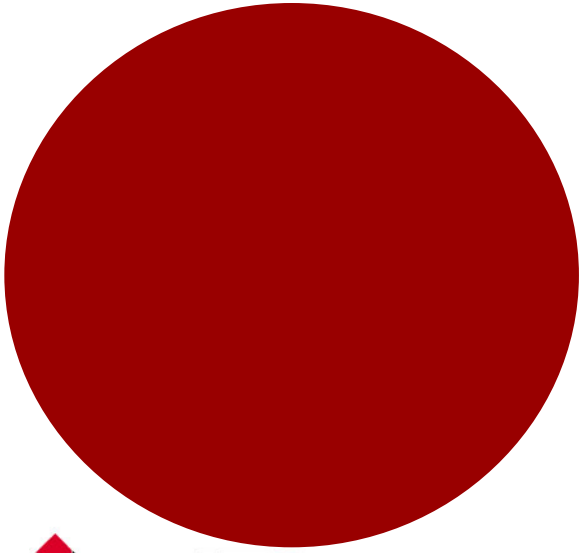
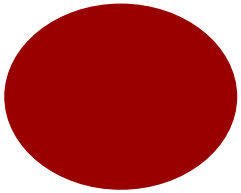
But Processes are Dynamic…



Process average can shift 1.5σ above (or below) middle of tolerance.

Sigma Levels

	3σ capability	4σ capability	5σ capability	6σ capability
% Correct	93.319%	99.379%	99.9767%	99.99966%
DPMO	66,807	6,210	233	3.4


The New Definition…

"While the old Six Sigma was just a metric, the new Six Sigma is a management system for running the business on a day-to-day basis."

Six Things to Know About the History of Six Sigma
- Motorola University

Six Sigma is…

- A Philosophy for Quality Improvement
- Scientific Problem Solving Methods
- A Statistical Measure of Variability
- A Reduction in Defects in an Operation or Process
- An Innovative Approach to Training
- A Way to Achieve Significant Savings
- Breakthrough Improvements in Performance

A Philosophy

"We now believe that perfection is possible."

Robert Galvin, Chairman
Motorola Executive Committee

Six Sigma is NOT

- A complicated way to manage your organization
- A new way for the ‘quality department’ to audit reports
- Something that requires you to discard what you learned with TQM, CQI, etc.
- A new way to spend money without clear benefit to the organization
- Something that requires complicated computer systems

Expansion of Six Sigma

Lean & Six Sigma

6σ

What is Lean?

- Focus on reducing the number of or eliminating non-value-added steps in a process
- Eliminating wastes in processes
- Analyzing and improving process flows
- Reducing complexity

Integrating Lean and Six Sigma

- Natural evolution
- Applying the right tools to a project
- Leverage the tools and methodologies to maximize process improvements
- Reducing waste and variability go hand in hand in process improvement

What is Lean Six Sigma?

A business improvement methodology that integrates tools from lean manufacturing practices and six sigma to enable companies to deliver better quality processes and products with the speed demanded by their customers.

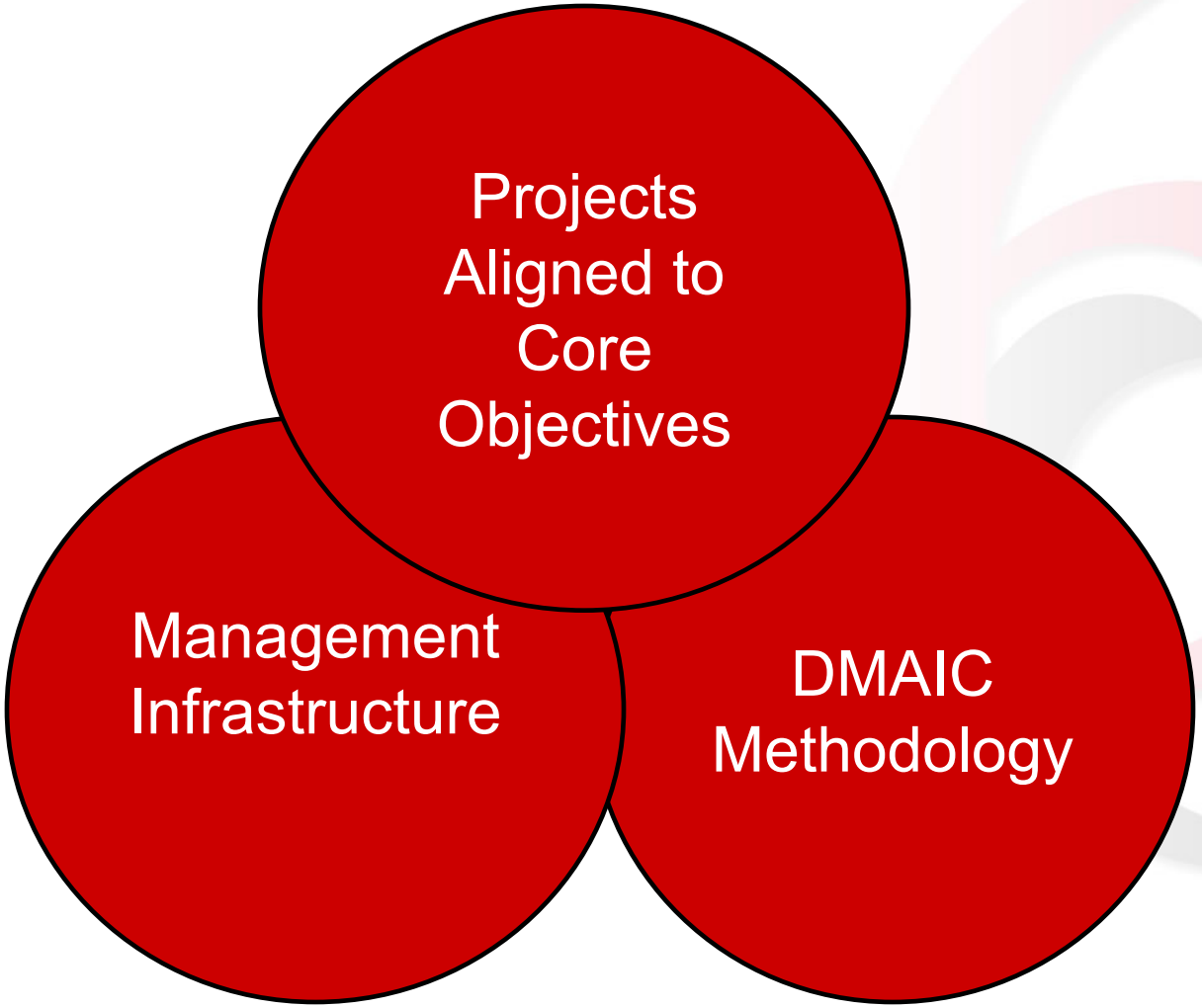
Benefits of Lean Six Sigma

- Improved quality, efficiency and margins
- Improved customer satisfaction
- Self-sustaining infrastructure
- Commonality of language, training, tools and methods

Key Elements in a Six Sigma Implementation

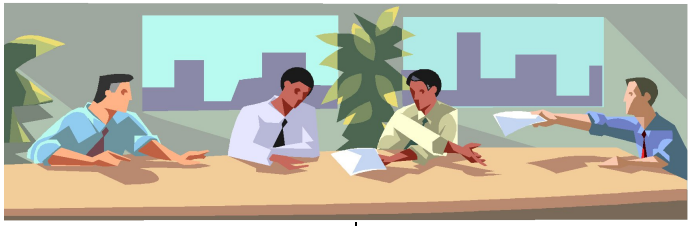
SIX SIGMA INFRASTRUCTURE

Key Elements of Six Sigma

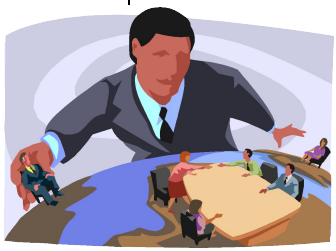


Management Infrastructure

Executive Team



Champions



Green Belts and Black Belts

Executive Team

- Six Sigma Vision
- Mandate Improvement
- Identify Champions
- Review All Projects

Champions

- Communicate the Vision
- Select Projects
- Select Candidates for Training
- Review Projects Weekly
- Remove Barriers and Supply Resources

Green Belts

- Lead Small Six Sigma Projects
- Participate as Team Members on Larger Projects
- Communicate Six Sigma to Organization
- Carry out Technical Tasks, Collect and Analyze Data

Black Belts

- Manage and Facilitate Six Sigma Project Teams
- Discover Opportunities for New Six Sigma Projects
- Mentor Green Belts and Team Members
- Train Team Members
- Influence Others in the

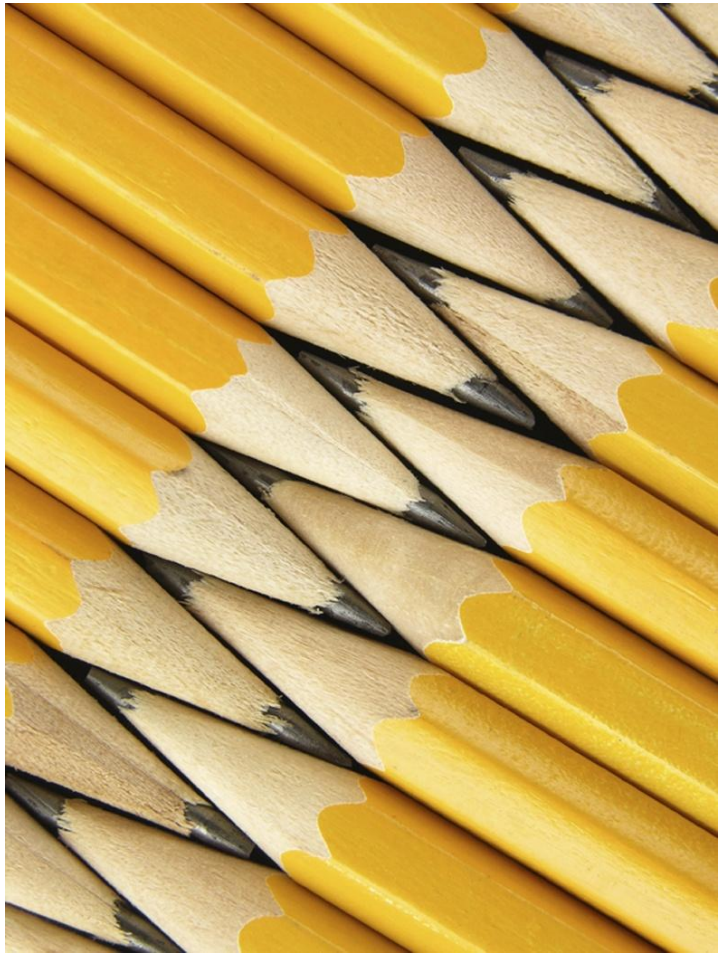
Master Black Belt

- Lead Mega Projects
- Provide Statistical Expertise to Black Belts and Green Belts
- Coach and Teach Belts

Innovative Training

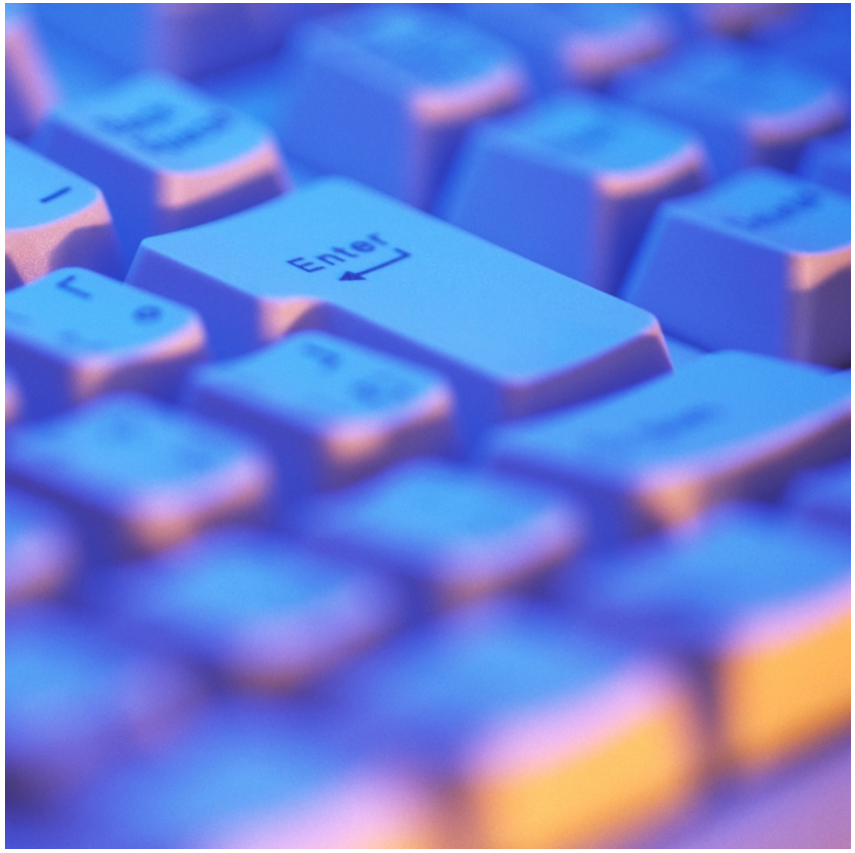
- Learn – do, do, and do
- Examples, case studies, and projects reinforce learning
- Application to projects during training cycle assures use of methods and results
- Consulting support for project leaders reinforces training
- Networks of project leaders provide additional support and focus on results
- Standardized computer software to utilize Six Sigma tools throughout organization

Hand Tools



- Brainstorming
- Cause & Effect Matrix
- Fishbone Diagrams
- Error Proofing
- Histograms
- Pareto Plots
- Process Flow Diagrams
- Process Management Plans
- Scatter Diagrams
- Control Charts

Power Tools



- Value Stream analysis
- ANOVA
- Contingency Tables
- Linear Regression
- Logistic Regression
- Designed Experiments
- Measurement Systems Analysis
- Process Capability

Key Six Sigma Concepts

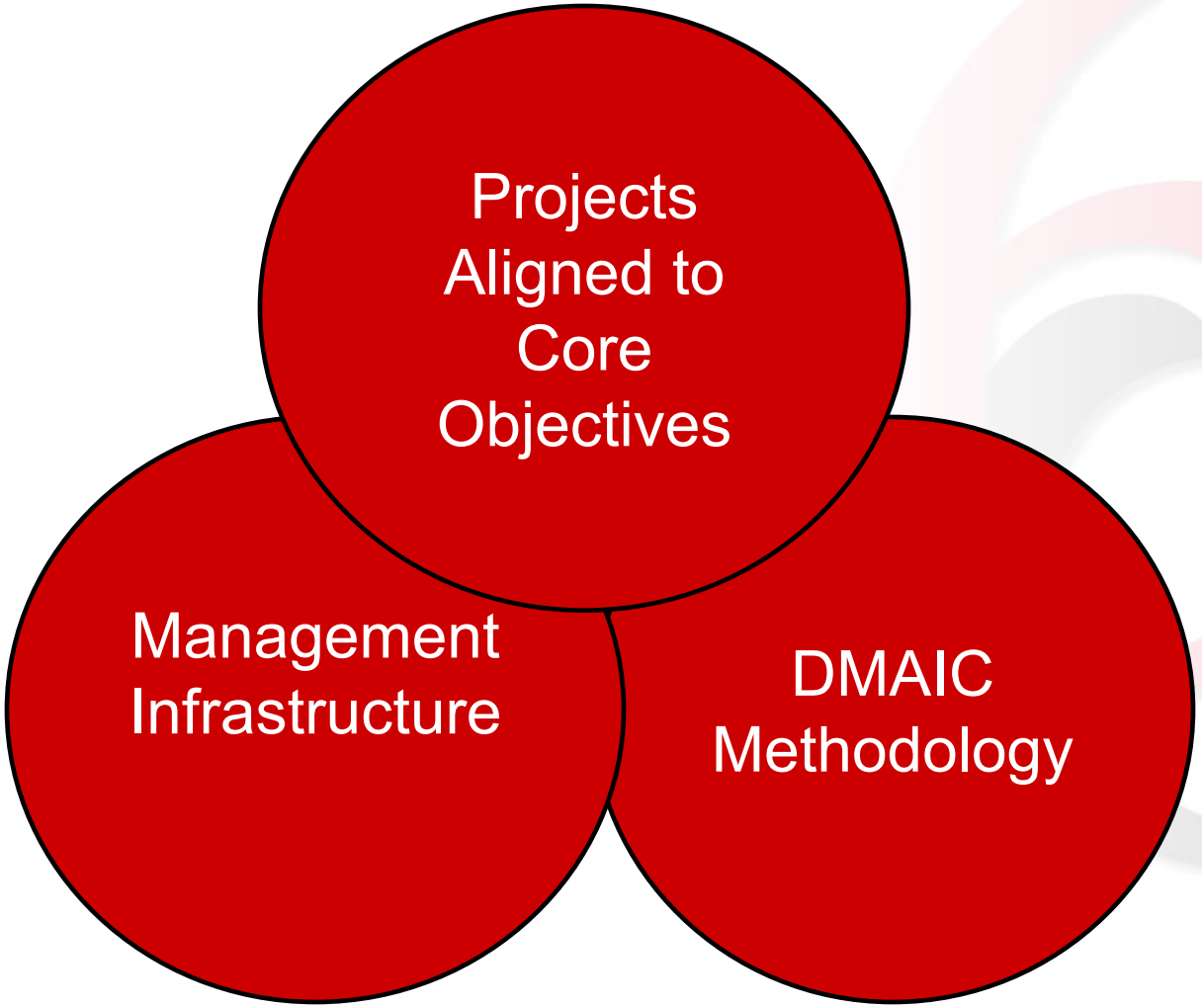
Voice of the Customer (VOC) → Critical to Quality (CTQ) → Project Metrics (Y)

$$Y = f(X)$$

Key Elements in a Six Sigma Implementation

SIX SIGMA PROJECTS

Key Elements of Six Sigma



Selecting the Right Projects

- Aligned to core organizational strategies
- Scoped correctly
- Results can be easily quantified
- Address customer needs
- Contain an element of discovery

Emphasize Process, Focus on Results

- What really matters to the company – bottom line results
- Can we measure the impact of each project?
- How much has each project contributed this year and will contribute in future years?

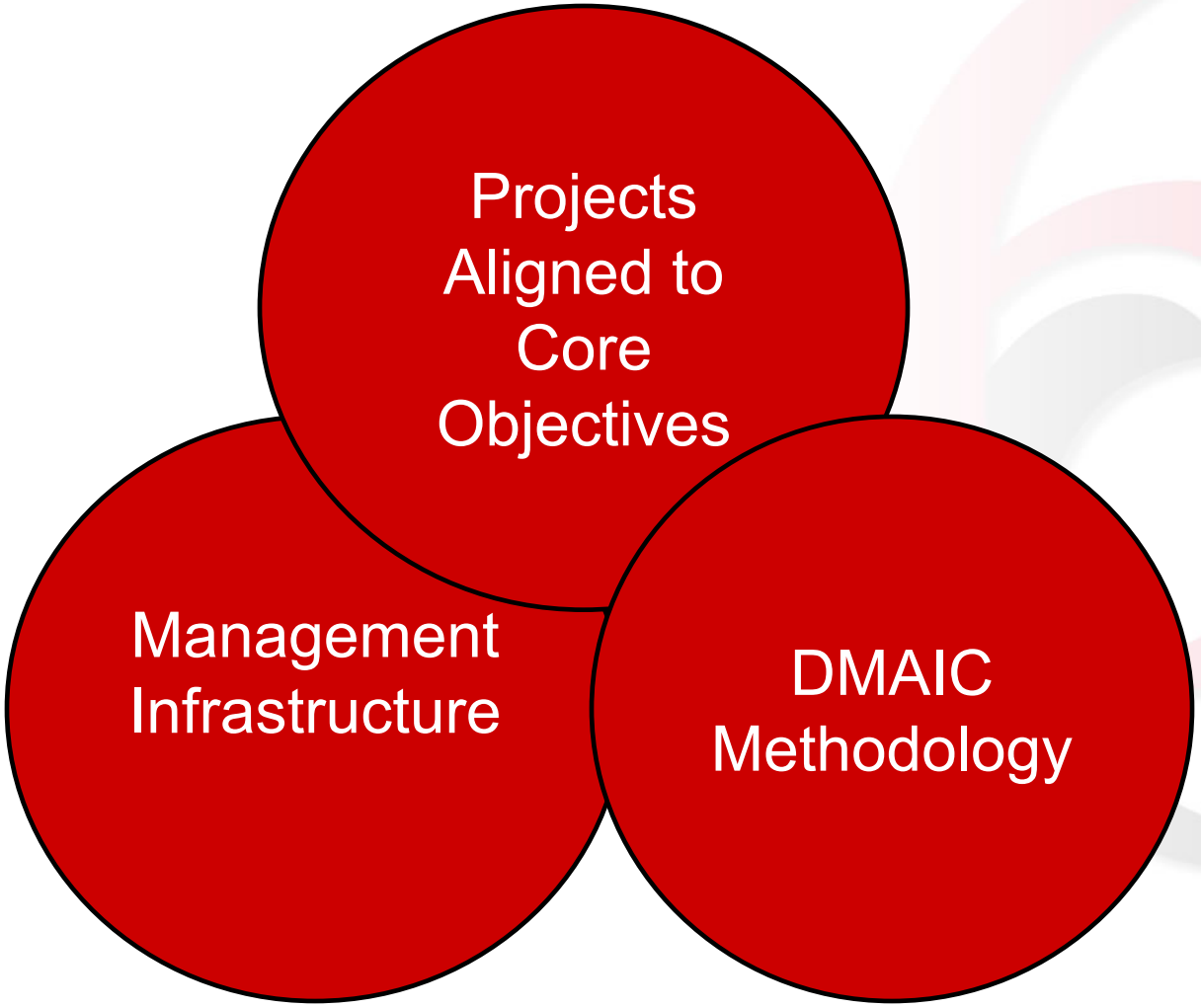
Focus on Results

- Safety
- Public Confidence
- Cost Avoidance
- Cost Savings
- Revenue Generation
- Quality Assurance

Key Elements in a Six Sigma Implementation

DMAIC METHODOLOGY

Key Elements of Six Sigma



Lean Six Sigma DMAIC Process

DEFINE
What problem are we addressing?

- ❑Potential projects evaluated and selected
- ❑Project charter completed
- ❑VOC collected and analyzed
- ❑Process mapped

MEASURE
What data is needed and what is the current performance?

- ❑Data collection plan created
- ❑Data collection completed
- ❑Process baseline established

ANALYZE
What are the root causes of the problem?

