QIMacros®

User Guide

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Licensing:

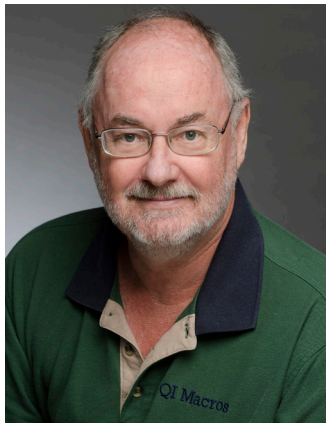
QI Macros is a single user license. You need to purchase one license for each user:

qimacros.com/support/qi-macros-faqs/#licensing

Quantity Discounts:

Discounts are calculated on a per-order basis. Consolidate your license purchases for the best possible price:

qimacros.com/discounts



Jay Arthur is the creator of QI Macros Quality Improvement Software for Excel and the author of:

- *Lean Six Sigma Demystified (2nd)*, McGraw Hill, ©2011
- *Lean Six Sigma for Hospitals (2nd)*, McGraw Hill, ©2016
- *Breakthrough Improvement with QI Macros and Excel*, McGraw Hill, ©2014.

QIMacros®

User Guide Table of Contents

About this User Guide

This guide covers the use of QI Macros. It does *not* cover Excel, SPC, or Six Sigma. See qimacros.com/training for other resources addressing these topics.

Licensing and Compatibility

Licensing
By installing and using QI Macros software, you agree to be bound by the terms of the QI Macros License Agreement:
qimacros.com/pdf/qi-macros-license-agreement.pdf

QI Macros is owned by KnowWare International Inc. and protected by U.S. Copyright laws. Any enhancements added to the existing macros are considered the property of KnowWare International Inc.

You may not copy, rent, or lease QI Macros or the documentation accompanying it. QI Macros is a single user, perpetual license. One license must be purchased per user, per computer.

Compatibility

- **PC:**
  Windows 8, 10, and 11
  Excel 2013 – 2021/Office 365
- **MAC:**
  macOS
  Excel 2019 – 2021/Office 365
- **Tablets:** Windows 8, 10, and 11 Tablets running a full version of Excel 2013 – 2021, Office 365

qimacros.com/support/excel-compatibility

While every new release of QI Macros seeks to be backward compatible with as many releases of Windows, macOS, and Excel as possible, it cannot pretend to be forward compatible with future changes (i.e., service packs and releases of new versions).

Enhancements
QI Macros is regularly upgraded whenever customers request new functionality or when Microsoft comes out with a new version of Windows or Excel. See a list of enhancements:
qimacros.com/support/enhancements

Installation

Installation Instructions:

qimacros.com/support/qi-macros-tech-support/#install

Installed by IT?

IT, log in as the end-user prior to installation, right-click the setup file and select “Run as Administrator.”

Need Installation Assistance?

Person-to-person support is available Monday through Friday, 8 a.m. to 5 p.m. Mountain Time.

- Phone: 303-756-9144 or 888-468-1537
- Email: **support@qimacros.com**
- Chat: **www.qimacros.com/chat**

After installation, open your Excel program: the QI Macros tab appears on the Excel menu. A down arrow to the right of a menu item indicates further options:

Overview

QI Macros Menu Categories & Tools

Control Charts
- Control Chart Wizard: creates the appropriate control chart for your data automatically
- Attribute charts: quickly create p, np, c, and u charts
- Variable charts: quickly create XmR, XbarR, and XbarS charts
- Control chart templates for ongoing data collection

Capability Charts
- Histograms and process capability (Cp, Cpk and Pp, Ppk)
- Box & whisker, dot, and scatter plots
- Capability Suite: creates all the charts needed for a complete capability study.

Improvement Charts
- Pareto
- Fishbone (Ishikawa) diagrams
- Other chart templates such as bullet, funnel, and tornado

Data Mining
- Improvement Project Wizard: creates pivot tables and all the necessary charts for a complete improvement project.
- PivotTable Wizard: quickly summarizes large data sets.
- Word count and restacking tools

Other Charts
- Chart Wizard: creates all possible chart types for your data.
- Line, run, bar, and other Excel charts

Statistical Tools
- Stat Wizard: automatically selects the right hypothesis test
- ANOVA, t-tests, F-tests, regression analysis
- Stat templates for ongoing data collection

Templates for Lean Six Sigma
- Templates for Gage R&R and design of experiments
- Calculators for sample size, DPMO, and more
- Templates & diagrams for lean, project management, and quality improvement

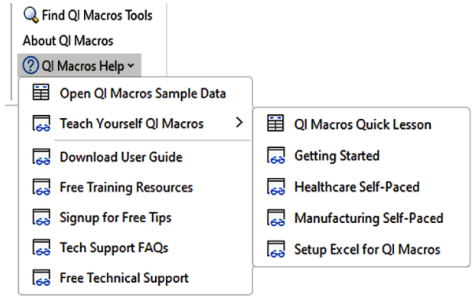
Help & Training Menu

Find QI Macros Tools: Use this feature to quickly find QI Macros charts and tools: qimacros.com/training/qi-macros-find-tools

About QI Macros: Use this menu option to identify the currently installed version of QI Macros.

QI Macros Help Menu

Use these menu options for sample data sets, step-by-step tutorials, free online training resources, and more.



QI Macros Sample Data
Wondering what your data should look like? Just want to try running a quick chart? Click this help menu option to open a folder full of sample Excel data sets for most common charts.

Teach Yourself QI Macros
Want a quick walk-through for creating a chart? The Quick Lesson opens a tutorial that runs right in Excel. Or, click one of the other options to access online tutorials.

Download User Guide
Download a PDF of this user guide with clickable links.

Free Training Resources
Open a webpage of links to different training options

Signup for Free Tips:
Sign up for emailed newsletters which contain in-depth explorations of QI Macros charts and tools, news, stories, and fun facts.

Tech Support FAQs
Open a web page of solutions to common technical support questions.

Free Technical Support
Register your license to qualify for free technical support, informational monthly newsletters, and upgrade discounts.

Additional Free Resources

Video tutorials: How-to videos for most of the QI Macros tools:

- qimacros.com/training/qi-macros-tutorial
- qimacros.com/qi-macros/video-tour
- qimacros.com/training/videos

Additional training: qimacros.com/free-resources

Free webinars: A monthly live webinar hosted by Jay Arthur, developer of QI Macros: qimacros.com/training/qi-macros-webinar

Share with your friends & colleagues!
Download a fully functioning trial: qimacros.com/trial/30-day

Monthly newsletter: qimacros.com/newsletter

Getting Started

Data Format & Selection

Input your data into an Excel worksheet. The simplest format for your data is one column and one row of labels, and one or more columns of data (e.g., samples).

Date/Labels ↓

	A	B	C	D	E	F
1	Sample Number	Obs 1	Obs 2	Obs 3	Obs 4	Obs 5
2	S1	74.030	74.002	74.019	73.992	74.008
3	S2	73.995	73.992	74.001	74.011	74.004
4	S3	73.988	74.024	74.021	74.005	74.002
5	S4	74.002	73.996	73.993	74.015	74.009

← **Defects/Samples**

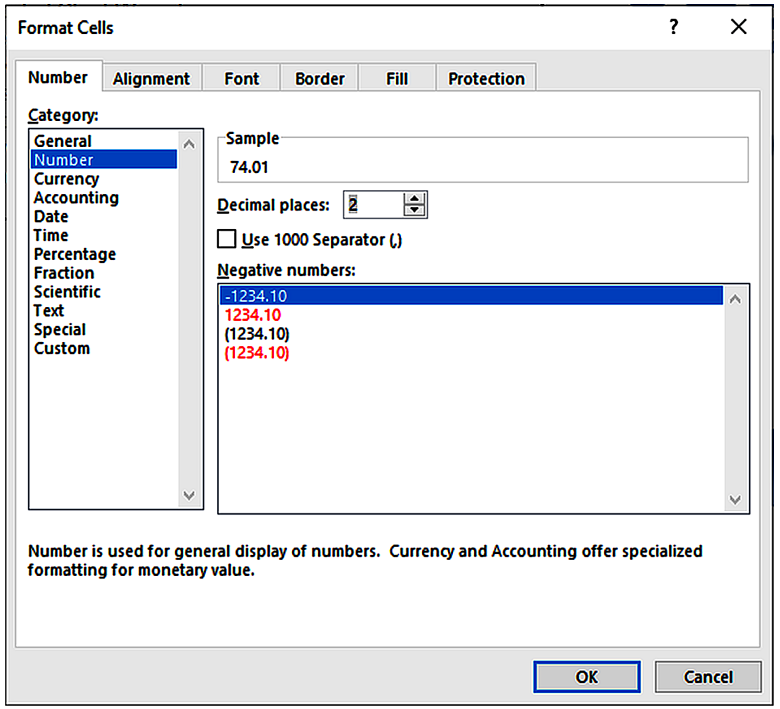
You may also use data that is arranged in horizontal rows.

Numeric Data and Decimal Precision

Excel formats most numbers as "general," not "number." *If you do not specify a format for your data, Excel will choose one for you.*

To achieve the desired precision in your data:

- Highlight your data, right-click, and select Format Cells.
- Select "Number" from the Category list.
- Specify the preferred number of decimal places.



More information about data formatting:

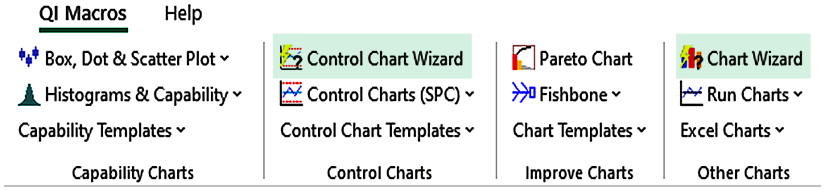
- qimacros.com/free-excel-tips/how-to-organize-data-excel
- qimacros.com/free-excel-tips/format-data-for-charts

Sample data: Access sample data sets from the help menu to learn how to set up data and to practice running charts:

- qimacros.com/qi-macros/test-data

Creating Charts

1. Select your data: *Select only the data you want on the chart.* Hold down the control (Ctrl) key to highlight data in non-adjacent columns.
2. Select a chart from the QI Macros menu. If you're not sure, select the QI Macros Chart Wizard or Control Chart Wizard to automatically create charts appropriate for your data. (See the Wizards section of this guide for more information.)



