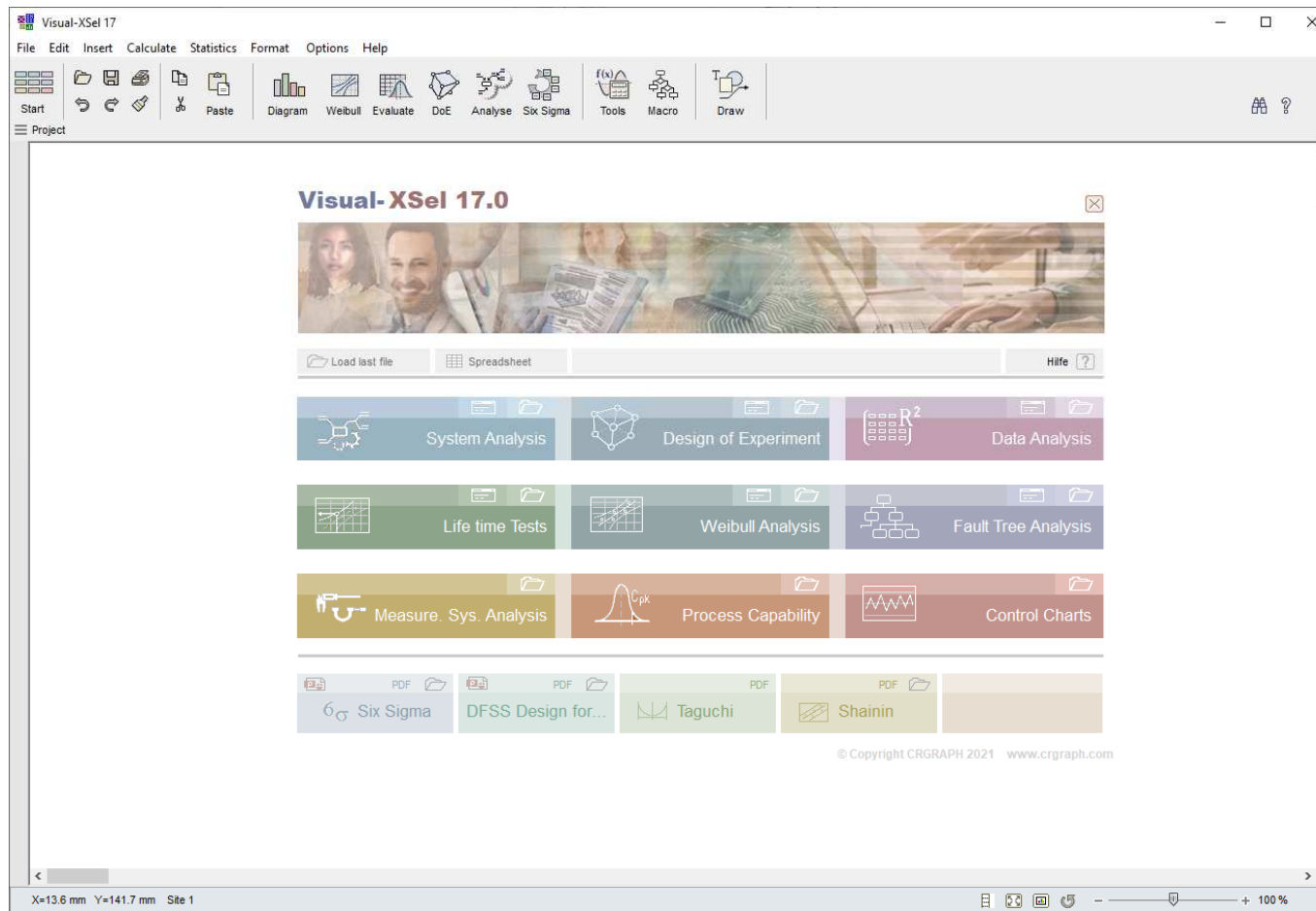


Visual-XSel 17.0 Introduction

www.crgraph.com

Basic functions and examples of statistics & Six Sigma



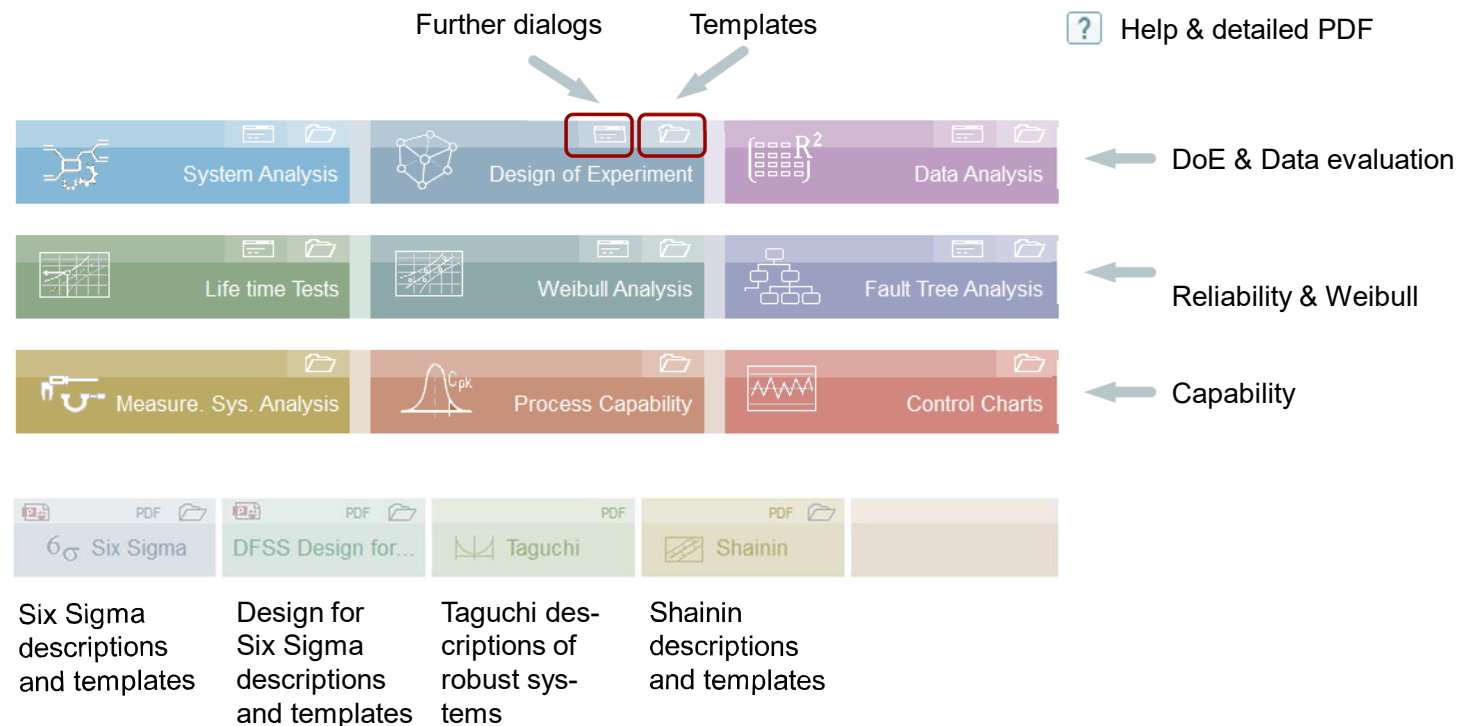
Main Guide

The Main Guide shows three important statistical methods: DoE, Reliability and Capability analyses. A pre investigation for DoE is to find the relevant parameters with the System Analysis.

Most of the methods are available as templates. The calculation methods are open source, can be viewed and easily modified.



← This icon starts the Main Guide



Main Guide

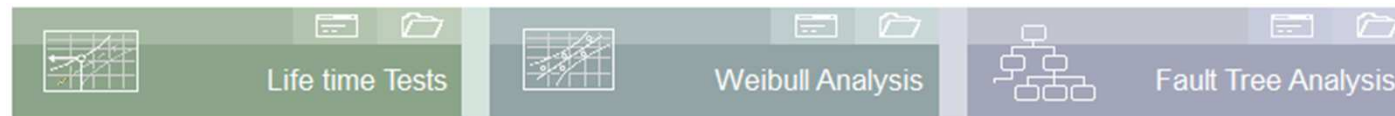
Detailed profiles with introduction to the methods and subsequent program descriptions can be found under the links shown



