

Examples

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Preface

We would like to thank our customers for their continued trust and support in our products and services. It is the aim of this manual to serve as a quick and easy guide to the use of qs-STAT[®] millennium, with the help of several self-contained worked examples showing actual tasks and detailed procedures. More details and support may be found in the manual "1x1 for qs-STAT[®] millennium", the program features summary as well as the online help.

Please consider that because of the flexibility of the software and the multiple configuration possibilities only standard settings can be given as examples here. Input screen masks, graphical displays, and reports must not necessarily have the same layout shown in this manual. Especially in case of company specific configurations, significant differences are possible. However, the main procedures will be the same. All the path descriptions for test data, catalogs, databases, etc. refer to the standard installation path in the C:\Q-DAS\QSSTAT_ME directory.

In a standard qs-STAT[®] installation, the data sets referred to in the worked examples are located in the directory C:\Q-DAS\QSSTAT_ME\EXAMPLES.

You also have the possibility to download these data sets as well as further worked examples from our internet website <u>www.q-das.de</u>.

We wish you success working with Q-DAS[®] QM tools.

Note:

Our offer includes seminars and courses in connection with our products. We would be pleased to mail you a detailed description of the course contents as well as a questionnaire to help you decide on the course that is right for you. Furthermore, we would gladly submit to you an individual offer for custom-tailored on-site training programs. For self-education, we recommend the purchase of our statistical reference books.

Legal Rights and Warranty

All rights to the documentation and the rights to the qs-STAT[®] software belong to Q-DAS[®] GmbH. The information contained in this document or the program help text is subject to change at any time without notification. Q-DAS[®] GmbH undertakes no obligation with this document.

Limitation of Warranty

No warranty for the correctness of the contents of this manual is assumed. Since, despite every effort, errors can never be fully precluded, we are grateful for the notification of such errors. You may contact us under one of the following addresses:

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Highlights:

transformation

Objective:

The goal of this task is to demonstrate the recording data capabilities within qs-STAT. The user will learn how to create a file from start to finish, entering critical tolerance information and manually recording measured values using the 'linear transformation' option. □ Linear

Background Information:

When creating a file, it is important that the correct tolerance information is entered for each characteristic as this will directly affect the capability results. Any additional data that can be entered is most beneficial when using qs-STAT to drill down on a process to determine any special causes.



Task:

Create a qs-STAT file for the four crankshaft features on Pin 4 (P4), as outlined in the part drawing above. Reference the information on the following page for descriptions and measurement values.

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Additional Information:

Part No.	1
Part Descr.	Crankshaft

Char. No.	1	2	3	4
Char. Descr.	Posn. Jrnl P4	Diam. P4	Round. P4	Straight P4
Nominal	99.82	49.019		
USL	99.87	49.025	0.004	0.003
LSL	99.77	49.013		

Measured Values:

Crankshaft	Posn Jrnl P4	Diam P4	Round P4	Straight P4
1	99.83	49.014	0.0005	0.0009
2	99.82	49.018	0.0004	0.002
3	99.82	49.015	0.0009	0.0002
4	99.84	49.014	0.0004	0.0012
5	99.84	49.015	0.0007	0.0009
6	99.81	49.015	0.0007	0.0018
7	99.83	49.014	0.0013	0.0011
8	99.83	49.014	0.0007	0.0006
9	99.84	49.016	0.0001	0.0011
10	99.82	49.016	0.0006	0.0009
11	99.86	49.015	0.0013	0.0007
12	99.85	49.015	0.0017	0.0014
13	99.83	49.016	0.0027	0.0009
14	99.83	49.015	0.0007	0.0012
15	99.84	49.014	0.0028	0.0011



Procedure:

1. In qs-STAT Process Capability Module, go to the File pull-down menu and select File new or click the icon seen to the right. The 'create new characteristic ...' window will appear as seen below. Under variable characteristics change the number to 4 and click ok.

Module	Individuals	Values	Ν
Sample	Analysis		
Process	Capability Ar	nalysis	
Measure	ement Systen	n Analysis	;
Reliabilit	y Analysis		

create new characteristic	×
Sample / Process Analysis Measurement System Analysi	s
variable characteristics	
1 主 new characteristics	Default
Positional tolerances	
0 文 new positional tolerances	Default
0 🚖 new attribute characteristics	Default
Error log sheet	
0 🗲	Default
1 🚖 new error types	Default
	L L
OKCancel	Help

File new

L D	

2. For the Parts Mask, the essential information is the part number and part description. These should be unique identifiers. Fill in the Part number as 12345 and the part description as crankshaft.

Part		Test Facility		
Part number	Description	Number	Description	Reason for Test
12345	Crankshaft		Q-DAS Inc.	
Contr.item	Amendment status	Test Begin	Test End	
	-			
Manufacturer		Contract		
Number	Name	Contract	Contractor	
Material	-p	Customer		
Description		Number	Name	
Drawing		Machine	-10	
Number	Amendment	Number	Description	
Remark				
Training Course E	xample		-2	
		3		

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Recording Data Introduction



The three icons below navigate between the Parts, Characteristic and Value Masks, respectively.



3. Switch from the Parts Mask to the Characteristics Mask. Fill in the characteristic number and description. These should be different than the part number and part description, but should also be unique identifiers.

Nu urobior -	Exception of the second s	AL	111.1		D : 101	
Number	Description	Nominal Value	Unit	_	Decimal Pl.	-
וו	Posn Jnrl P4	99.82	mm		2	-
Char. Type	measured quantity	Up.Spec.Lim.	Up.Allowan	ce	Up.nat.bound.	
variable 🗾 💌	🛱 undefined 📃	99.87	0.05		Г	
Class	Events Catalog	Lo.Spec.Lim.	Lo.Allowand	e	Low.nat.bound.	
significant 🗾 💌	· · · ·	99.77	-0.05		Г	
Gage						
Number	Description	Subgroup size		Subgroup	o type	_
		5	†	fixed		-
Group	Recording Type	Un Plaus Lim		Productio	n Tune Description	n
	manual				in type b coonpilo	_
	Process Parameter Catalog			Productic		-
		EU.Fiaus.Elm.		Froductio	лтуре	_
Group	Recording Type manual	Up.Plaus.Lim.		Productic Productic	on Type Descript on Type	tio



 4. Enter the tolerance information from the part drawing on page 1 and select a measured quantity from the list that relates to the characteristic.