3. Answer any prompts.
4. Review your charts.
5. Save your workbook with a unique file name.

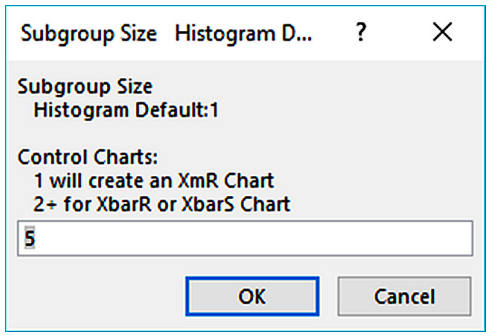
Control chart templates are another method for creating control charts. (Refer to the Control Charts Templates section of this guide for more information.)

qimacros.com/training/videos/control-chart-video

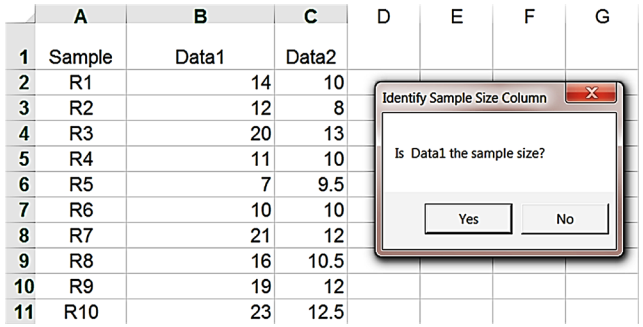
Common Error Messages
Charts require a certain number of data columns to run properly:

1 Column	1 or More Columns	2 Columns	2 or More Columns
Pareto Pie Run c, np, XmR Levey Jennings Moving Average Dot Plot	XmR Histogram Frequency Histogram EWMA Cusum XmedianR	Scatter u, p Hotelling	Box & Whisker Multi Vari XbarR XbarS Matrix Plot

Many charts require more than one column of data. If you highlight only one column of data and then select one of these charts, you may see a prompt requiring you to choose a subgroup size:



The u chart assumes that your defects column is to the left of your sample size column. If the columns are reversed (larger numbers on the left), QI Macros asks if the left column is the sample size:

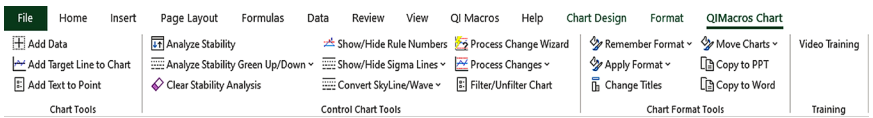


	A	B	C	D	E	F	G
1	Sample	Data1	Data2				
2	R1	14	10				
3	R2	12	8				
4	R3	20	13				
5	R4	11	10				
6	R5	7	9.5				
7	R6	10	10				
8	R7	21	12				
9	R8	16	10.5				
10	R9	19	12				
11	R10	23	12.5				

QI Macros Chart Menu

Click on a QI Macros chart to access the QI Macros Chart menu. The QI Macros Chart tab allows you to revise an existing chart by adding more data, showing a process change, deleting a point, etc.

The QI Macros Chart menu tab appears on the upper right corner of the Excel menu bar:

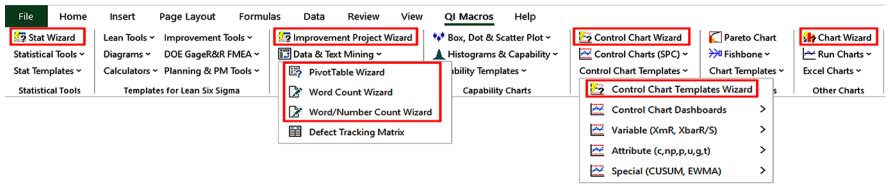


Refer to the QI Macros Chart Menu section of this booklet for more information about these tools.

Wizards and Data Mining Tools

Wizards Overview

QI Macros is the only Six Sigma software with built-in wizards that automatically choose charts based on your data and data mining tools to quickly reorganize your data into a usable format.



Improvement Project Wizard: creates a pivot table and generates a control chart, defect Pareto charts, and a fishbone diagram.
qimacros.com/data-mining-analysis-excel/data-mining-wizard

Chart Wizard: creates all the probable charts for your data (Pareto charts, control charts, histograms, etc.) and runs descriptive statistics. qimacros.com/quality-tools/chart-wizard

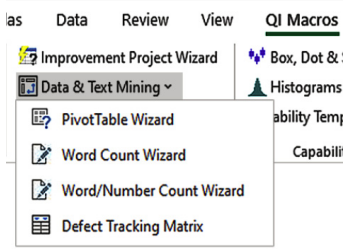
Control Chart Wizard: chooses the right control chart for your data (c, np, p, u, XmR, XbarR, or XbarS).
qimacros.com/control-chart/control-chart-wizard

Control Chart Templates Wizard: analyzes your data and places your data in the right control chart template.
qimacros.com/control-chart/control-chart-template-wizard

Stat Wizard: analyzes your data and chooses the right hypothesis tests. qimacros.com/hypothesis-testing/statistics-wizard-excel

QI Macros Wizards are discussed in greater detail in the following pages and at this link: qimacros.com/qi-macros/wizards

Data & Text Mining



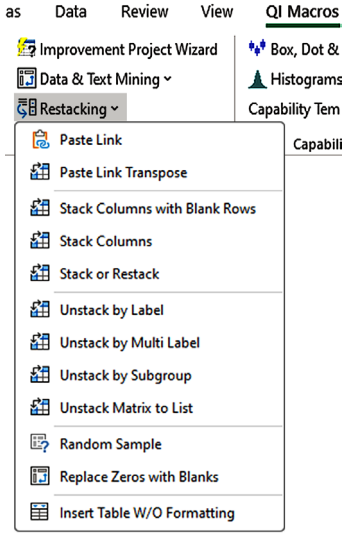
QI Macros data mining & restacking tools quickly analyze your data and reorganize it into a usable format.

PivotTable Wizard: summarizes up to four columns of tabular data using Excel's PivotTable function.
qimacros.com/quality-tools/pivot-table-cross-tab

Word Count Wizard: counts the number of times a word or two-word phrase appears in your data.

Word/Number Count Wizard: counts instances of text *and* numbers. qimacros.com/quality-tools/word-count

Restacking



Paste Link/Paste Link Transpose: pastes, links, and transposes your data in one step. Use this feature to link your data to a dashboard; updates to your data sheet will then automatically update the dashboard template and charts.
qimacros.com/quality-tools/pastelink

Stack/Restack/Unstack: quickly restacks one column of data into multiple columns or restacks multiple columns of data into one column. Converts two columns to three, four columns to two, etc.
qimacros.com/quality-tools/restack

QI Macros data mining tools are discussed in greater detail here:
qimacros.com/data-mining-analysis-excel

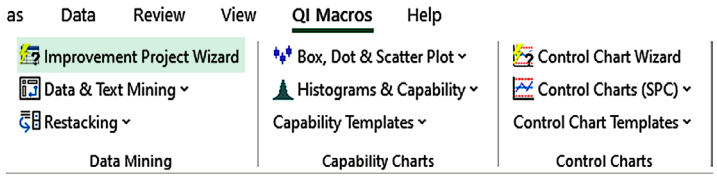
Improvement Project Wizard

The Improvement Project Wizard quickly finds the improvement project in large amounts of data.

1. Make sure each column in your data sheet has a heading and that there aren't blank rows or columns separating the data you want in the pivot table.

	A	B	C
1	**Date**	**Line**	**Defect**
2	1/2/2018	Line 3	Folded flaps
3	1/2/2018	Line 2	Bent/Damaged flaps
4	1/2/2018	Line 2	Carton will not open
5	1/2/2018	Line 3	Folded flaps
6	1/2/2018	Line 3	Off color
7	1/2/2018	Line 1	Bent/Damaged flaps

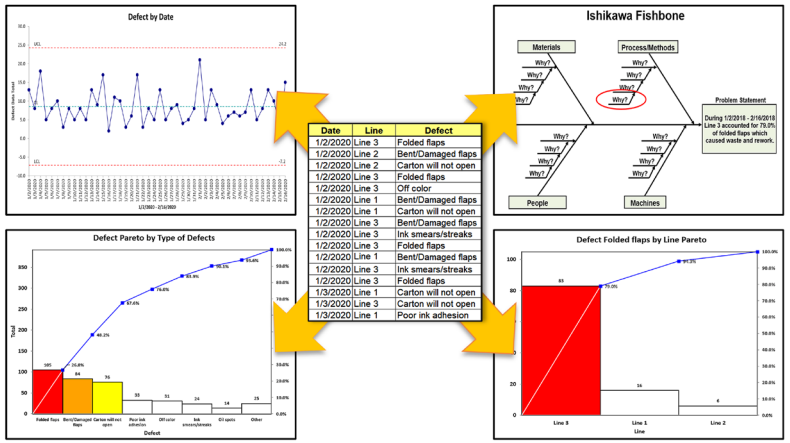
2. Select two column headings (preferably a date and currency, numbers, or text.)



3. Select Improvement Project Wizard from the QI Macros menu.

The Improvement Project Wizard:

- Summarizes the data in a pivot table
- Creates a control chart using the selected fields
- Creates a fishbone (Ishikawa) diagram from the largest bar of the Pareto chart
- Creates Pareto charts using the remaining columns



qimacros.com/improvement-project-wizard

PivotTable Wizard

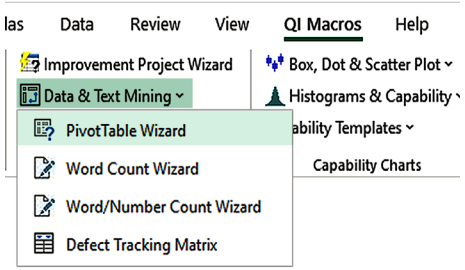
Pivot tables are a valuable tool for every quality improvement professional, and QI Macros makes creating them easy.

1. Make sure each column in your data sheet has a heading and that there aren't blank rows or columns separating the data you want in the pivot table.

2. Hold the control (Ctrl) key to highlight up to four column headings from your data sheet.

	A	B	C	D	E	F	G	H	I	J	K	L
1	**Region**	**POST DATE**	**ENT**	**ADM DATE**	**DIS DATE**	**AS**	**COS**	**FC**	**IN1**	**PT**	**DENIED CHARGES**	**ACCT BAL**
2	North	06/24/18	Hosp1	02/10/18	2/13/18	OL		X	AEH	O	543.07	543.07
3	South	12/21/17	Hosp2	07/10/17	7/13/17	OL		X	BCP	E	215.4	215.4
4	South	02/22/18	Hosp2	12/03/17	12/6/17			X	CGH	O	157.92	157.92
5	South	05/20/18	Hosp3	10/17/17	10/20/17	OL		X	MAH	O	90.73	55.83
6	North	07/12/18	Hosp1	05/04/18	5/7/18	AP		X	HEH	O	4103.78	4103.78

3. Select PivotTable Wizard from the Data & Text Mining section of the QI Macros menu.



4. The wizard organizes your data into a pivot table.

5. Hold the control (Ctrl) key to highlight labels and data in the pivot table to draw charts using QI Macros for further analysis.

	A	B	C	D	E	F	G	H	I
1	Sum of DENIED CHARGES	ENT							
2	ADM DATE	Hosp1	Hosp2	Hosp3	Hosp4	Hosp5	Hosp6	Hosp7	Grand Total
3	03/26/17			387.48					387.48
4	04/23/17			379.62					379.62
5	03/11/18			6908.98					6908.98
6	07/22/18		311.16						311.16
7	07/24/18					2124.86			2124.86
8	08/04/18				3224.83				3224.83
9	08/18/18		193.65	343.51					537.16
10	10/21/18			230.42					230.42
11	11/14/18			2186.16					2186.16
12	11/17/18			2627.84					2627.84
13	11/24/18			311.2					311.2
14	12/19/18		643.81						643.81
15	01/05/19		1630.38						1630.38
16	01/19/19			243.64					243.64

qimacros.com/training/videos/cross-tab-pivottable-wizard

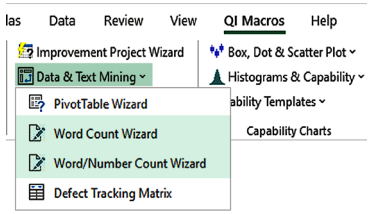
Word Count Wizard

Most data tracking systems contain note or comment fields with interesting and valuable data, but it is often hard to analyze. The QI Macros Word Count Wizard simplifies this process by parsing the words out of sentences and paragraphs and creating pivot tables to count the occurrences of individual words and two-word phrases.