www.weibull.de/COM/System_Analysis.pdf

www.weibull.de/COM/Design_of_Experiment.pdf

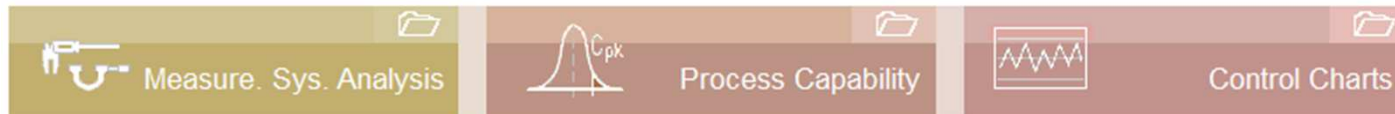
www.weibull.de/COM/Data_Analysis.pdf



www.weibull.de/COM/Life_Time_Tests.pdf

www.weibull.de/COM/Weibull_Analysis.pdf

www.weibull.de/COM/Fault_Tree_Analysis.pdf



www.weibull.de/COM/Measurement_System_Analysis.pdf

www.weibull.de/COM/Process_Capability_Studies.pdf

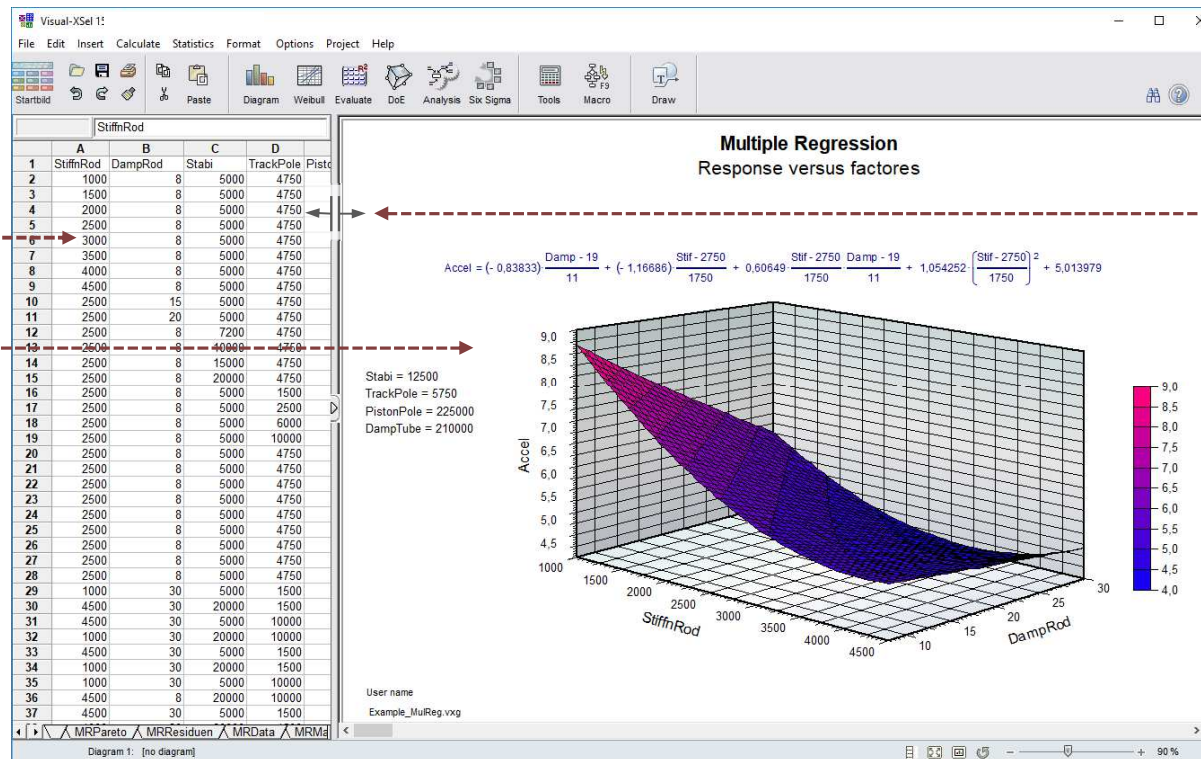
www.weibull.de/COM/Control_Charts.pdf

Data and representation

An Excel-like spreadsheet is available on the left, whose width is automatically aligned with the data, or can be adapted manually. On the right there is the main window for all diagrams, output etc. The representation is exact what you get at printing out.

Spreadsheet

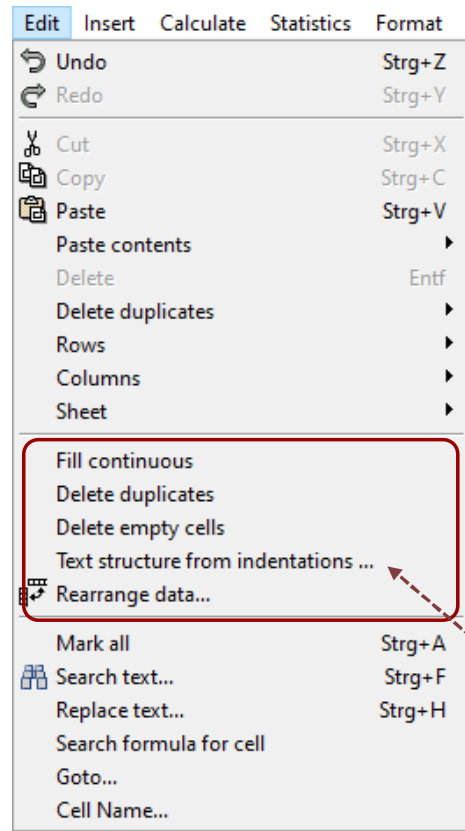
Main window for diagrams and results



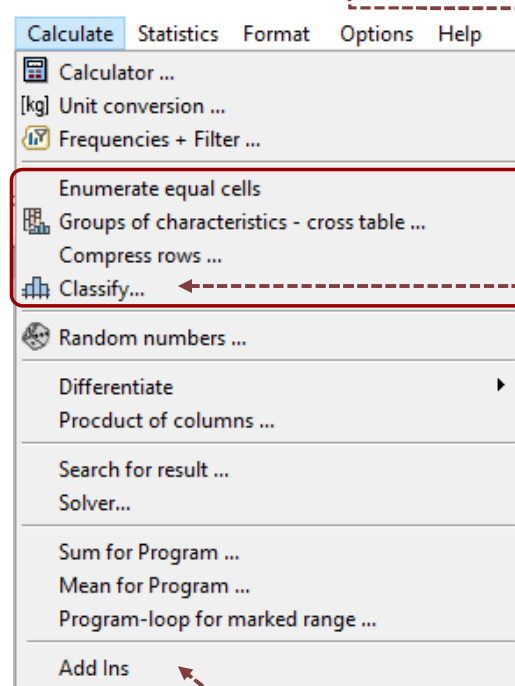
The separation widens automatically, depending on where you are actively working, but can be changed manually.

Spreadsheet functions

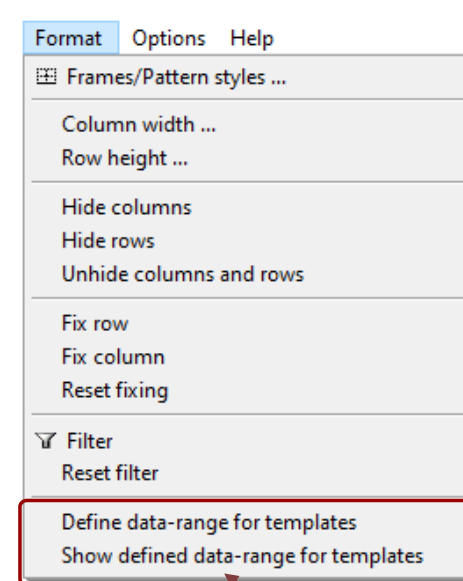
There are powerful editing functions for the table, for example for classifying data.



Creates an outline from indented texts from which structure diagrams can be displayed



own Add Ins
=> user defined functions



Displays or defines the target area of the data for templates

Filter & quick statistics

Click on the first row, or mark the column, a filter symbol appears

D	E	F	G	H	I
:kPole	PistonPole	DampTube	Accel		
4750	210000	69000	9,49469		
4750	210000	69000	8,08628		
4750	210000	69000	7,23335		
4750	210000	69000	6,67517		
4750	210000	69000	6,28572		
4750	210000	69000	6,00264		
4750	210000	69000	5,78746		
4750	210000	69000	5,61431		
4750	210000	69000	6,18275		
4750	210000	69000	5,8643		
4750	210000	69000	6,67517		

Depending on the data, a frequency distribution is shown (numerical are classified here).

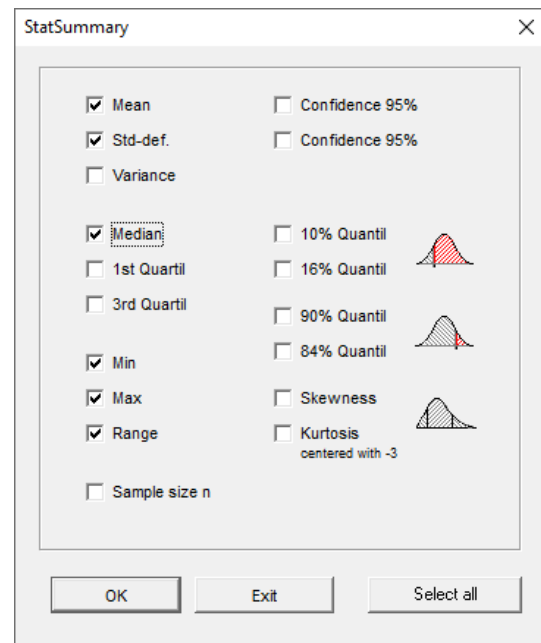
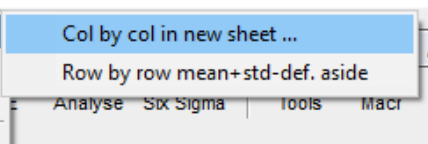
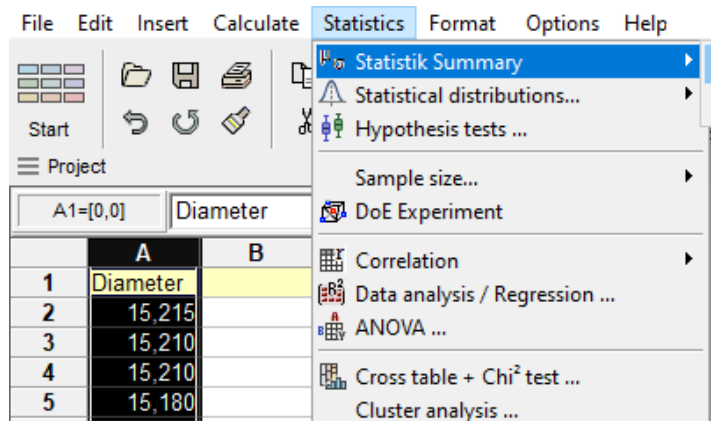
The screenshot shows the 'Accel' column selected in the software. A frequency distribution histogram is displayed, showing the distribution of acceleration values. The histogram has a y-axis with values from 3,5 to 9,5 and an x-axis with values from 3 to 12. A filter dialog box is open, showing a 'Filter' section with 'Selection' and 'Conditioned filter' options. The 'Statistics' section at the bottom shows a normal distribution fit with parameters: n=54, Min=3,3711, Max=9,6533, Range=6,2822, Mean=6,0752, StDev=1,3747, Median=6,1647, classWidth=0,5, and Distribution 'confirmed' (pval=0,095).

The statistics below show the most important characteristic values as well as a statistical test for normal distribution.

click here to copy the results to the clipboard

Descriptive statistics

More extensive characteristic values also for several columns are possible via Statistics Summary



	A	B
1	Diameter	Diameter
2	Mean	15,217
3	StdDef	0,025093
4	Median	15,22
5	Min	15,145
6	Max	15,245
7		

Special paste

When pasting data from the clipboard, data columns can be selected and or rearranged if there are more than 2 columns of data on the clipboard (equal to Edit / Paste contents / transform before paste)

A preview shows the contents of the clipboard

Wanted columns can be selected or omitted. Transfer is done in the order in which the check boxes are set

Clipboard
✕

Take it unchanged

A	B	C	D	E
StiffnRod	DampRod	Stabi	TrackPole	PistonPole
1000	8	5000	4750	210000
1500	8	5000	4750	210000
2000	8	5000	4750	210000
2500	8	5000	4750	210000
3000	8	5000	4750	210000
3500	8	5000	4750	210000
4000	8	5000	4750	210000
4500	8	5000	4750	210000
2500	15	5000	4750	210000
2500	20	5000	4750	210000
2500	8	7200	4750	210000
2500	8	10000	4750	210000

Rearrange

Transpose

Rows to columns

Columns to rows

Reihe in Spalten

Select columns

- [1] StiffnRod
- [2] DampRod
- [3] Stabi
- [4] TrackPole
- [5] PistonPole
- [6] DampTube
- [7] Accel