Use the icons below to move forwards and backwards through the characteristics.



Alternatively you can display the characteristic list and move through the characteristics by checking the appropriate one. See the steps below.

	Recording Data Introduction	Page 5 of 6
Info icon	Characteristics list Characteristics list Color Type OK Exit	
Characteristics ○ qs-STAT ○ 3/Round. P ○ 3/Round. P ○ 4/Straight. P	P4 P4 P4 P4 P4 P4 P4 P4 P4 P4	

- 5. Complete the characteristic information for the other three characteristics.
- 6. Switch over to the Value Mask and enter in the data set for the first characteristics, Posn Jrnl P4.
- 7. For the second characteristic, Diam. P4, use the linear Linear transformation when manually typing in the data. Set the linear transformation up as seen in the screen below. By doing this you 'input' 14 and the 'value' that is displayed in qs-STAT will be 49.014.

Linear transf	ormation	\mathbf{X}
Accumulating	Constant	49
Multiplication f	actor	0.001
Va	lue = 49 + 0.001	1 * Input
	OK Canc	el Help

Transformation





- 8. Complete the data entry for the last two characteristics. Practice using the linear transformation; re-set it before typing in the data for each characteristic.
- 9. Be sure to Save the file under File Save as ...

The completed Value mask should look like the one seen below, with 4 characteristics and 15 values each.

Q V	🧟 Value								
Char	Characteristic								
Nu 1	mber	Description Posn Jnrl I	Description Posn Jnrl P4						
	Posn Jnrl P4	Diam P4	Round, P4	Straight, P4					
1	99.83	49.014	0.0005	0.0009					
2	99.82	49.018	0.0004	0.0020					
3	99.82	49.015	0.0009	0.0002					
4	99.84	49.014	0.0004	0.0012					
5	99.84	49.015	0.0007	0.0009					
6	99.81	49.015	0.0007	0.0018					
7	99.83	49.014	0.0013	0.0011					
8	99.83	49.014	0.0007	0.0006					
9	99.84	49.016	0.0001	0.0011					
10	99.82	49.016	0.0006	0.0009					
11	99.86	49.015	0.0013	0.0007					
12	99.85	49.015	0.0017	0.0014					
13	99.83	49.016	0.0027	0.0009					
14	99.83	49.015	0.0007	0.0012					
15	99.84	49.014	0.0028	0.0011					
16									
17									



Objective:

This task is designed to expand on the user's basic knowledge of the recording data setup in qs-STAT and to introduce additional, advanced recording data options. These will include the "logical operator" and "Common Additional Data Fields" such as date, time, operator, machine, etc.

Background Information:

Within qs-STAT, it may be necessary to link or connect certain related characteristics; for example to determine the calculated true position value of X and Y coordinates or to find the sum of two sets of data measured from two length characteristics. These types of functions can be done using the 'logical operator' feature. As for additional data fields, this information can be used to assist in the traceability of a part or to drill down on a process in order to determine the exact location of the problem, i.e. Machine and Cavity number.



Highlights:

- ☑ Recording Data
- Additional Data
 Fields
- ☑ Logical Operator

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Task:

Create a new file and the recording data environment for the three characteristics highlighted on the part sketch. Record the measured values and the additional data fields for each characteristic as outlined below. (Hint: Use the Common Additional Data Fields option when entering the machine and cavity information.)

Create the special characteristic for the distance between Journals 2 and 3. Using the logical operator complete the data values.

Spindle	Jrnl 1	Cavity	M/C #	Jrnl 2	Cavity	M/C #
1	12.479	2	1	65.436	2	1
2	12.489	2	1	65.422	2	1
3	12.498	2	1	65.46	2	1
4	12.546	2	1	65.433	2	1
5	12.485	3	1	65.454	3	1
6	12.513	3	1	65.461	3	1
7	12.55	3	1	65.439	3	1
8	12.547	3	1	65.463	3	1
9	12.491	4	2	65.45	4	2
10	12.521	4	2	65.463	4	2
11	12.524	4	2	65.446	4	2
12	12.485	4	2	65.467	4	2
13	12.542	5	2	65.43	5	2
14	12.508	5	2	65.423	5	2
15	12.493	5	2	65.429	5	2
16	12.446	5	2	65.439	5	2

Measured Values & Additional Data:

Snindle	Irnl 3	Cavity	M/C #
opinale	01111 0	Oavity	W //O #
1	90.051	2	1
2	90.05	2	1
3	90.039	2	1
4	90.036	2	1
5	90.035	3	1
6	90.071	3	1
7	90.058	3	1
8	90.062	3	1
9	90.062	4	2
10	90.053	4	2
11	90.049	4	2
12	90.039	4	2
13	90.054	5	2
14	90.075	5	2
15	90.045	5	2
16	90.041	5	2



Process Capability Analysis

Measurement System Analysis

Procedure:

1. Starting with a new file in the Process Capability Module Individuals Values Module, fill in the appropriate parts and characteristic Sample Analysis information for each of the three Journals.

Charact	eristics						
naracteristic							File new
umber 	Descrip Journa	otion I 1	Nominal Value 12.500	e Unit	Decima 3	al Pl.	
har.Type /ariable	measur II uno	ed quantity defined 🗾	Up.Spec.Lim. 12.580	Up.Allow 0.080	ance Up.nat	.bound.	
lass significant	Events	Catalog Catalog 💌	Lo.Spec.Lim.	Lo.Allow -0.080	ance Low.na	at.bound.	
age							
umber	💁 Charact	eristics					
	Characteristic						
oup	Number 2	Description Journal 2		Nominal Value 65.500	Unit mm	Decimal Pl. 3	
	Char.Type variable	measured q	uantity ed 🗾	Up.Spec.Lim. 65.580	Up.Allowance 0.080	e Up.nat.bou	nd.
nark	Class significant	Events Cata	alog alog 💌	Lo.Spec.Lim. 65.420	Lo.Allowance	Elow.nat.bo	und.
	Gage						
	Number	🙎 Characteri	stics				
		Characteristic			1		
	Group	Number 3	Description Journal 3		Nominal Value 90.000	Unit mm	Decimal Pl.
	,	Char. Type variable	measured q ▼ II undefin	quantity ied 💌	Up.Spec.Lim. 90.100	Up.Allowance 0.100	Up.nat.bound.
	Remark	Class significant	Events Cata	alog alog 💌	Lo.Spec.Lim. 89.900	Lo.Allowance -0.100	Low.nat.bound.
	<u> </u>	Gage			P		
		Number	Description		Subgroup size 5	Sut	ogroup type ed
		Group	Recording manual	Туре	Up.Plaus.Lim.	Pro	duction Type Description
			Process Pa Process P	rameter Catalog arameter Ca 💌	Lo.Plaus.Lim.	Pro	duction Type
					<u>P</u>		1
		Bemark					
		Hemark					



2. In the Value Mask, prior to entering data turn on the additional data fields for machine and cavity. This can be done by right mouse clicking on the highlighted cell and selecting "Display additional data fields." In the pop up window, check Cavity number and Machine number; select "all characteristics" and click OK.