- ❑Potential root causes identified
- ❑Analysis of data completed

IMPROVE
What is the best solution to remove each root cause?

- ❑Brainstorm potential solutions
- ❑Pilot solutions
- ❑Optimize process outputs
- ❑Document solution implementation plan

CONTROL
How can we insure the gains are maintained?

- ❑Select appropriate controls
- ❑Document control plan
- ❑Deliver project documentation
- ❑Celebrate completed project

Define Flow

Develop a List of Potential Projects

Evaluate Projects based on Organizational Criteria

Initiate Project Charter: Problem Statement and Mission Statement

Collect VOC data

Use VOC Data to Develop CTQ Metrics

Complete a Stakeholder Analysis

Develop SIPOC, Process Maps and Value Stream Maps

Define Tollgate

Project Charter Worksheet

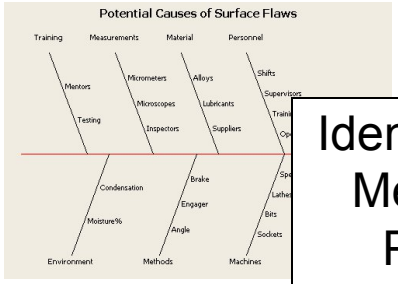
Date:	
Project Title:	
Project Leader:	
Champion:	

Team Members: Name	Function	% Time	Initials

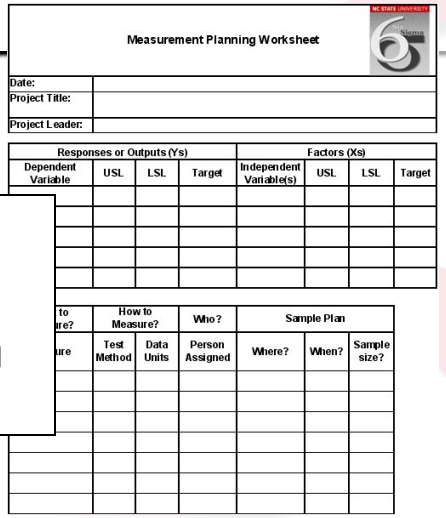
Define Tollgate

- Meet with project team and champion
- Initiate project charter
- Complete stakeholder analysis
- Collect Voice of the Customer data
- Generate project CTQs
- Map the process (SIPOC or general process map)

Measure Flow



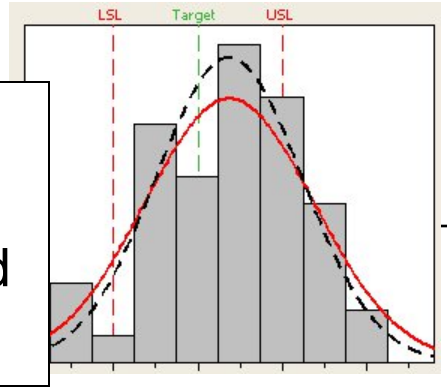
Identify Project Metrics and Potential Critical Xs



Create a Data Collection Plan

Validate Measurement System

Collect Data



Determine Process Baseline and Capability

Update Charter and Project Plan and Complete Measure Tollgate

Measure Tollgate

- Determine project critical Ys and Xs
- Create the data collection plan
- Complete a measurement systems analysis
- Collect data
- Calculate process capability and baseline
- Update charter

Analyze Flow

Brainstorm to create a list of potential root causes.

Examine data with graphical tools

Review Process Flow Maps

Create value stream maps

Use 5 Whys to List Potential Root Causes

Verify Root Causes

Prioritize Root Causes

Analyze Tollgate

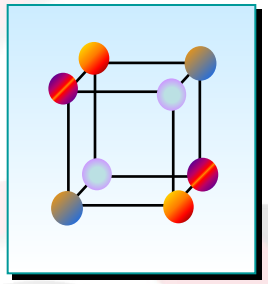
- Generate a list of potential root causes
- Data analysis to explore effect of potential root causes
- Process analysis to explore effect of potential root causes
- Verification of root causes
- Prioritize list of potential root causes

Improve Flow

Based on root cause analysis, brainstorm potential solutions, risks, costs and benefits.

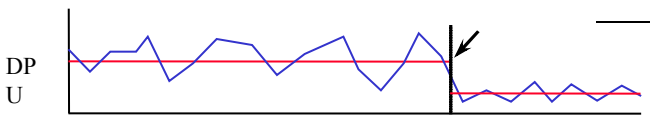
Prioritize Solutions

DOE Where Appropriate



Review / Approve solutions with management

Pilot solutions and measure effectiveness



Solution Implementation Plan

Reach Goals

Yes

No

Update financials & Project Plan Improve Tollgate

Improve Tollgate

- Brainstorm potential solutions for each root cause
- Prioritize potential solutions
- Create a pilot/DOE to test solution effectiveness
- Use data to verify the effectiveness of solutions
- Document new process
- Create a solution implementation plan

Control Flow

Brainstorm appropriate controls to sustain the gains

Select measurement based controls where appropriate

Create process management plan and review with management

Implement and validate controls

Realize project savings and determine final benefits

Hand over to process owner, determine translation opportunities and clear tollgate

Document and close Project. Celebrate!

Control Tollgate

- Determine appropriate controls
- Create a process management plan
- Implement and validate controls
- Develop translation plan
- Realize benefits of implementing solution
- Close project and communicate results

Lean Six Sigma DMAIC

Variation Reduction

DEFINE	MEASURE	ANALYZE	IMPROVE	CONTROL
What problem are we addressing?	What data is needed and what is the current performance?	What are the root causes of the problem?	What is the best solution to remove each root cause?	How can we insure the gains are maintained?
•Charter •VOC/CTQ •Project Plan •Stakeholder Analysis •Process Map	•Project Metrics •Potential Xs •Data Collection Plan •Defect Count •MSA •Capability •Baseline	•5 Whys •Process Maps •FMEA •Graphical Analysis •Hypothesis Testing	•DOE •Pilot •FMEA •Error Proofing	•SPC •Control Plan •Audits •Training •Translation

Waste Reduction (Lean)

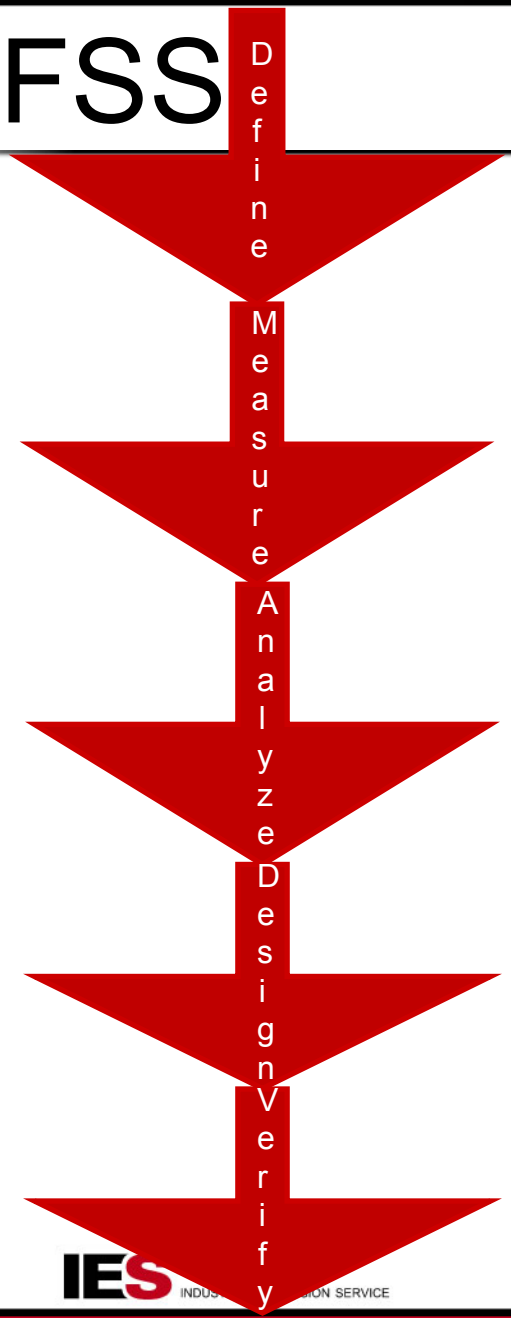
•Charter •VOC/CTQ •Project Plan •Stakeholder Analysis •Process Map •Value Stream Map	•7 Waste Determination •Cycle Time •WIP •Takt Time	•Graphical Data Analysis •Future State VSM	•5 S •Pull Systems •Error Proofing •Kaizen Events •Kanban •Load Leveling	•Process Flow Maps •Visual Controls •Audits •Training

DESIGN FOR SIX SIGMA

What is DFSS?

Design for Six Sigma (DFSS) is the process used by six sigma teams to invent new products, services, and processes that consistently meet customers' needs and expectations.

DFSS



Initiate, scope and plan the project

Understand customer needs and specify CTQs

Develop design concepts and high level design

Develop detailed design and control / test plan

Test design and implement full-scale processes

DMAIC and DFSS

DEFINE
What problem are we addressing?

MEASURE
What data is needed and what is the current performance?

ANALYZE
What are the root causes of the problem?

IMPROVE
What is the best solution to remove each root cause?

CONTROL
How can we insure the gains are maintained?

Does process or product exist?

Is an incremental improvement enough?

Is the improvement a new process or product?

DEFINE
What problem are we addressing?

MEASURE
What are the customer's needs?

ANALYZE
What is the high level design concept?

DESIGN
What is the best design?

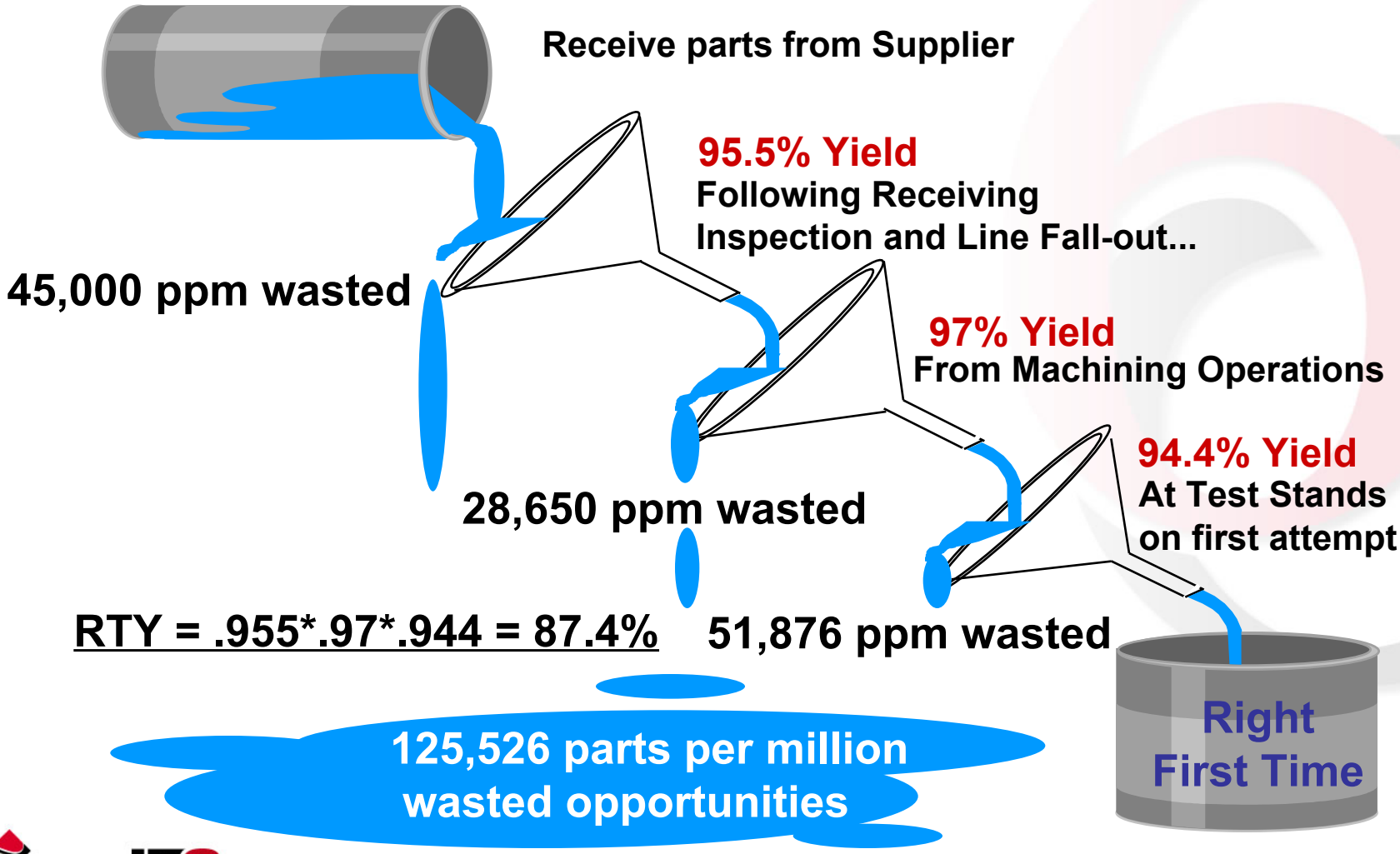
VERIFY
Does the new process / product meet the customer needs?

COST OF POOR QUALITY

Objectives

- Understand rolled throughput yield
- Review the traditional costs of poor quality
- Understand the true costs of poor quality and identify the sources of the hidden costs

Rolled Throughput or Total Process Yield



Rolled Throughput Yield Exercise

- Round 1

  RTY = ___% x ___% x ___% x ___% x ___%

  = ___%

- Round 2

  RTY = ___% x ___% x ___%

  = ___%

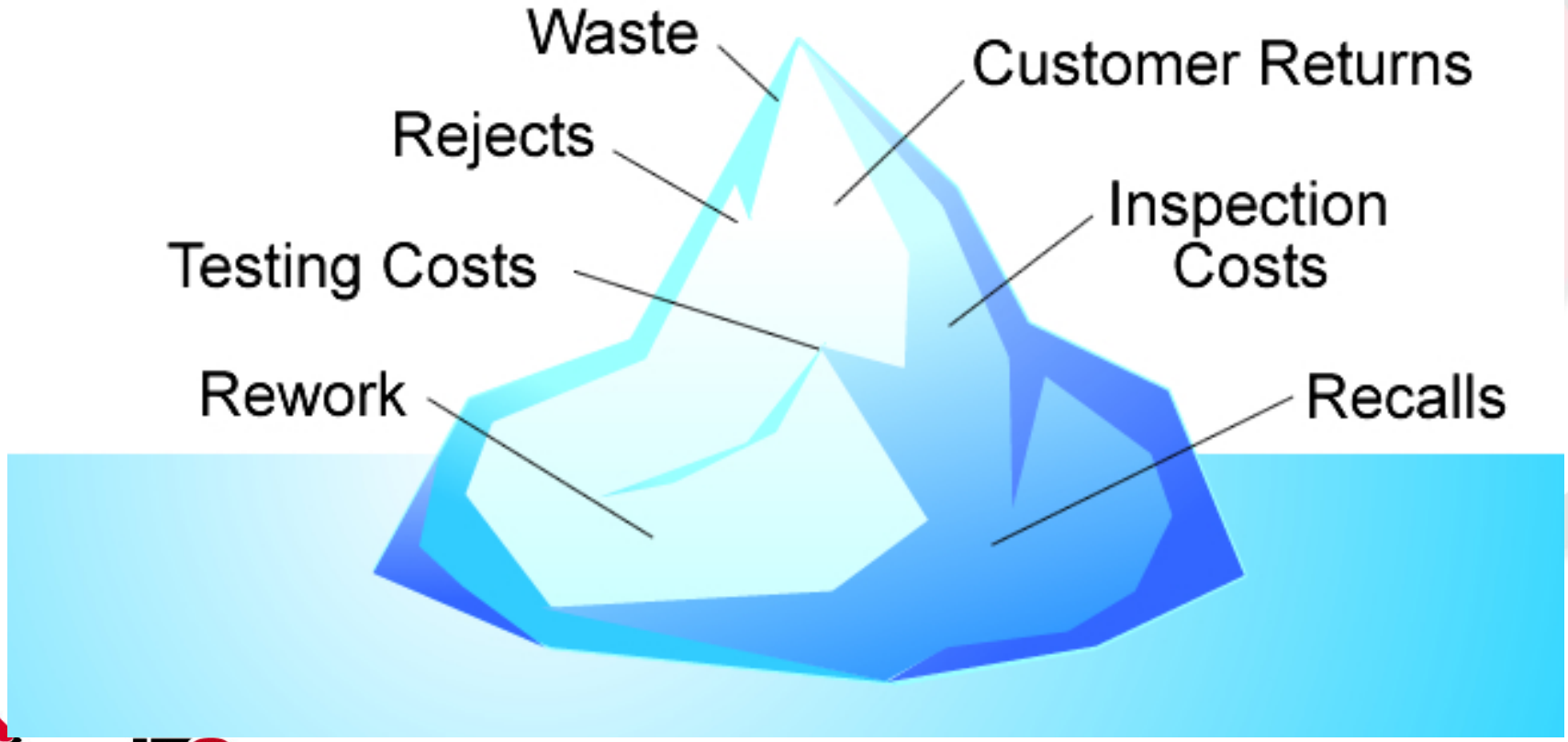
Cost of Poor Quality

- Prevention Costs
- Appraisal Costs
- Internal Failures
- External Failures

Traditional Cost of Poor Quality

(4-5% of Sales)

When quality costs are initially determined, the categories included are the visible ones as depicted in the iceberg below:

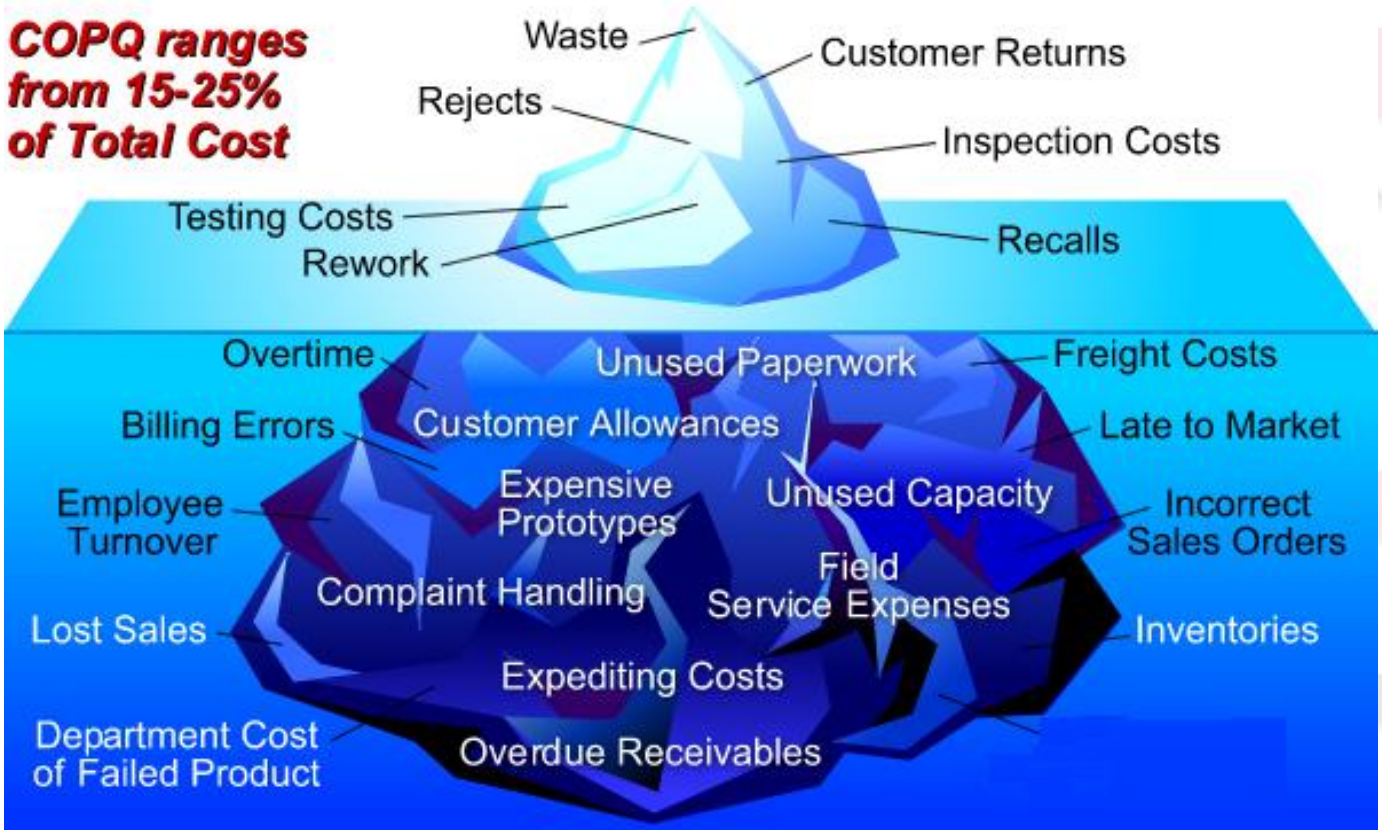


New Thinking About Poor Quality Costs

- Traditional costs of poor quality
- Hidden costs
- Lost income
- Customers' costs
- Socio-economic costs

Cost of Poor Quality

As a company gains a broader definition of poor quality, the hidden portion of the iceberg becomes apparent:



Examples of Hidden Costs

- Non-value-added work
- Unaccounted rework
- Meetings
- Excess inventories
- Early shipments

Examples of Lost Income

- Lost customer loyalty
- Poor word of mouth
- Returns, replacements
- Discounts
- Unsold merchandise