To change the order, deselect all and select them one at a time

✕ top row
↑ higher

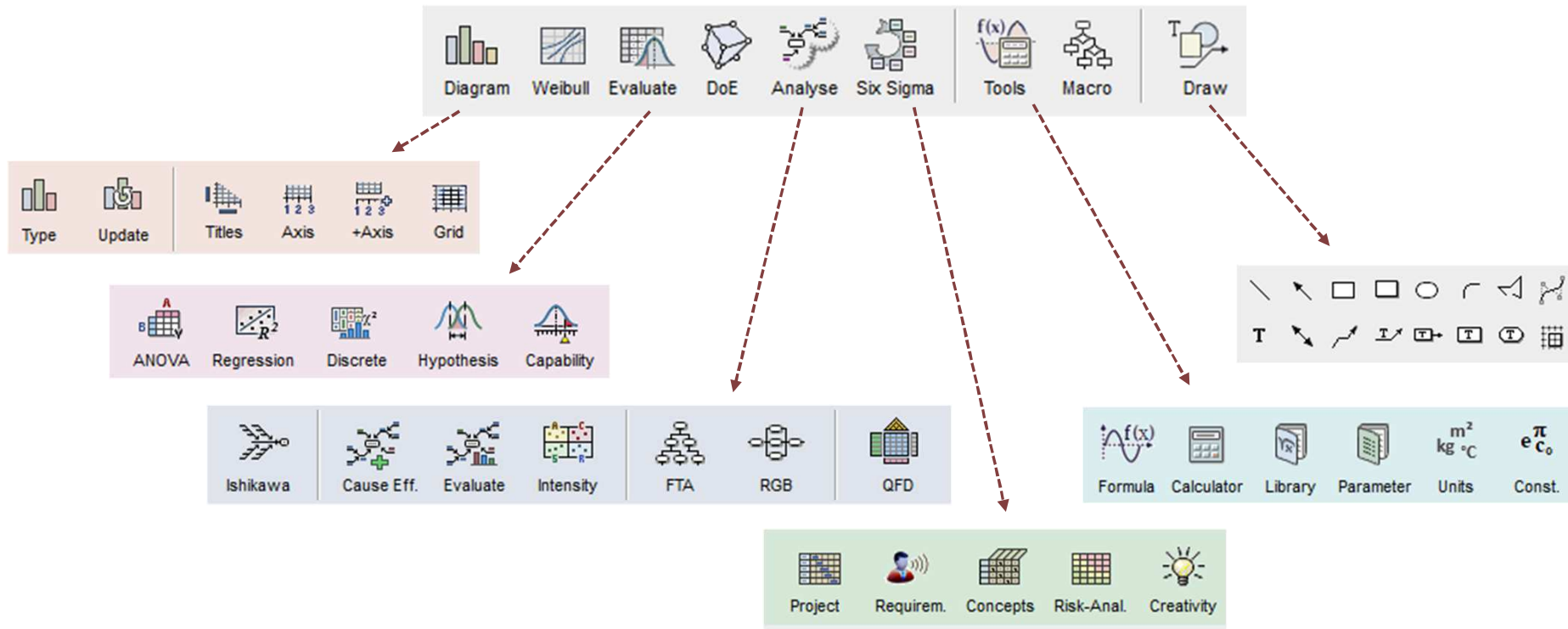
↓ lower
Ok
Exit

Inhalt der Zwischenablage immer zeigen wenn mehr als 2 Spalten



Note:
This function should also be used if you want to import columns from PDF files separated by spaces. Otherwise, all the columns of the PDF file are copied into one column.

The icon bar



The icons Weibull and DoE are described in separate sections

Icon bar Evaluation

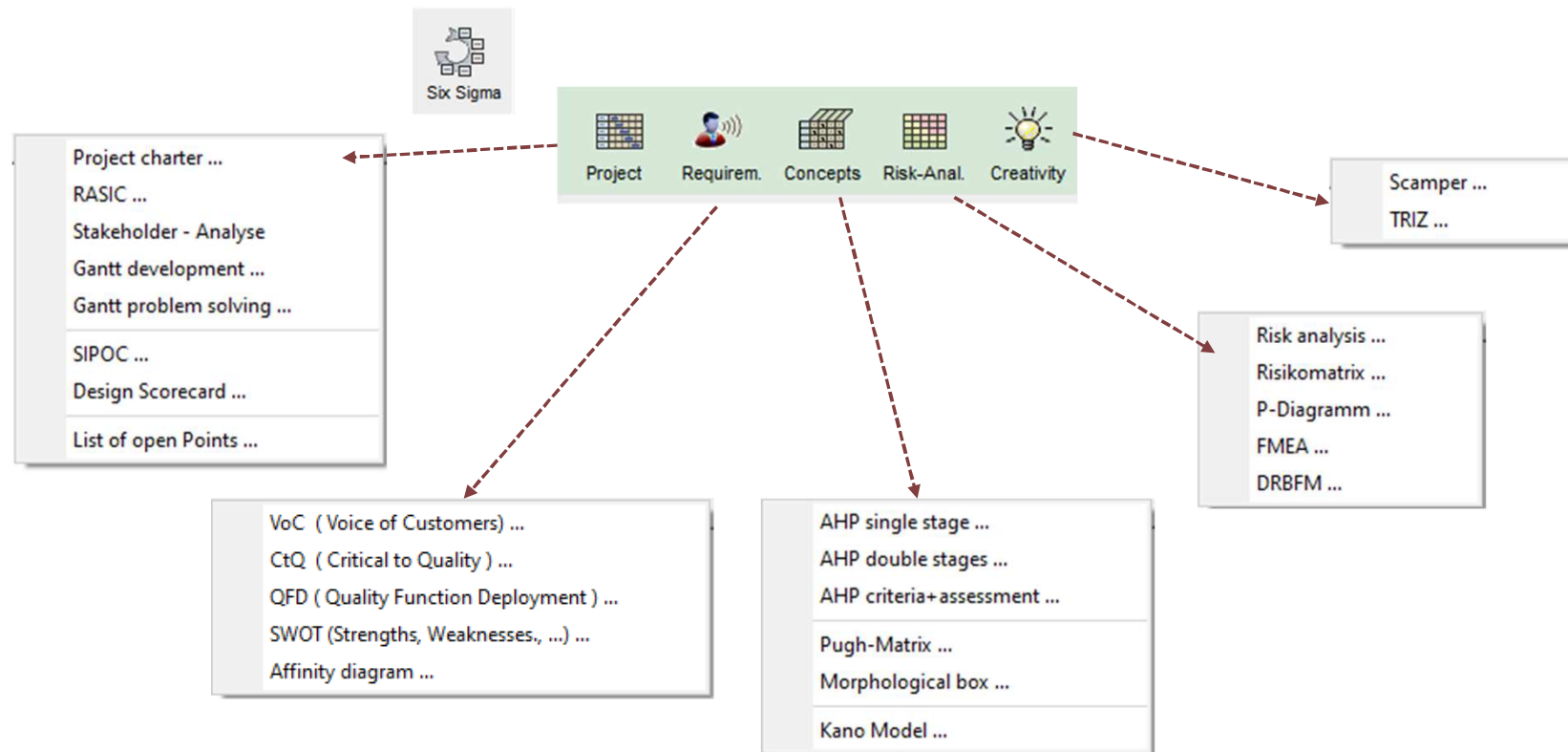
The screenshot displays the 'Evaluate' icon bar and its associated dropdown menus. The icon bar includes the following icons and labels:

- Evaluate** (Icon: Bar chart with a normal distribution curve)
- ANOVA** (Icon: Grid with a bar chart)
- Regression** (Icon: Scatter plot with a regression line and R^2)
- Discrete** (Icon: Bar chart with a chi-squared symbol χ^2)
- Hypothesis** (Icon: Two overlapping normal distribution curves)
- Capability** (Icon: Bar chart with a normal distribution curve and a specification limit)

The dropdown menus are as follows:

- ANOVA:**
 - ANOVA One Way ($\mu_1=\mu_2$) ...
 - ANOVA One Way (balanced $\mu_1=\mu_2=\mu_3..$) ...
 - ANOVA One Way ($\mu_1=\mu_2; \mu_1=\mu_3; \mu_2=\mu_3$) ...
 - ANOVA Two Way (tabular $x_1 x_2 - y$) ...
 - ANOVA Two Way (balanced $y - x_1 x_2 x_3 ..$) ...
 - ANOVA Two Way (nested $y - x_1 x_2$) ...
 - Modell-ANOVA ($y - x_1 x_2 x_3..$) ...
- Regression:**
 - Cross table + Chi² test ...
 - Discrete Regression (response with t ...)
- Discrete:**
 - Analysis Guide...
 - Multiple Regression manual ...
 - Regression (straight-line) via diagram ...
 - Multiple Regression full auto ...
 - PLS Partial Least Square (correlating data) ...
 - Discrete Regression (response with two levels) ...
 - Neural Networks ...
 - Use all data-rows for model
 - For rows mean+std-dev right beside
 - Repetitions from columns to rows
 - Model-values in sheet
 - Normalized data table -1..+1
 - Reset model
- Hypothesis:**
 - Guide hypotheses ...
 - Test of normal-/Weibull-distribution (non classified)
 - Test of mixed distribution
 - Test of outliers (normal distr.)
 - t-Test (one sample) ...
 - t-Test (two samples normal) ...
 - Multi t-Test ...
 - u-Test (two samples non normal) ...
 - Sign test (one sample) ...
 - Sign test Wilcoxon (one sample) ...
 - Mood's Median Test (more samples, median) ...
 - Kruskal Wallis Test (more samples, ranking) ...
 - F-Test (two samples normal) ...
 - Levenes Test (more samples all distr.) ...
 - Bartlett Test (more samples) ...
 - Binomial-Test ...
 - Poisson-Test ...
 - Chi² cross tab test ...
 - Chi² multi cross tab test ...
 - Chi² homogeneity test ...
 - More tests ...
- Capability:**
 - MSA Overview
 - MSA continuous measurements
 - MSA discrete measurements
 - MSA ordinal scaled ...
 - More ...
 - Guide process capability ...
 - Machine capability Cm/Cmk ...
 - Process performance Pp/Ppk ...
 - Process capability Cp/Cpk
 - More ...
 - Tolerance specification

Icon bar Six Sigma



The calculator

The alphanumerical calculator with special functions

The image shows the Visual-XSel 17.0 interface with several windows open:

- Tools bar:** Contains icons for Tools, Formula, Calculator (highlighted with a red box), Library, Parameter, Units (m², kg °C), and Const. (e, π, C₀).
- Alphanumeric Calculator:** The main window where a formula $y = 1 - \left(\frac{5}{2}\right)^2$ is entered. Below the input field, the result $y=1-e^{(-5/2)^2}$ and the numerical value 0.99326205 are displayed. Buttons for OK, Copy result, and Help are at the bottom.
- Constants dialog:** A window titled "Constants" with tabs for "Physical" and "Program specific". It lists various physical constants like π, e, g_n, k_{Boltz}, ε₀, μ₀, γ, C₀, R_n, V_m, Farady, U_{Atom}, and ∞.
- Formula library:** A window titled "Formula-Library" showing a list of mathematical formulas. The "Weibull" category is selected in the right-hand pane. The main area displays several formulas, including:

$$\sigma^2 = T^2 \left[\Gamma\left(1 + \frac{2}{b}\right) - \left[\Gamma\left(1 + \frac{1}{b}\right) \right]^2 \right]$$

$$A_D = \frac{MTTF}{MTTF + MTTR}$$

$$R = 100 \left\{ 1 - P_A \right\}^{(n+1) \cdot L_v^b}$$

$$P_A = 100 \left\{ 1 - R \right\}^{(n+1) \cdot L_v^b}$$

$$n = \frac{1}{L_v^b} \frac{\ln(1 - P_A)}{\ln(R)} - 1$$

$$L_v = \left(\frac{1}{n+1} \frac{\ln(1 - P_A)}{\ln(R)} \right)^{\frac{1}{b}}$$

Annotations with red dashed arrows point to specific features:

- The input is done as in a fully defined formula. At the beginning, a variable for the result is needed, here y=** (points to the input field).
- Available math. functions can be accessed under the symbol *Sin*** (points to the function list dropdown).
- The most recent entries can be retrieved here** (points to the history list below the function list).