Q V	alue						
Char	acteristic						
Nur 1	mber	er Description Up.S Journal 1 12.5					
	Journa	1 Journal 2 Journ	nal 3				
1							
2		Delete values					
3		Insert values					
4		Record additional da	ta				
5		Take over record for	•				
6		Copy Ctrl+C					
7		Insert Ctrl+V					
8		Linear transformation					
9		Display additional data fields					
10		Common Additional Data Fields					
10		Column to the left					
-11		Column to the right					

—	Display addition	nal data	-			
_	attribute					
_	Time					
_	Date					
—	Event					
—	Batch number					
V	Cavity number					
_	Operator name					
_	Text					
~	Machine numbe	er				
-	Process parame	eter				
-	Gage number					
_	Order					
	Highli	ight all				
	No hig	ghlight				
Windows of same type current characteristic (all characteristics) all characteristics of the part all characteristics in the group						
	OK	Cancel				



3. Again right mouse click in the highlighted cell and select "Common Additional Data Fields."

Q V	alue								
Characteristic									
Number Description 1 Journal 1				n		Jp.Spe 12.580			
	Journ	al 1 – C	avity number	Machine nu	mber	Journa			
1		Delei	te values						
2		Insert values							
3		Reco	ord additional	data					
4		Take	over record	for:		•			
5		Copy	,		Ctrl+	c 🗌			
6		Insei	rt		Ctrl+	v			
7		Linear transformation							
8		Display additional data fields							
9		 Common Additional Data Fields 							
10		Column to the left							
11		Colu	mn to the righ	ıt					

Common Additional Data Fields means that the additional information, such as machine # and cavity # are carried over for each part - all characteristics (across the row).

	Journal 1	Cavity numbe	Machine numb	Journal 2	Cavity numbe	Machine numb	Journal 3	Cavity numbe	Machine nu
1	12.479	2	1	65.436	2	1	90.051	2	1
2									
3									

For this example, we want the additional data to carry over for each characteristic (across the row) and for each part (down the column). The "Takeover" function works for the second half.

4. Go to "Options" pull down menu, "Configuration of Recording data / Data Set" – "Takeover." Check the boxes for Cavity and Machine. Click OK.

Version:

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Advanced Recording Data



Options Extras Help
Configuration of Evaluation
System settings
Configuration of Recording data / Data Set
Configuration of Recording data / Standard

Options for Recording o	f Data		×
Input sequence Takeover Recording data	Takeover Takeover of values in data set		
	🗖 Date		Batch
	Time		Cavity
	attribute		Machine
	Event		Gage
	C Operator	Γ	Process parameter
	Text		Order
	measured value		
	up to current value		
	Standard for new records		
		OK	Cancel Help

Prior to typing in the data, change the "Input sequence" such that the additional data fields are skipped. This will allow the values to be typed in one after another down the column.

- 5. Go to the "Options" pull down menu, "Configuration of Recording data / Data Set" "Input sequence." Check the box for "Skip add. data fields." Click OK. Refer to the graphic on the following page.
- 6. Now type in all of the data for the three characteristics including the machine and cavity numbers.



Options for Recording of	Data	×
Input sequence Takeover Recording data	Input sequence Characteristic Characteristic after every value after values every subgroup after subgroups manual	
	OK Cancel Help	

The completed Values Mask is seen below for the three Journals, including the additional data.

Q	/alue								
Cha	aracteristic						Transfor	mation	
N	umber	Desc	cription		Up.Spec.Lim.	Lo.Spec.Lim.	Factor	Co	Instant
1		Jour	mal 1		12.580	12.420	1.000	0.	000
		112				·		10	
	Journal 1	Cavity number	Machine numb	Journal	2 Cavity numbe	Machine numb	Journal 3	Cavity numb	Machine nur 📃 📥
1	12.479	1	2	65.436	1	2	90.051	1	2
2	12.489	1	2	65.422	1	2	90.050	1	2
3	12.498	1	2	65.460	1	2	90.039	1	2
4	12.546	1	2	65.433	1	2	90.036	1	2
5	12.485	1	3	65.454	1	3	90.035	1	3
6	12.513	1	3	65.461	1	3	90.071	1	3
7	12.550	1	3	65.439	1	3	90.058	1	3
8	12.547	1	3	65.463	1	3	90.062	1	3
9	12.498	2	4	65.450	2	4	90.062	2	4
10	12.521	2	4	65.463	2	4	90.053	2	4
11	12.524	2	4	65.446	2	4	90.049	2	4
12	12.485	2	4	65.467	2	4	90.039	2	4
13	12.542	2	5	65.430	2	5	90.054	2	5
14	12.508	2	5	65.423	2	5	90.075	2	5
15	12.493	2	5	65.429	2	5	90.045	2	5
16	12.446	2	5	65.439	2	5	90.041	2	5
17									
18									-
									•



7. Add a fourth characteristic for the distance between Journals 2 and 3.



Append element

In the Characteristics Mask on the third characteristic, click the "Append element" icon. This will add a fourth element to the end of the list.

8. Fill in the appropriate tolerance information calculated from Journals 2 and 3, as seen below.

qs-STAT	Characteristic				
🔊 1/Spindle	Number	Description	Nominal Value	Unit	Decimal Pl.
	4	Dist. Journal 2-3	24.500	mm	3
- 🗍 😇 🛱 3/Journal 3	Char. Type	Measured quantity	Up.Spec.Lim.	Up.Allowance	Up.nat.bound.
	variable 💌	🗖 🕂 undefined 📃 💌	24.680	0.180	
	Class	Events Catalog	Lo.Spec.Lim.	Lo.Allowance	Low.nat.bound.
	significant 💌	Event Catalog 📃 💌	24.320	-0.180	
	Gage				
	Number	Description	Subgroup size	Subg	group type d 📃 💆
	Group	Recording Type	Up.Plaus.Lim.	Prod	uction Type Description
		Process Parameter Catalog Process Parameter Ca	Lo.Plaus.Lim.	Prod	uction Type
	Bemark			I)//	

9. Using the "Link characteristics" icon a Logical Operation Formula can be input so the distance between Journals 2 and 3 is automatically calculated.