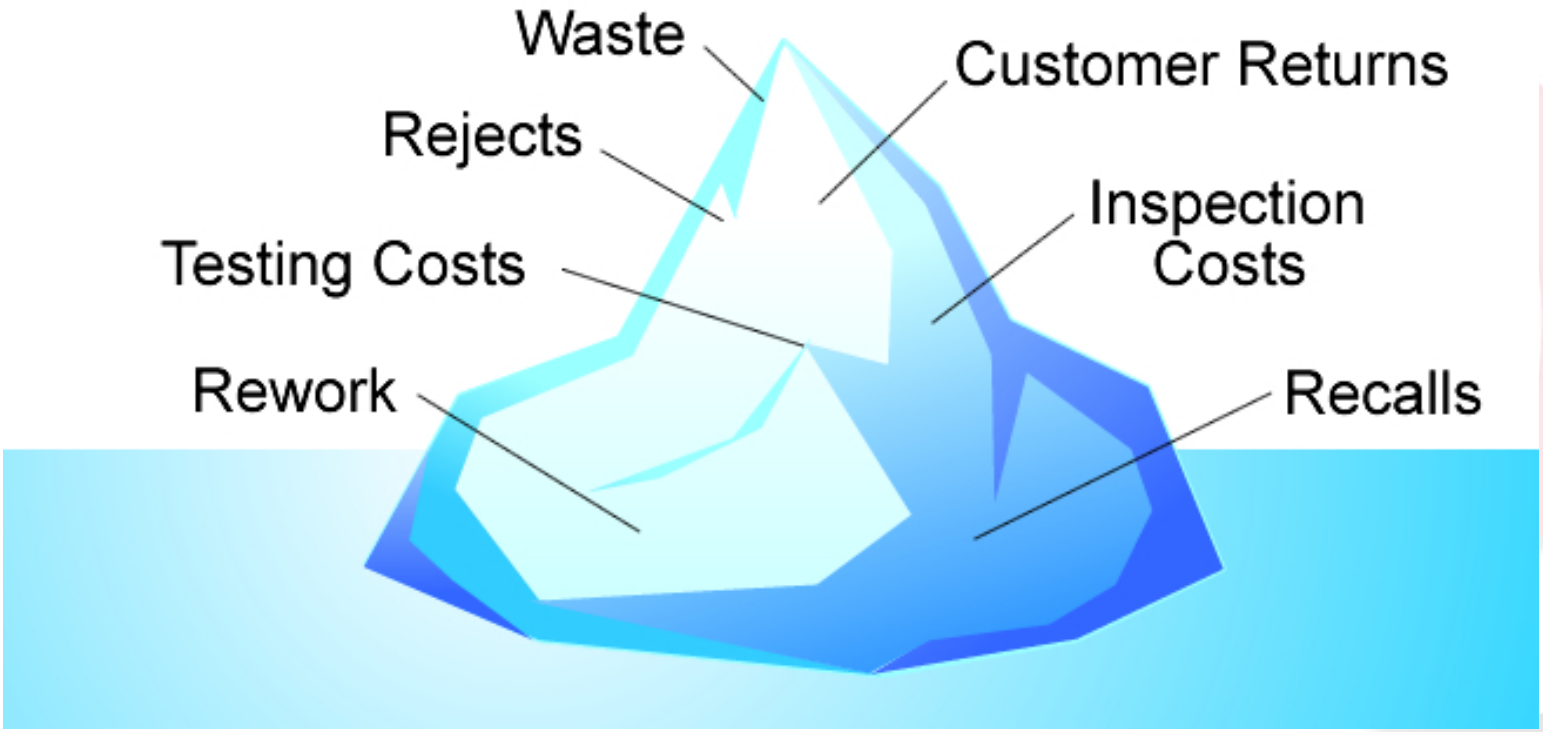
Examples of Customers' Costs

- Downtime
- Delays
- Repairs and maintenance
- Excessive training
- Excess inventory

Examples of Socio-economic Costs

- Environmental harm
- Excessive regulation
- Safety problems
- Over testing
- Program delays

Exercise



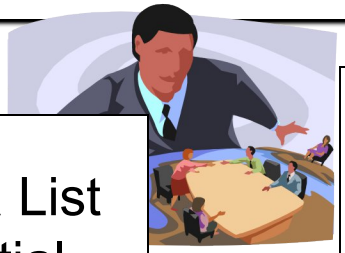
List the hidden costs of poor quality associated with your project

DEFINE: LAUNCHING THE SIX SIGMA PROJECT

Objectives

- Understand the flow through the Define phase of a six sigma project
- Create a project charter
- Complete a stakeholder analysis

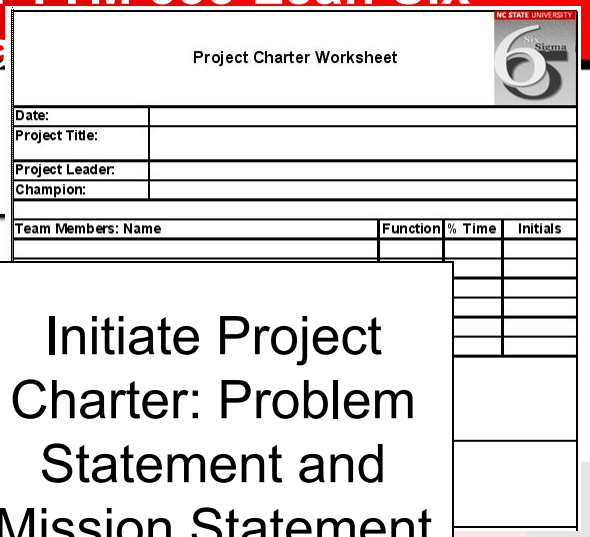
Define Flow



Develop a List of Potential Projects

Evaluate Projects based on Organizational Criteria

Initiate Project Charter: Problem Statement and Mission Statement

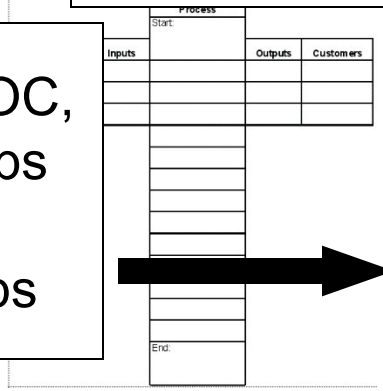


Collect VOC data

Use VOC Data to Develop CTQ Metrics

Complete a Stakeholder Analysis

Develop SIPOC, Process Maps and Value Stream Maps



Define Tollgate

Improvement Projects

"All improvement takes place project by project and in no other way."

Dr. Joseph M. Jura

Nominating Projects

- Customer complaints and returns
- Measurement and assessment
  - Costs of poor quality
  - Field failures
  - Overstocks and stock outs
- Critical items in financial reports
- Other black belt or green belt project teams
- Survey of all associates
- Strategic business plans

Selecting A Project - Criteria

- Chronic wastes
- Significant impact on business
- Manageable size, can be done by team
- Likely to be a winner, important for early projects
- Measurable and visible

Select Projects That:

- Have the greatest potential to:
  - Retain old and attract new customers
  - Reduce high costs of poor quality
  - Provide high returns on investment
  - Reduce time cycles
- Must be solved now
- Do not involve organizational change
- Do not have uncontrolled risks

Project Charters

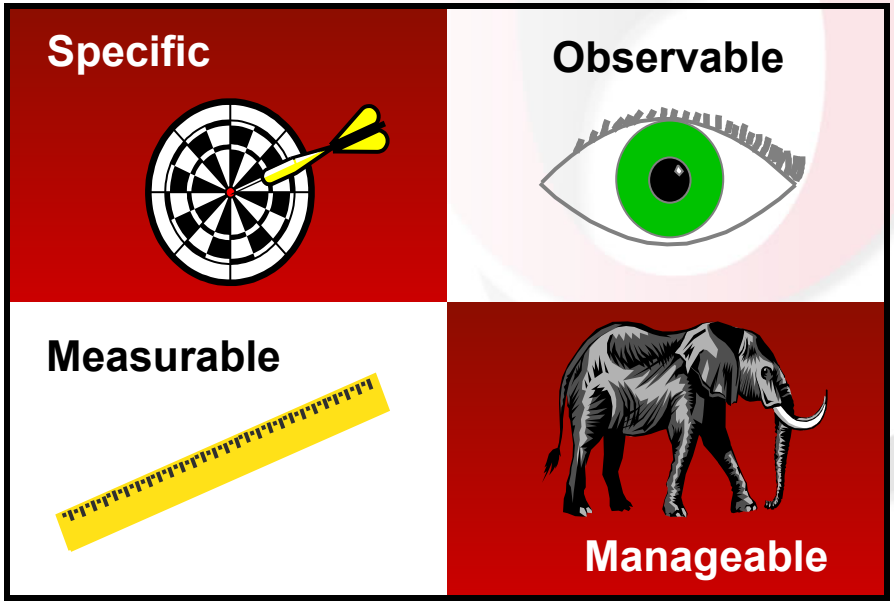
Project Charter Worksheet			
Date:			
Project Title:			
Project Leader:			
Champion:			
Team Members: Name	Function	% Time	Initials
Problem Statement:			
Mission Statement:			
Project Scope:			
Stakeholders:			
Business Case:			

- Contract between the six sigma team and the champion
- Define the purpose for the six sigma project
- Updated as new information is obtained

Problem Statements

A good problem statement:

- States the facts
- Assesses Economic Impact
- Is targeted
- Is visible
- Is linked to strategic objectives



Problem Statements Should Never:

- Infer blame
- Guess at the root cause
- Guess at a solution

Prepare A Problem Statement (Ex. 1)

Problem Statement:

Our company's procedure for submitting responses to RFPs has many delays because we have to gather information from multiple departments.

Prepare A Problem Statement (Ex. 2)

- Problem Statement

  We submit 23% of our responses to RFPs past the due date. We could reduce late responses with the installation of a new computer based collaboration system.

Prepare A Problem Statement (Ex. 3)

- Problem Statement

  We have missed the deadline for submission date on RFPs 23% of the time in the last six months, resulting in loss of revenue.

  - **This statement is:**
    - **Specific**. It names a particular process and what the problem is.
    - **Observable**. Evidence of the problem can be obtained from internal reports and customer feedback.
    - **Measurable**. Response time is measured in days.
    - **Manageable**. The problem is limited to one type of process.

Mission Statements

- Define the intended end result
- Establish clear responsibility
- Provide legitimacy
- Confer rights to the green belt team
- Quantify two or three critical elements:
  - The intended amount of improvement
  - The timetable
  - $$$ savings if possible

Prepare A Mission Statement

- Example: Good or Poor Mission Statement?
  - The project management group needs to reduce the number of late responses to RFPs they cause by not filling out the paperwork correctly the first time.

Prepare A Mission Statement

An effective mission statement also indicates the numerical goal of the project - what the results of a successful project will be.

- **Problem**: We have missed the deadline for submission date on RFPs 23% of the time in the last six months (Jan. 1 – June 30), resulting in loss of revenue.
- **Mission**: Reduce the percentage of late submissions to less than 1% in the next five months (by Dec. 31) resulting in $XX in new revenue.

Practice Exercise 1:

Write a Problem Statement & Mission Statement

- An auditing firm has started to experience difficulty in submitting the final project reports to its customers. The data management group is blaming the field agents for not collecting the data in a timely manner, but the program director believes that the sales group is over committing company resources and making unrealistic promises on delivery dates. The company's relationship is suffering and the number of new projects rewarded to the company has started to decline in the last three months.

Practice Exercise 1:

Problem Statement & Mission Statement

- Problem Statement:

- Mission Statement:

Practice Exercise 2:

- Using the charter template provided, write a problem statement and a mission statement for your project.

Stakeholder Analysis

- A comprehensive Stakeholder Analysis helps teams gain the support and cooperation from key players outside the six sigma team.
- Teams should:
  - Identify stakeholders
  - Determine their interest/position in the project as well as their influence
  - Develop a plan to get stakeholders' support

Stakeholder Analysis

- As a team, list all potential stakeholders
- Reduce the list to key people
- Determine whether the stakeholder will block or support the project
- Develop a plan to get stakeholders' support

Stakeholder Analysis Worksheet						
Date:						
Project Title:						
Project Leader:						
Stakeholder Name & Position	Relationship to Project					Communication Type & Frequency
	Is affected by outcome	Can influence outcome	Has useful expertise	Provides resources	Has decision authority	

Class Activity

1. Brainstorm a list of potential stakeholders for projects.
2. Brainstorm strategies for managing stakeholders.

VOICE OF THE CUSTOMER

Objectives

- Discuss collecting data on the voice of the customer
- Use voice of the customer data to develop project critical to quality (CTQ) metrics

Who is a Customer?

"A customer is anyone who receives or is affected by the product or process. Customers may be internal or external."

Joseph M. Juran

Key Six Sigma Concept

Voice of the Customer (VOC) → Critical to Quality (CTQ) → Project Metrics (Y)

Identifying the Customer

- Internal Customer
  - Next step in the process
  - Stakeholders
  - Process Owners
  - Management Team
- External Customer
  - End user of the product or service

Voice of the Customer (VOC)

- Some voice of the customer data may be readily available:
  - Warranty Requests
  - Complaints
  - Returns
- If teams need to collect information from customers they may:
  - Conduct surveys or interviews

Collecting VOC

- Mailed Questionnaire
- Interview
- Electronic Questionnaire
- Focus Groups
- Telephone

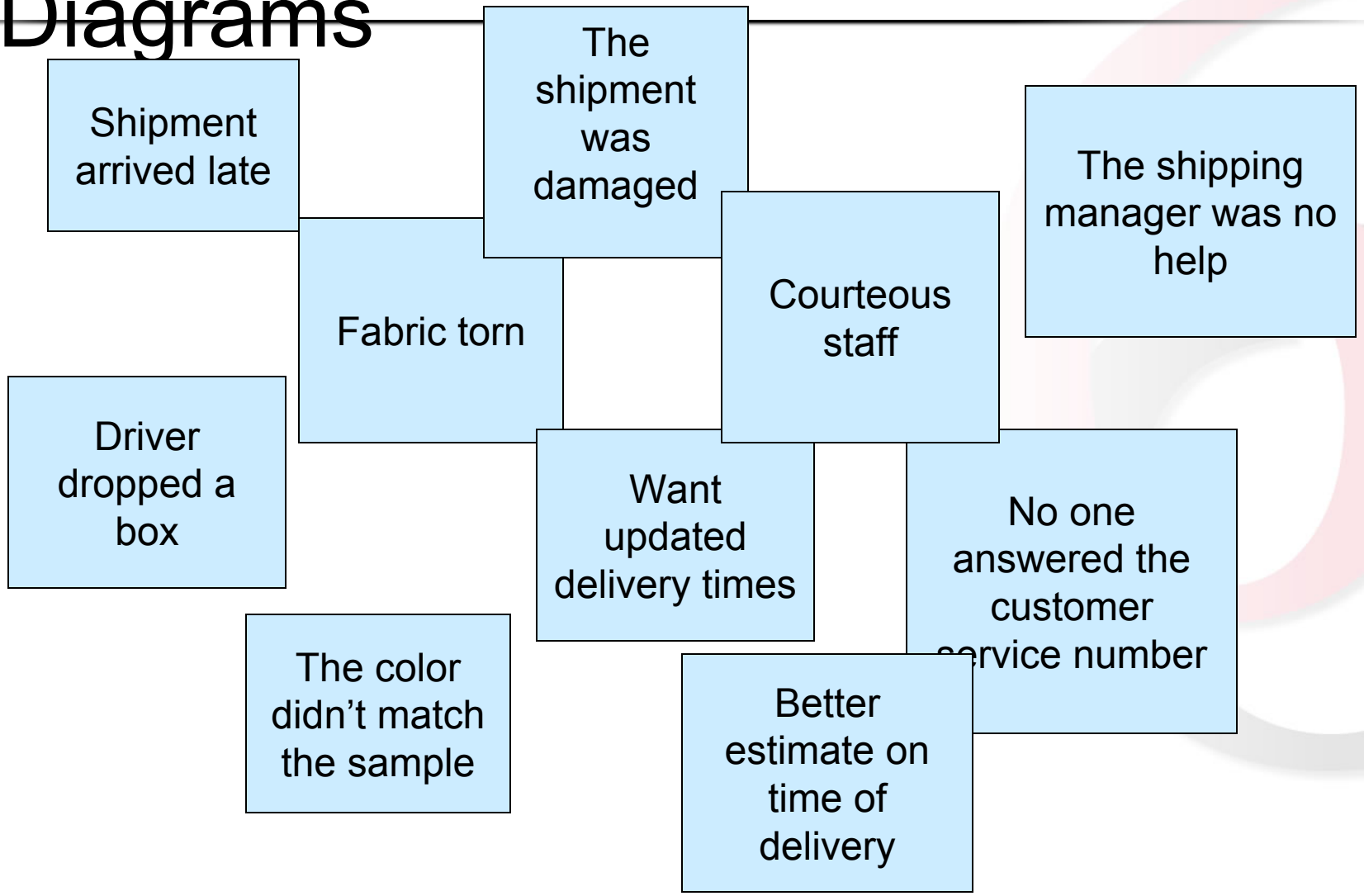
General Steps for Interviews and Surveys

- Review the problem statement
- Define the customer(s)
- Select customers to target for feedback
- Decide on the data collection technique
- Write questions for a questionnaire or interview
- Pilot the questions
- Conduct the interview or survey
- Analyze the data and debrief the team

Comparison of Data Collection Methods

	Mailed Questionnaire	Interview	Electronic Questionnaire	Focus Group	Telephone
Relative Cost	Low	High	Low perhaps	High	Low perhaps
Amount of time to collect data	Longer	Longest	Longer	Longest	Long
Response rate	Poorest	Very high	Poorest	Very high	Good
Require literate sample	Yes	No	Yes	No	No
Permit follow up questions	No generally	Yes	No generally	Yes	Yes
Encourage frank responses	Best	Weak	Best generally	Weak	Somewhat
Standardization of responses	Easy	Hardest	Easy	Somewhat	Somewhat

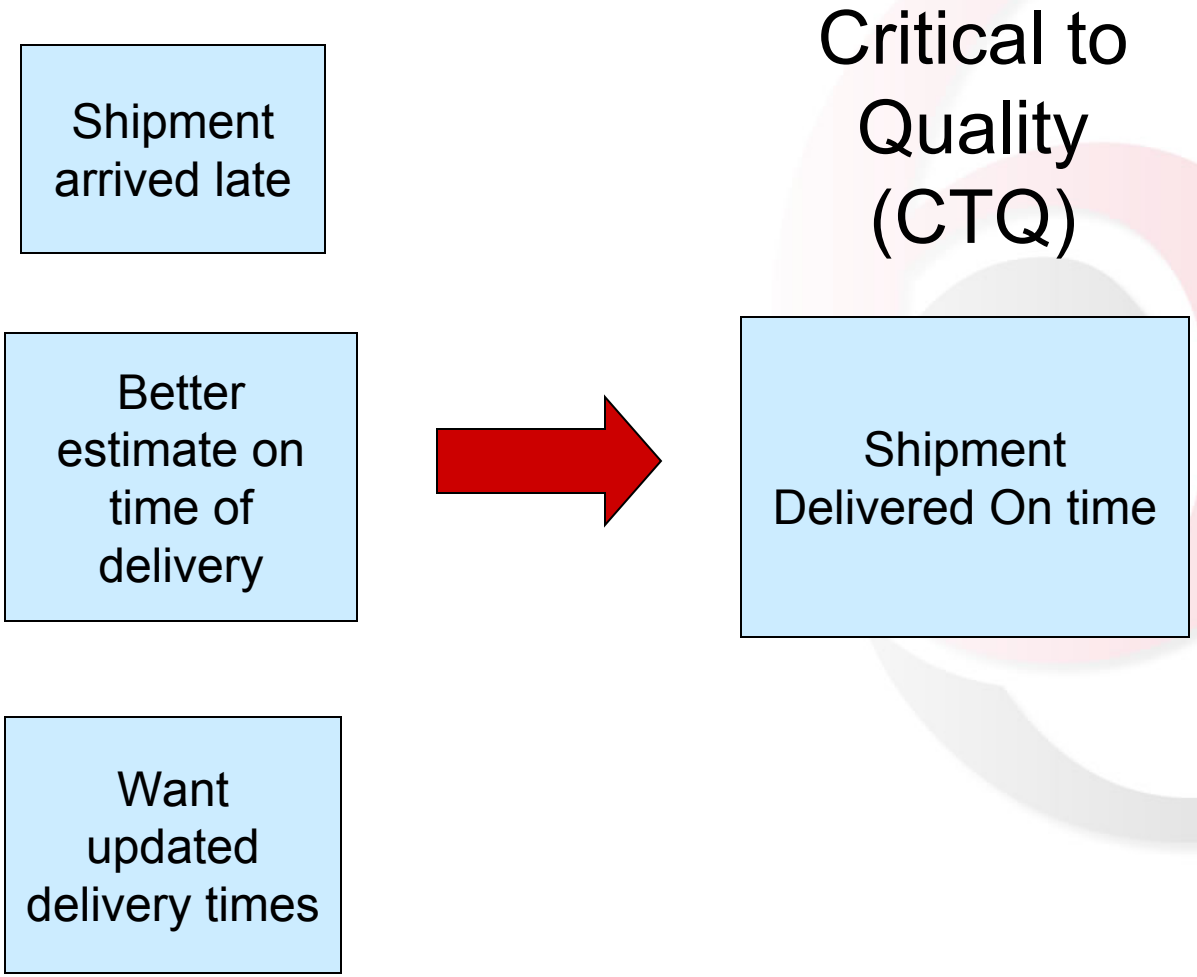
Analyzing VOC Data: Affinity Diagrams



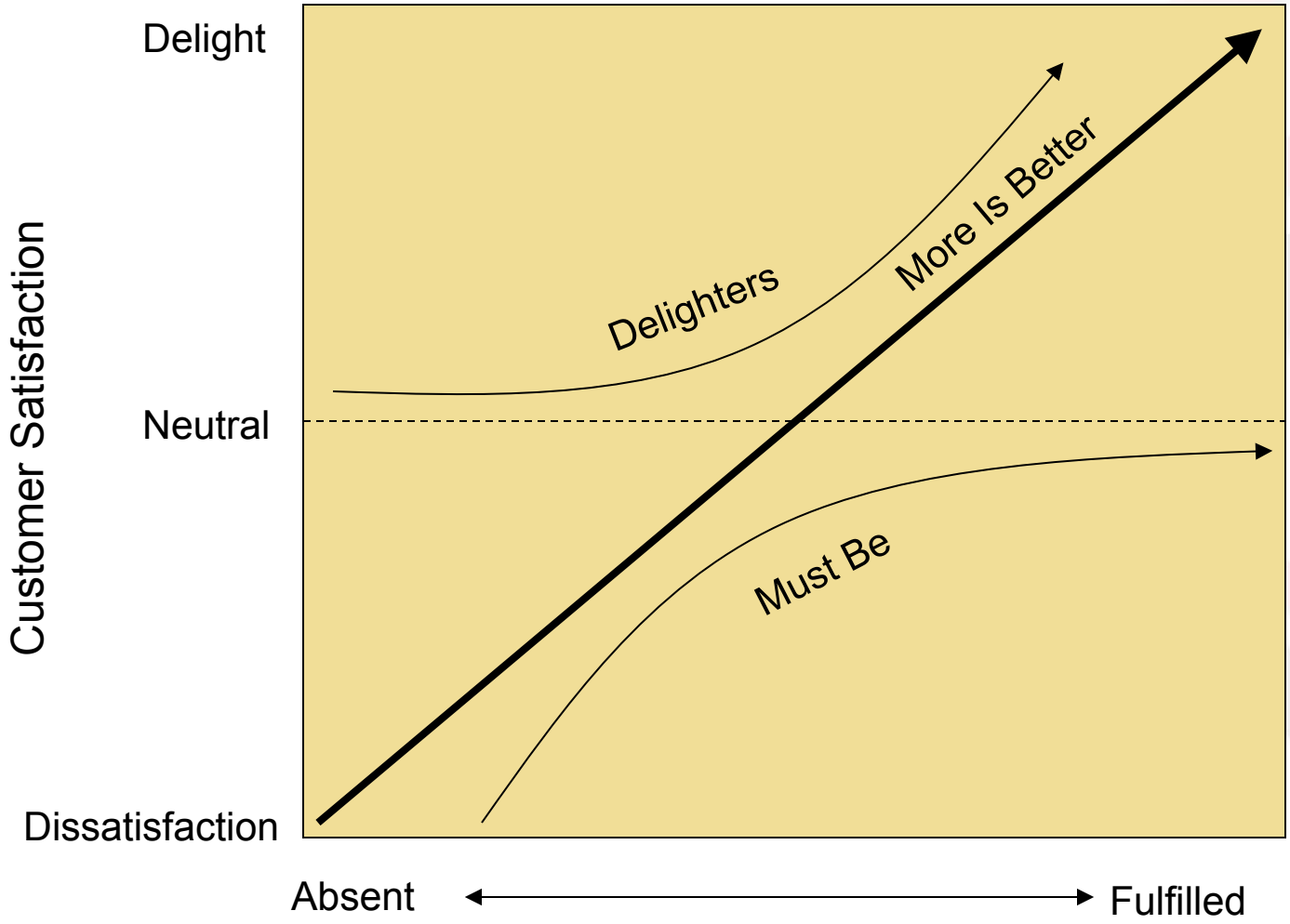
Analyzing VOC Data: Affinity Diagrams

Delivery Times	Product Quality	Customer Service
Shipment arrived late	My shipment was damaged	The shipping manager was no help
Better estimate on time of delivery	Fabric torn	Courteous staff
Want updated delivery times	Driver dropped a box	No one answered the customer service number
	The color didn't match sample	

Translating VOC to Critical to Quality



Kano Model


Delight
Neutral
Dissatisfaction
Customer Satisfaction
Delighters
More Is Better
Must Be
Absent
Fulfilled
Degree of Achievement

Translating CTQs to Project Metrics

Critical to Quality (CTQ)	Project Metric (Y)
Shipment Delivered On time	Number of Orders Delivered On time

Class Activity

- Give an example of a VOC you've heard or said.
- What is the corresponding CTQ?