1. Highlight your data (omit the header row).

	A
1	**MEMOTEXT - Wordcount**
2	DA REJECT - DUP DOS (MULTIPLE VISITS SAME DAY). CLD AND TT SHELLY AT AETNAWAS TOLD THAT THIS SHOULD BE INCLUDED IN THE SURGERY CHARGES. E-MAILED GARY S TO SEE IF THIS IS CORRECT. THE SURGERY ACCT IS IN MC STATUS. CATHY X266
3	DANIEL FROM DAVIS WIRE 0 CALLED TOSAY THEY RECVD A W/C CLAIM FOR THIS PT AND THEY ARE NOT ASSOCIATED WITH DAVIS WIRE IN THAT REGARD...THE INS INFO IS INCORRECT...WILL DELETE AND REFER TO WC FOLLOWUP...ADAVIS
4	DA REJECT - DUP DOS (MULTIPLE VISITS SAME DAY).
5	DA REJECT - DUP DOS (MULTIPLE VISITS SAME DAY)/ RECEIVED FROM ,AILHANDLERS EOB THAT THEY WILL NOT PAY CLAIM/ CALLED TT KATHY/ SHE STATED CLAIM NOT PAID BECAUSE THEY RECEIVCED 2CLAIMS FROM US WITH SAME DOS/ NON WERE MARKED CORR

2. Select Word Count Wizard from the Data & Text Mining section of the QI Macros menu. (Word/Number Count Wizard will count instances of text *and* numbers.)



	A	B	C	D	E
1	Count of Word			Count of Two-Word Phrases	
2	Word	Total		Two-Word Phrases	Total
3	dup	11		da reject	8
4	dos	9		reject dup	8
5	reject	8		dup dos	8
6	da	8		multiple visits	6
7	same	7		same day	6
8	multiple	6		dos multiple	6
9	day	6		visits same	6
10	visits	6		rekey call	2
11	claim	4		davis wire	2

3. QI Macros Word Count Wizard creates two pivot tables: one for single words and one for two-word phrases.

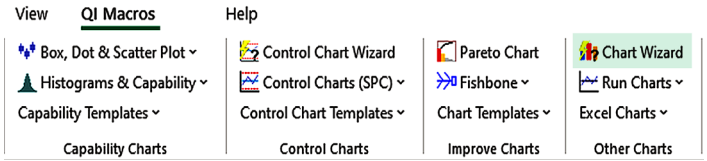
The pivot tables give you a clearer view of your data. You can highlight data within the pivot table to draw Pareto charts for further insights.

qimacros.com/training/videos/word-count-wizard

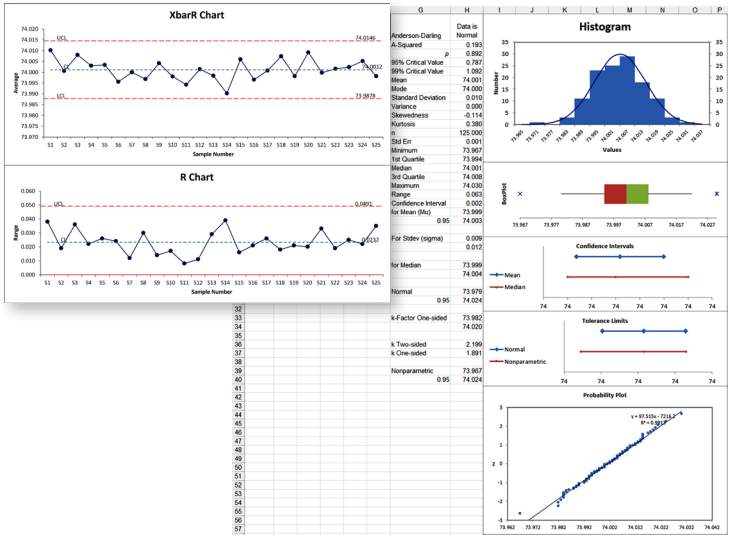
Chart Wizard

The QI Macros Chart Wizard analyzes your data and chooses the right charts for you.

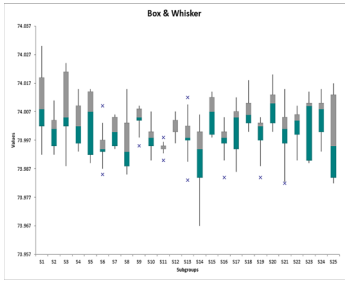
1. Highlight your data, then select Chart Wizard from the menu.



2. The QI Macros Chart Wizard will create a control chart and run descriptive statistics consisting of a normality test, histogram, box plot, confidence intervals, and a normal probability plot.



3. The Chart Wizard will also create a scatter or box & whisker plot for data sets consisting of more than one column of samples.



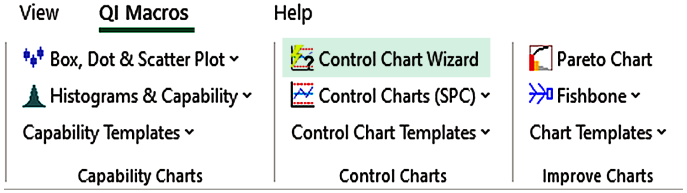
qimacros.com/quality-tools/chart-wizard

Control Chart Wizard

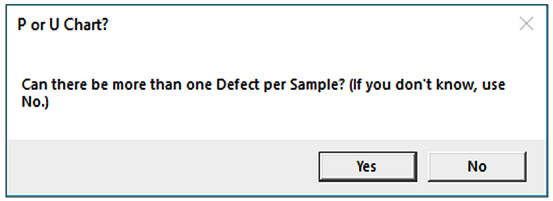
Choosing the right control chart depends on your data – attribute (counted) or variable (measured) – and the sample size:

	Number of Samples		
Type of data	1	2 or more	Varies
Fraction Defective		np	p
Number of Defects		c	u
Time, Length, Weight, $ (Measured)	XmR	XmR XbarR XbarS	XbarR XbarS

1. Highlight your data.
2. Select Control Chart Wizard from the QI Macros menu:



3. The wizard analyzes your data and selects the correct chart. If it needs to determine between two possible charts, you may see a prompt:



4. In addition to generating a control chart, QI Macros will automatically insert your data into a control chart template which may be used for ongoing data collection. (Refer to the Control Charts Template section of this book for more information about templates.)

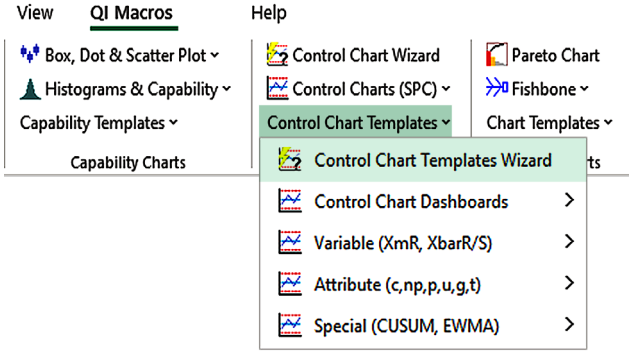
Guidelines for selecting charts:

- qimacros.com/pdf/spc-free-training.pdf
- qimacros.com/free-excel-tips/choosing-control-charts

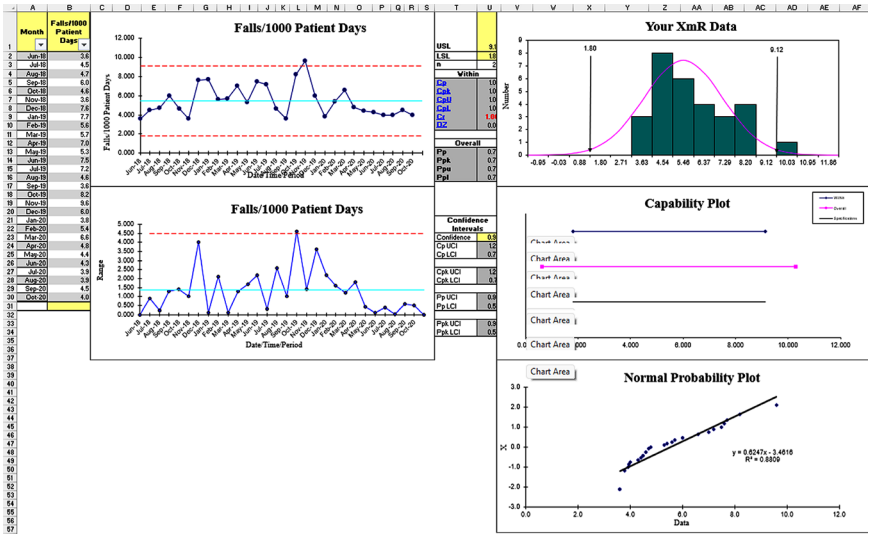
qimacros.com/control-chart/control-chart-wizard

Control Chart Templates Wizard

The QI Macros Chart Templates Wizard analyzes your data and places your data in the right control chart template. Highlight your data and select Control Chart Templates Wizard from the Control Chart Templates menu.



The QI Macros Chart Templates Wizard will place your data into the correct template. Your charts will populate automatically, as you input data.

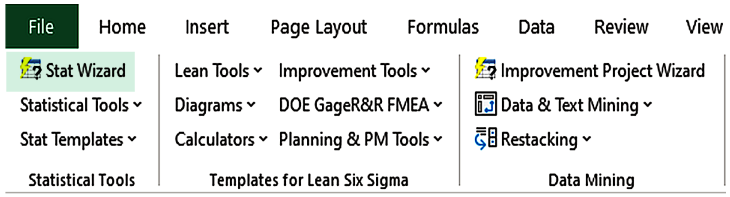


qimacros.com/control-chart/control-chart-template-wizard

Stat Wizard

The Stat Wizard analyzes your data and chooses the right statistical tests for you. The Stat Wizard tells you if the means and variances of two or more samples are the same or different.

1. Organize your data into columns. (Access sample data sets from the QI Macros Help menu.)
2. Highlight your data, then choose Stat Wizard from the QI Macros menu.



3. The Stat Wizard determines the number of columns of data and whether the data is decimals or integers. Based on that information, QI Macros runs the following statistics:

1 Column	Descriptive statistics 1 sample t-test for means
2 Columns	F-test for variances t-test for means Equivalence test for means Chi-square table for independence (if data is integers)
3+ Columns	Descriptive Statistics (for each individual data column) ANOVA for means Levene's test for variances Chi-square table for independence (if data is integers)

The QI Macros Stat Wizard answers these questions:

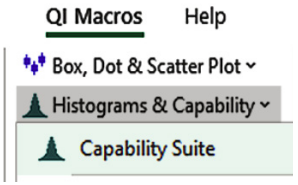
- Is your data normal?
- Do you reject or accept the null hypothesis?
- Are the means or variances the same or different?

qimacros.com/hypothesis-testing/statistics-wizard-excel
qimacros.com/hypothesis-testing

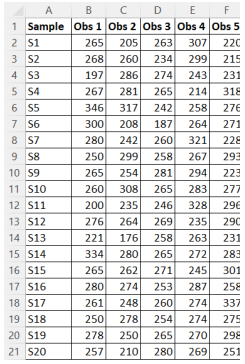
Capability Charts

Capability Suite

The QI Macros Capability Suite evaluates both data normality and data stability as well as process capability.