Link characteristics



Link charac	teristics 🛛 🔀	
	Input Logical Operation Formula	
f(m1,m32)	x3-x2	
	OK Cancel Help	

 For the distance between the two Journals, type in the Logical Operation Formula: x3 - x2. The "x" represents characteristic, and this formula calculates characteristic #3 minus characteristic #2.

Other examples of Logical Operator Formulas include:

- average value of characteristics avg(x1; x2; x4)
- maximum value of characteristics max(x1..x4) (i.e. max of characteristic 1 thru characteristic 4)

The Value Mask is now filled in for the Distance between Journals 2 and 3.

Cha	racteristic						Transfo	mation		
Nu	imber		Description	U	p.Spec.Lim.	Lo.Spec.Lim.	Factor	C	Constant	
4			Dist. Journal 2-3	2	24.680	24.320	1.000		0.000	\frown
	Journal 1	Caviture	mbe Machine numb	lournal 2	Cavitu pumb	Machina numh	Journal 3	Cavitu num	Machina nu	Dist Journal
1	12.479	1	2	65.436	1	2	90.051	1	2	24.615
2	12.489	1	2	65.422	1	2	90.050	1	2	24.628
3	12.498	1	2	65.460	1	2	90.039	1	2	24.579
4	12.546	1	2	65.433	1	2	90.036	1	2	24.603
5	12.485	1	3	65.454	1	3	90.035	1	3	24.581
6	12.513	1	3	65.461	1	3	90.071	1	3	24.610
7	12.550	1	3	65.439	1	3	90.058	1	3	24.619
8	12.547	1	3	65.463	1	3	90.062	1	3	24.599
9	12.498	2	4	65.450	2	4	90.062	2	4	24.612
10	12.521	2	4	65.463	2	4	90.053	2	4	24.590
11	12.524	2	4	65.446	2	4	90.049	2	4	24.603
12	12.485	2	4	65.467	2	4	90.039	2	4	24.572
13	12.542	2	5	65.430	2	5	90.054	2	5	24.624
14	12.508	2	5	65.423	2	5	90.075	2	5	24.652
15	12.493	2	5	65.429	2	5	90.045	2	5	24.616
16	12.446	2	5	65.439	2	5	90.041	2	5	24.602
17										

Version:

Value Chart Features



Objective: The goal of this task is to introduce the user to the Data Handling graphical analysis aspect of qs-STAT. Several of the investigative tools that are available for the Individual Value chart will be demonstrated using example data containing measurements from multiple machine, gages, operators, etc.

Background Information:

Process data may contain a multitude of elements of variation, and it can be difficult to find the root of the problem in the JUNGLE of variation. gs-STAT can assist the user in deciphering where the primary cause is located, by seperating out the data by machine number or by indicating whether an assignable cause has been recorded at the value.



Highlights:

Page 1 of 11

☑ Graphical Analysis

☑ Value chart

filo



Task:

set of Analyze an existing data from the file. Multifixture.dfg and investigate for any causes of variation that may be able to be removed from the analysis.

Procedure:

Module Individuals Values Sample Analysis Process Capability Analysis Measurement System Analysis Reliability Analysis

1. In the Module Process Capability Analysis, open the file Multifixture.dfg. This file is located in the gs-STAT installation directory, Q-DAS\QSSTAT_ME\Examples.

Value chart Individuals:



🗳 •	

Individuals Values Numerics

x-y Plot Positional Tolerances

F2

F3

F4

F5

Value chart

Value plot

Histogram

Probability plot

Cumulative line x-y Plot

Upon opening the file, a Value chart individuals will
automatically open as the default screen setup. This
chart can be found under the Individuals pull-down menu.

Value obert individuale will



All of the options for the charts can be accessed in one of two ways:

a) Use the icons/buttons on the toolbar

Q	Q-DA	S Inc.	qs-S	TAT (C)	Proc	ess Ca	apability	Analysis	\$								
File	Edit	Module	Individuals	Values	Numerics	QCC	Summary	Window	Options	Extras	Help						
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Doc-No:



b) Right mouse click on the graphic, and select the appropriate item.



Grid lines:



2. Select the "Grid lines" icon and turn on grid lines.

Grid lines





Any changes that are made to the appearance of the Save settings graphics, such as grid lines, can be saved as the new default by clicking the "Save settings" icon.

X-axis display:

3. Along the x-axis of a Value chart, the Value No. is displayed. This can be changed to show date & time, scaled time, machine #, etc. Click the "Value axis" icon and select Type of scale ... Time axis.





Time axis (scaled time) is displayed to show when the down time occurred.

₽ŝ

Information values:

4. The "Information values" box is a very useful tool when it comes to analyzing your data. It gives all the specifics about a particular value. Click on the "Special" icon, then the "Information values" icon.



With the Information values turned on, put the mouse inside the Value chart. The mouse becomes a hand which points to a specific value. In the graphic above, the hand is on value # 90. The Info box to the right shows what events occurred, the batch #, cavity #, etc.

The blue and red triangles along the Value No. axis at #10 and #90 indicate that an event has occurred there.

Separation of data:

When multiple machines are present, it may be useful to separate the data by machine in order to see where the machines are running with respect to each other and with respect to the tolerance.



5. Go to the "Special" icon and click on the "Separate" icon. In the window that appears, check the Activate box; select Allocation for ... Machines.

	qs-STAT® System settings	
\smile	- Allocation for	
	 Machines 	
	C Cavities/spindles/clamping locations	
	C Gages	
	C Inspectors	
	- Legend	
	 Text 	
	C Number	
	C none	
	- Text width	
	15 Character	
	- Activate	
(Activate	
	OK Cancel	
0.10	USL	
		⊼+3s
0.05		Machine 1
1	J.A A MULL	
E 1/4	V PA NO V NO V MAN	
	\X/\XXX	
-0.05 -		Machine 2
		Machine 2
		⊼-3s
-0.10		
0 10	20 30 40 50 60 70 80 90 100 ∀alue No.→	



6. To change the coloring of the lines and symbols for Lines / each separate machine, go to the "Lines / Symbols etc." icon. In the window that appears, click on the first or second line box and select a new color. For the symbols, the type of symbol can be changed in addition to the symbol color.