Statistical methods/functions

There are three ways to apply statistical methods.

Diagram-functions

e.g. test of normality, hypothesis of equality with Boxplot or test of normality

⇒ Select *Diagram*

Internal functions

e.g. calculation of distributions, DoE, regression, sample size, etc.

⇒ Select menu *Statistics*

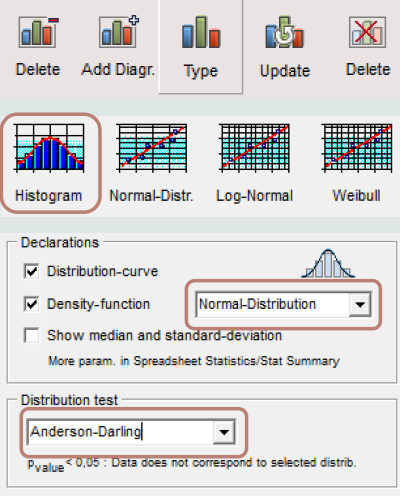
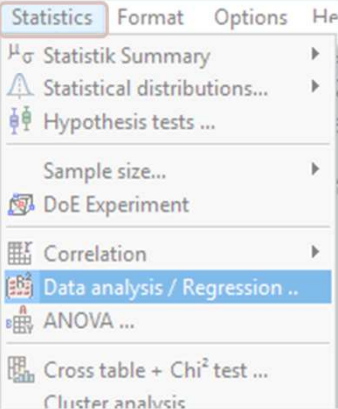
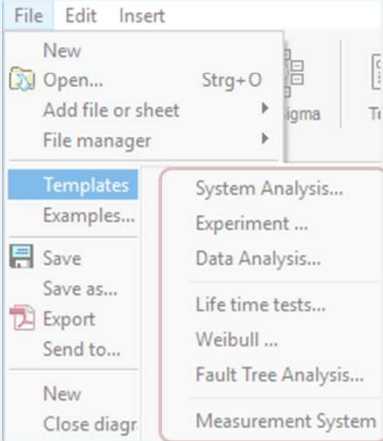
Templates

e.g. hypothesis-test, or Weibull-Analysis.

⇒ Select menu *File/Templates*

Examples for diagram functions

Examples from the diagram functions are shown first

Diagram-functions	Internal functions	Templates
<p>e.g. test of normality, hypothesis of equality with Boxplot or test of normality</p> <p>⇒ Select <i>Diagram</i></p> 	<p>e.g. calculation of distributions, DoE, regression, sample size, etc.</p> <p>⇒ Select menu <i>Statistics</i></p> 	<p>e.g. hypothesis-test, or Weibull-Analysis.</p> <p>⇒ Select menu <i>File/Templates</i></p> 

Creating a Histogram

A histogram can be made with various settings and representations

- ① Click in left area of the program to make visible the spreadsheet

Input data beginning at 2nd row

	A	B
1	9,98	
2	9,98	
3	9,99	
4	9,99	
5	10	
6	10	
7	10	
8	10,01	
9	10,01	
10	10,02	
11		

move the mouse over the diagram

Frequency-distribution dialog box settings:

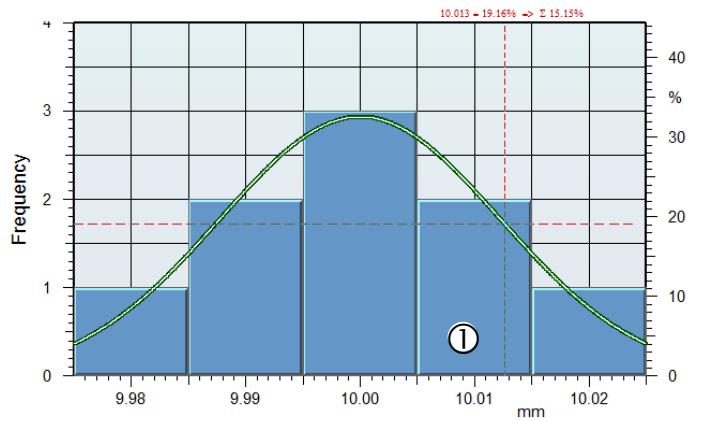
- Class-width: 1
- Darstellung: Standard
- Declarations:
 - Distribution-curve
 - Gauss-function (dens) Normal distribution
 - Show median and standard-deviation
- Probabilities:
 - Determine frequencies from existing val. Calculated frequencies in #Chart
 - Define frequencies in second column
- Distribution test: Anderson-Darling
- Pvalue < 0,05 : Data is not normal-distributed

Histogram Data:

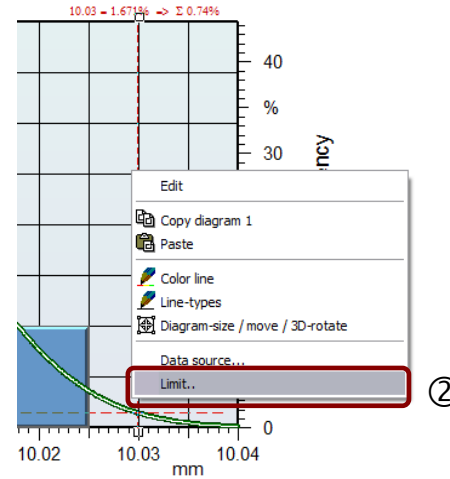
mm	Frequency	Relative frequency (%)
9.98	1	10.00%
9.99	2	20.00%
10.00	3	30.00%
10.01	2	20.00%
10.02	1	10.00%

Visual-XSel 17.0 Introduction

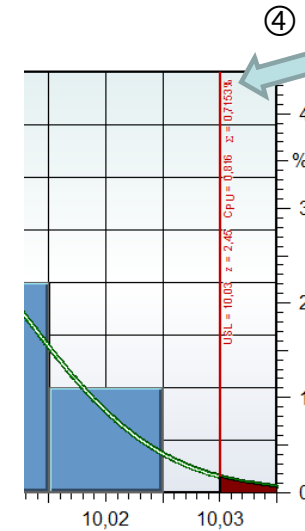
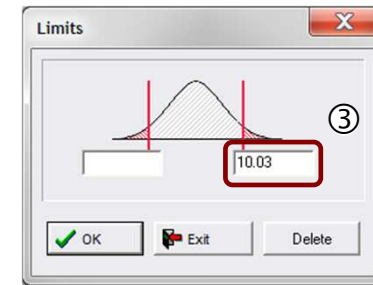
Set a limit, for example for process capability



move mouse along the gaussian curve

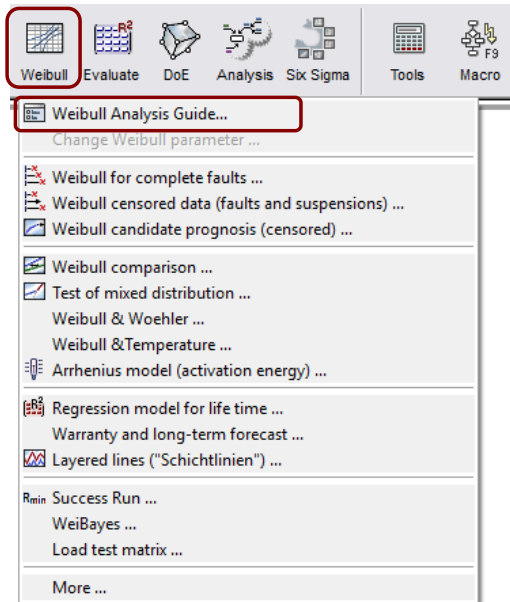


click the right mouse button and use Limit (hint: no element has to be clicked before and the mouse must be over the diag.)



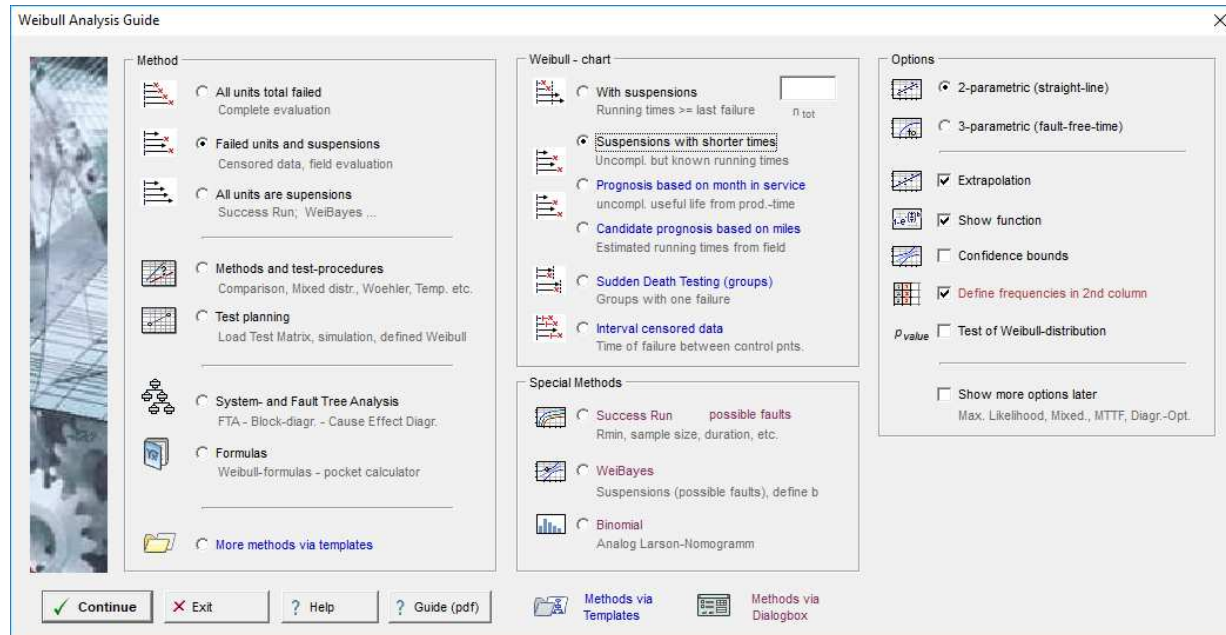
Reliability & Weibull

The most important reliability issues are available via the icon Weibull.
 The Weibull Analysis Guide pilots you through more methods, especially for variants of the Weibull-chart.