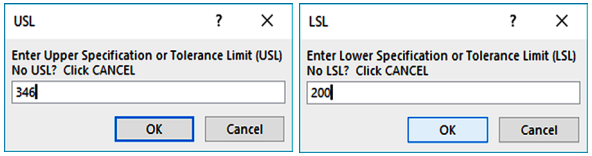


1. Highlight your data and select Capability Suite from the Histograms & Capability section of the QI Macros menu.

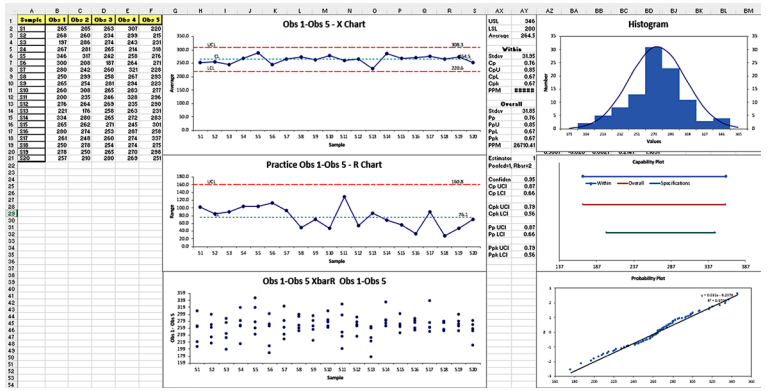


	A	B	C	D	E	F
1	Sample	Obs 1	Obs 2	Obs 3	Obs 4	Obs 5
2	S1	265	205	263	307	220
3	S2	268	260	234	299	215
4	S3	197	286	274	243	231
5	S4	267	281	265	214	318
6	S5	346	317	242	258	276
7	S6	300	208	187	264	271
8	S7	280	242	260	321	228
9	S8	250	299	258	267	293
10	S9	265	254	281	294	223
11	S10	260	308	265	283	277
12	S11	200	235	246	328	296
13	S12	276	264	269	235	290
14	S13	221	176	258	263	231
15	S14	334	280	265	272	283
16	S15	265	262	271	245	301
17	S16	280	274	253	287	258
18	S17	261	248	260	274	337
19	S18	250	278	254	274	275
20	S19	278	250	265	270	298
21	S20	257	210	280	269	251

2. Enter upper and lower specification limits (USL & LSL), or use the calculated defaults.



3. The Capability Suite will draw the following charts:
   - X Chart
   - Range or Standard Deviation chart
   - Values plot
   - Histogram with Cp, Cpk, Pp, Ppk
   - Probability plot
   - Capability plot



qimacros.com/training/videos/capability-suite

Histogram

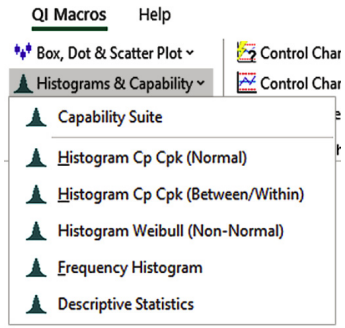
Histograms show the spread – or dispersion – of variable data. The upper specification (USL) and lower specification limits (LSL) determine how well the process delivers on customer requirements. Measurements outside of the specification limits represent data points that don't meet customer requirements.

1. *Do not sort your data before running a histogram.*

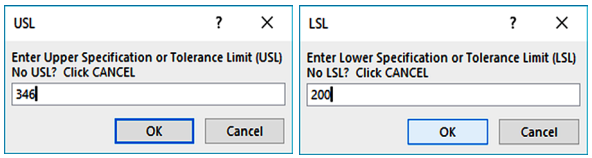
	A	B	C	D	E	F
1	Sample	Obs 1	Obs 2	Obs 3	Obs 4	Obs 5
2	S1	265	205	263	307	220
3	S2	268	260	234	299	215
4	S3	197	286	274	243	231
5	S4	267	281	265	214	318
6	S5	346	317	242	258	276

2. Highlight your data (a minimum of 20 data points is recommended).

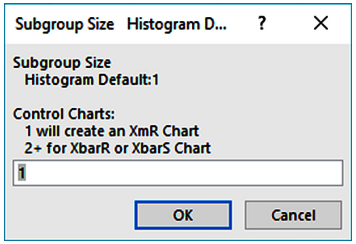
3. Select the type of histogram you want from the Histograms and Capability section of the QI Macros menu.



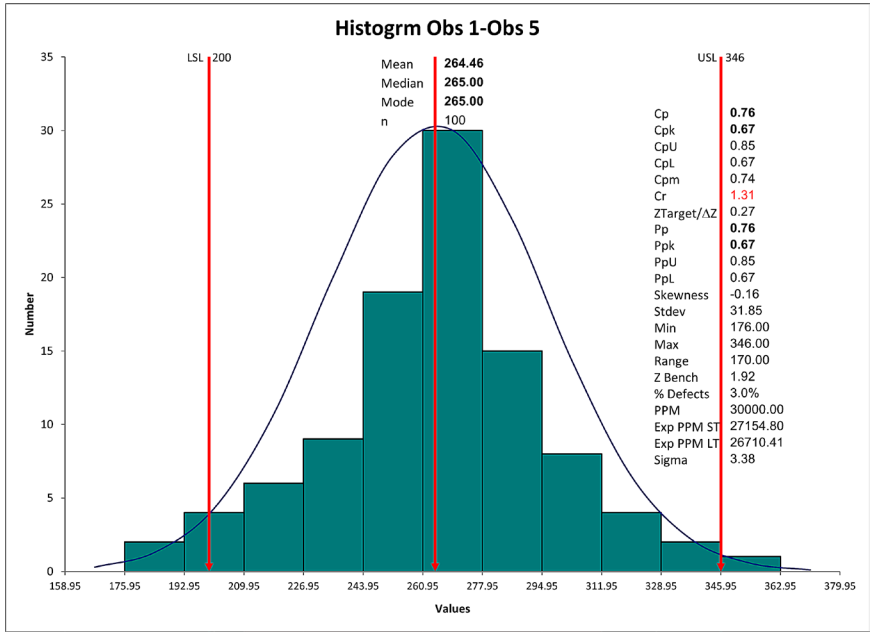
4. Enter the USL and LSL and the approximate number of bars at the prompts. Click OK to use the defaults or enter your own. For one-sided histograms (no USL or no LSL) click Cancel at the appropriate prompt.



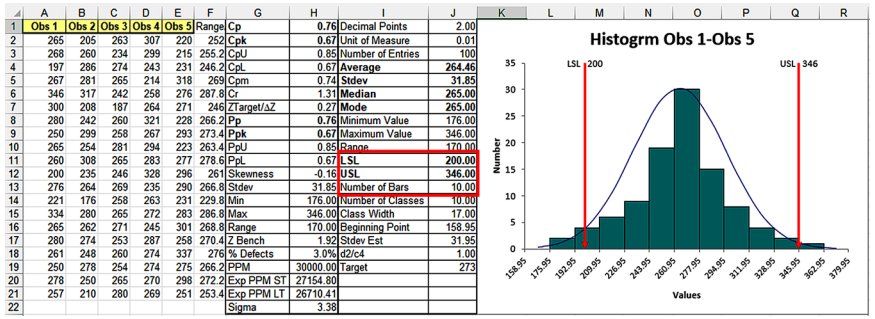
5. If you select a single column of data, the histogram prompts you for a subgroup size. Input a subgroup size or use the default of 1 if there are no subgroups.



6. QI Macros creates the histogram.



7. You can change the USL, LSL and Number of Bars by simply typing over the current values in the data table. QI Macros will update the histogram and data labels, and recalculate Cp, Cpk and Pp, Ppk.

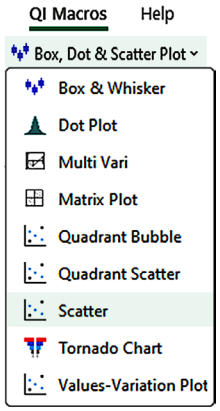


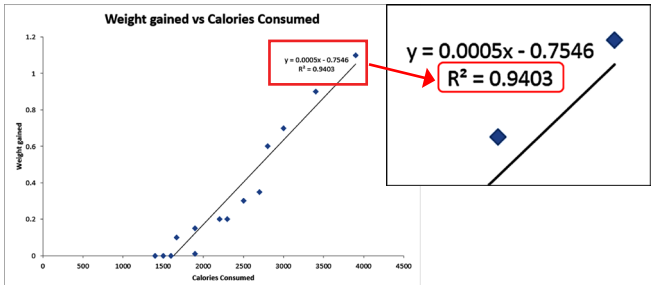
	A	B	C	D	E	F	G	H	I	J
1	Obs 1	Obs 2	Obs 3	Obs 4	Obs 5	Range	Cp	0.76	Decimal Points	2.00
2	265	205	263	307	220	252	Cpk	0.67	Unit of Measure	0.01
3	268	260	234	299	215	255.2	CpU	0.85	Number of Entries	100
4	197	286	274	243	231	246.2	CpL	0.67	Average	264.46
5	267	281	265	214	318	269	Cpm	0.74	Stdev	31.85
6	346	317	242	258	276	287.8	Cr	1.31	Median	265.00
7	300	208	187	264	271	246	ZTarget/ΔZ	0.27	Mode	265.00
8	280	242	260	321	228	266.2	Pp	0.76	Minimum Value	176.00
9	250	299	258	267	293	273.4	Ppk	0.67	Maximum Value	346.00
10	265	254	281	294	223	263.4	PpU	0.85	Range	170.00
11	260	308	265	283	277	278.6	PpL	0.67	LSL	200.00
12	200	235	246	328	296	261	Skewness	-0.16	USL	346.00
13	276	264	269	235	290	266.8	Stdev	31.85	Number of Bars	10.00
14	221	176	258	263	231	229.8	Min	176.00	Number of Classes	10.00
15	334	280	265	272	283	286.8	Max	346.00	Class Width	17.00
16	265	262	271	245	301	268.8	Range	170.00	Beginning Point	158.95
17	280	274	253	287	258	270.4	Z Bench	1.92	Stdev Est	31.95
18	261	248	260	274	337	276	% Defects	3.0%	d2/c4	1.00
19	250	278	254	274	275	266.2	PPM	30000.00	Target	273
20	278	250	265	270	298	272.2	Exp PPM ST	27154.80		
21	257	210	280	269	251	253.4	Exp PPM LT	26710.41		
22							Sigma	3.38		

- qimacros.com/pdf/histogram-manual-calcs.pdf
- qimacros.com/training/videos/histograms

Scatter Plot

A scatter plot proves or disproves a suspected cause-effect link between two indicators (e.g., calories consumed and weight gain).



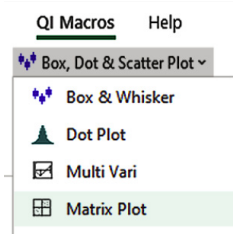


- An R^2 value greater than .80 indicates a strong correlation.
- Points tightly clustered along the trend line indicate a correlation, while points arranged more like a shotgun blast indicate no correlation.

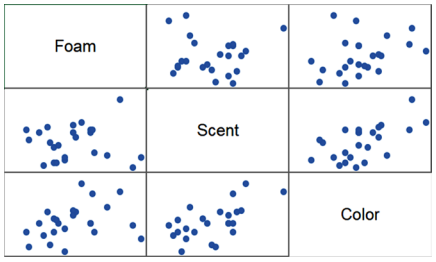
qimacros.com/training/videos/scatter-plot

Matrix Plot

A matrix plot quickly identifies correlations between two or more indicators. Points tightly clustered along a line indicate a strong correlation; points arranged more like a shotgun blast indicate no correlation.