Symbols etc.



Zoom Function:

7. On the Value chart, there are several zoom functions available. Click the "Zoom functions" icon and select Set up the zoom lines, using the zoom horizontal. mouse or the numbers in the lower corners of the graphic. Then click "execute zoom."







Notice the value chart is now only displaying values 1 -50.

Select Function:

Under certain circumstances, a value or a group of values may need to be removed from the capability analysis. For example, if there is an obvious outlier that has an assignable cause, then by using the "select function" that value can be de-selected. The capability of the characteristic will then be recalculated without that value or rather without the whole subgroup. In Process Capability Module, the statistics are based on sub grouping or sample plans, therefore an individual value alone can not be removed.



8. In the value chart below, there are outliers with assignable causes (events) at value #10 and #90. To de-select these, click the "Select Function" icon and the "Start Select (region)" icon. Using the mouse draw a circle around each value. Be sure to completely close the circle. Then right mouse click on the value inside the circle.



9. Now click the "Execute select function" icon.



The de-selected subgroups now appear as dashed lines.

Version: 1



Numerics QC	:C Summary V
Evaluation res	sults
Form sheets	۱.
Distributions (without offset)
Distributions (incl. offset)
Distribution se	election
Test procedur	res 🕨
Individual valu	Jes 🕨 🕨
Display classif	ication

10. Open up a Form Sheet 3 from the Numerics pull down menu to view the capability results after the deselection.

Below is a comparison of the capability results before and after the de-selection. To undo the previous de-selection, click the "undo select function" icon.

[Drawing Va	lues	C	ollected Va	lues		Statistics
Tm	=	0.000				x	= 0.00027
LSL	=	-0.100	×mh	=	-0.096	⊼ -3s	= -0.08178
USL	=	0.100	×max	=	0.105	⊼ +3s	= 0.08232
Т	=	0.200	R	=	0.201	- 6s	= 0.16409
			n _{⊲T>}	=	99	p _{<t></t>}	= 99.97440 %
			n _{≥USL}	=	1	p _{≥USL}	= 0.01329%
			n _{≺LSL}	=	0	p _{⊲LSL}	= 0.01231%
			n tot	=	100	П _{ей}	= 100
	Mo	del distribution		=		Normal Distri	ibution
	Cald	culation method	k	=	M4 P	ercentile (0.135	o%-X-98.005%)
	Prospect	ive performan	ce index	=/	Тр	= 1.0	00 ≦ 1.22 ≦ 1.44
	Critical	performance	index	4	Трк	= 0.9	98 ≦ 1.22 ≦ 1.45
					~		
		T	he requirem	ents were	not met (<u>T</u> p	, <u>Ι_{ρk}</u>)	↓
	Calc	culation method	k	=		Q-DAS	1

Before de-selection:

The Capability Indices are

 $T_p / T_{pk} = 1.22 / 1.22$

The ' \mathbf{T} ' indicates that the process is unstable.

At the same time, the capability number requirements were not met. Nowadays, the requirement is typically set at 1.67 as a minimum number. Of course the requirements you will work with depend on your company's standards.

By de-selecting the values, you can determine whether those assignable causes are the sole reason for the stability issue and the low capability numbers.



After de-selection:

	Drawing Va	alues	Co	ollected Va	lues		Statistics
Tm		0.000				x	= 0.001
LSL		-0.100	×mh		-0.05	X 163	= -0.09095 [rt]
USL		0.100	×max	=	0.04	X _{sp3}	= 0.05745 [rt]
Т	=	0.200	R	=	0.09	X _{sp3} -X _{lo3}	a = 0.14841 [rt]
		****	n _{<t></t>}	=	90	p _{<t></t>}	= 99.93587 %
			n _{>USL}		0	p>USL	= 0.00000%
			n _{elei}		0	P≼tst	0.06413%
		(D		100	D	= 90
*****		annan barran an an a'	"tot		100	''eff	
			l'ibt		100	''eff	
	Mc	odel distributio		=	Log	j ''en jarithmic Norr	nal Distribution
	Mc	odel distributio		=	Log	j ''en	nal Distribution
	Mo	odel distributio	od	=	Log	arithmic Norr	nal Distribution
	Mo Cal Potenti	odel distributio culation meth al performan	on od ce index	=	Log Pp	in reff arithmic Norr ercentile (0.1	nal Distribution 35%-x-99.065%) 1.09 ≤ 1.35 ≤ 1.61
	Mc Cal Potenti Critic	odel distributio culation meth al performan cal capability	od ce index index	=	Log Pp Pp	j ''eff jarithmic Norr ercentile (0.1 = (nal Distribution 35%-x-99.005%) 1.09 ≤ 1.35 ≤ 1.61 0.87 ≤ 1.10 ≤ 1.33
	Mo Cal Potenti Critic	odel distributio culation meth al performan cal capability	on od ce index index	=	Log Pp Pp	inarithmic Norr ercentile (0.1 = (nal Distribution 35%-x-99.065941 1.09 ≤ 1.35 ≤ 1.61 0.87 ≤ 1.10 ≤ 1.33
	Mc Cal Potenti Critic	del distributio culation meth al performan cal capability	on od ce index index The requirem	= = c	Pp Ppk	ercentile (0.1 = (0.1 = (0.1 = (0.1)	nal Distribution 35%-x-99:065%1 1.09 ≤ 1.35 ≤ 1.61 0.87 ≤ 1.10 ≤ 1.33

First, the ' n_{eff} ' has changed to equal 90. ' n_{eff} ' (effective values) indicates the number of values used in the calculations. To the left of that is ' n_{tot} ' = 100, showing that there were originally 100 values for this characteristic.

Secondly, the Capability Indices have changed to

P_p /P_{pk} = 1.35 /1.10

The 'T' has changed to a 'P' indicating that the process is now stable.

The message "The requirements were not met $(P_p P_{pk})$ shows that the capability of the process still needs improvement.

Note: The Select Function is best used as an investigative tool to see whether a specific problem or cause is the sole reason for instability or low capability indices.



Objective:

This task will demonstrate a broad range of qs-STAT graphics used in a general statistical analysis. It will provide the user with a standard default screen setup, emphasizing the four steps to system acceptance. Customization of form sheets and printout of standard reports will also be discussed.