More information

www.weibull.de/COM/Weibull_Analysis.pdf



Creating a Weibull-chart

	A	B
1		
2	1589	1
3	2934	1
4	4938	-1
5	5906	1
6	6958	1
7	8995	1
8	11293	1
9	13578	1
10	15000	-4
11		

1. Running times at second row (first row legend).
The frequencies has to be defined in col. B
Suspensions must be marked with minus, e.g. "-1"
[File open](#) [Paste](#) [Paste Special](#)

2. Choose chart Weibull
or use icon on the right

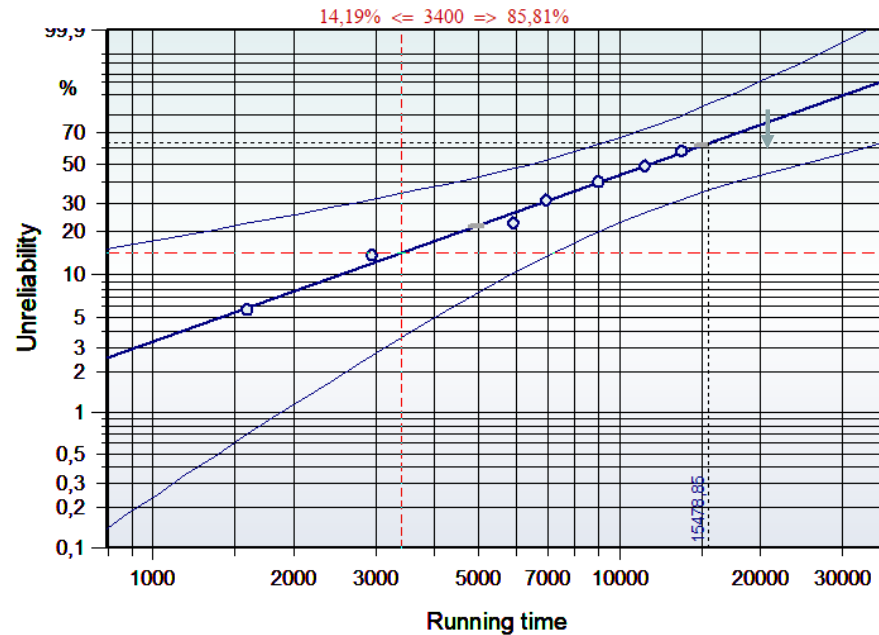
Define running times (col A) and frequencies, (col B) or use *Paste*.
Click the Weibull icon and define the axis titles.

define here the number of faults and suspensions (marked with „-“).

define here the running times

More information
www.weibull.de/COM/Weibull_Analysis.pdf

Move with the mouse over the chart for crosslines



Move with the mouse over the formula, to get expert information

For the selected Weibull-Distribution a statistical test can be applied. The coefficient of determ. R²=0,99 for the fitted distribution is good (may be not for extrapolating)
[Change distribution or test](#)

T = 15478,85 b = 1,239

$$H = 100\% \cdot \left(1 - e^{-\left(\frac{t}{T}\right)^b} \right)$$

t₁₀ = 2515,6 R² = 0,9905

Boxplot with category „Cylinder“

File Edit Insert Calculate Statistics Format Options Help

Start Paste Diagram Weibull Evaluate DoE Analyse Six Sigma

Project

H1=[7,0] Cons

	A	B	C	D	E	F	G	H	I
1	Weight	Fuel	Cyl	Capacity	Power	AxleRatio	Accel	Cons	
2	1340	Gas	4	1599	90	3.64	10.1	5.8	
3	1350	Gas	4	1995	105	3.39	8.7	5.9	
4	1375	Gas	4	1995	125	3.73	7.7	6.4	
5	1460	Gas	6	2996	195	3.46	6	8.3	
6	1395	Dies	4	1995	105	3.07	8.9	4.5	
7	1450	Dies							
8	1495	Dies							
9	1670	Gas							
10	1730	Gas							
11	1780	Gas							
12	1810	Gas							
13	1815	Dies							

Visual-XSel - Diagram-types - Diagram 1

Favorites Standard Statistics Special Table

Line 3D-Net Bar Pareto **Boxplot**

Histogram Normal-Distr. Log-Normal Weibull Text only

Data selection

Data columns (double-click)

- [A] Weight
- [B] Fuel - [Categorical]
- [D] Capacity
- [E] Power
- [F] AxleRatio
- [G] Accel

Represented data

[H] Cons

Attributes for groups

[C] Cyl

4 6 8

OK Exit Help

Boxplot

Mittlere Markierung

Median

Arithm. Mittelwert

Whisker

99%

Darstellung

Gruppengröße: 1

Anzahl Boxplots mit gleicher Farbe

Breite: auto

vertikal quer

Test auf Gleichheit

kein Test

Signifikanz: 5% 1%

Gleichheit (Mittel / Median) gekennzeichnet durch Pfeile

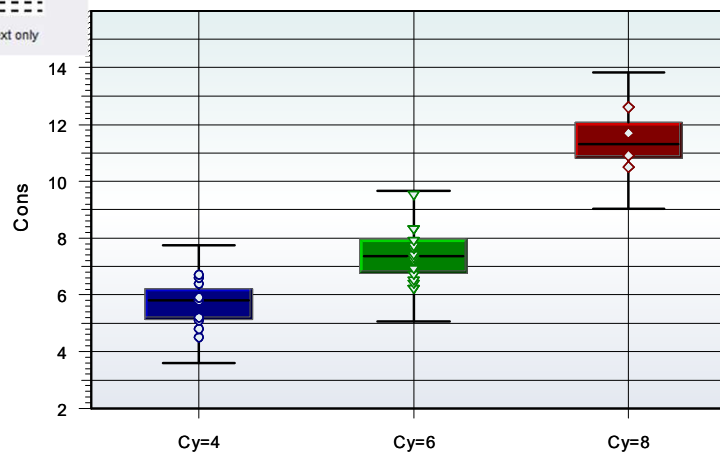
Vorgabe für Bestimmung der Bereiche

normalverteilt

nicht normalvert.

Cy=4 : normalverteilt
Cy=6 : normalverteilt
Cy=8 : nicht normalvert.

OK Diagrammauswahl Hilfe



Menu Data/Spreadsheet and open file:
[Examples/Example_PLS_Consumption.vxt](#)

2nd Boxplot with category Fuel

Open Data/Spreadsheet T1 and mark column H. Add diagram with symbol (+)

Data selection dialog:

- Data columns (double-click): [A] Weight, [D] Capacity, [E] Power, [F] AxleRatio, [G] Accel
- Represented data: [H] Cons
- Attributes for groups: [B] Fuel - [Categorical], [C] Cyl

Options dialog:

- Options: Diagram-points, same beside, Values at pnts, Values at 25%, 50%, 75%, Values outer range, Range<0 not possible
- Representation: Group-size: 1, number of boxplots with equal colour: auto, Width: auto, vertical, horiz, 3D
- Test of equality: u-test (no normal-distr.)
- Significance: 5%, 1%
- Definition for ranges: normal distributed, non normal distrib.

Boxplot Data:

Fuel	Cyl	Cons
Gas	4	5.8
Gas	4	5.9
Gas	4	6.4
Gas	6	8.3
Dies	4	4.5
Dies	4	4.8
Dies	4	5.2
Gas	4	6.6
Gas	6	7.6
Gas	6	6.5
Gas	6	5.8
Dies	6	7.9

Green arrows between Boxplots means that there is no statistical difference in consumption (u-Test). Red lines indicate a significant difference

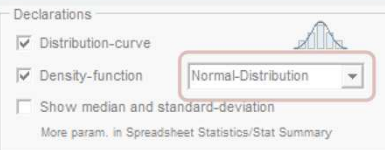
Examples for diagram functions

The following examples show internal functions

Diagram-functions

e.g. test of normality, hypothesis of equality with Boxplot or test of normality

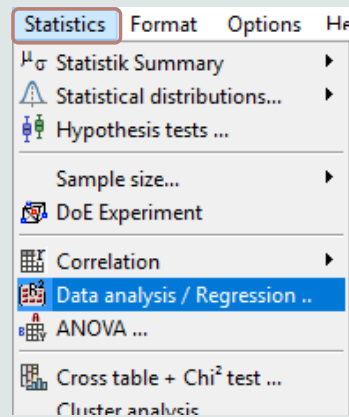
⇒ Select *Diagram*



Internal functions

e.g. calculation of distributions, DoE, regression, sample size, etc.

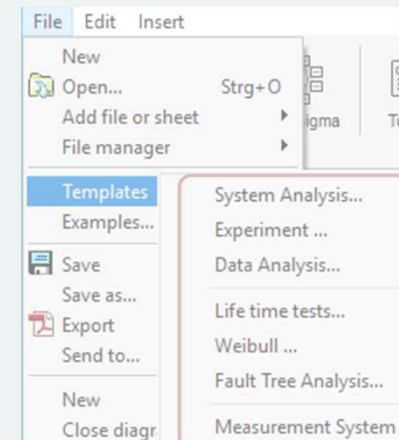
⇒ Select menu *Statistics*



Templates

e.g. hypothesis-test, or Weibull-Analysis.