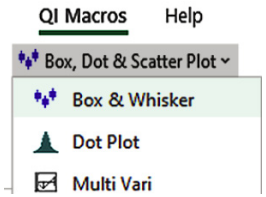
Foam	Scent	Color
6.3	5.3	4.8
4.4	4.9	3.5
3.9	5.3	4.8
5.1	4.2	3.1
5.6	5.1	5.5
4.6	4.7	5.1
4.8	4.8	4.8
6.5	4.5	4.3
8.7	4.3	3.9



qimacros.com/training/videos/scatter-plot-matrix

Box & Whisker

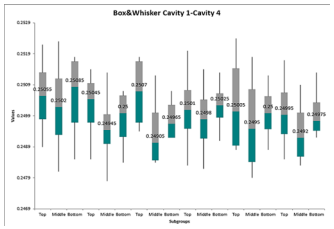
Box & whisker plots show the dispersion of data over time. Each bar is like a histogram turned on its side.



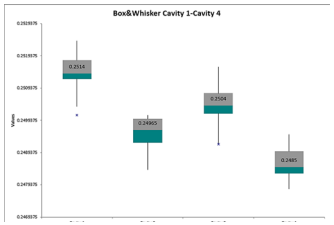
This chart requires two or more columns of data. QI Macros asks if your data is grouped in rows or columns. (This example has 18 rows and 4 columns).

The QI Macros box & whisker plot will display the median value for each box on the chart.

Box & Whisker arranged by rows



Box & Whisker arranged by columns



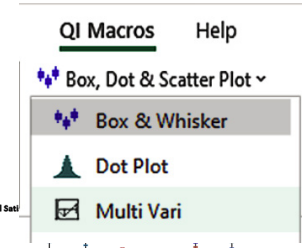
Box & Whisker data

	Cavity 1	Cavity 2	Cavity 3	Cavity 4
Top	0.2522	0.2501	0.2510	0.2489
Middle	0.2523	0.2497	0.2507	0.2481
Bottom	0.2518	0.2501	0.2516	0.2485
Top	0.2514	0.2501	0.2508	0.2485
Middle	0.2513	0.2494	0.2495	0.2478
Bottom	0.2505	0.2495	0.2507	0.2484
Top	0.2518	0.2498	0.2516	0.2494
Middle	0.2512	0.2484	0.2496	0.2485
Bottom	0.2501	0.2492	0.2507	0.2492
Top	0.2520	0.2499	0.2503	0.2483
Middle	0.2514	0.2495	0.2501	0.2482
Bottom	0.2513	0.2501	0.2504	0.2491
Top	0.2524	0.2488	0.2511	0.249
Middle	0.2518	0.2486	0.2504	0.2479
Bottom	0.2512	0.2497	0.2503	0.2488
Top	0.2517	0.2496	0.2503	0.2485
Middle	0.2509	0.2487	0.2497	0.2483
Bottom	0.2513	0.2500	0.2492	0.2495

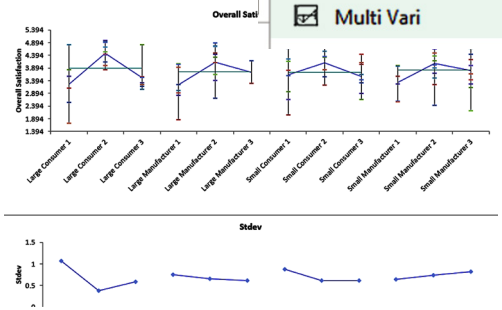
qimacros.com/training/videos/box-whisker-plot

Multi Vari Chart

The Multi Vari chart summarizes data based on labels and plots the averages and data points.



	A	C	D	H
1	Size of Customer	Product Type	Customer Type	Overall Satisfaction
2	Small	Consumer	2	3.54
3	Large	Consumer	3	3.16
4	Small	Manufacturer	2	2.42
5	Large	Manufacturer	2	2.7
6	Small	Consumer	3	3.31
7	Large	Consumer	2	4.12
8	Large	Manufacturer	1	3.24
9	Large	Manufacturer	2	4.47
10	Large	Consumer	2	3.83
11	Small	Consumer	1	2.94
12	Small	Manufacturer	2	3.24
13	Small	Manufacturer	2	4.18
14	Large	Consumer	2	4.53
15	Small	Consumer	2	3.22
16	Large	Manufacturer	1	1.86

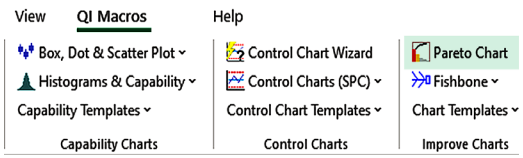


qimacros.com/training/videos/multi-vari-chart

Improvement Charts

Pareto Chart

Pareto charts combine a sorted bar graph with a cumulative line graph.



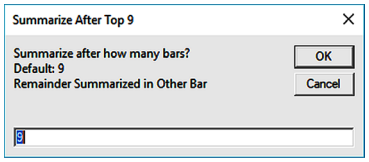
Often, two or three big bars represent most of the problem. Using the 80-20 rule (qimacros.com/pareto-chart-excel/80-20-rule), Pareto charts help narrow your focus to simplify problem solving.

1. Put labels in the left hand column and data in the right hand column of your data sheet.

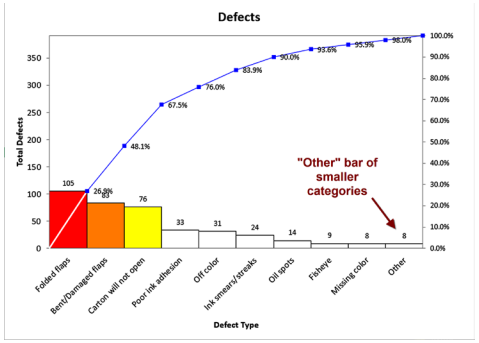
	A	B	C	D	E
1	Defect Type	Line 1	Line 2	Line 3	Total Defects
2	Bent/Damaged flaps	37	22	24	83
3	Carton will not open	29	18	29	76
4	Damaged Pallet	3			3
5	Fisheye	9			9
6	Folded flaps	16	6	83	105
7	Ink smears/streaks		5	19	24
8	Mislabeled			3	3
9	Missing color			8	8

2. Highlight your labels and one or more columns of data. QI Macros creates a separate Pareto for each data column.

3. Select Pareto Chart from the QI Macros menu. If you have more than nine data points, you'll be prompted for the desired number of bars. The remaining categories are summarized in an "other" bar.



Here's a sample Pareto chart with an "other" bar:

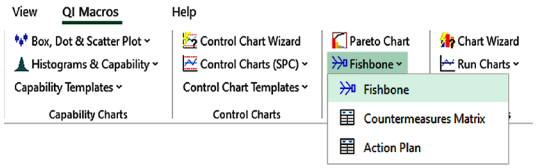


qimacros.com/pareto-chart-excel/pareto-chart-video

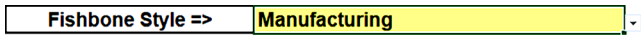
Fishbone (Ishikawa) Diagram

Fishbone (Ishikawa) diagrams identify the special root causes of delay, waste, rework or cost.

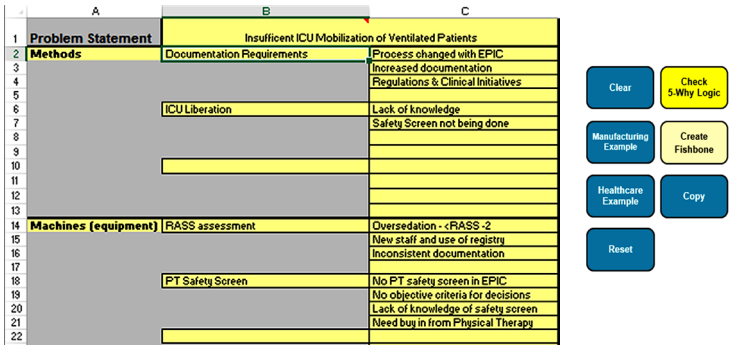
1. Access the fishbone diagram from the Improve Charts section of the QI Macros menu:



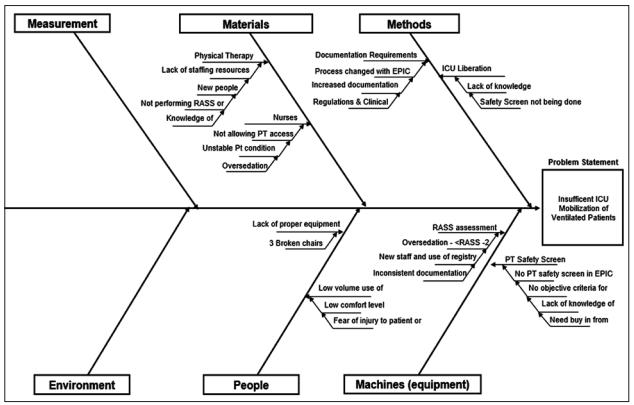
2. Select the fishbone style you prefer (healthcare, manufacturing, marketing, process, or service):



3. Input text in the yellow shaded cells, then click the Create Fishbone button:



4. QI Macros will populate a fishbone with the text you input:



Revising the Fishbone

To revise the fishbone, click the outline worksheet tab and update your text, then click the Create Fishbone button again.

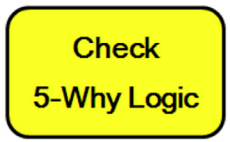
Copying the Fishbone

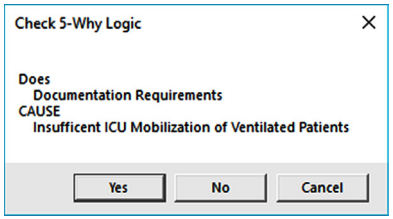
To copy the fishbone to Powerpoint or Word, click on the Copy button, then paste the fishbone diagram as either a picture or drawing object. (Pictures are static, drawing objects can be revised.)

5-Why Logic

The Check 5-Why Logic tool will walk you through the logic of your fishbone. Does X cause Y? Revisit and reword your 5 whys as needed.

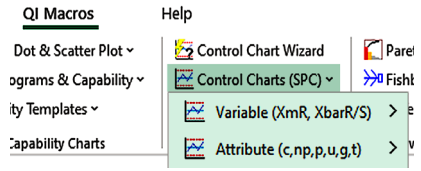
To check the logic in your fishbone, click on the Check Logic button and answer the prompts:





qimacros.com/fishbone-diagram-template

Control Charts



Attribute Control Charts: c, np, p, and u

Use attribute control charts to track the number of defects in counted data.

1. Highlight your labels and data (as shown).

c or np Charts

	A
1	No. Pinholes
2	4
3	5
4	3
5	3
6	5
7	2
8	5
9	3
10	2

p Charts

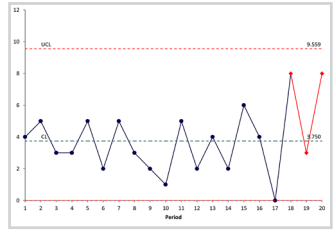
	A	B	C
1	Sample Number	Nonconforming Units	Sample Size
2	S1	12	100
3	S2	8	80
4	S3	6	80
5	S4	9	100
6	S5	13	110
7	S6	12	110
8	S7	11	100
9	S8	16	100
10	S9	10	90
11	S10	6	90

u Charts

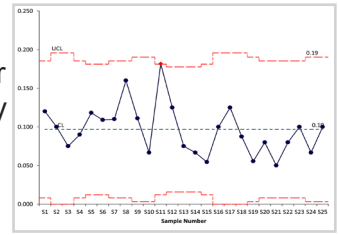
	A	B	C
1	Sample Number	Nonconforming Units	Sample Size
2	S1	12	100
3	S2	8	80
4	S3	6	80
5	S4	9	100
6	S5	13	110
7	S6	12	110
8	S7	11	100
9	S8	16	100
10	S9	10	90
11	S10	6	90

2. Select c, np, p, or u chart from the Control Charts (SPC) menu. The np chart prompts for a sample size if you did not include it in your selection.

c or np charts have flat upper and lower control limit lines.



p and u charts can have wavy upper and lower control limit lines that vary with the sample size.



qimacros.com/control-chart/show-hide-sigma-lines
qimacros.com/control-chart/p-and-u-chart-formats

XmR, XbarR, and XbarS Control Charts

An X chart shows process performance using continuous, variable data (i.e., time, length, weight, money, etc.).