Individual Activity

- Identify the customer(s) for your project.
- List two potential CTQs for your project.
- List the metrics for each CTQ.

THE LEAN SIX SIGMA TEAM

Objectives

- Distinguish between the types of teams you may lead
- Introduce the Drexler/Sibbet Team Performance Model
- Identify challenges your team may face
- Create a class mission and vision statement

Teams

- Leadership Teams
- Implementation Teams
- Project Teams
- Single Unit Teams
- Cross-Functional Teams
- Dispersed (virtual) Teams

The Lean Six Sigma Team

- Project
- Cross-Functional
- Dispersed

Challenges

Keeping in mind that your Lean Six Sigma teams are cross-functional and most likely dispersed, what challenges do you expect?

Success

SUCCESS
LOOKS
LIKE

The Team Performance Model

- Allan Drexler and David Sibbet recognized that most teams face a similar set of challenges.
- Challenges arise from concerns that all teams have throughout the life of the project or team.
- Developed a set of best practices to help team leaders address the concerns and challenges all teams face

Team Performance Model

- Orientation
- Trust Building
- Goal Clarification
- Commitment
- Implementation
- High Performance
- Renewal

Reasons Team Fail

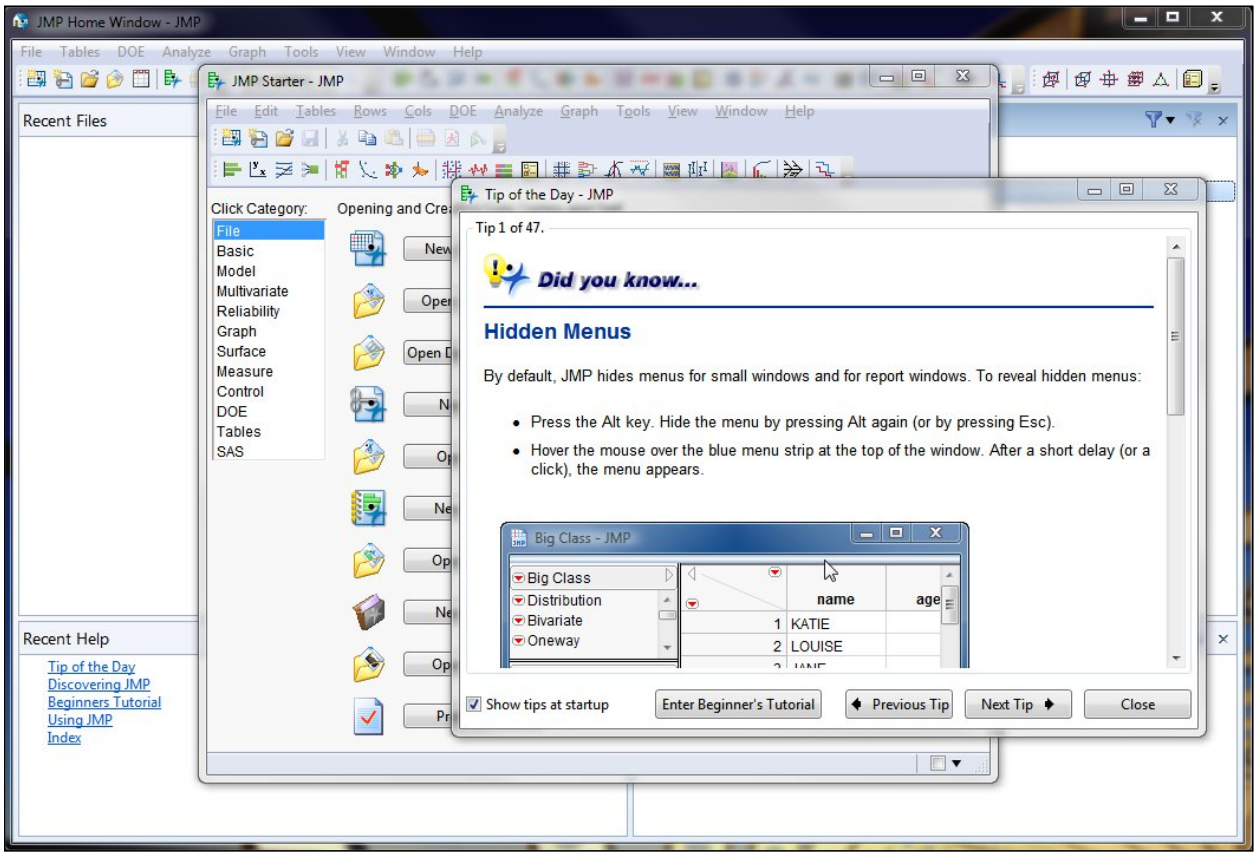
- Goals and purpose are not clearly defined
- Leaders aren't trusted
- Individuals aren't taught how to work in teams
- Stakeholders are not engaged
- Teams don't take time to get to know each other and to build trust
- Leaders don't trust the team's decisions
- Burnout

Objectives

- Become familiar with the JMP user interface
- Create a new JMP table
- Import data into JMP
- Understand how to use JMP for basic data management

Introduction to JMP

1. Open JMP.



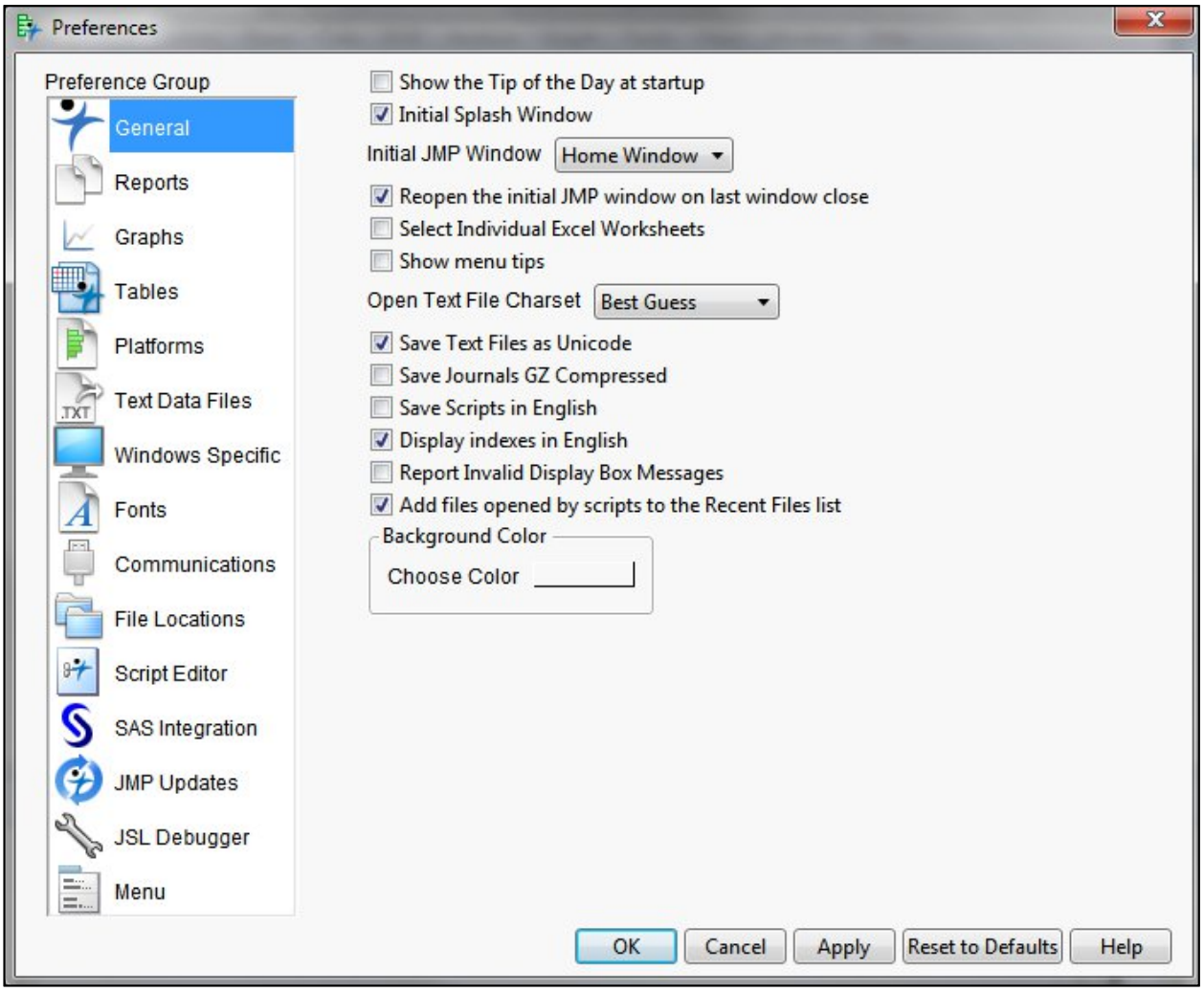
By default, the **Tip of the Day** window opens when JMP is started. Deselect the check box next to **Show tips at startup** to prevent the window from opening by default.

2. Close the **Tip of the Day** window.

The JMP Starter window also opens by default when JMP is started. Users may navigate JMP from the JMP Starter window, from pull down menus or from buttons on the tool bar.

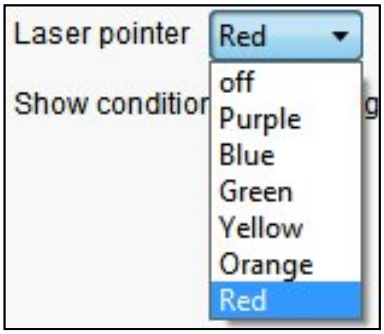
Setting Preferences

1. Select **Preferences** on the **File** category on the **JMP Starter** window or use the pull-down menu and select **File → Preferences**.

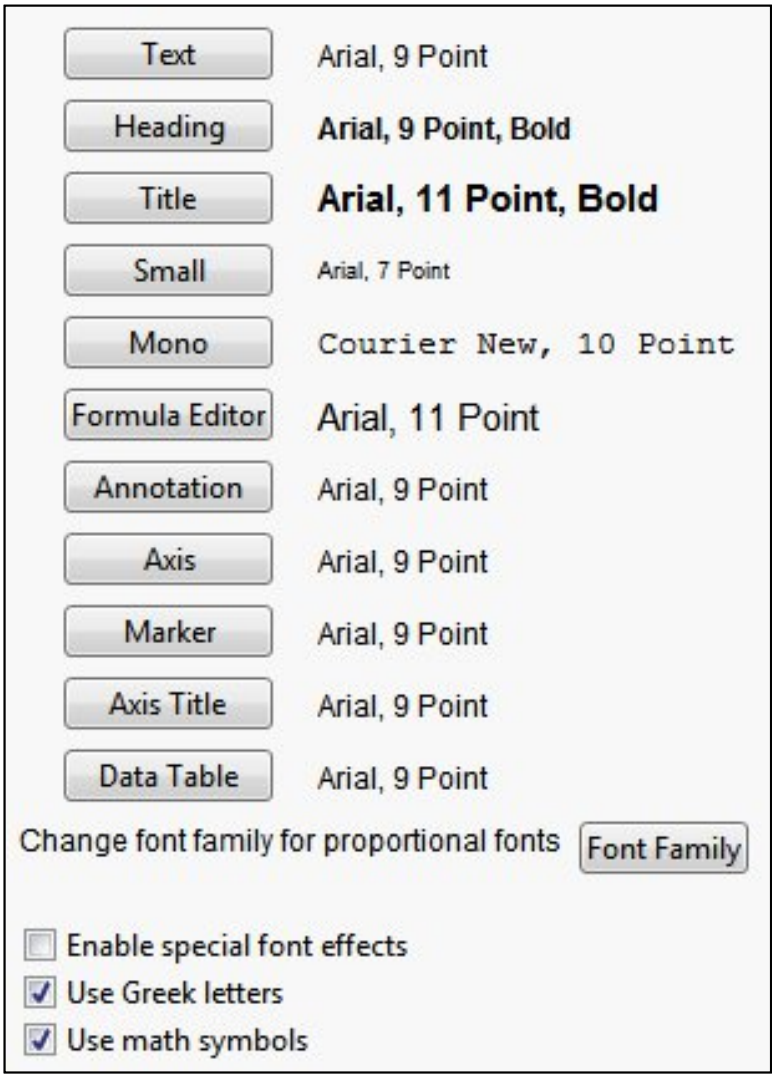


Users may customize their JMP session through the **Preferences** window. Preferences are broken down by categories listed on the right side of the window.

2. Select **Reports**.
3. Click the down arrow next to **Laser Pointer**. The laser pointer is useful when presenting using JMP.

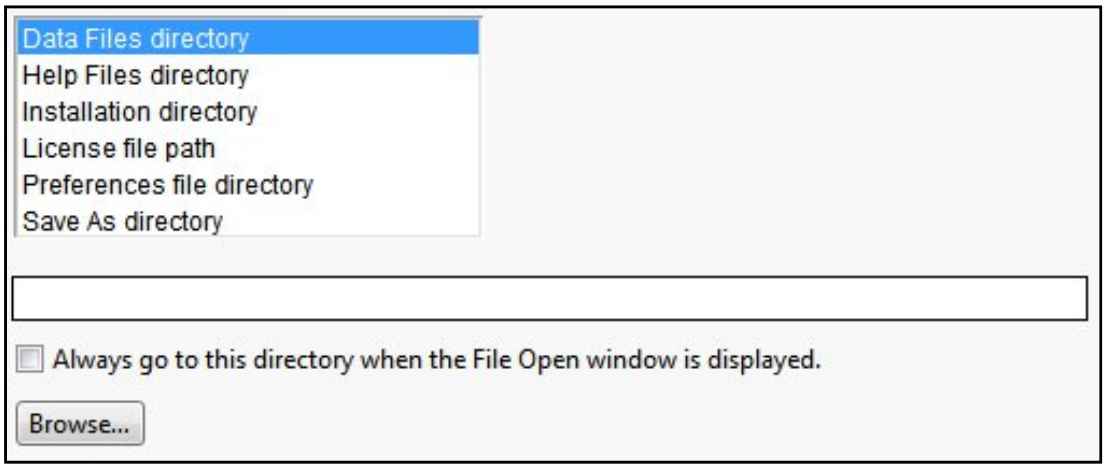


4. Select a color of your choice.
5. Select **Apply**.
6. Select **Fonts**.

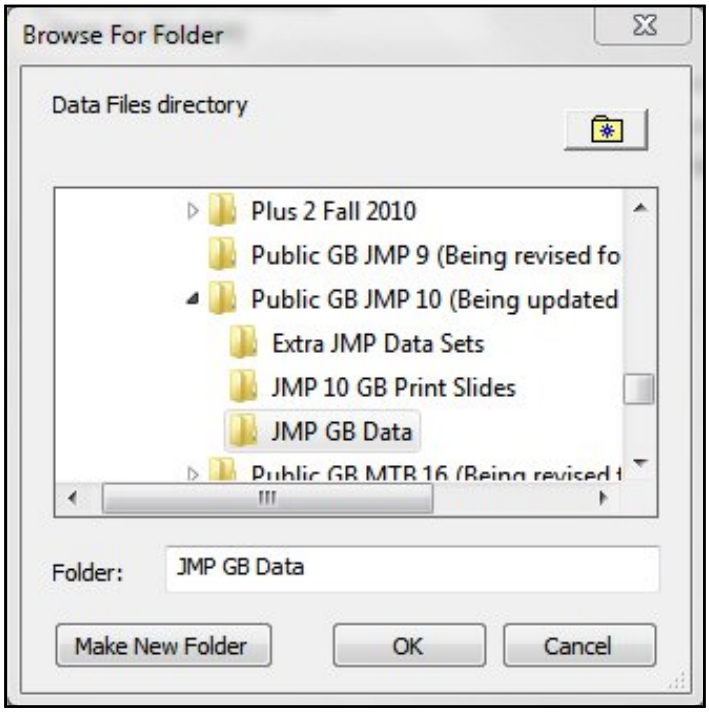


All the fonts used in JMP windows and output may be customized from this window.

7. Select **File Locations**.

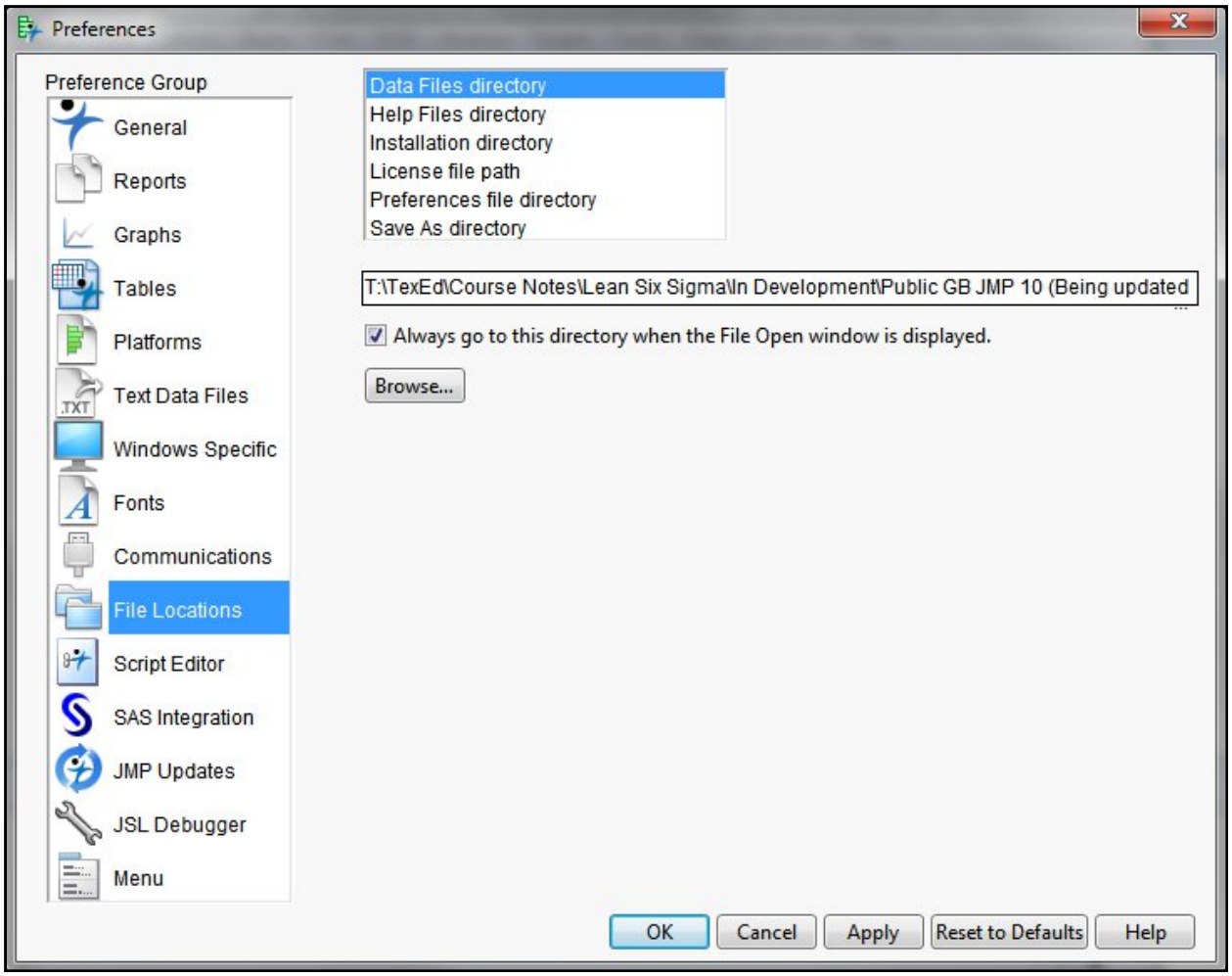


8. To set the default location for the Open File dialog, make certain **Data Files Directory** is selected and select **Browse…**.
9. Navigate to the course data file.