⇒ Select menu *File/Templates*



How to calculate distribution values or the „z“-value

Statistical distributions - calculate values or display them as a graph

①

②

③

④

⑤

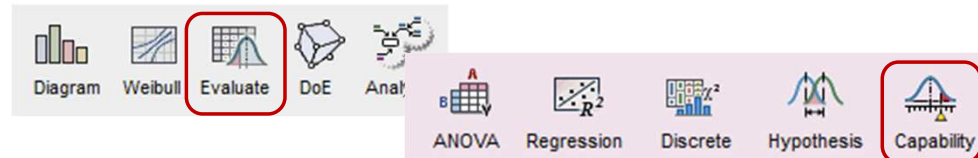


If using the Inverse normal distribution with mean = 0 and std-dev = 1, the result x (normally the quantile) has in this case the meaning of the so called „z“-value

Visual-XSel 17.0 Introduction

Find the right distribution of data

The guide includes a distribution test and makes a suggestion which is the best (the one with the highest p-value, here the Weibull distribution)



	A	E
1	Diameter	
2	15,215	
3	15,210	
4	15,210	
5	15,180	
6	15,235	
7	15,200	
8	15,240	
9	15,240	
10	15,245	
11	15,220	
12	15,240	
13	15,195	
14	15,145	
15	15,230	
16	15,225	
17	15,220	
18	15,240	
19	15,220	
20	15,225	

Number values = 20 only positive values
different values = 14
Min = 15,145 Max = 15,245

Possible outlier at the beginning

Characteristic	Symbol	Distrib.
Lin. meas.		N
Straightness	—	B1
Levelness	∩	B1
Roundness	○	B1
Cylindrical shape	⊖	B1
Linear shape	∩	B1
Surface shape	⊖	B1
Roughness	⊖	B1
Imbalance		B2
Parallelism	//	B1
Perpendicularity	⊥	B1
Slope/angularity	∠	B1
Position	⊕	B1
Coaxiality, concentricity	⊕	B2
Symmetry	≡	B1
Concentricity	≡	B1/B2
Linear movement	∥	B1, L1*

Possible tolerances for Cpk= 1,33

Median = 15,22
LSL = 0 USL = 15,28
(15,28)*

* Estimated values for conf. 90%

- MSA Overview
 - MSA continuous measurements
 - MSA discrete measurements
 - MSA ordinal scaled ...
 - More ...
- Guide process capability ...
 - Machine capability Cm/Cmk ...
 - Process performance Pp/Ppk ...
 - Process capability Cp/Cpk
 - More ...
- Tolerance specification

Possible tolerances for the data are displayed here

Standard Regression

x-y regression can be realized via a line diagram

Data selection dialog:

- Data columns (double-click): [B] Fuel - [Categorical], [C] Cyl, [D] Capacity, [E] Power, [F] AxleData
- Reference X-axis (empty if Y categor.): [A] Weight
- Represented data: [H] Cons

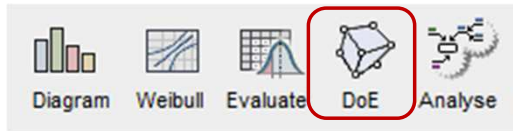
Regression dialog:

- Regression-type:
 - $y = bx$ $R^2 = 31\%$
 - $y = a + bx$ $b =$
 - $y = a + b \cdot x + c \cdot x^2$ $R^2 = 31\%$
 - $y = a + b \cdot x + c \cdot x^2 + d \cdot x^3$ $R^2 = 31\%$
 - $y = a + b \cdot x + c \cdot x^2 + \dots + x^z$ $R^2 = 31\%$
 - $y = a \cdot x^b$ $R^2 = 33\%$
 - $y = a \cdot e^b \cdot x$ $R^2 = 34\%$
 - $y = a \cdot e^b / (b/x)$ $R^2 = 33\%$
 - $y = a + b/x$ $R^2 = 30\%$
 - $y = a + b \cdot \log(x)$ $R^2 = 30\%$
 - $y = a + b \cdot x + c \cdot z$
 - $y = a + b \cdot x + c \cdot z^2$
 - $y = a + b \cdot x^2 + c \cdot z$
 - $y = a + b \cdot x^2 + c \cdot z^2$
 - No regression
- Transformation horizontal:
 - Offset $x' = x +$
 - Flip $x' =$ $- x$
- Transformation vertical:
 - Offset $y' = y +$
 - Flip $y' =$ $- y$
- Options:
 - Extrapolate Curves
 - Confidence %
 - Show Regression-Function
 - Number of digits for coefficients:
 - Least Square ΔX^2

Regression equation: $y = 1.69580064 \cdot e^{0.0008773 \cdot x}$ $r = 0.579$

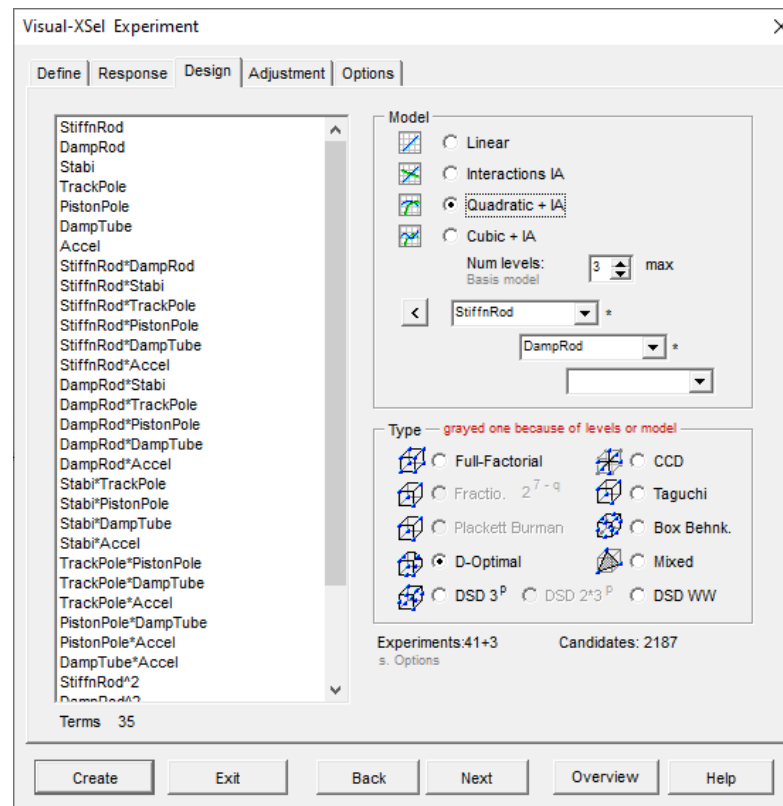
Menu File/Examples and open file: Example_PLS_Consumption.vxt

In Visual-XSel all important designs are available and new the DSD 2*3^P and DSD IA (extension for Definitive Screening Designs, e.g. for interactions)

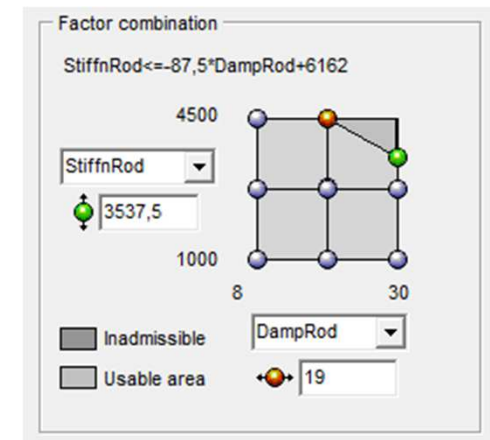


Detailed description under:

www.weibull.de/COM/Design_of_Experiment.pdf



- Import parameters from tables (other progr.)
- Derive DoE's from structure diagrams
- Up to 120 parameters and 16 responses
- Categorical parameters
- 3-times interactions
- Considering existing experiments
- Techn. constrains can be defined
- and much more ...



System analyses

③

In Visual-XSel there are a variety of analyses tools, like a cause effect diagram

The screenshot displays the Visual-XSel software interface. At the top, a toolbar contains icons for 'Diagram', 'Weibull', 'Evaluate', 'DoE', and 'Analyse'. The 'Analyse' icon is highlighted with a red box. Below this, a secondary toolbar shows 'Ishikawa', 'Cause Eff.', and 'Evaluate' icons, with 'Cause Eff.' also highlighted in red. A context menu is open over the 'Cause Eff.' icon, listing options such as 'New Cause Effect Diagram - Guide...', 'Create Cause Effect Diagram from text', 'Create Cause Effect Diagram from FT', 'Create text-structure from Cause Effect', and 'Basics-/Program-descriptions (pdf)'. A dialog box titled 'System analysis + further steps' is open, featuring a 'Create structure diagram' section with an 'Input title' field containing the word 'Title'. Below the title field, a flow diagram illustrates the process: a cause effect diagram leads to a Pareto chart, which leads to a DoE (Design of Experiments) cube. At the bottom of the dialog, three buttons are visible: 'Case Effect / Evaluation' (with a gear icon), 'Pareto Evaluation' (with a bar chart icon), and 'Create DoE' (with a cube icon). The dialog also includes 'OK', 'Abort', 'Main Effects...', 'Example...', and 'Help' buttons.



Continuous functionality – from the cause effect diagram to pareto evaluation to the experimental design.

A fault tree analysis can be derived from a cause effect diagram

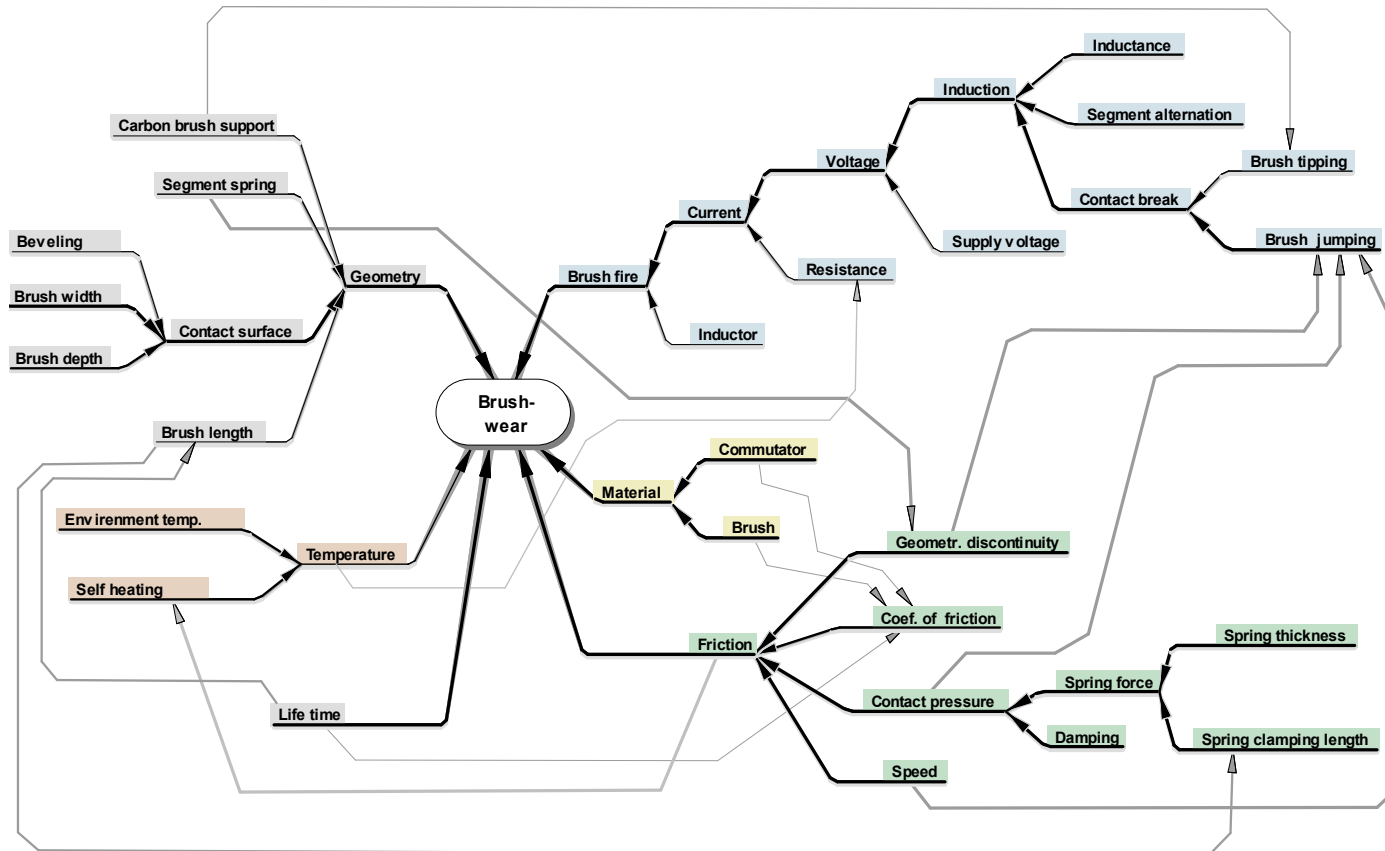
More information

www.weibull.de/COM/System_Analysis.pdf

System analyses

③

The cause effect diagram can be evaluated and provides cross-links to the assessment of dependencies important to decide what needs to go into a design and what doesn't.