1. Highlight your labels and data. You need 20 or more data points to get a useful graph.

   Your data should contain a column of labels and one or more columns of samples:

XmR charts

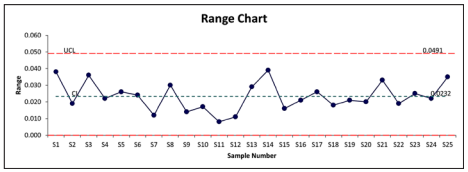
	A	B
1	Batch Number	Viscosity
2	B1	33.75
3	B2	33.05
4	B3	34.00
5	B4	33.81
6	B5	33.46

XmR, XbarR and XbarS charts

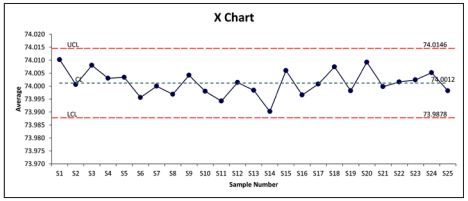
	A	B	C	D	E	F
1	Sample Number	Obs 1	Obs 2	Obs 3	Obs 4	Obs 5
2	S1	74.030	74.002	74.019	73.992	74.008
3	S2	73.995	73.992	74.001	74.011	74.004
4	S3	73.988	74.024	74.021	74.005	74.002
5	S4	74.002	73.996	73.993	74.015	74.009

2. Select an X chart from the QI Macros menu (XmR, XmR Median R, XmR Trend, XbarR, XbarS, or Xmedian Chart).

3. Evaluate the range chart first. If the range chart looks unstable, then the process is unstable.



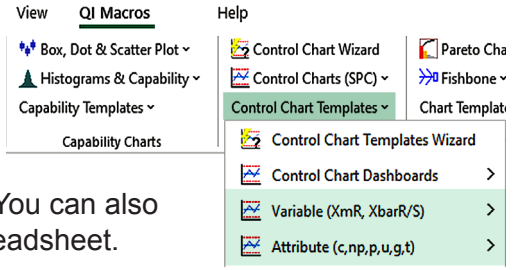
4. Next, evaluate the X chart. If the range chart looks stable *and* the X chart is stable, then the process is stable.

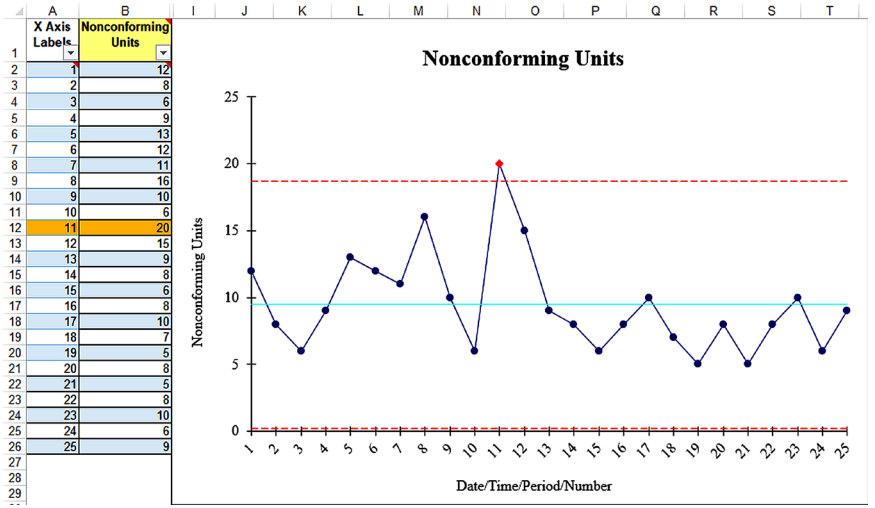


qimacros.com/training/videos/individual-moving-range-chart

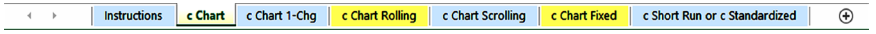
Control Chart Templates

QI Macros Control Chart Templates contain a data input area and a chart on one worksheet. Points are plotted on the chart as you add data to the input area. You can also link the cells to another spreadsheet.





Each template is made up of several worksheets (average, median, rolling, fixed, short run, etc.).



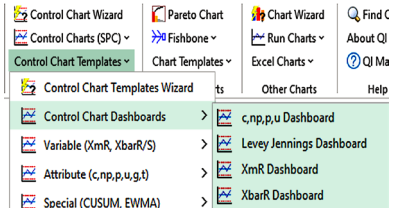
Once populated, click on the chart and use the QI Macros Chart menu to analyze stability, show process changes, etc.

For more information about the QI Macros Chart menu and its functions refer to the Control Chart Features section of this guide.

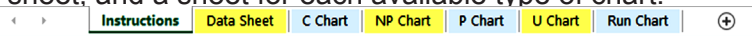
qimacros.com/control-chart/control-chart-template

Control Chart Dashboards

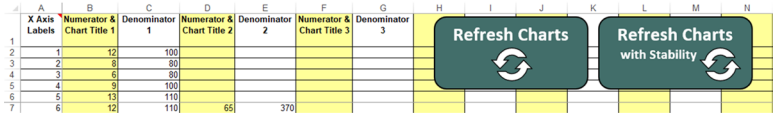
QI Macros control chart dashboards simplify the process of updating existing charts, organizing multiple control charts onto a single page, and creating dashboards for presentation.



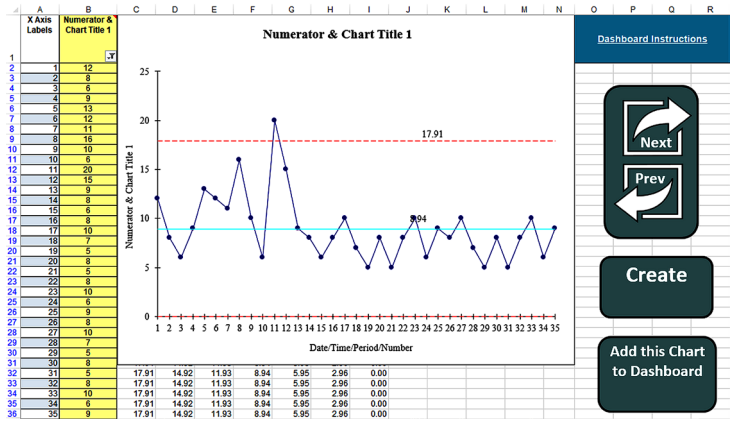
Each dashboard workbook contains an instruction sheet, a data input sheet, and a sheet for each available type of chart.



Input or paste your data into the data sheet, then click either the Refresh Charts button or the Refresh Charts with Stability button. Each set of labels and data creates a different chart.



Click on a chart sheet to see that chart for the first data set.



- Click the Next and Prev arrows to view different chart types for each data set.
- Click the Create Dashboard button to create a dashboard containing all of the control charts.
- Click the Add this Chart to Dashboard button to add more charts to the dashboard.

qimacros.com/control-chart/control-chart-dashboard

Specialized Control Charts

QI Macros contains tools for specialized control charts. Refer to the links on this page to learn more:

XmR Median R and XMedianR:
qimacros.com/control-chart/x-median-r-chart
qimacros.com/control-chart/median-control-chart-template

XmR Autocorrelated
qimacros.com/control-chart/xmr-control-chart-autocorrelated

XmR Trend
qimacros.com/control-chart/xmr-trend-chart

ZmR Chart
qimacros.com/control-chart/zmr-chart

I-MR-R:
qimacros.com/control-chart/i-mr-r-s-chart

p' and u' Charts:
qimacros.com/control-chart/p-prime-control-chart
qimacros.com/control-chart/u-prime-control-chart

g and t Charts:
qimacros.com/control-chart/g-chart-template
qimacros.com/control-chart/t-chart-excel

Levey Jennings:
qimacros.com/control-chart/levey-jennings-chart

ANOM:
qimacros.com/control-chart/analysis-of-means-chart

CUSUM:
qimacros.com/control-chart/cusum-chart

EWMA:
qimacros.com/control-chart/ewma-chart

Fixed Limit:
qimacros.com/control-chart/fixed-limit-control-chart

Moving Average:
qimacros.com/control-chart/moving-average-chart

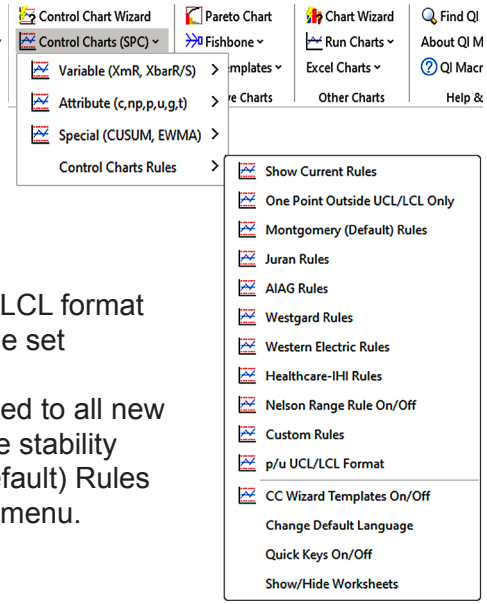
Hotelling T2:
qimacros.com/control-chart/hotelling-t2-chart

Control Chart Features

Control Chart Stability Rules

QI Macros Control Charts conduct stability analysis and turn unstable points or conditions red. They also plot markers for unstable points as diamonds. QI Macros' default stability rules are defined in Montgomery's *Introduction to Statistical Quality Control.*

Stability rules can be customized using the Control Chart Rules menu. From this menu you may:



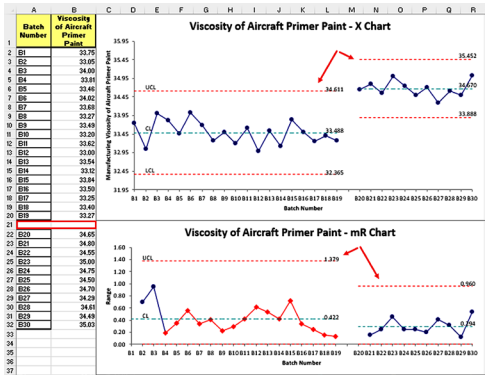
- Select a stability analysis rule set
- Show or hide sigma lines
- Change p and u chart UCL/LCL format
- Define a custom stability rule set

Changes are saved and applied to all new QI Macros charts. To reset the stability rules, select Montgomery (Default) Rules from the Control Chart Rules menu.

- qimacros.com/free-excel-tips/control-chart-rules
- qimacros.com/control-chart/stability-analysis-control-chart-rules

Create Stair Step Limits

To calculate two or more sets of control limits on charts, leave a blank row in the data where the limits change. QI Macros calculates separate upper and lower control limits (UCL/LCL) for each group of data.



QI Macros Chart Menu

QI Macros provides additional tools to update and analyze charts. First click the chart, then click the QI Macros Chart tab to access these tools:

Chart Tools

Add Data: Add the new data and labels in the rows under your old data. Click the chart and select Add Data from the QI Macros Chart tab. Enter the number of rows to add and click OK.