10. Select **OK**.

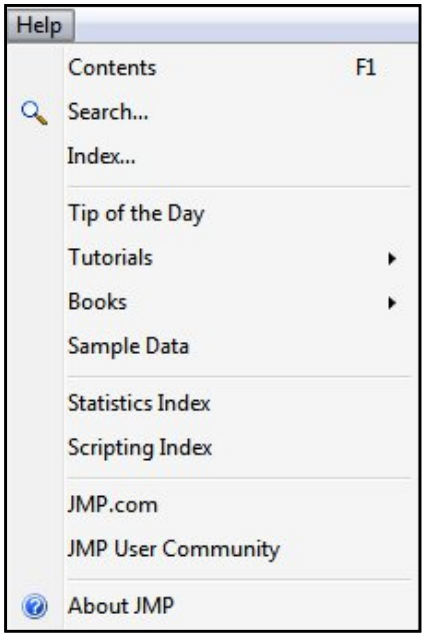
11. Select the check box next to **Always go to this directory when the File Open window is displayed**.



12. Select **Apply**. The default **Save As** directory may also be selected from this window.
13. Select **OK** to close the **Preferences** window.

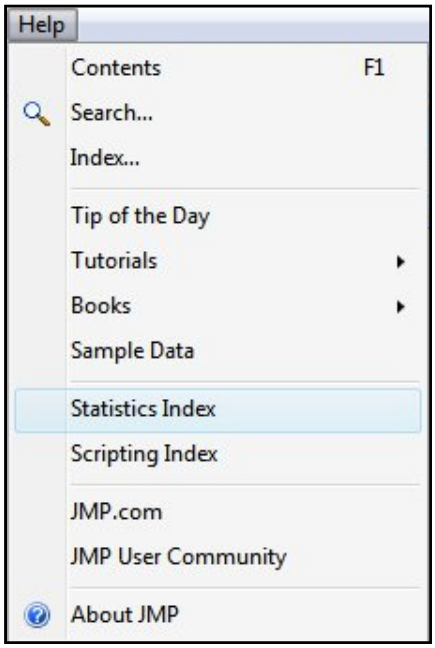
Using the Help Options in JMP

1. Select **Help** from the pull-down menu.

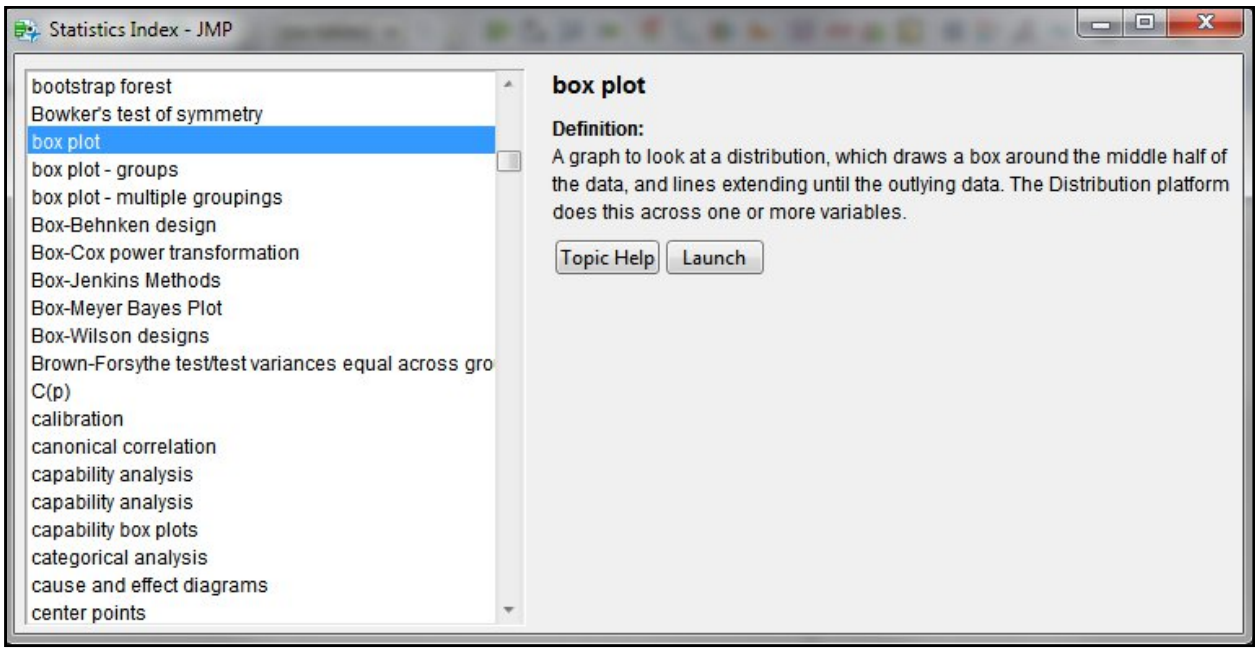


JMP user manuals were automatically copied to the hard drive when JMP was installed. The contents of these documents can be listed or searched by selecting Contents or Search. JMP also makes it easy to search by statistical operation.

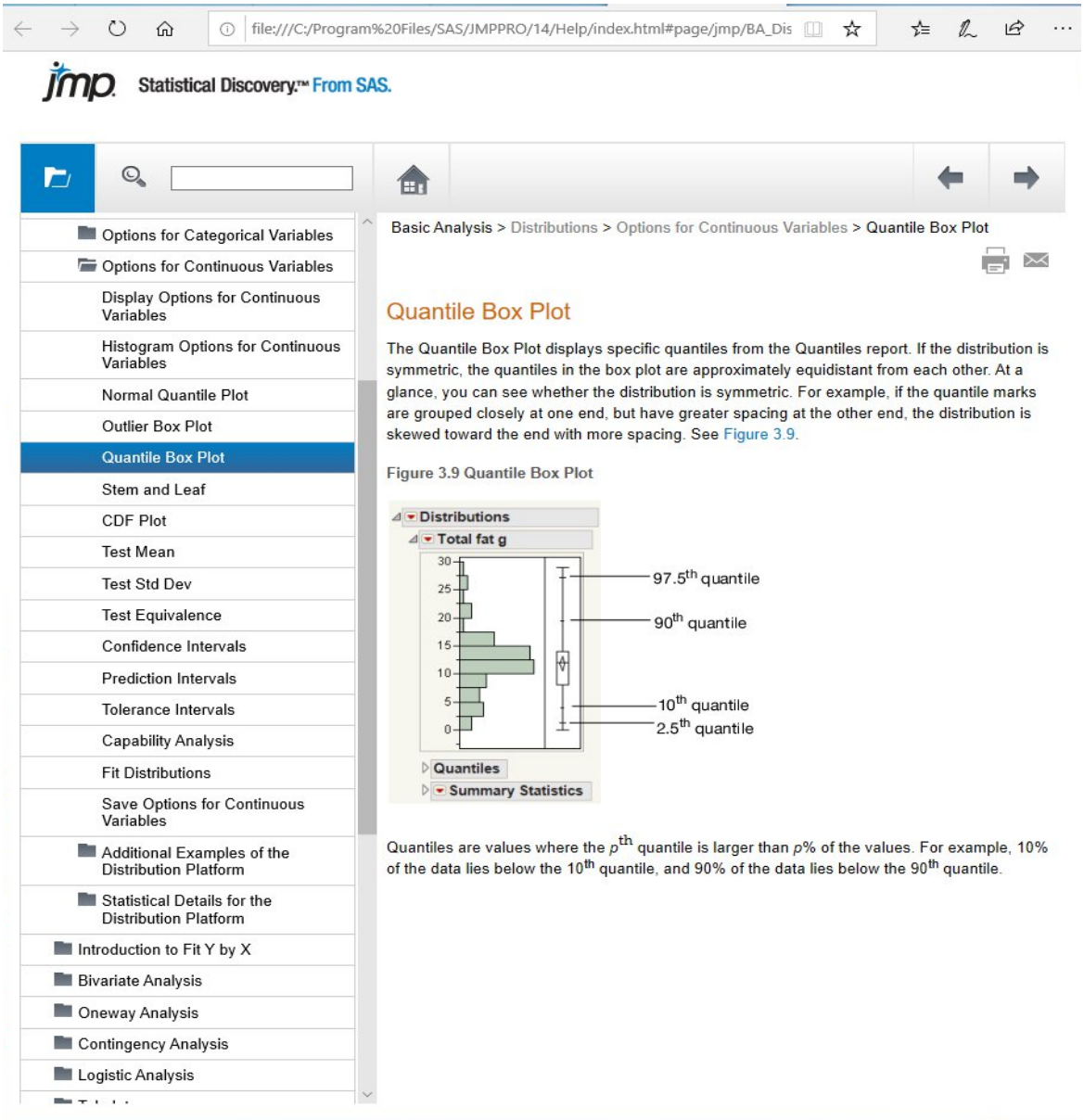
2. Select **Statistics Index**.



3. Scroll to **Box Plot**.



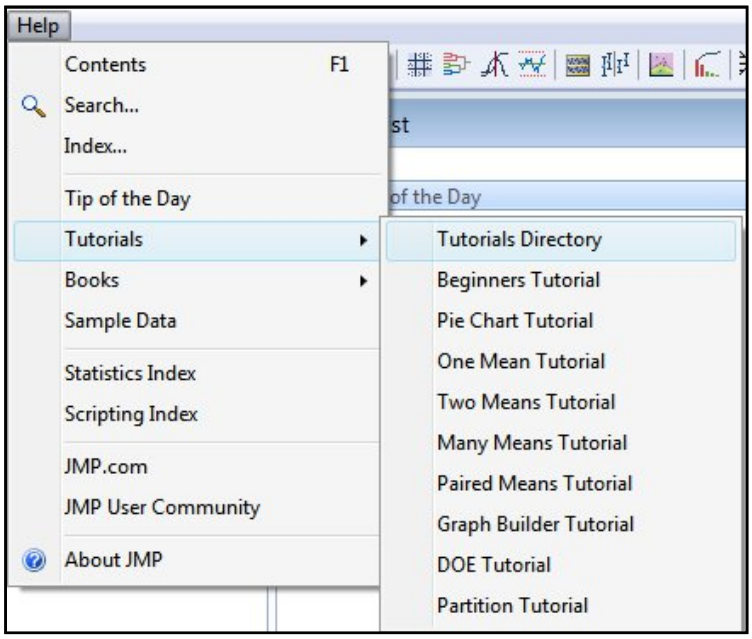
4. A description of the Box Plot is displayed. For more information on how to generate the Box Plot, select **Topic Help**.

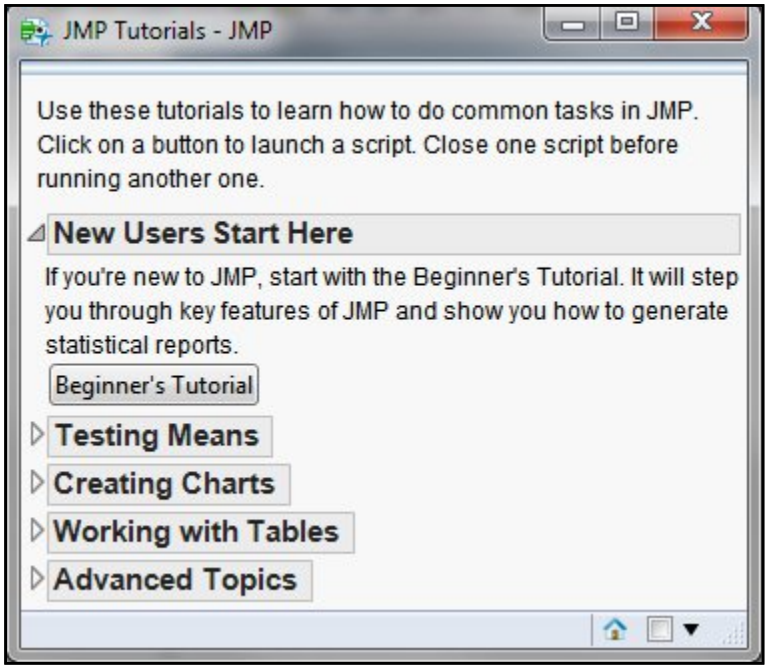


5. Close the **Help** window.
6. Close the **Statistics Index** window.

Several tutorials are also available from the Help menu.

1. **Select Help → Tutorials → Tutorials Directory**.





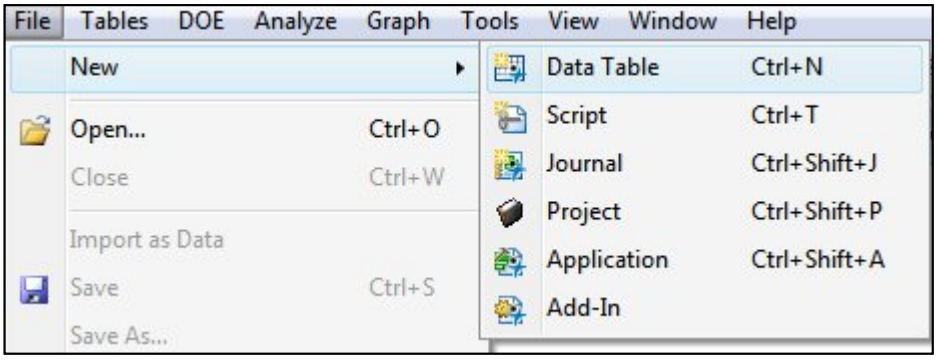
2. Select **Beginner's Tutorial**.

3. Select **Close**.
4. Close the **Beginner's Tutorial** window.

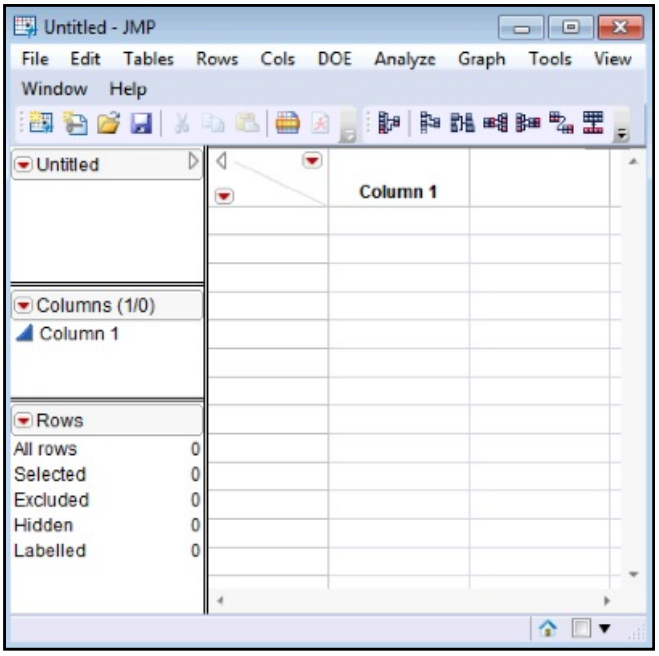
Context Sensitive Help is also available in JMP and will be discussed in a subsequent section.

Creating a New JMP Data Table

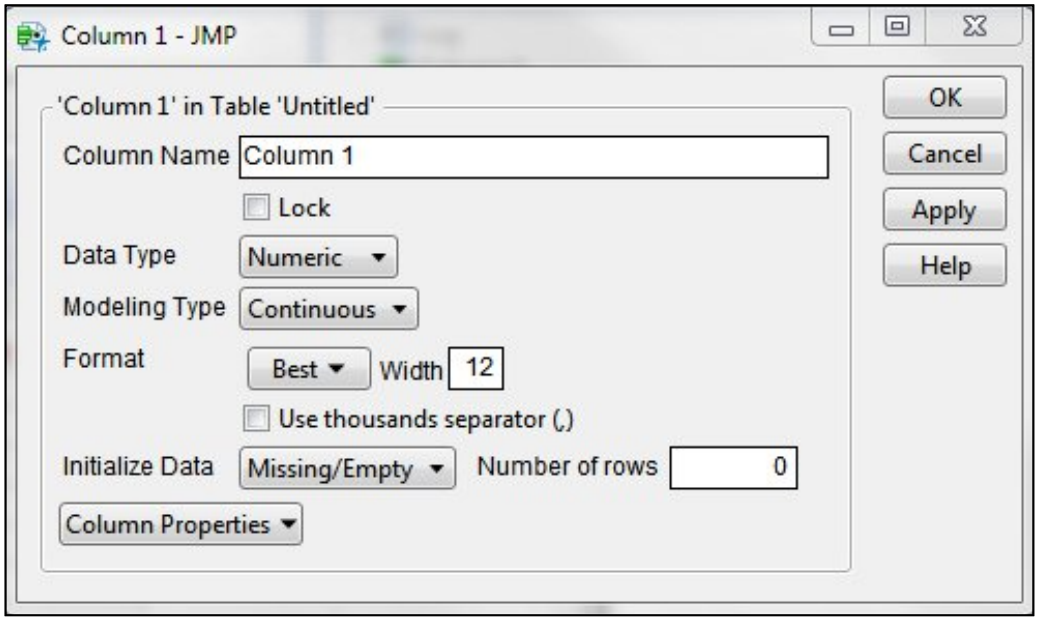
1. Select **File** → **New** → **Data Table**.



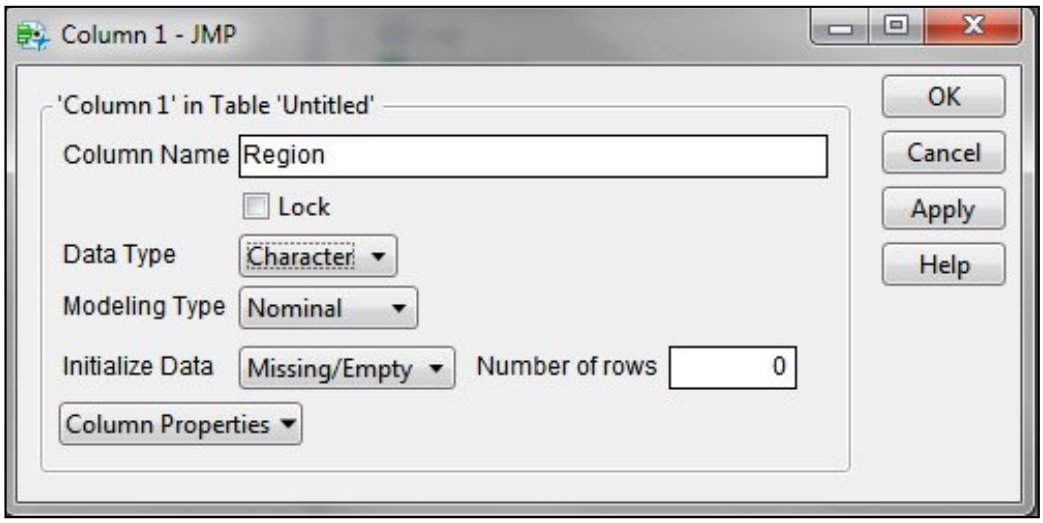
The new JMP data table opens with one column and no rows.