Background Information:

In a previous recording data example, four crankshaft features were created in order to demonstrate the setup of each qs-STAT Mask. Building upon the original example, a file has been created which includes a total of sixteen features on the crankshaft with 50 measurements each. The data is ready to be analyzed.



Highlights:

☑ Data Handling

☑ Graphical Analysis

☑ Control Chart

☑ Histogram

☑ Multiple Charts



Task:

Evaluate the existing set of data from the file, Crankshaft.dfg, according to the recommended Four Steps to System Acceptance:

- 1) In Tolerance
- 2) In Control
- 3) Appropriate Distribution Model
- 4) Passing Capability Indices

Procedure:

Sample Analysis Process Capability Analysis Measurement System Analysis Reliability Analysis

File – Open

Module Individuals Values N1. In the Process Capability Analysis Module, open the file Crankshaft.dfq. This file is located in the qs-STAT installation directory, Q-DAS\QSSTAT ME\Examples.

As the characteristics selection window appears, click OK.


Histogram:

2. Leave the default Value chart open on the desktop and from the "Individuals" pull down menu; open a "Histogram."



Individuals Values	Numerics				
Value chart	F2				
Value plot	F3				
Histogram	F4				
Probability plot	F5				
Cumulative line					
x-y Plot					
x-y Plot Positional To	olerances				

On a Histogram, the Characteristic description is found along the bottom, x-axis, of the chart.

The "Absolute frequency" scale is shown on the left side *Absolute* of the histogram. This scale is the actual number of frequency vs. values that fall within each column of the histogram.

The "Relative frequency" axis is displayed on the right side showing what percentage of the values fall in each column.

For example, according to the Absolute frequency scale, sixteen values fall in the topmost column, whereas approximately 32% of the values fall in that column according to the Relative frequency scale.

3. As long as the Absolute frequency scale is on, a value plot can be overlaid on the histogram. Click the "Special" icon and the "Actual value plot on/off" icon to turn the value plot on as seen on the following page.

Relative frequency



Special

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Graphical Analysis





Histogram with Value plot overlaid

The histogram in the example above for Position Journal P4 is a Normal Distribution (ND). qs-STAT automatically selects the best fit distribution model for the data based on the statistical evaluation method selected by the customer or recommended by Q-DAS. This setup can be found in the "Configuration of Evaluation" which is under the "Options" pull down menu.

The following information regarding Quantile limits applies solely to data that is normally distributed.

The default setting on the histogram shows blue dashed lines for the "average \pm 3 sigma." 99.73% of the data is predicted to fall within these lines, based on the process model. These lines can be changed from one sigma up to seven sigma, although three sigma is the standard.



- Quantile 4. Click on the "Quantile limits" icon to change the visible limits limits from 3-99.73% to 6-99.999...% **7-6**8 7+6s USL 16 -30 Quantile limits 14 Visible 25 1 + 12 -Apsolute trequency + 8 - 01 1 - 68.27 % 2 2 - 95.45 % 20 3 - 99.73 % 4 - 99.9937 % 5 - 99.99994266 % 15 ø 6 - 99,999999803 % 6. 7 - 99,9999999974 % 10 4 -Intermediate values -5 Visible 2 ΟK Exit n .n 99.78 99.80 99.76 99.82 99.84 99.86 99.88 99.90 Posn Jnrl P4 [mm] ND →

The table below refers to Process Capability, Ppk, for various quantile limits. The table can be interpreted as follows: for the above data set to reach a P_{pk} of 2.00, the specification limits would have to be opened up to the ± 6s lines or the variation would need to be reduced to comply with the current specification limits. With a capability of $2.00 \pm 6s$, the probability is that 0.001 parts per million would be out of specification.

Ppk	Probability
1.00 ± 3s	2700 ppm
1.33 ± 4s	63 ppm
1.67 ± 5s	0.6 ppm
2.00 ± 6s	0.001ppm

1<u>bs</u>

W



Another feature available on the histogram is the C-value function. This feature graphically interprets the capability of the process.

Additional 5. First turn off the Relative value axis on the right side of data axis the histogram. Click on the "Additional data axis" icon and select the first option.





6. Now click the "C-value function" icon and select C-value function Calculation method: M4₁ Percentile



The C-value function uses the Percentile method to calculate the green V line seen above. Locate where this line intersects the USL and the LSL, using the Index scale to the right. The minimum of these two results is the capability of the process. In this case, the results are approximately 1.8 and 1.2, therefore the capability is 1.2

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The C-value function can also be used to estimate what setting adjustment to make in order to reach a required capability.

For example, if the requirement is a minimum capability of 1.33, the graphic below shows that the process is just below the requirement with a capability of 1.22. To estimate the adjustment needed, imagine a line parallel to the interceptor at the 1.33 index and extended to the value axis. The difference between this point and the process average is the minimum setting adjustment, assuming the process variation gets no larger.





From another perspective, the C-value function can be used to estimate what the tolerance would need to be increased to in order to reach a required capability index.

In this example, set the capability requirement at 1.67. Use the zoom function (horizontally) to zoom out beyond the USL to the intercept of the green V line with the 1.67 index.

x-3s



According to the graphic below, the tolerance would need to be moved from 99.87 to 99.885 in order to meet a capability requirement of 1.67.

⊼+3s

^b Turning on the 5th quartile will achieve the same results as using the zoom function, in this case.



Turn off the C-value function by clicking on the icon again and selecting Exit.

Navigating Charts

7. Use the arrow icons below to move forwards or backwards through the characteristics.





If several charts, such as a value chart and histogram, are both open be sure to click the "All windows" icon when scrolling through the characteristics so the charts move forwards/backwards together.



Multiple charts

8. Click the "Display several characteristics" icon to display multiple charts. Determine the number of charts to display by clicking the arrow on the "Number of characteristics" icon.



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The multiple graphics can also be displayed by number of rows (lines) and number of columns.

9. Click the "Number of characteristics" icon and select 2 lines, 4 columns. Scroll through the characteristics so the four Pin Diameters are on the first line and the four Pin Roundness' are on the second line.



10. On the Value chart, move to the Straightness characteristics and click the "overlay charts" icon. The resulting graphic is on the following page.





Value chart overlay (Straightness P1-P4)

11. Similar to the overlay is the actual value chart cascaded, seen below. This displays the four Pin Straightness' one after another.