Add Target Line to Chart: Select Add Target Line to Chart and enter a label and value at the prompts.

Add Text to Point: Click the point on the chart, and select Add Text to Point from the QI Macros Chart menu. Type your text into the window.

Control Chart Tools

Analyze Stability: runs stability analysis after you add new data, delete a point, or show a process change on a control chart.

Analyze Stability Green Up/Green Down: shows "good" rule violations in green depending on whether "up" (higher) is better or "down" (lower) is better.

Clear Stability Analysis: clears stability analysis from the chart and resets all data points and lines to blue.

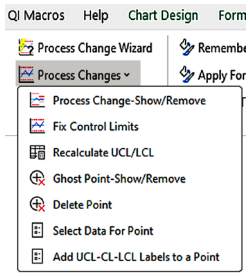
Show/Hide Rule Numbers: displays numbers corresponding with any stability analysis rules that have been violated.

Show/Hide 1-2 Sigma Lines: displays or hides sigma lines.

Convert Skyline to Wave/Wave to Skyline: changes the way upper and lower control limits are displayed on p, u, XbarR, and XbarS charts.

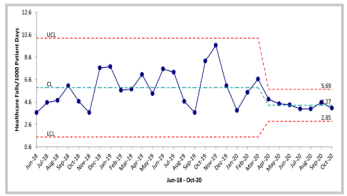
Process Change Wizard: Select the chart, then select Process Change Wizard from the QI Macros Chart menu. The Process Change Wizard will analyze the chart and adjust the control limits where it identifies runs and/or trends in your data.

Process Changes



- **Process Change-Show/Remove:** Click the point on the chart where the process change occurred, then select Show Process Change from the Process Changes sub-menu.

  QI Macros calculates a new set of control limits starting at the point selected.

  This feature can be used multiple times on the same chart. Follow the same steps to remove a process change.
- **Fix Control Limits:** Use historical control limits or your limits instead of the calculated control limits.
- **Recalculate UCL/LCL:** Recalculate control limits using all of the data points after adding new data to a chart.
- **Ghost Point-Show/Remove:** Ghosting removes a point from the calculations, but leaves it on the chart.
- **Delete Point:** Deleting a point removes it from the calculations *and* from the chart.
- **Select Data For Point:** This tool moves the cursor to the cell containing the corresponding value in your data sheet.
- **Add UCL-CL-LCL Labels to a Point:** Quickly add control limit labels to a point to provide further explanation about your data.

Chart Format Tools

Remember Format, Apply Format, Apply to All: customizes the chart fonts, colors, styles, etc.

Change Titles: revises chart and axis titles.

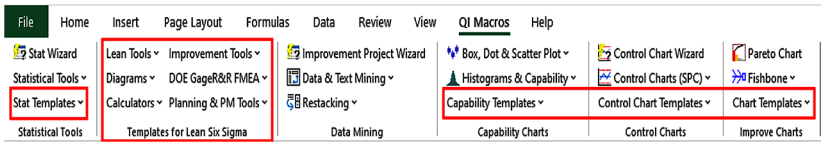
Move Charts, Copy to PPT, Copy to Word: exports a chart or charts to a separate worksheet, Powerpoint, or Word document.

qimacros.com/control-chart/update-control-chart

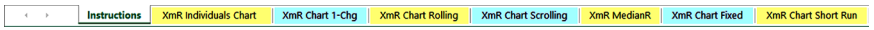
Templates for Lean Six Sigma

QI Macros templates simplify Lean Six Sigma project documentation, and advanced analysis like Gage R&R and DOE.

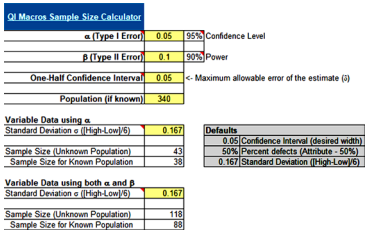
Templates are grouped with their corresponding category. Lean Six Sigma templates are grouped into their own category and sub-categorized:



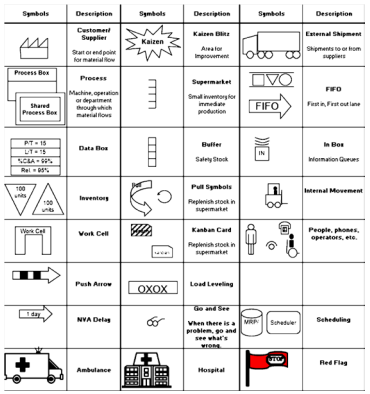
Each template contains instructions and a worksheet tab for each tool included in that template:



To use templates like the Calculators, DOE, Gage R&R, etc., type or paste data into the yellow shaded input areas.



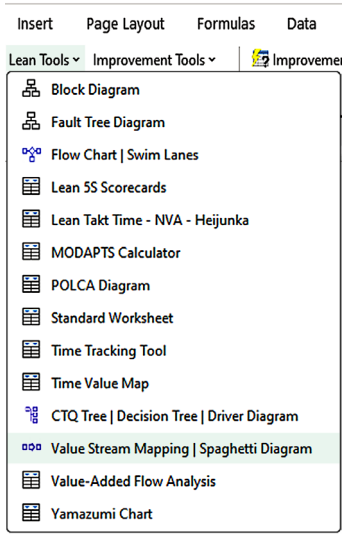
Use Excel's drawing toolbar to update the template and to insert boxes, arrows and other symbols for templates like the value stream map.



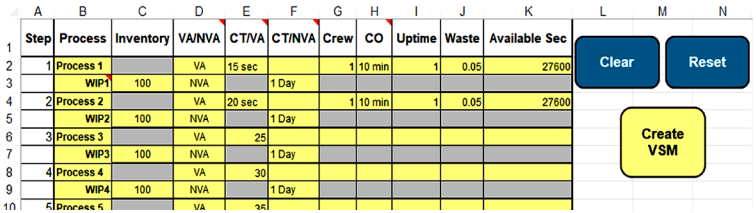
qimacros.com/lean-six-sigma/lean-six-sigma-tools

Value Stream Map

A value stream map analyzes value-added and non-value-added activities and delays. The QI Macros Value Stream Mapping template contains an automated value stream map (VSM Text), a worksheet of symbols, three different examples to help you get started, and a Spaghetti Diagram.



The VSM Text worksheet tab is pre-populated with values to give you an idea of what to input in each cell. Use the clear button to delete the contents and the reset button to re-populate the cells with sample text. Each step in a value stream map represents an operation that is performed on the product.



- **Process:** Briefly describe the process or work.
- **Inventory:** Estimate the amount of inventory on hand.
- **VA/NVA:** Indicate if the step is value-added or non-value added.
- **CT/VA and CT/NVA:** Input the cycle time for value-added and non-value-added steps.
- **Crew:** Input the number of people it takes to perform the process.
- **CO:** Input the time from the completion of one step to the beginning step for the next product.
- **Uptime:** Input % of uptime.
- **Waste:** Input % of waste or scrap.
- **Available Sec:** Input available time.Once all fields are populated, click the Create VSM button to create a value stream map.

qimacros.com/training/videos/value-stream-map

Gage R&R

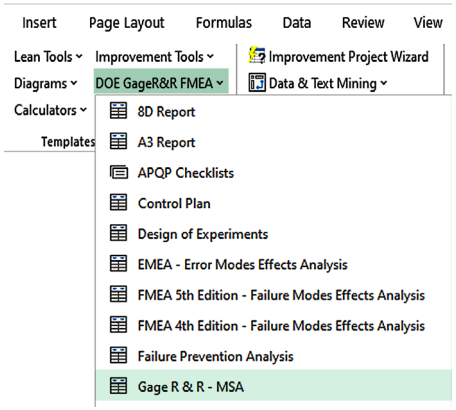
When you perform a Gage R&R study, three factors come into play:

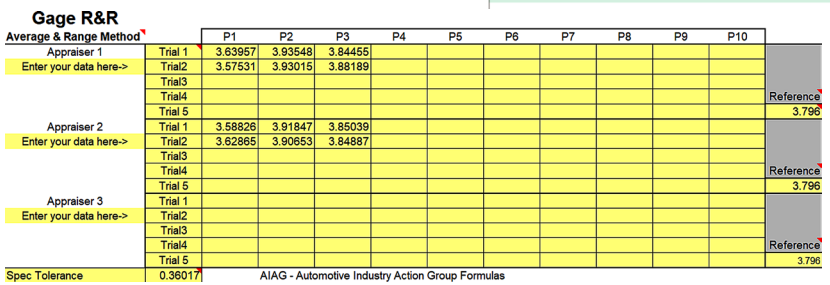
- **Part Variation:** This shows the difference between individual parts.
- **Equipment Variation (Repeatability):** Can one person, using the same gage, measure the same part consistently?
- **Appraiser Variation (Reproducibility):** Can two people using the same gage, measure the same part consistently?

To conduct a Gage R&R study, you will need five to ten parts that span the distance between the upper and lower spec limits. The parts should represent the actual or expected range of process variation. Number each part for the study, but don't put them in any kind of order. For example, if you're measuring to 0.0001, the range of parts should be 10 times the resolution (e.g., 0.4995 to 0.5005).

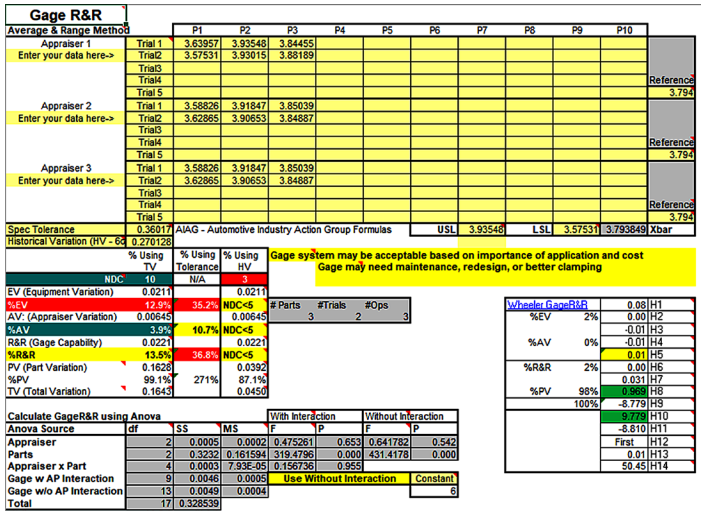
1. Select Gage R&R from the DOE, Gage R&R, FMEA section of the QI Macros menu, then save the template with a unique file name.