A parameter library helps to overlook anything

Effects / Parameters

Title (Selection)

Phys./techn. effects	Examples
Force	Constant_speed
Moment	Speed difference
Stroke	Impact speed
Speed	Flow speed
Pressure	Reaction rate
Flow	Wind speed
Electricity	Sliding
Temperature	Acceleration
Energy	Frequency
Heat	Oscillation

Attributes

Attributes	Last choice
Geometry	
Mass	
Attributes	
Material	
Substance	
Medium	

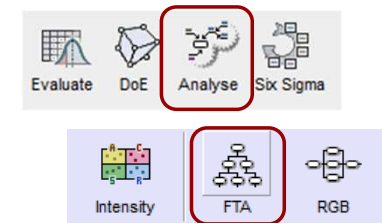
Click -> show examples General: Double-click -> use for title

OK Cancel Formulas

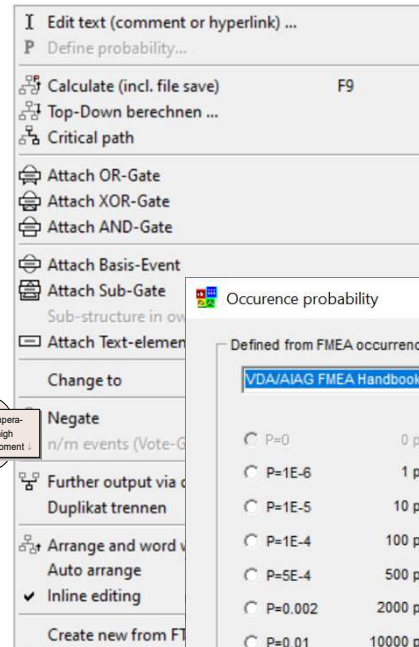
This choice does not lay any claim to completeness

Fault-Tree-Analysis

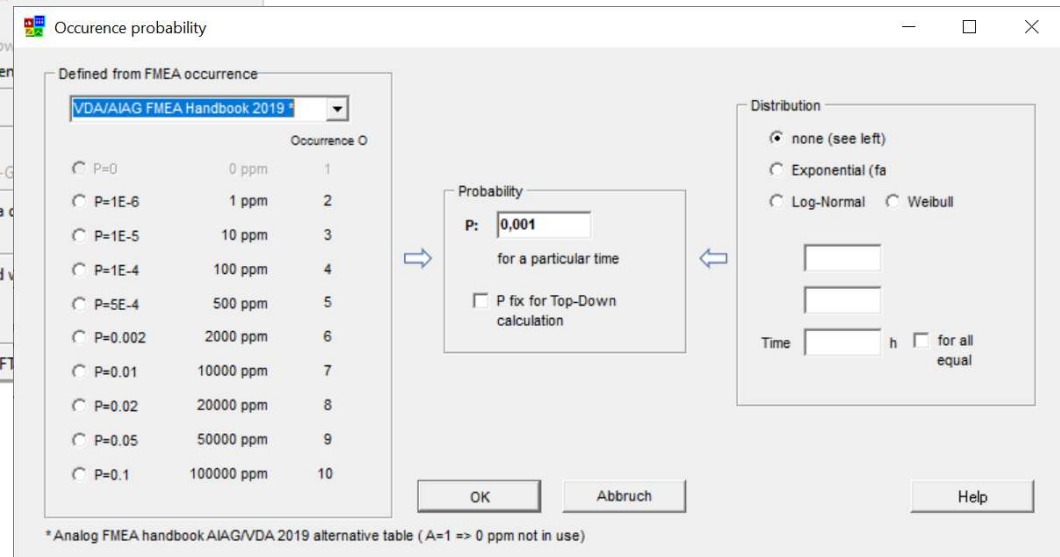
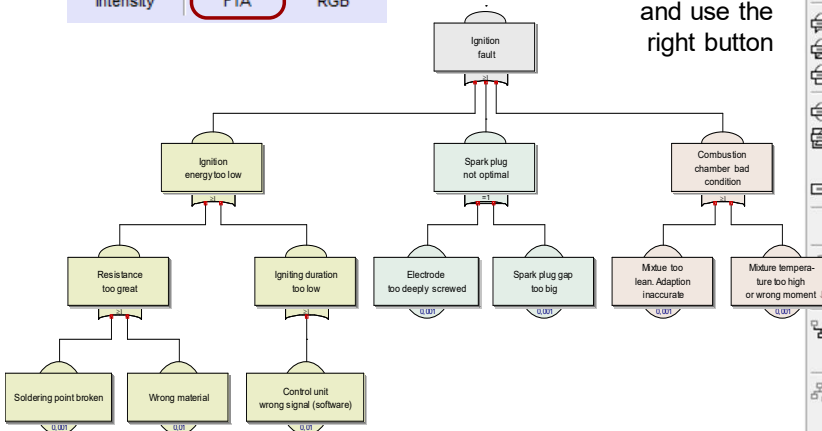
The graphical FTA with powerful functions



Click to one of the elements and use the right button



- All FTA elements also Vote-Gates
- Sub-Gates with layers
- Short-cuts
- Calculation of the critical path
- Probability from distribution or via a standardized FMEA table
- Import from text structure
- Export as FMEA form or cause-effect-diagram
- Supports new VDA/AIAG FEMA Handbook 2019

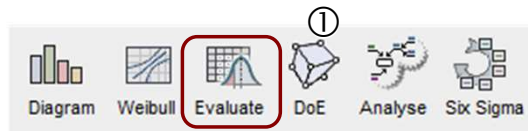


See examples in menu *File, Templates, System-Analysis*

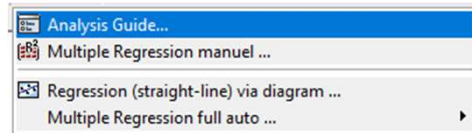
For more information read www.weibull.de//COM/Fault_Tree_Analysis.pdf

Multiple Regression

The multiple regression is the most powerful analysis tool for the DoE results or historical data



C	D	E	F	G
abi	TrackPole	PistonPole	DampTube	Accel
5000	4750	210000	69000	9,49469
5000	4750	210000	69000	8,08628
5000	4750	210000	69000	7,23
5000	4750	210000	69000	6,67



Menu Data/Spreadsheet and open file:
Example_MulReg.vxt

Data Analysis Guide

Apply...

Exit

Help

Response

quantitative - metrical
continual data with sufficient resolution

Discrete countable attributes
two or more characteristics

Alternative Auswertungen

Standard diagram regression

Matrix Plot

Quantitative - metrical

More parameters
Multiple Regression or PLS

Countable characteristics
Transformation with arcsin

Lifetime
Transformation with ln(y)

Evaluate repetitions as mean and standard-dev.

Correlation

Data analysis Multiple Regression

Menu Data/Spreadsheet and open file:

Example_MulReg.vxt

Multiple Regression (Data tab):

Spreadsh.-Table: T1

Response: Accel

Unit: (4)

Indep. parameters: (4)

StiffnRod, DampRod, Stabi, TrackPole, PistonPole, DampTube

Multiple Regression (Model tab):

Model:

- Linear
- Interaction
- Quadratic (5)
- Cubic
- Cubic only
- x 4

Parameter scaling: Normal, Standardize-1, Standardize to s

Regression: MLR (standard for experiments), PLS (for high correlating data or mixing ratio)

Multiple Regression (Regress. tab):

Terms	28/16	MLR	PLS	Coefficient	p-val
Constant				5.013979	
StiffnRod				-1.16686	0
DampRod				-0.83833	0
Stabi				-0.47435	0
TrackPole				-0.24166	0
PistonPole				0.794462	0
DampTube				0.160125	0
StiffnRod*DampRod				0.60649	0
StiffnRod*Stabi				-0.11392	0.008
StiffnRod*TrackPole				-0.0481	0.265
StiffnRod*PistonPole				0.007545	0.855
StiffnRod*DampTube				-0.00597	0.886
DampRod*Stabi				0.01606	0.694
DampRod*TrackPole				0.039027	0.375
DampRod*PistonPole				-0.17985	0
DampRod*DampTube				-0.02574	0.52
Stabi*TrackPole				0.001886	0.965
Stabi*PistonPole				-0.05134	0.215
Stabi*DampTube				0.051293	0.197
TrackPole*PistonPole				-0.09208	0.035
TrackPole*DampTube				0.09476	0.038
PistonPole*DampTube				0.021674	0.607
StiffnRod ²				1.054252	0
DampRod ²				-0.00611	0.96

p-Value
Error probability
Further infos use Help-button
The coefficient describes the importance in the model and the p-value is the error probability of this influence. It should be less than 0.05.
The actual p-value=0.265 means, that the model-term is not significant (bar is red) and should be excluded of the model

Coefficient of determination
 $R^2 = 1 - \frac{SS_{Res}}{SS_{Total}}$
Explanation quota of the model
Further infos use Help-button
The coefficient of determination R² indicates, which quota the regression model can explain the data.
The actual value R²=0.9846 shows, that there is only 1.5% unexplained rest of scattering. The result of the regression is good.

Summary Statistics:
R² = 0.985
R²_{adj} = 0.979

Detailed description under:

www.weibull.de/COM/Data_Analysis.pdf

Calculation of a spot check size

Example car wash: The drying time of a varnish should be examined. It should be reached an exactness from $\pm 0,5$ hrs. The drying time has a standard deviation of 2 hrs. How big has to be the necessary sample size?