The available options for Value charts and Histograms have now been discussed. Next take a look at how to edit Form sheets.



12. Open up Form sheet 3 from "Numerics." Click the "Special" icon and the "Edit mode on/off" icon. Right mouse click on a blank cell in the form sheet, and the options will appear as seen below; select "Change."

🧟 Form 3	B Edit n	node							
Part no.	=	12:	345		Pa	rt descr.	=	Cranks	haft
Char.No.	=	1	2		Ch	ar.Descr.	=	Posn Jn	rl P3
Dra	iwing Va	lues		Colle	ected Va	alues		Statist	tics
Tm	=	195.82					x	=	195.8148
LSL	=	195.77	×mh		=	195.80	⊼-3s	=	195.7896
USL	-	195.87	×max		-	195.83	⊼+ 3s	=	195.8400
т	-	0.10	R		-	0.03	6s	=	0.0503
			n _{⊲T>}	\	-	50	p _{eTe}	=	100.00000 %
	_/	New line	2		=	0	p₅usL	=	0.00000%
			- ed		- /	50	p⊲LSL	=	0.00000%
	7		ine		1-	0	n _{e#}	-	50
Mode]=		Normal Dis	tribution		
Сору				7					
	Galo	ulanon mennoe			=	M4 1 P	ercentile (0.1	35%-7-99	.865%)
				/					
Potentia	al perforn	nance index	~	PP	= 1.4	8 5 1.99 5 2	.51		1.66
0.71									
Critic	al capar	hility index	=	Ррк	= 1.3	0 5 1.78 5 2	.26		1.66
			The very						
			ine requ	ureme	nts wer	re met (P _P ,P	pk)		
	Calc	ulation method			=		Q-DA	S1	

In the 'Configuration" window, click the "Selection" button for the "Output field selection (listing)." From here select an output point, such as standard deviation, and click OK. The standard deviation will now appear on the form sheet.



Graphical Analysis

💼 Output field selection (listing)					
Dutput Points	Field No.	Sub-number	Long text	Short text 🛕	
 Average and Median values (1000-1139) Minimum and maximum values, location parameters (1200-1399) Variances, standard deviations, ranges (2000-2399) Classification, form parameter, estimator (2400-2398) Scewness, kurtosis, excess, quantity (3000-3399) 	2000	0	Variance	s ²	
	2010	0	Variance of Average	s ² (x)	
	2011	0	Variance of Median	s ² (x)	
 Regr.coeff., standard dev. (4000-4099) Quantiles (4100-4599) 	2012	0	Variance of Minimur	s ² (x _{min})	
- Imilia Guanties (4100-4339) - Imilia Test procedures (4600-4999) - Imilia Forces Capability (5000-5999) - Imilia Output Point (6000-6500) - Imilia Classifications (6501-6999)	2013	0	Variance of Maximu	s ² (x _{max})	
	2020	0	Variance of Varianc	s ² (s ²)	
	2021	0	Variance of Standar	s ² (s)	
- 📾 Output Point (7000-7999) - 📾 QCC parameter (8000-8999)	2023	0	Variance of Ranges	s²(R)	
	2030	0	Variance of Skewne	s ² (g ₁)	
En IIII Lassifications	2032	0	Variance of Kurtose	s ² (b ₂)	
value fields Graphic selection ✓ Text selection	2034	0	Variance of Excesse	² (3,)	
	2100	0	Standard dev.	s	
	2100	1	Standard dev.	-	
	2110	0	Standard dev. of Av	ঃ[ম]	
	<	1		>	
	Print	ок	Cancel	Help	

Available fields for the Form sheets

Part no.	=	123	845		Par	t descr.	:	=	Cranksh	aft
Char.No.	=	2	2		Ch	ar.Descr.		-	Posn Jnr	I P3
Dra	awing Value:	s		Colle	ected Va	lues			Statistic	s
Tm	= 19	95.82						x	=	195.8148
LSL	= 19	95.77	×mh		=	195.80		x-3s	=	195.7896
USL	= 19	95.87	×max		=	195.83		x+3s	=	195.8400
Т	= (0.10	R		=	0.03		6s	=	0.0503
			П _{<t></t>}		=	50		p _{⊲T>}	= '	100.00000 %
s	= 0.00	083885	D-USL		=	0		p⊳ust	=	0.00000%
		\checkmark	n tot		=	50		p⊲lsL	=	0.00000%
			n _{≂tst}		=	0		Πeff	=	50
	Model	distribution			=		1	Jormal Dist	tribution	
	Calcula	tion method			=	M4 ₁	Perc	entile (0.1	35%- ⊼- 99.8	365%)
Detect		:!				0 / 4 00 /	2.54			
Potent	iai periorniari	ce index	-	۳p	= 1.4	0.7.1.99.7.	2.51	ó	1	.66
0.4		. i= .l			- 40	0/470/				
Chu	саг сараршту	index	-	Грк	= 1.5	0 2 1.70 2.	2.20	ó	1	.66
			The rec	u ireme	nte war	e met (D	Dι			
			mere	quirente		e mer (Fp/	r pk/			
	Calcula	tion method			=			Q-DA	S1	

Click the Edit on/off icon again to exit the Edit mode.

Edited Form sheet with changes



The last graphic necessary to fulfill the four steps to system acceptance is the Quality Control Chart.

12. Under the "QCC" pull down menu, select "Display analysis QCC."



The default setting shows an x_{bar} and s chart for the average and standard deviation. This can be changed to an x_{bar} and R chart by going to the QCC – "Calculate analysis QCC." Under the variation charts folder, select "R chart (exact calculation)."



QCC Summary Window Display analysis QCCF8 Display SPC QCC Display saved QCC Calculate analysis QCC

Calculate analysis QCC Calculate SPC QCC



The Q-DAS Inc. suggested screen setup is seen below. It follows the Four Steps to System Acceptance:

- 1) In Tolerance
- 2) In Control
- 3) Appropriate Distribution Model
- 4) Passing Capability Indices



To save this screen setup as the default setting, go to the "Window" pull down menu and select "List." Click the Save button.

🙎 Windo	ow List 🛛 🔀					
cons. no.	Window					
1	/alue chart Individuals					
2	Display analysis QCC					
3	Histogram Individuals					
4	Form 3					
·						
ОК	Cancel Save Help					

Highlights:

Objective:

To complete the Worked Examples for the Process Box Plot Capability Module the summary graphics need to be ☑ C Values chart discussed. These graphics are particularly useful for parts with multiple characteristics and allow for an overview display of information on a single graphic. The user should now feel comfortable navigating throughout I Defects/No. of gs-STAT Process capability Module.