2. Right click on **Column 1** and select **Column Info...**

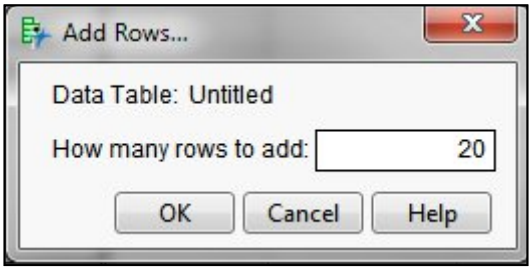


3. Change **Column 1** to **Region**.
4. Click **Numeric** and select **Character**.

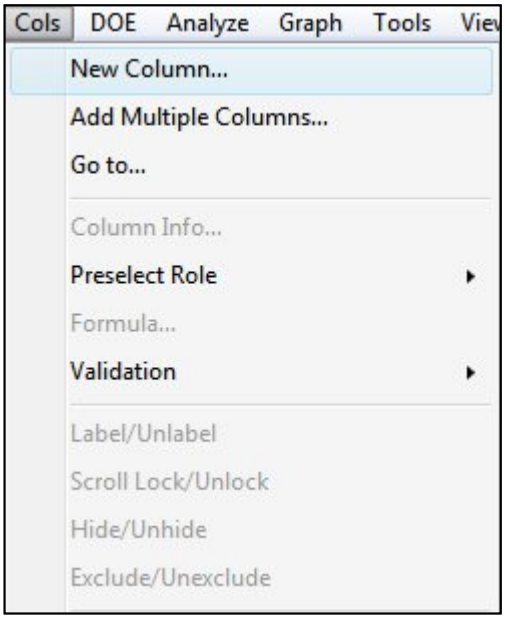


5. Select **OK**.

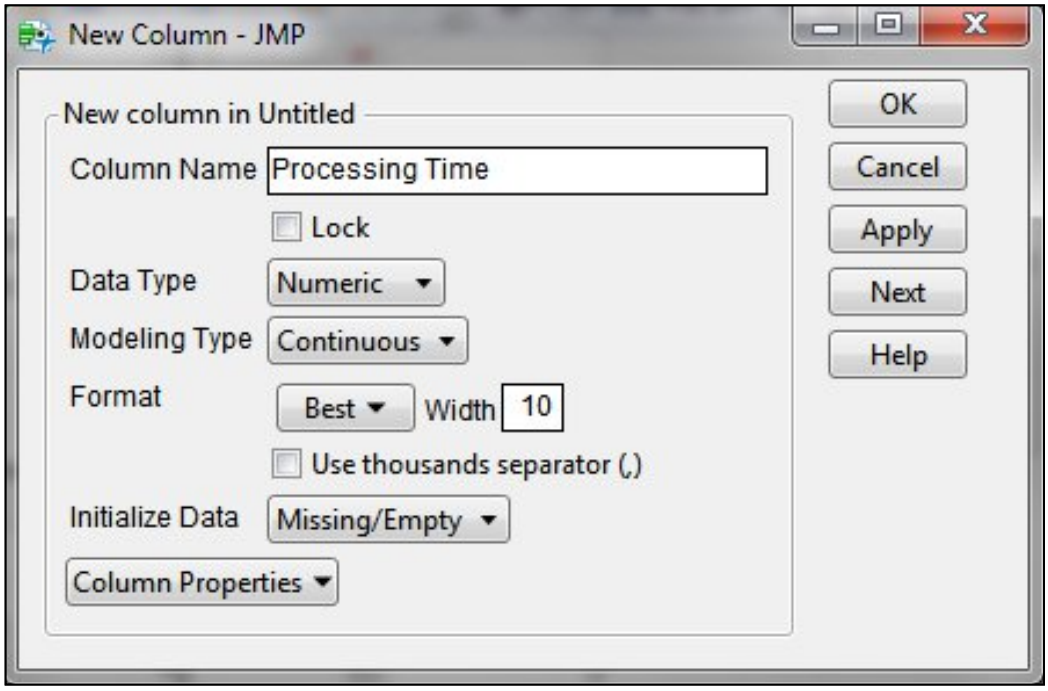
6. Select **Rows** → **Add Rows…**



7. Select **OK**.
8. Select **Cols → New Column….**

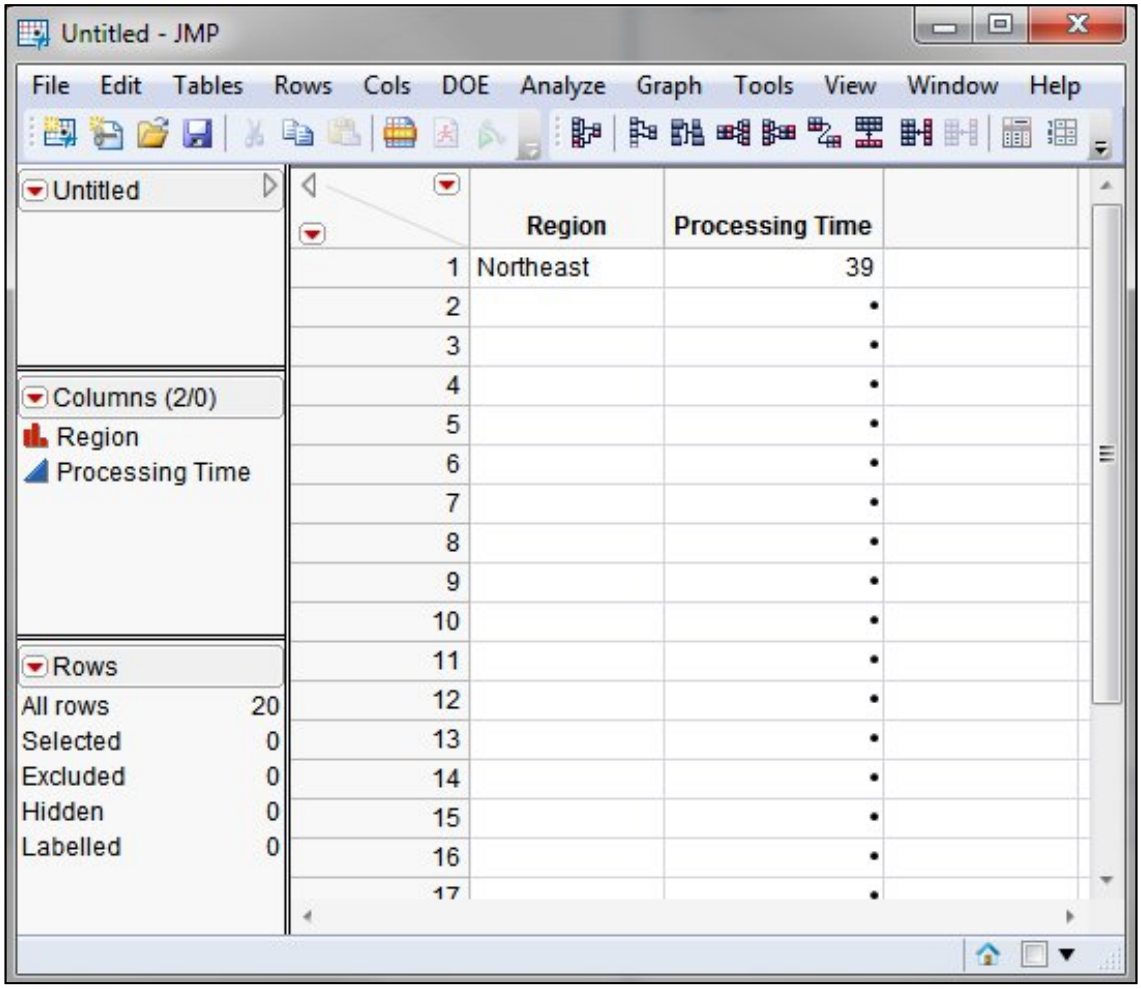


9. Change **Column 2** to **Processing Time**.


New Column - JMP
New column in Untitled
Column Name
Processing Time
Lock
Data Type
Numeric
Modeling Type
Continuous
Format
Best
Width
10
Use thousands separator (,)
Initialize Data
Missing/Empty
Column Properties
OK
Cancel
Apply
Next
Help

10. Select **OK**.

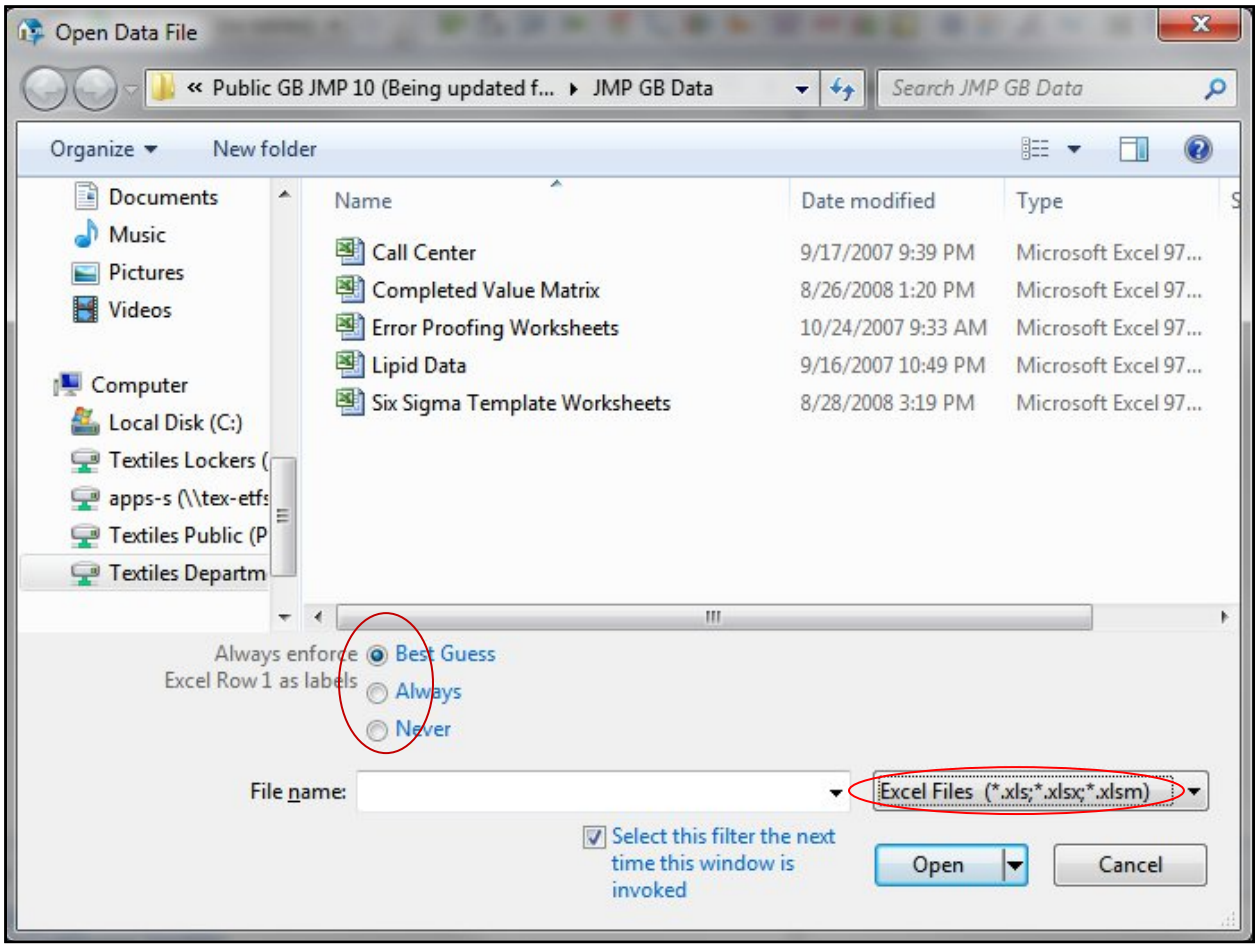
11. Click in the first cell in the **Region** column.
12. Type **Northeast**.
13. Tab to the **Processing Time** Column.
14. Type **39**.



15. Save the file as **Contract.JMP**.
16. Close the file.

Opening an Excel Spreadsheet

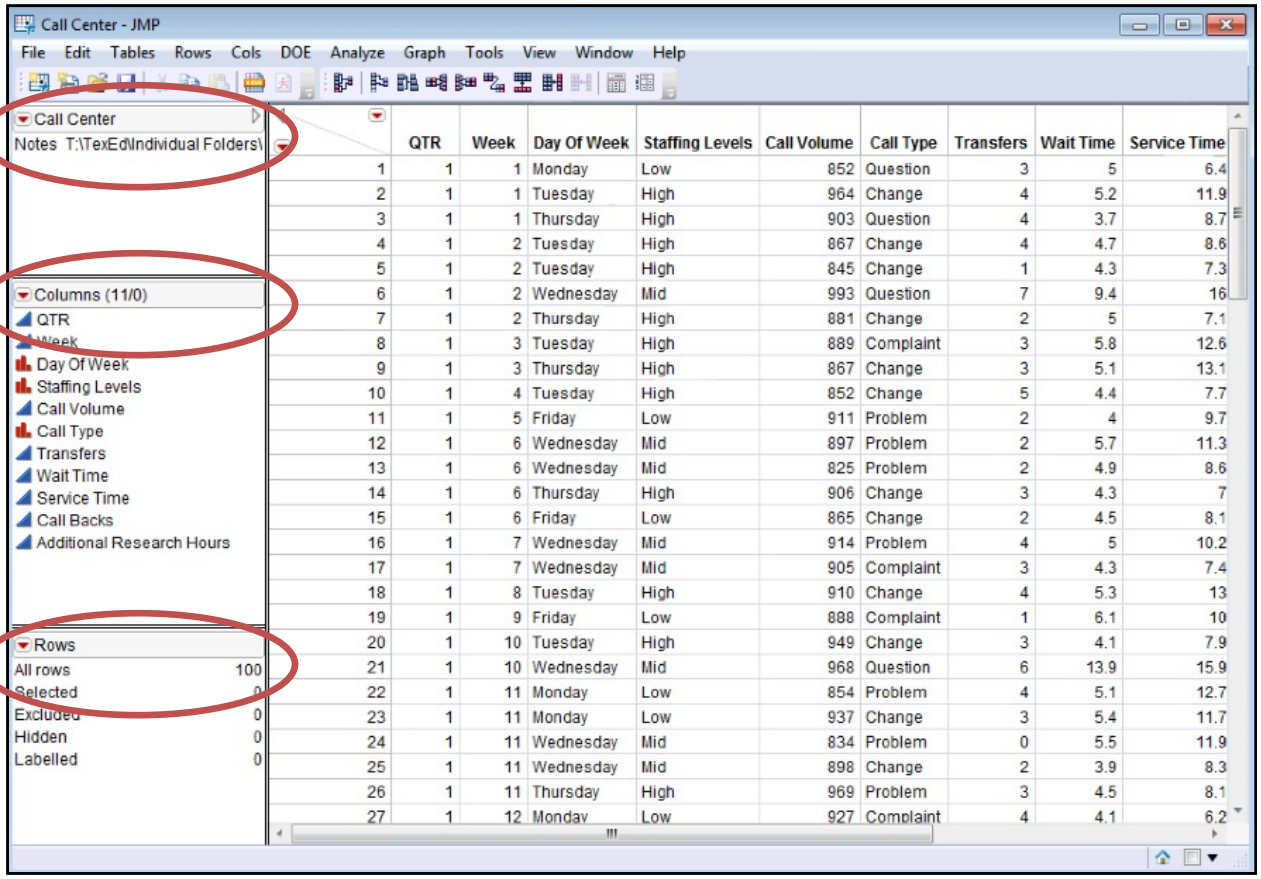
1. Select **File** → **Open**.
2. Change the lower right box of file type to Excel Files (*.xls, *.xlsx, *.xlsm).



JMP will try to automatically determine whether or not the values in Row 1 of the spreadsheet should be used as column headings, to insure this is done, select the check box next to **Best Guess** or **Always** to Always enforce Excel Row 1 as labels. JMP's default is to open all worksheets in an Excel file. To open Excel worksheets individually, the default must be changed in the **Preferences** → **General** menu.

3. Select **Call Center.XLS** and select **Open**.

The Excel spreadsheet is opened as a JMP data table.



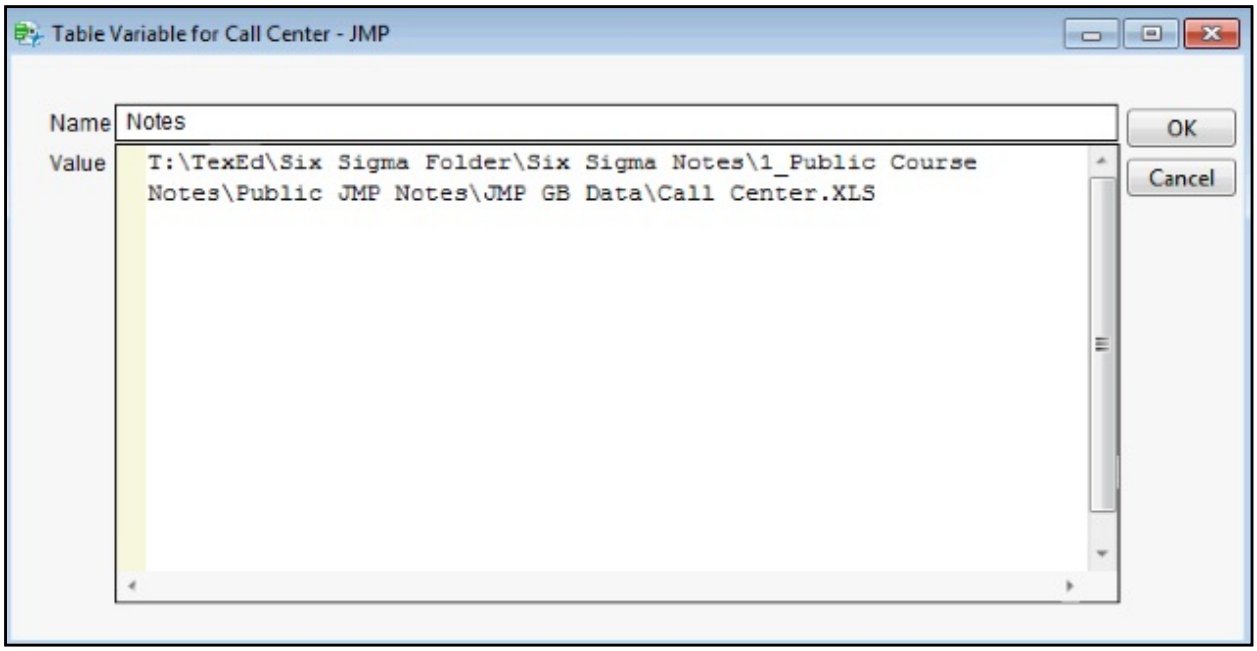
	QTR	Week	Day Of Week	Staffing Levels	Call Volume	Call Type	Transfers	Wait Time	Service Time
1	1	1	Monday	Low	852	Question	3	5	6.4
2	1	1	Tuesday	High	964	Change	4	5.2	11.9
3	1	1	Thursday	High	903	Question	4	3.7	8.7
4	1	2	Tuesday	High	867	Change	4	4.7	8.6
5	1	2	Tuesday	High	845	Change	1	4.3	7.3
6	1	2	Wednesday	Mid	993	Question	7	9.4	16
7	1	2	Thursday	High	881	Change	2	5	7.1
8	1	3	Tuesday	High	889	Complaint	3	5.8	12.6
9	1	3	Thursday	High	867	Change	3	5.1	13.1
10	1	4	Tuesday	High	852	Change	5	4.4	7.7
11	1	5	Friday	Low	911	Problem	2	4	9.7
12	1	6	Wednesday	Mid	897	Problem	2	5.7	11.3
13	1	6	Wednesday	Mid	825	Problem	2	4.9	8.6
14	1	6	Thursday	High	906	Change	3	4.3	7
15	1	6	Friday	Low	865	Change	2	4.5	8.1
16	1	7	Wednesday	Mid	914	Problem	4	5	10.2
17	1	7	Wednesday	Mid	905	Complaint	3	4.3	7.4
18	1	8	Tuesday	High	910	Change	4	5.3	13
19	1	9	Friday	Low	888	Complaint	1	6.1	10
20	1	10	Tuesday	High	949	Change	3	4.1	7.9
21	1	10	Wednesday	Mid	968	Question	6	13.9	15.9
22	1	11	Monday	Low	854	Problem	4	5.1	12.7
23	1	11	Monday	Low	937	Change	3	5.4	11.7
24	1	11	Wednesday	Mid	834	Problem	0	5.5	11.9
25	1	11	Wednesday	Mid	898	Change	2	3.9	8.3
26	1	11	Thursday	High	969	Problem	3	4.5	8.1
27	1	12	Monday	Low	927	Complaint	4	4.1	6.2

The data is stored in the data grid on the right. The grid is a series of columns and rows containing all the data values. New rows and columns may be added as needed.

The three panels on the left side of the window: Table Panel, Columns Panel and Row Panel contain information about the data table.

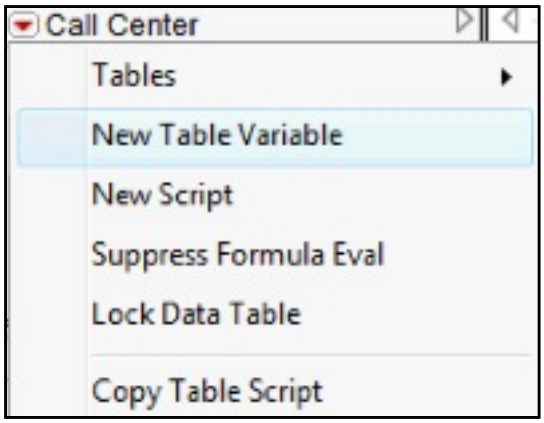
The Table Panel may contain Table Variables and Table Properties. Table Variables are often used to store information about the data in the table.

4. Double-click Notes to open the **Table Variable** created when JMP imported the Excel spreadsheet.

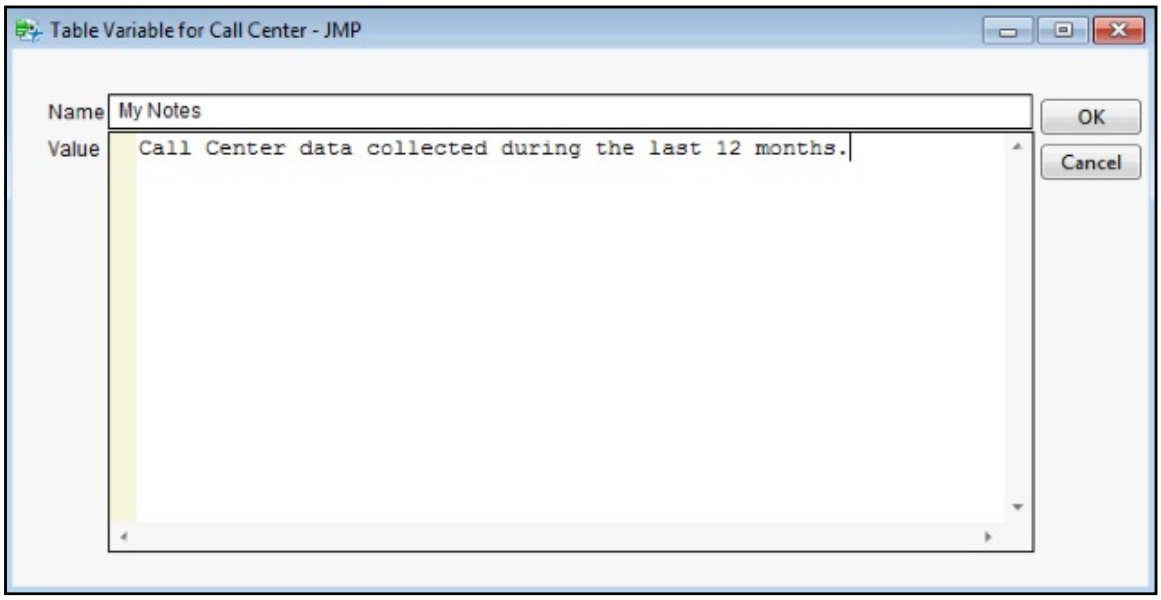


Additional information may be added by the user in the Value text box. New Table Variables may also be created as needed.

5. Select **Cancel**.
6. Click the **Red Triangle** next to **Call Center** and select **New Table Variable**.



7. Type a name for the **Table Variable**.
8. Tab to the **Value** field and type information that needs to be stored with the data table.

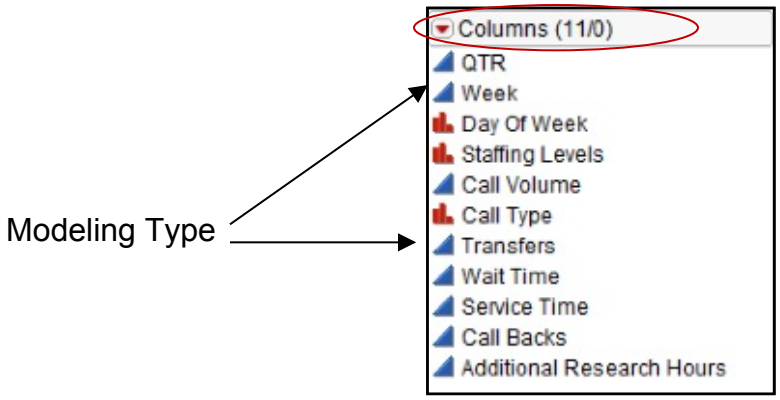


9. Select **OK**. The Table Variable is listed in the Table Panel.

Next, examine the Columns panel.

1. Scroll to the Columns panel.

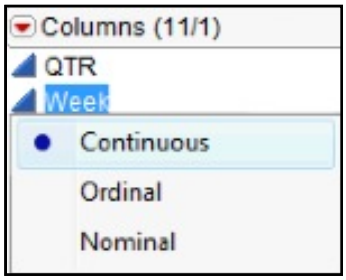
The name of each column in the data table is listed in the Columns Panel. The (11/0) at indicates that the data table contains 11 columns and none of the columns are currently selected. Several operations including reordering columns and renaming columns can be done from the Columns Panel or in the data grid.