2. Enter your data into the yellow input areas. If you have references or specification tolerances, enter them.





3. Evaluate the Gage R&R graphs and data to identify where to improve your measurement system.



Gage R&R

Average & Range Method		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	
Appraiser 1	Trial 1	3.63957	3.93548	3.84455								
Enter your data here->	Trial2	3.57531	3.93015	3.88189								
	Trial3											Reference
	Trial4											3.794
	Trial 5											
Appraiser 2	Trial 1	3.58826	3.91847	3.85039								
Enter your data here->	Trial2	3.62865	3.90653	3.84887								
	Trial3											Reference
	Trial4											3.794
	Trial 5											
Appraiser 3	Trial 1	3.58826	3.91847	3.85039								
Enter your data here->	Trial2	3.62865	3.90653	3.84887								
	Trial3											Reference
	Trial4											3.794
	Trial 5											

Spec Tolerance	0.36017	AIAG - Automotive Industry Action Group Formulas	USL	3.93548	LSL	3.57531	3.793849	Xbar
Historical Variation (HV - 6σ)	0.270128							

	% Using TV	% Using Tolerance	% Using HV
NDC	10	N/A	3
EV (Equipment Variation)	0.0211		0.0211
%EV	12.9%	35.2%	NDC<5
AV: (Appraiser Variation)	0.00645		0.00645
%AV	3.9%	10.7%	NDC<5
R&R (Gage Capability)	0.0221		0.0221
%R&R	13.5%	36.8%	NDC<5
PV (Part Variation)	0.1628		0.0392
%PV	99.1%	271%	87.1%
TV (Total Variation)	0.1643		0.0450

Gage system may be acceptable based on importance of application and cost
Gage may need maintenance, redesign, or better clamping

# Parts	#Trials	#Ops
3	2	3

Wheeler GageR&R			
%EV	2%	0.00	H2
		-0.01	H3
%AV	0%	-0.01	H4
		0.01	H5
%R&R	2%	0.00	H6
		0.031	H7
%PV	98%	0.969	H8
	100%	-8.779	H9
		9.778	H10
		-8.810	H11
		First	H12
		0.01	H13
		50.45	H14

Calculate GageR&R using Anova

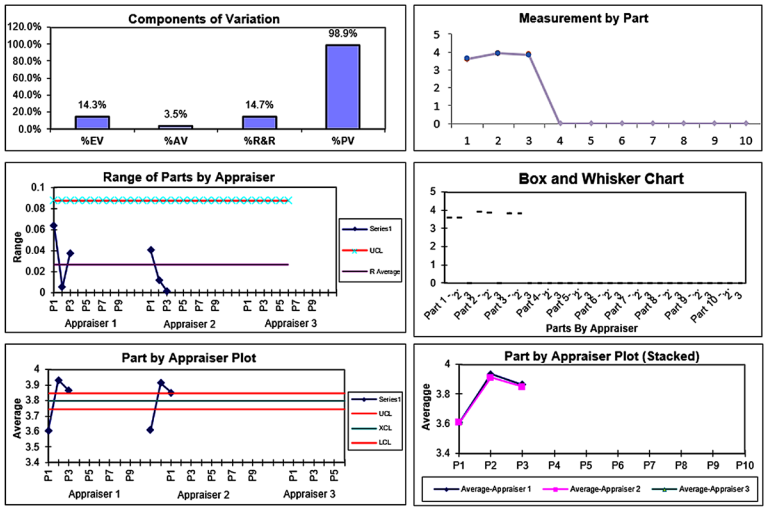
Anova Source	df	SS	MS	With Interaction F	With Interaction P	Without Interaction F	Without Interaction P
Appraiser	2	0.0005	0.0002	0.475261	0.653	0.641782	0.542
Parts	2	0.3232	0.161594	319.4796	0.000	431.4178	0.000
Appraiser x Part	4	0.0003	7.93E-05	0.156736	0.955		
Gage w AP Interaction	9	0.0046	0.0005	Use Without Interaction		Constant	
Gage w/o AP Interaction	13	0.0049	0.0004			6	
Total	17	0.328539					

Gage R&R system acceptability

% R&R<10%: Gage system is okay (most variation caused by parts, not people or equipment).

% R&R<30%: Gage system may be acceptable based on importance of application and cost of gage or repair.

% R&R>30%: Gage system needs improvement (people and equipment cause over 1/3 of variation).



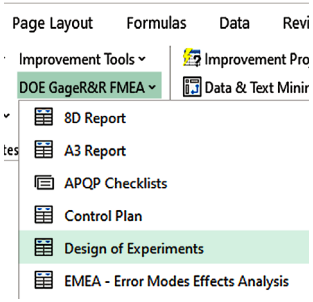
qimacros.com/gage-r-and-r-study/aiag-msa-gage-r-and-r

Design of Experiments (DOE)

DOE shortens the time and effort required to discover the optimal conditions to produce Six Sigma quality in your product or service.

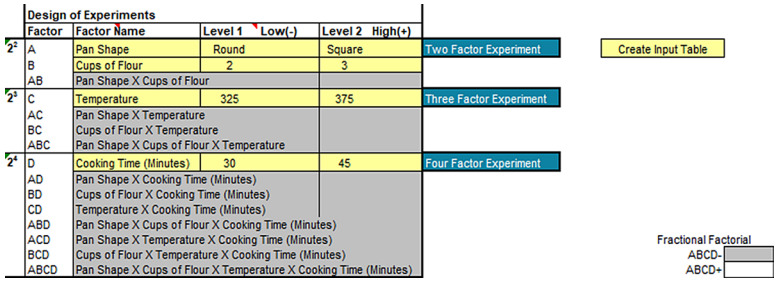
QI Macros DOE contains these templates:

- L4 Taguchi
- L16 Taguchi
- Full Factorial
- Fractional Factorial 8-run
- Fractional Factorial 16-run
- Plackett-Burman 8-run & 8-reflected
- Plackett-Burman 12-run
- Plackett-Burman 16-run



1. Select Design of Experiments from the DOE, Gage R&R, FMEA drop-down list on the QI Macros menu.

2. Input your factors and the low/high settings for each factor in the yellow input area.



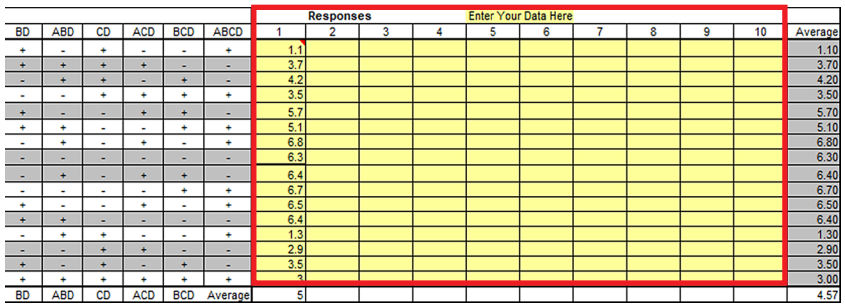
Design of Experiments

	Factor	Factor Name	Level 1 Low(-)	Level 2 High(+)	
2^2	A	Pan Shape	Round	Square	Two Factor Experiment
	B	Cups of Flour	2	3	
	AB	Pan Shape X Cups of Flour			
2^3	C	Temperature	325	375	Three Factor Experiment
	AC	Pan Shape X Temperature			
	BC	Cups of Flour X Temperature			
	ABC	Pan Shape X Cups of Flour X Temperature			
2^4	D	Cooking Time (Minutes)	30	45	Four Factor Experiment
	AD	Pan Shape X Cooking Time (Minutes)			
	BD	Cups of Flour X Cooking Time (Minutes)			
	CD	Temperature X Cooking Time (Minutes)			
	ABD	Pan Shape X Cups of Flour X Cooking Time (Minutes)			
	ACD	Pan Shape X Temperature X Cooking Time (Minutes)			
	BCD	Cups of Flour X Temperature X Cooking Time (Minutes)			
	ABCD	Pan Shape X Cups of Flour X Temperature X Cooking Time (Minutes)			

Create Input Table

Fractional Factorial
ABCD-
ABCD+

3. Use the +/- values in the orthogonal array to guide your test of every combination, and input results into the yellow input area.



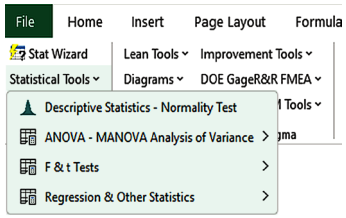
						Responses Enter Your Data Here										
BD	ABD	CD	ACD	BCD	ABCD	1	2	3	4	5	6	7	8	9	10	Average
+	-	+	-	-	+	1.1										1.10
+	+	+	+	-	-	3.7										3.70
-	+	+	-	+	-	4.2										4.20
-	-	+	+	+	+	3.5										3.50
+	-	-	+	+	-	5.7										5.70
+	+	-	-	+	+	5.1										5.10
-	+	-	+	-	+	6.8										6.80
-	-	-	-	-	-	6.3										6.30
-	+	-	+	+	-	6.4										6.40
-	-	-	-	+	+	6.7										6.70
+	-	-	+	-	+	6.5										6.50
+	+	-	-	-	-	6.4										6.40
-	+	+	-	-	+	1.3										1.30
-	-	+	+	-	-	2.9										2.90
+	-	+	-	+	-	3.5										3.50
+	+	+	+	+	+	3										3.00
BD	ABD	CD	ACD	BCD	Average	5										4.57

4. The DOE template will provide a chart of the analysis of major effects, contour plots, a mean plot, and plots of major interactions.

qimacros.com/lean-six-sigma-articles/design-of-experiments

Statistical Tools

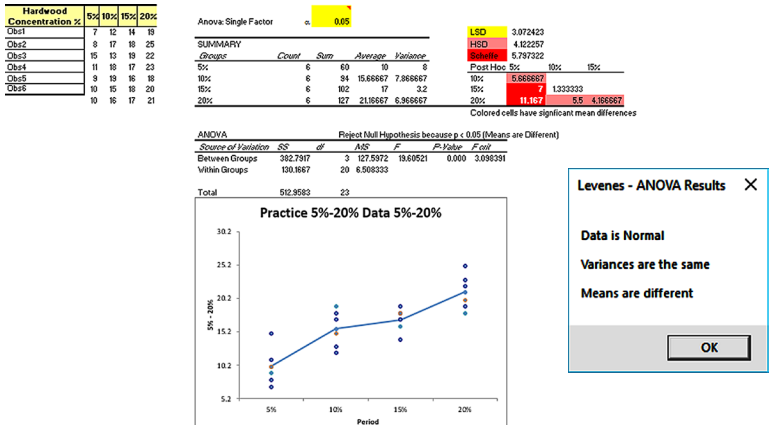
Unlike Excel's Data Analysis Toolpak, QI Macros statistical tools mistake-proof data entry and interpret the results of statistical tests.



1. Select data for analysis. Some tools like ANOVA can take multiple data columns. Others – like regression – use two columns. A few use only one column. Data must be in columns for these tools to work. (Open QI Macros Sample Data from the QI Macros Help menu to see examples of how your data should be organized.)

2. Select the statistical analysis tool from the Statistical Tools section of the QI Macros menu. An arrow to the right of a menu category indicates further choices. If you aren't sure what statistical tool to use, simply choose the Stat Wizard and answer the prompts, or use the default answers provided.

3. QI Macros interprets the results, tells you to reject or accept the null hypothesis and whether the means or variances are the same or different.



- qimacros.com/hypothesis-testing/statistics-wizard-excel
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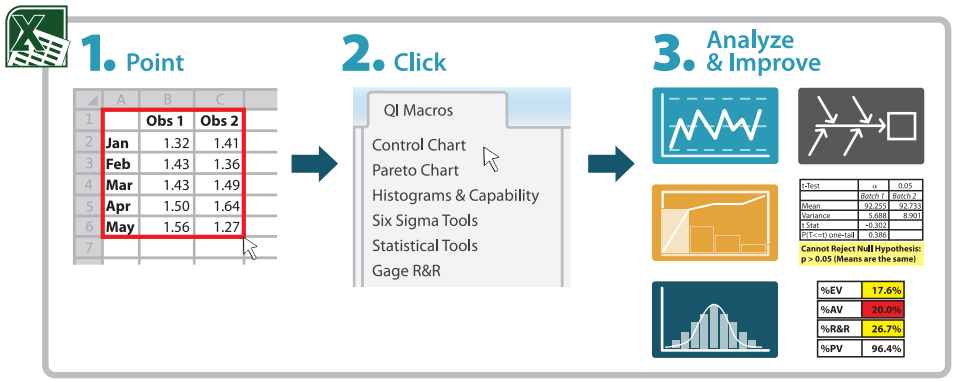

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