The calculation can occur with the Calculator (view of the main window):

Calculate Statistics Format Options Project Help

- Statistik Summary
- Statistical distributions...
- Hypothesis tests ...
- Sample size... (1)
- DoE Experiment
- Correlation
- Data analysis / Regression ... (1)
- ANOVA ...
- Cross table + Chi² test ...
- Cluster analysis

Analysis Six Sigma Tools Macro Draw

Formula-Library

Sample size for required reliability R_{min}

$$n = \frac{1}{L_v^b} \frac{\ln[1 - P_A]}{\ln[R_{\min}]}$$

Metrical sample size for accuracy delta and confidence level 95%

$$n = \left(\frac{1,96 \cdot s}{\Delta} \right)^2 \cdot p(1 - p)$$

Discrete sample size

Number of different

ndc = $\frac{\sigma_{\text{Process}}}{\sigma_{\text{Measurement}}}$

- Delete
- Insert new formula
- Edit formula (2)
- Calculate formula (2)
- Copy formula in text-format (3)
- Copy formula graphic
- Copy formula in Excel-format
- Paste
- Load bitmap
- Save bitmap

Input

s: 2 (4)

Δ: 0,5

OK

Exit

Hint: At step ② there must be clicked the right mouse button (formula: Metrical sample size)

The result of 61.46 is rounded up, therefore n=62

Examples for templates

The other examples treat templates

Diagram-functions

e.g. test of normality, hypothesis of equality with Boxplot or test of normality

⇒ Select *Diagram*

The screenshot shows a toolbar with icons for 'Delete', 'Add Diagr.', 'Type', 'Update', and 'Delete'. Below the toolbar are four diagram types: 'Histogram', 'Normal-Distr.', 'Log-Normal', and 'Weibull'. A 'Declarations' section contains checkboxes for 'Distribution-curve' and 'Density-function', with a dropdown menu set to 'Normal-Distribution'. A 'Distribution test' section has a dropdown menu set to 'Anderson-Darling' and a note: 'P-value < 0,05 : Data does not correspond to selected distrib.'

Internal functions

e.g. calculation of distributions, DoE, regression, sample size, etc.

⇒ Select menu *Statistics*

The screenshot shows the 'Statistics' menu with options: 'Statistik Summary', 'Statistical distributions...', 'Hypothesis tests ...', 'Sample size...', 'DoE Experiment', 'Correlation', 'Data analysis / Regression ..', 'ANOVA ...', and 'Cross table + Chi² test ...'. The 'Data analysis / Regression ..' option is highlighted.

Templates

e.g. hypothesis-test, or Weibull-Analysis.

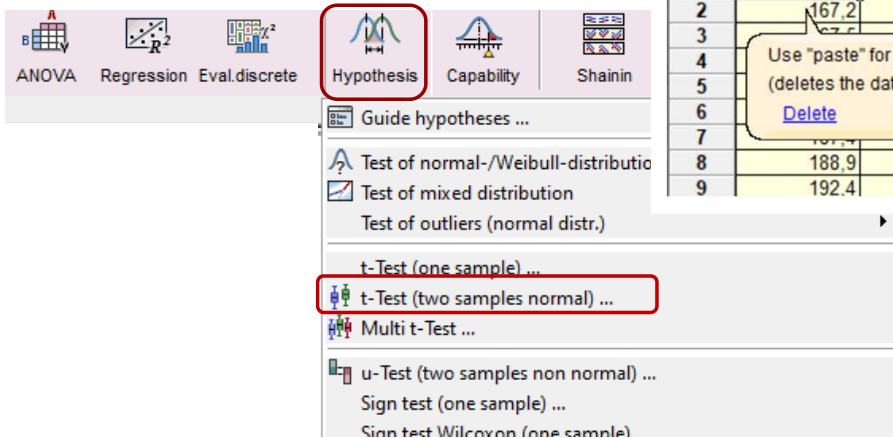
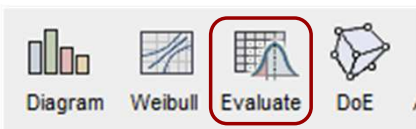
⇒ Select menu *File/Templates*

The screenshot shows the 'File' menu with 'Templates' highlighted. A sub-menu is open showing options: 'System Analysis...', 'Experiment ...', 'Data Analysis...', 'Life time tests...', 'Weibull ...', 'Fault Tree Analysis...', and 'Measurement System'.

Statistical t-tests via templates

Hypothesis tests are available via templates

Open the Spreadsheet and the table where are the sub-groups of the Boxplots.
Mark column A and B.



Paste data in the yellow fields

	A	B	C	D
1	Data 1	Data 2		
2	167.2	184.1		t test
3				
4				
5				
6				
7				
8	188.9	193.3		beta-risk
9	192.4	196.5		power

Use "paste" for your data
(deletes the data from the example)
Delete Paste Paste-Spec

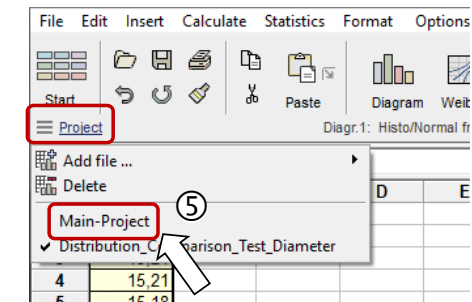


Start the macro for evaluation

t_test	4,71
t_crit	2,07
Significance	0,05
Mean 1	5,6667
Mean 2	7,3625
p-Value	0,000

The null hypothesis, that the means are equal, must be rejected!

The null hypothesis, that the variances are equal, can not be rejected.

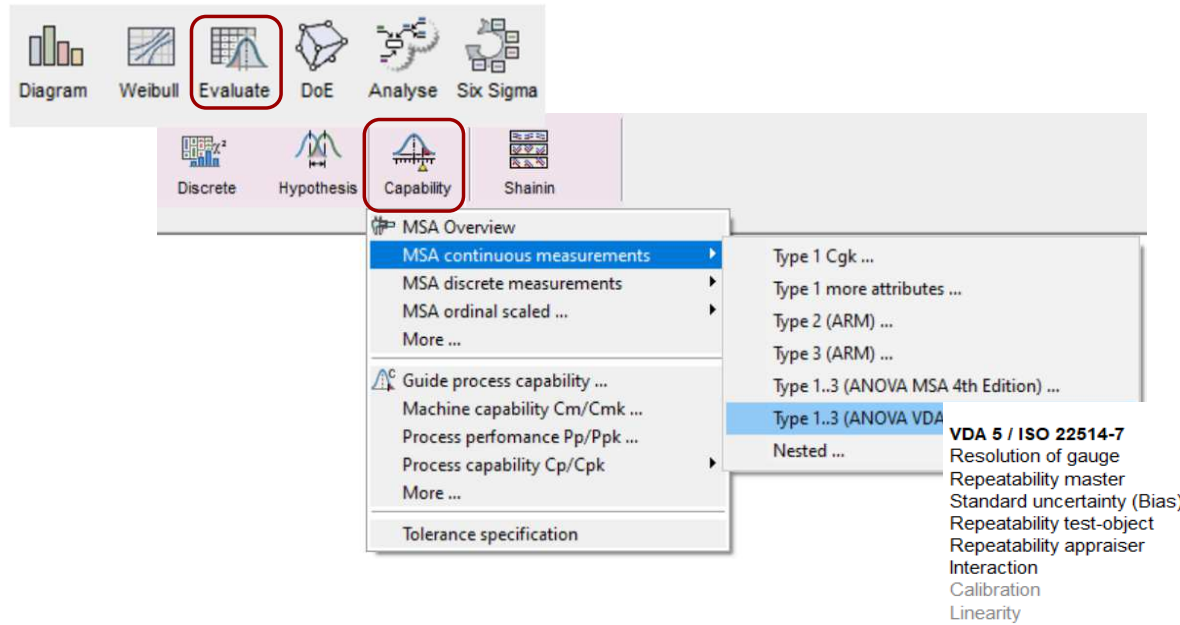


Note:

The template for the test is embedded in the actual project. To have a view to the previous representation and data select *Project / Main-Project!*

Measurement-System-Analysis

All important methods for continuous or discrete data are available



- Supports VDA 5 or MSA4th edition Type 1,2 and 3
- ANOVA or nested ANOVA
- One sided tolerances or natural limits
- Supports AQDEF format for import
- Gage R&R, Bowker, Fleiss-Kappa, Kendal

More information's:

www.weibull.de/COM/Measurement_System_Analysis.pdf

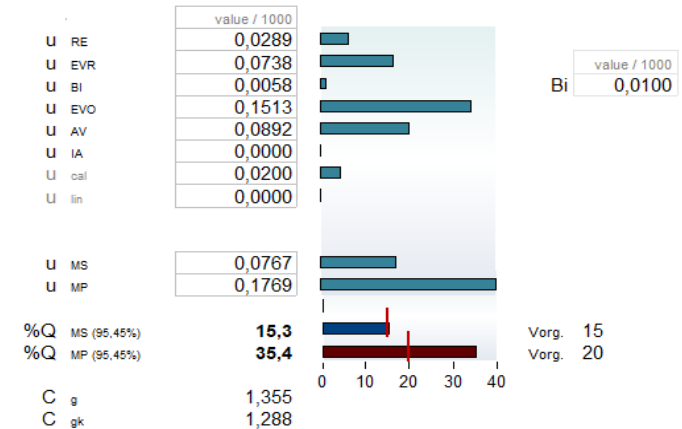
www.weibull.de/COM/Measurement_System_Analysis_discrete.pdf

VDA 5 / ISO 22514-7
 Resolution of gauge
 Repeatability master
 Standard uncertainty (Bias)
 Repeatability test-object
 Repeatability appraiser
 Interaction
 Calibration
 Linearity

Uncertainty measurement
 Uncertainty process

Measurement
 (reference to 4s, or 95,45%)

Capability index
 (reference to 95,45%)



Six Sigma - templates

For Six Sigma also powerful Excel and Visual-XSel templates are available

The screenshot shows the Visual-XSel software interface. The 'File' menu is open, and the 'Six Sigma (FMEA, QFD, SIPOC)' option is selected. A preview window titled 'Table for Cpk - values + overstepping reference values' is displayed, showing a table of Cpk values and a normal distribution curve.

Table for Cpk - values + overstepping reference values

Sigma	Cp	Cpk**	inside %*	outside %*	ppm*	ppm-SS**
1	0.33	-	84,13	15,87	158655	691462
1.5	0.50	0.00	93.32	6.68	66807	500000
2	0.67	0.17	97.72	2.28	22750	308538
2.5	0.83	0.33	99.38	0.621	6210	158655
3	1.00	0.50	99.87	0.135	1350	66807
3.5	1.17	0.67	99.98	2.33E-02	233	22750
4	1.33	0.83	99.9968	3.17E-03	32	6210
4.5	1.50	1.00	99.9997	3.40E-04	3.4	1350
5	1.67	1.17	99.99997	2.87E-05	0.287	233
5.5	1.83	1.33	99.999998	1.90E-06	0.019	32
6	2.00	1.50	99.9999999	9.87E-08	0.001	3.4

* one sided without mean displacement
 ** one sided with mean displacement of 1.5 s

More information's at

<http://www.crgraph.com/Topics.htm>

and

<http://www.crgraph.com/Software.htm>

(on the right side)

Contact: info@crgraph.de