The icons to the left of the column names indicate the modeling type of each column. Modeling type is extremely important in JMP because JMP uses the modeling type to determine what type of analysis to perform with the columns. The three modeling types are:

- Continuous – Numerical data that is measured on a potentially infinite scale. To help determine if a column is continuous, ask whether or not it would make sense to report an average for that column. Continuous data is represented by a blue triangle.
- Nominal – Character or numeric data that is used to classify rows into groups. Nominal data is sometimes referred to as attribute of categorical data. The order of groups does not matter for nominal data. Nominal data is represented by red bars.
- Ordinal – Character or numeric data that is used to classify rows into groups. The groups are ordered if the modeling type is ordinal but the "distance" between the groups cannot be quantified. Ordinal data is represented by green bars.

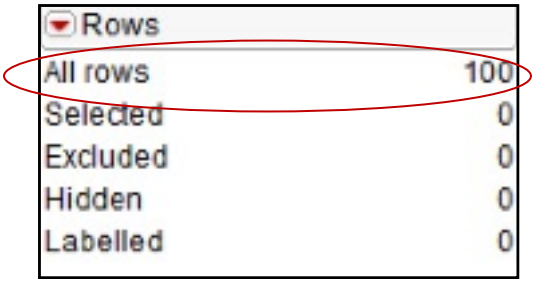
2. Click the blue triangle next to **Week**.



The modeling type may be changed by selecting Ordinal or Nominal from the pop-up list. Note, the column was selected in both the Columns panel and the data grid.

Finally, examine the Rows panel.

1. Scroll to the **Rows** panel.



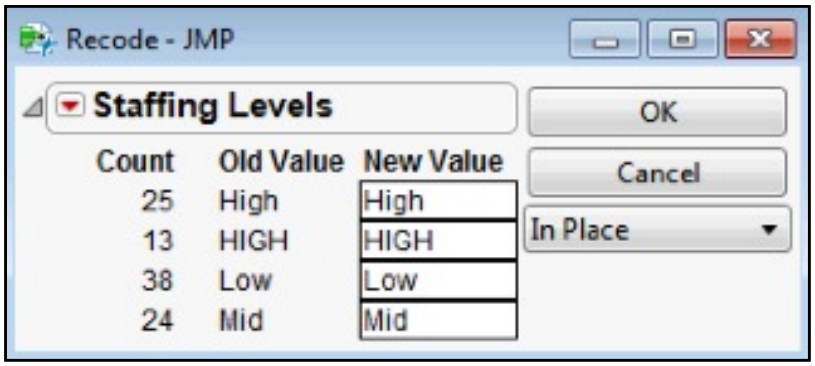
The first line in the Rows panel lists the number of rows in the data table. The remaining items listed in the Rows panel are row states that will be discussed later.

2. Save the data table.
3. Select **File** → **Save**.
4. Accept the default name, Call Center.JMP by selecting **Save**.

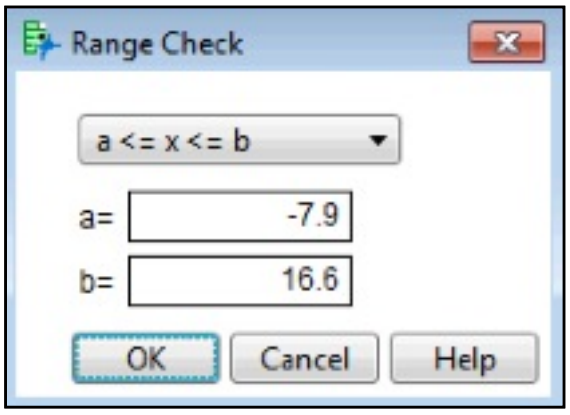
Data Cleansing

It is sometimes necessary to check that the correct data values have been entered in the table.

1. Select the **Staffing Levels** column.
2. Select **Cols** → **Recode**.



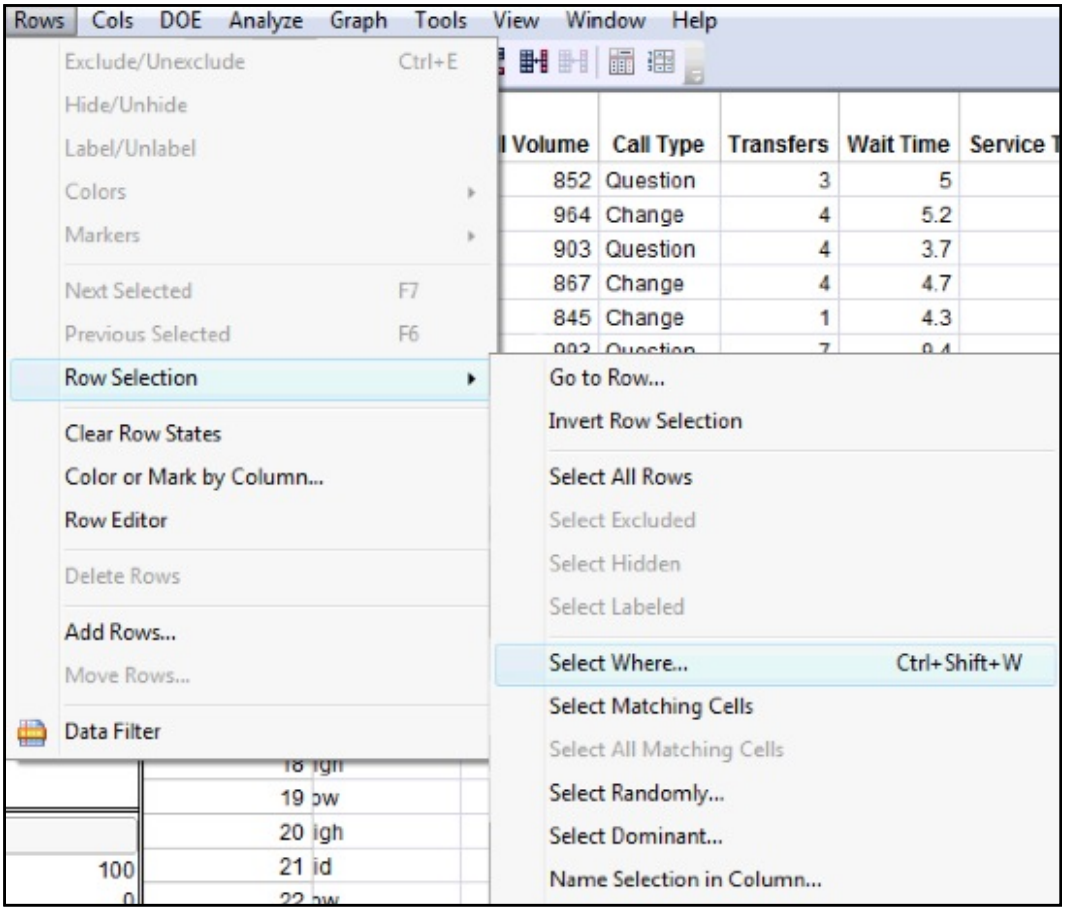
3. Change **HIGH** to **High**.
4. Select **OK**.
5. Select **Continue**.
6. Select the **Additional Research Hours** column.
7. Select **Cols** → **Validation** → **Range Check…**



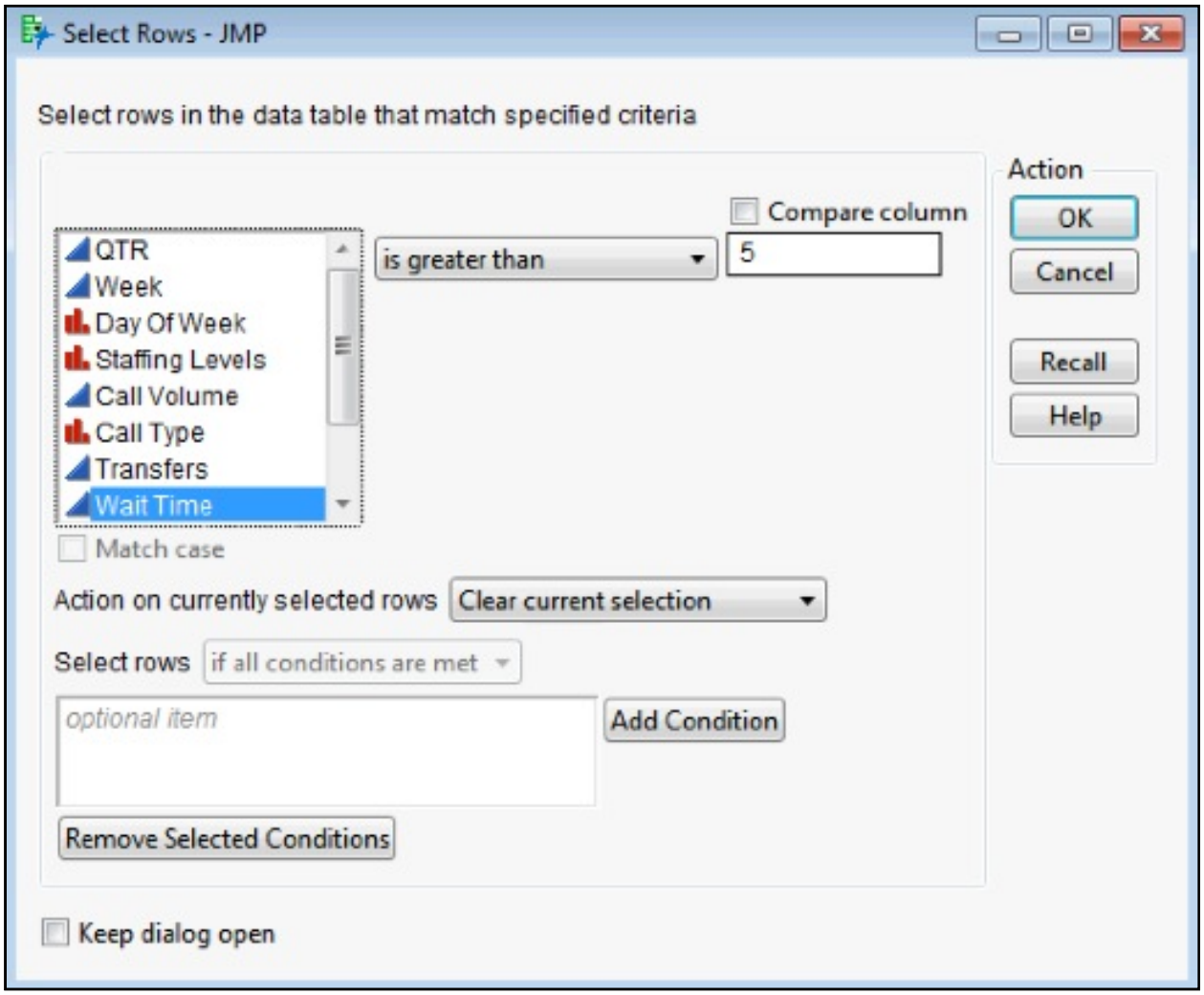
8. The number of hours cannot be less than 0. Change **-7.9** to **0**.
9. Select **OK**.
10. Select **Yes**.

Creating New Tables

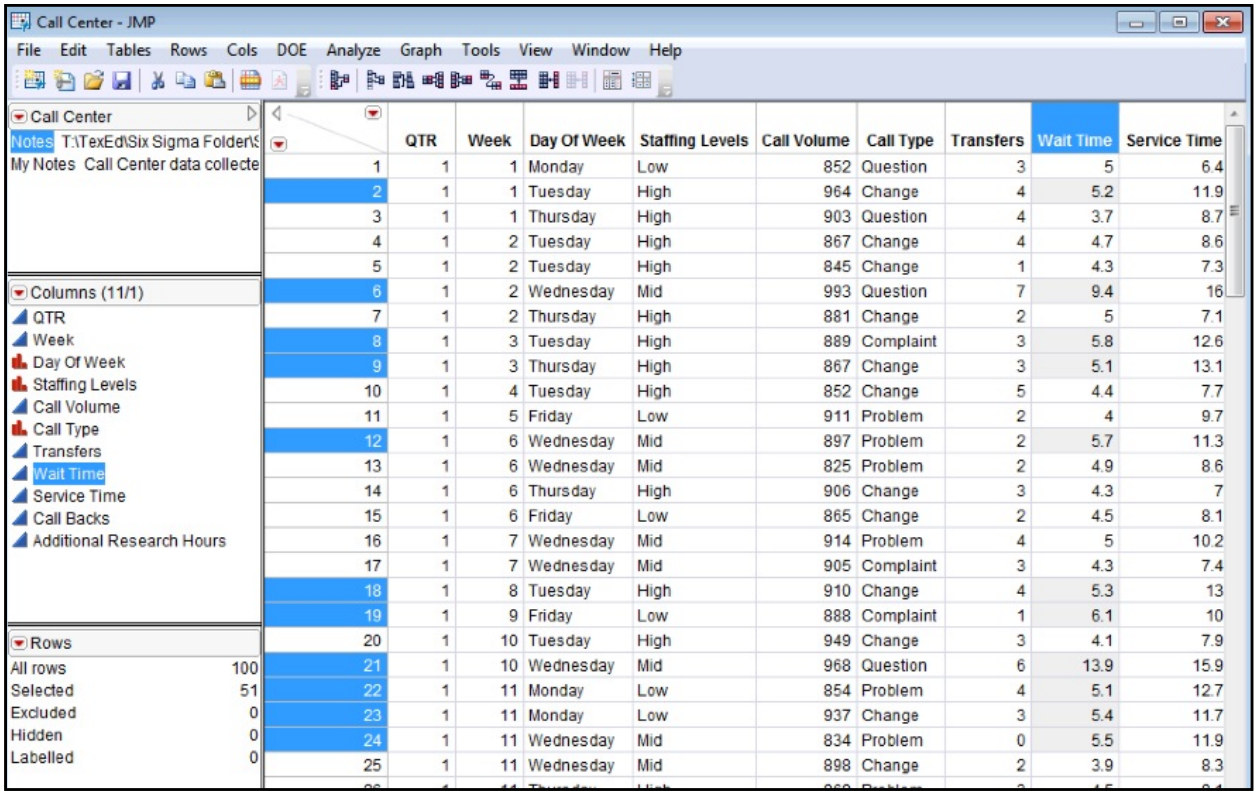
1. Select **Rows** → **Row Selection** → **Select Where …**



2. Select **Wait Time** from the list of columns.
3. Click the down arrow next to equals and select **is greater than**.
4. Type **5** in the text field.



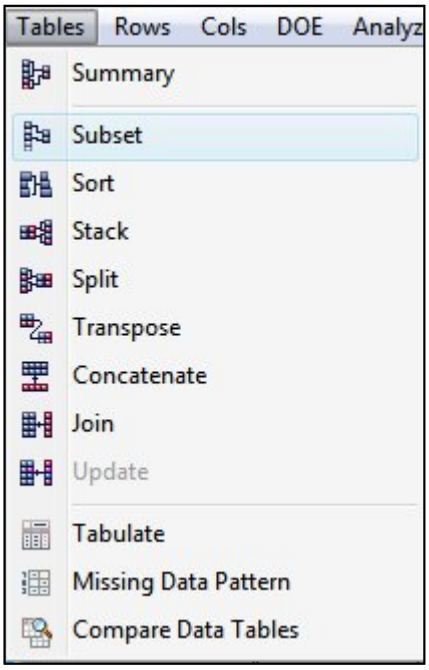
5. Select **OK**.

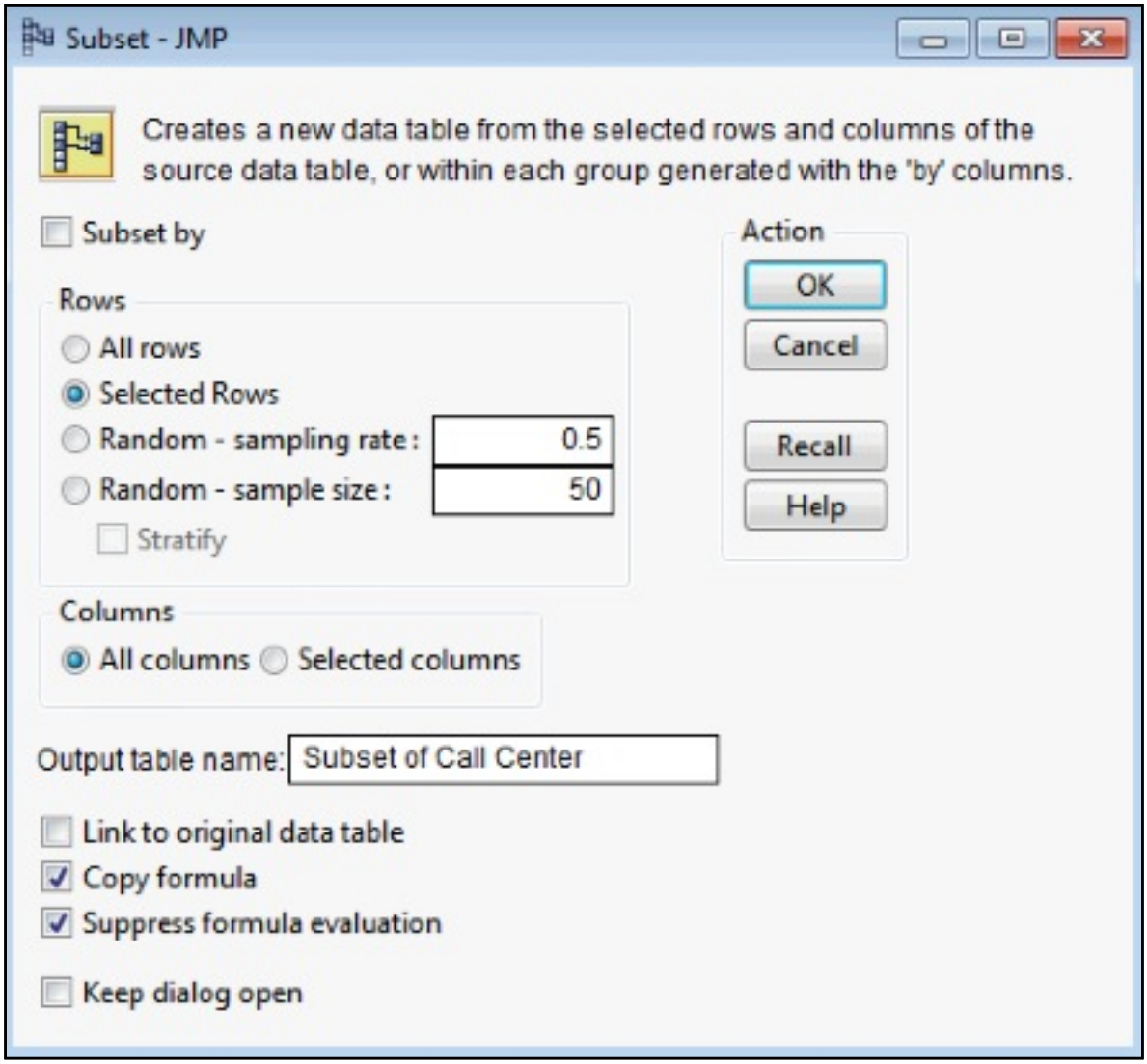


	QTR	Week	Day Of Week	Staffing Levels	Call Volume	Call Type	Transfers	Wait Time	Service Time
1	1	1	Monday	Low	852	Question	3	5	6.4
2	1	1	Tuesday	High	964	Change	4	5.2	11.9
3	1	1	Thursday	High	903	Question	4	3.7	8.7
4	1	2	Tuesday	High	867	Change	4	4.7	8.6
5	1	2	Tuesday	High	845	Change	1	4.3	7.3
6	1	2	Wednesday	Mid	993	Question	7	9.4	16
7	1	2	Thursday	High	881	Change	2	5	7.1
8	1	3	Tuesday	High	889	Complaint	3	5.8	12.6
9	1	3	Thursday	High	867	Change	3	5.1	13.1
10	1	4	Tuesday	High	852	Change	5	4.4	7.7
11	1	5	Friday	Low	911	Problem	2	4	9.7
12	1	6	Wednesday	Mid	897	Problem	2	5.7	11.3
13	1	6	Wednesday	Mid	825	Problem	2	4.9	8.6
14	1	6	Thursday	High	906	Change	3	4.3	7
15	1	6	Friday	Low	865	Change	2	4.5	8.1
16	1	7	Wednesday	Mid	914	Problem	4	5	10.2
17	1	7	Wednesday	Mid	905	Complaint	3	4.3	7.4
18	1	8	Tuesday	High	910	Change	4	5.3	13
19	1	9	Friday	Low	888	Complaint	1	6.1	10
20	1	10	Tuesday	High	949	Change	3	4.1	7.9
21	1	10	Wednesday	Mid	968	Question	6	13.9	15.9
22	1	11	Monday	Low	854	Problem	4	5.1	12.7
23	1	11	Monday	Low	937	Change	3	5.4	11.7
24	1	11	Wednesday	Mid	834	Problem	0	5.5	11.9
25	1	11	Wednesday	Mid	898	Change	2	3.9	8.3

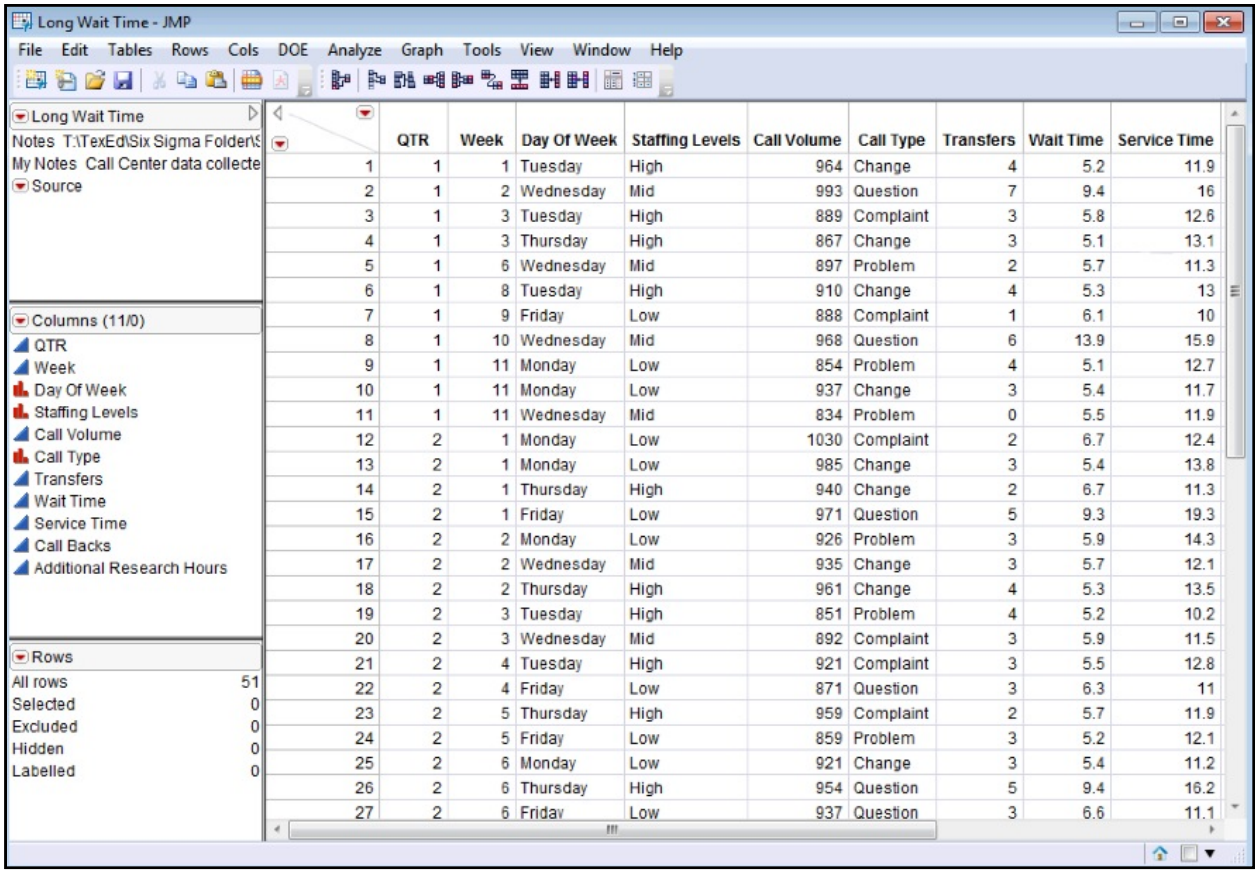
Note, the number of Selected Rows is now 51 in the Rows panel.

6. Select **Tables** → **Subset**.





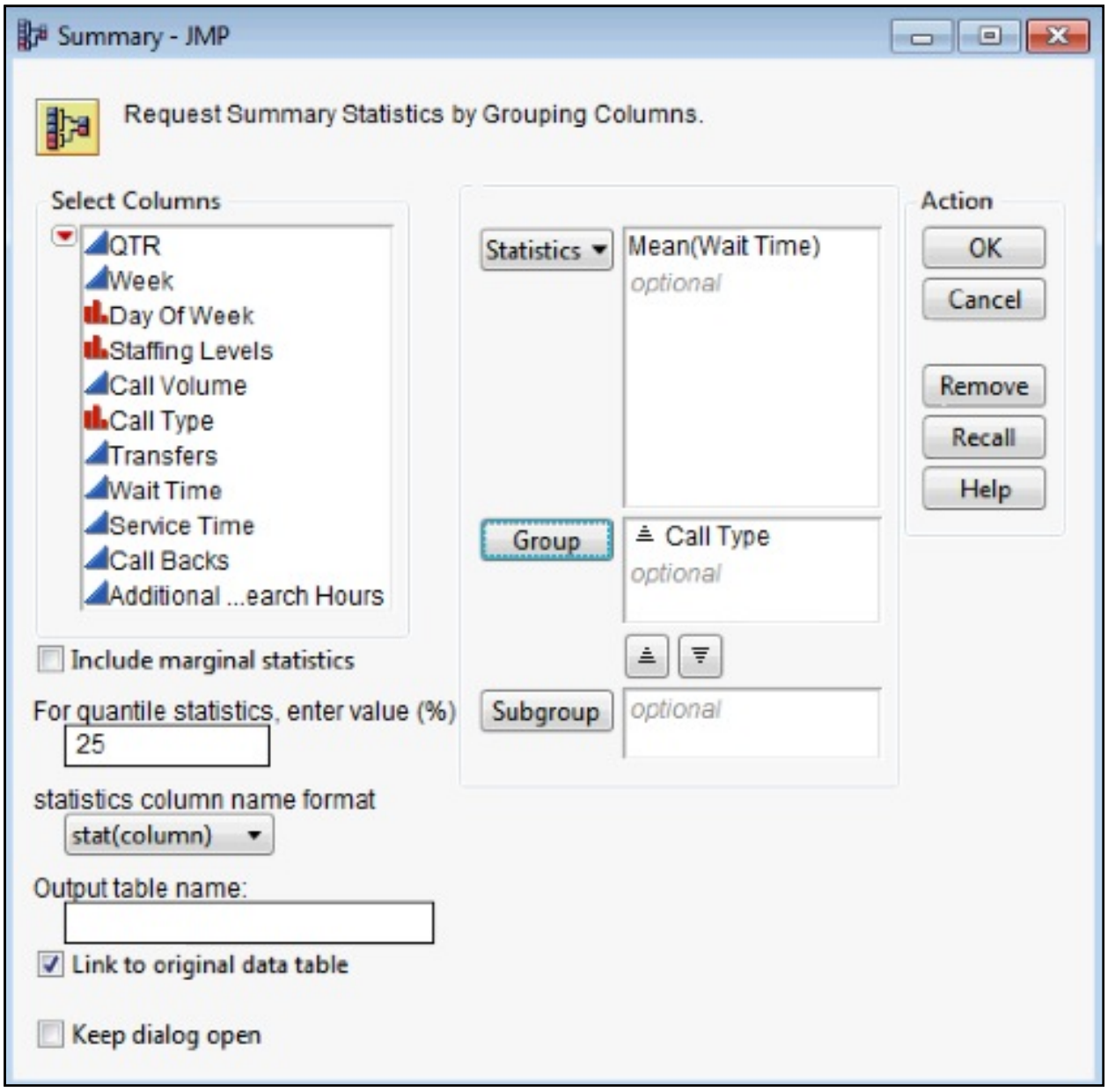
7. Change the name of the Output table to **Long Wait Time**.
8. Select **OK**.



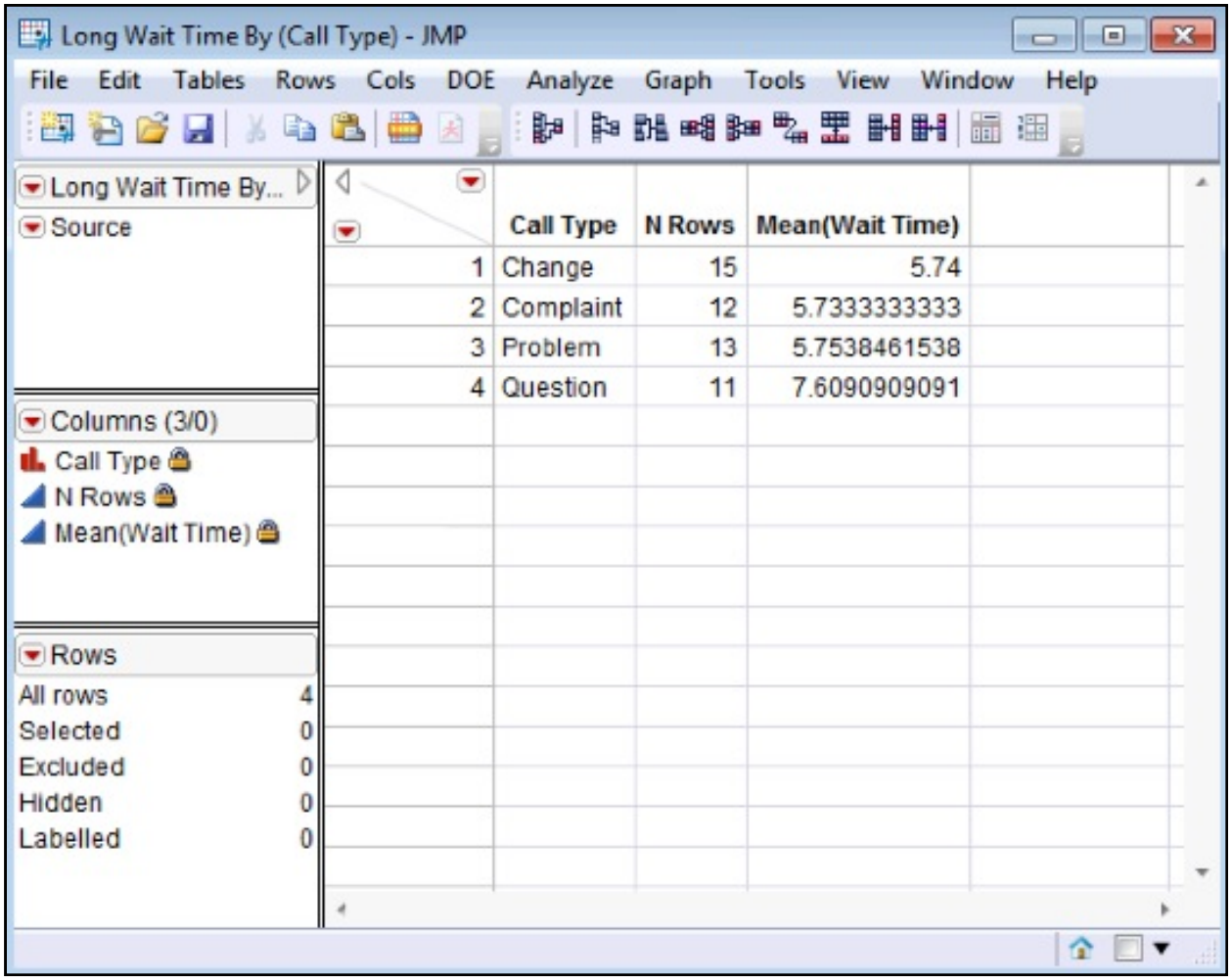
	QTR	Week	Day Of Week	Staffing Levels	Call Volume	Call Type	Transfers	Wait Time	Service Time
1	1	1	Tuesday	High	964	Change	4	5.2	11.9
2	1	2	Wednesday	Mid	993	Question	7	9.4	16
3	1	3	Tuesday	High	889	Complaint	3	5.8	12.6
4	1	3	Thursday	High	867	Change	3	5.1	13.1
5	1	6	Wednesday	Mid	897	Problem	2	5.7	11.3
6	1	8	Tuesday	High	910	Change	4	5.3	13
7	1	9	Friday	Low	888	Complaint	1	6.1	10
8	1	10	Wednesday	Mid	968	Question	6	13.9	15.9
9	1	11	Monday	Low	854	Problem	4	5.1	12.7
10	1	11	Monday	Low	937	Change	3	5.4	11.7
11	1	11	Wednesday	Mid	834	Problem	0	5.5	11.9
12	2	1	Monday	Low	1030	Complaint	2	6.7	12.4
13	2	1	Monday	Low	985	Change	3	5.4	13.8
14	2	1	Thursday	High	940	Change	2	6.7	11.3
15	2	1	Friday	Low	971	Question	5	9.3	19.3
16	2	2	Monday	Low	926	Problem	3	5.9	14.3
17	2	2	Wednesday	Mid	935	Change	3	5.7	12.1
18	2	2	Thursday	High	961	Change	4	5.3	13.5
19	2	3	Tuesday	High	851	Problem	4	5.2	10.2
20	2	3	Wednesday	Mid	892	Complaint	3	5.9	11.5
21	2	4	Tuesday	High	921	Complaint	3	5.5	12.8
22	2	4	Friday	Low	871	Question	3	6.3	11
23	2	5	Thursday	High	959	Complaint	2	5.7	11.9
24	2	5	Friday	Low	859	Problem	3	5.2	12.1
25	2	6	Monday	Low	921	Change	3	5.4	11.2
26	2	6	Thursday	High	954	Question	5	9.4	16.2
27	2	6	Friday	Low	937	Question	3	6.6	11.1

The new table contains 51 rows and 11 columns. To get more information from the data, a summary table may be created.

9. Select **Tables** → **Summary**.
10. Select **Call Type** → **Group**.
11. Select **Wait Time** → **Statistic** → **Mean**.



12. Select **OK**.



13. Close the table.
14. Close **Long Wait Time**.
15. Select **Yes** to save the table.

Practice Exercises

1. Create a summary table to compare the average wait time by staffing levels. Which staffing level has the longest wait time?
2. Create a table that contains only the rows where the number of call backs is greater than 1. Name the table Call Backs. How many rows are in the new table?
3. Use the Sort option on the Table pull down menu to organize the rows in the Call Backs table created above from the lowest value of Additional Research Hours to the highest value.

CORE PROJECT TOOLS

Objectives

- Discuss the use of a core set of tools throughout a Lean Six Sigma project
- Understand how to facilitate brainstorming
- Know the role of benchmarking in a Six Sigma project
- Use the 5 Why's tool
- Construct and interpret a cause-and-effect diagram, a Pareto plot, a box plot and a run chart

Brainstorming

Brainstorming allows teams to quickly generate a large number of ideas on any topic.

Two approaches to brainstorming:

- Structured
- Unstructured

Structured Brainstorming

- Team leader states the question or describes the topic in detail to insure everyone has a clear understanding of the topic.
- Each member, in turn, provides an idea. No ideas are judged or criticized.
- Facilitator records ideas on a flip chart.
- Review and organize list.

Unstructured Brainstorming

Very similar to structured brainstorming with one exception:

- Ideas are provided by any team member at any time.

Benchmarking

Benchmarking is the practice of searching for best practices. During a Lean Six Sigma project teams use benchmarking to:

- Explore what other organizations have been able to achieve to determine whether or not improvement is possible
- Learn how to be best in class

Benchmarking

- Library research
- Internet searches
- Telephone interviews
- Site visits

Planning for Interviews / Site Visits

- Identify who to benchmark
- Request a meeting
- Develop the list of questions to ask during the interview / visit
- Gather the information
- Debrief and disseminate the information

5 Whys

The 5 Whys method may be used to stimulate team member discussions about defects, process failures and root causes.

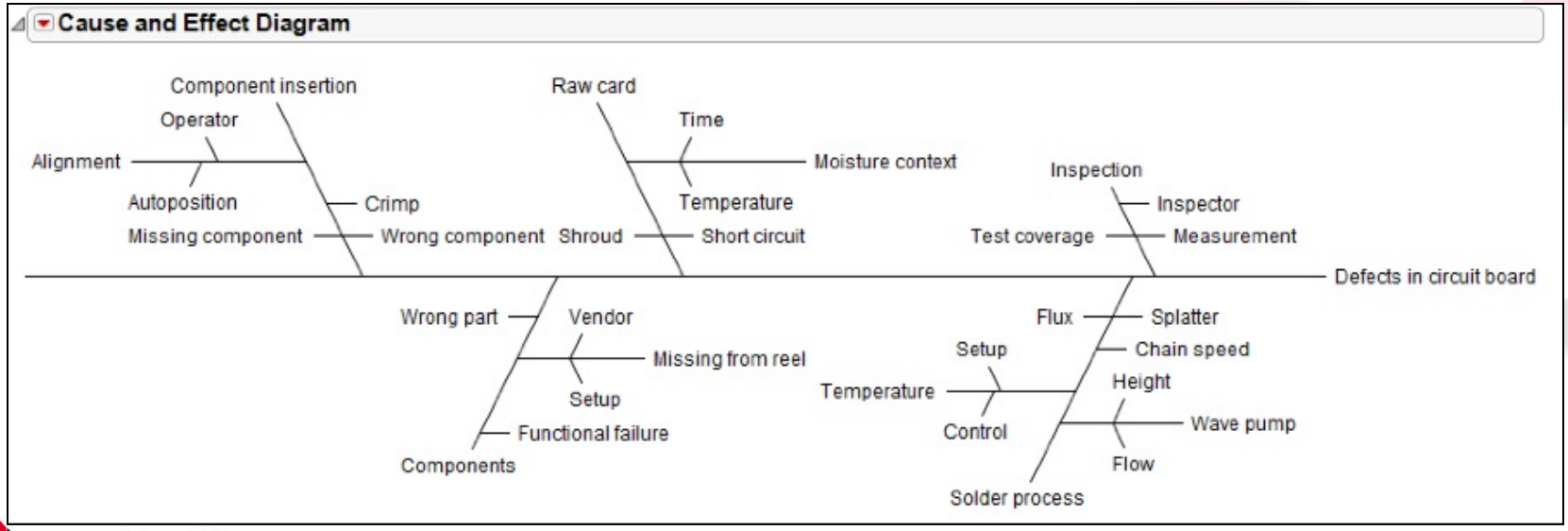
1. Choose a cause. Determine that all team members have a common understanding of what the cause means.
2. Ask “Why does this outcome occur?”.
3. Select one of the reasons from the answers to step 2 and ask, “Why does this occur?”.
4. Continue asking Why in this manner, until the team feels they have reached a potential root cause.

5 Whys Activity

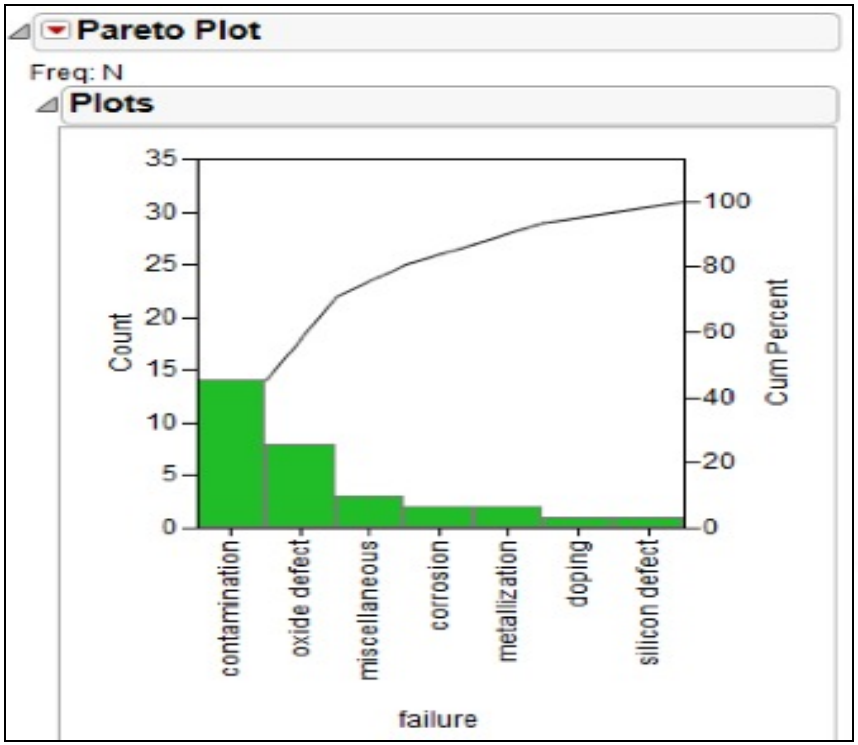
1. You're late for work again!
2. This isn't my order!
3. We have to shut down one production line because our supplier is late with materials!

Cause and Effect Diagram

- The Cause-and-Effect diagram may be used to organize ideas generated during a brainstorming or 5 Whys session. It lists potential causes.
- The Cause-and-Effect diagram may be used during any phase of the project

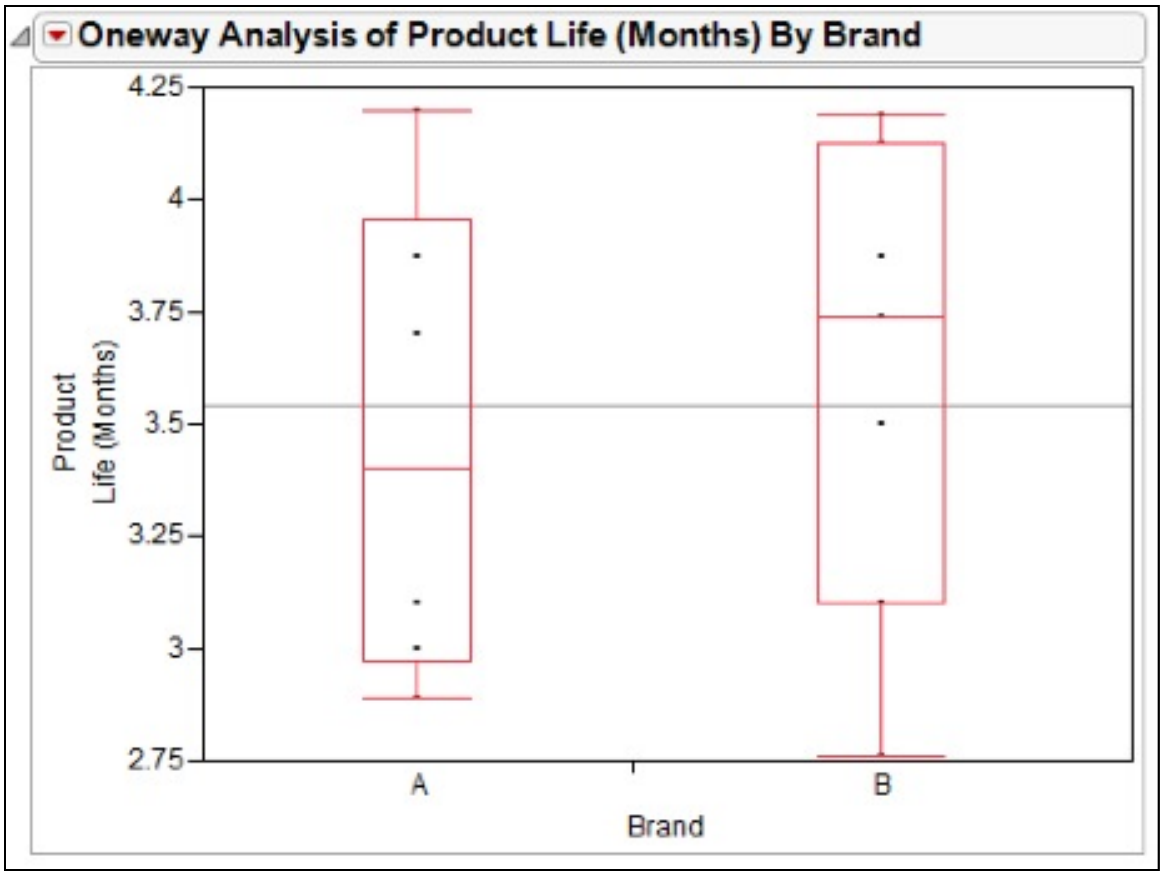


Pareto Plot



Based on a principle initially published by Vilfredo Pareto for who controls the wealth, the Pareto Plot was expanded by Joseph Juran to apply the “80-20” rule to almost everything.

Box Plots



- Box plots are used to compare the performance of multiple groups graphically

Run Charts

- The run chart is a picture of a process performance over time.
- Teams may use the run chart to look for trends, cycles and systematic changes in a process.