Background Information:

Example test files have been created for the user in order to best demonstrate specific graphics under the Summary category. These example files can be found in one of two places; either the Q-DAS installation directory - Examples folder or the Q-DAS installation directory - Tests folder.

☑ Characteristic Statistics

non-conforming units



Task:

Use the following files to view the different options available for each specified Summary graphic:

Nonconforming.dfq	Box Plot Defects/No.non-conforming units
Test_all.dfq	C Values chart Characteristic Statistics Standard Reports



Procedure:

Module Individuals Values Sample Analysis Process Capability Analysis Measurement System Analysis Reliability Analysis 1. In the Module Process Capability Analysis using the file Nonconforming.dfq (Q-DAS\QSSTAT_ME\Examples), open a **Box Plot** from the Summary pull down menu.









The Box Plot is shown with a Normalized tolerance for all characteristics. It portrays a good overall picture of the range and location of the data with respect to the tolerance.



2. Under Summary, open the **Defects/no. of nonconforming units** graphic.

> The scale on the left side shows the % of errors from the total. For example: Char 1, 4/150 * 100 = 2.7



The numbers in the bubbles on top of the columns show the actual number of values that are defective or outside specification. These can be turned on by clicking the Special icon and the "No. of error on/off" icon.



Looking at the value chart for Char 1 shows that there are four values outside specification. Therefore on the Defects/ no. of non-conforming units graphic, there is a four above the column.



Another option is to sort the characteristics from most defects to least defects or vice-versa. To do this, click the "Sort" icon under Special.



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This example data (nonconforming.dfq) contains a mix of measurements from multiple machine, gages, cavities and operators. It may be useful to separate the data in this graphic by cavities, for example.

Under the Special icon, select the "Separate" icon and separate the characteristics by cavities, which is "Group numbers" according to the default catalog.



The Total characteristics column in the back row is difficult to see once the data has been separated. It is helpful to rotate the graphic and view it from above. Click the "Change display" icon, then click the "3-D display" icon.

Change display







In the 3D settings window, check the Draw immediately box. This will give you a live display of the rotational changes being made. Increase the first two numbers in order to get a view from the top of the graphic such that all the rows are visible.



To view the value chart for a specific characteristic, select the characteristic on the Defects chart, then drag-anddrop from the Defects chart to the Value chart. This will update the value chart to that characteristic.





3. Using Test_all.dfq (Q-DAS\QSSTAT_ME\TESTS), open the **C values** chart.

The back row is the Cp or Pp value, and the front row is the Cpk or Ppk value.

The Cp or Pp abbreviation depends on your company's configuration of evaluation.

The solid horizontal red line is the required capability index for C_p/C_{pk} . The columns will then be green, yellow or red depending on whether they are above the requirement, borderline, or below the requirement, respectively.

The drag-and-drop feature used to select a characteristic and move the other graphics to that characteristic also works for the C value chart. See the explanation under the Defects/no. of non-conforming graphic information.

4. Open the **Characteristic Statistics 2** summary chart.

This report is similar to the C values chart but is displayed numerically instead of graphically. The green / red smiley face tells whether the required capability is being met.

Page 8 of 10

Summary Graphics



The / The significa	Char.No.	Char.Descr.	x	s	Index	Index	
that the	1	Test 1	20.00453	0.012554	T _p = 0.80	Т _{рк} = 0.71	•
characteristic is UNSTABLE.	2	Test 2	14.067923	0.0012418	P _p = 2.01	P _{pk} = 1.90	•
	3	Test 3	130.0392	0.032599	C _p = 1.79	С _{рк} = 1.42	•
Characteristic #	4	Test 4	0.50	0.36074	P _p = [915	P _{pk} = 1.93	[10]
4, 6, 7: the Cp or Pp	5	Test 5	718	61.0306	P _p = 1.07	P _{pk} = 0.82	
is not calculated because they are	6	Test 6	0.0253	0.013517	C _p = [915	C _{pk} = 1.51	$\overline{\mathbf{O}}$
unilateral tolerance features.	7	Test 7	0.0083	0.0046737	C _p = [915	C _{pk} = 1.67	$\overline{\mathbf{O}}$
	8	Test 8	30.00668	0.039701	C _p = 1.56	C _{pk} = 1.47	$\overline{\mathbf{O}}$
	9	Test 9	19.9973	0.063738	C _p = 1.87	C _{pk} = 1.68	$\overline{\mathbf{O}}$
	10	Test 10	64.916	1.10943	P _p = 1.50	P _{pk} = 1.48	
	11	Test 11	4.49	0.50805	P _p = 1.64	P _{pk} = 1.62	
	12	Test 12	26.4991	0.12480	T _p = 0.85	T _{pk} = 0.85	
	13	Test 13	28.54925	0.049194	C _p = 2.03	C _{pk} = 1.70	

Right mouse click on one of the Index columns to sort the characteristics by ascending / descending capability.

Char.No.	Char.Descr.	x	s	
13	Test 13	28.54925	0.049194	$C_{p} = 2I \downarrow \text{ sort descending}$
2	Test 2	14.067923	0.0012418	$P_{p} = 201 \qquad P_{pk} = 1.90 \qquad \bigcirc$
9	Test 9	19.9973	0.063738	C _p = 1.87 C _{pk} = 1.68
3	Test 3	130.0392	0.032599	C _p = 1.79 C _{pk} = 1.42
11	Test 11	4.49	0.50805	P _p = 1.64 P _{pk} = 1.62
8	Test 8	30.00668	0.039701	C _p = 1.56 C _{pk} = 1.47
10	Test 10	64.916	1.10943	P _p = 1.50 P _{pk} = 1.48

This chart can be edited in the same fashion as the Form sheet. Under the special icon, switch the Edit mode to on. New fields or columns can be added from there to customize according to your needs.



Summary Graphics

5. The software comes with a default set of **Standard Reports**. These reports can be found under the File pull down menu, either "Report preview" or "Print report." Choose the PC-01 report from the selection.

C:\Q-DAS\QSSTAT_ME\REPORTS				-
Name	Size	Туре	Modified	Attributes 🛃
🗐 4 Merkmale	7KB	DEF File	4/25/2002 11:3	
🗒 FarbigeObjekte	1KB	DEF File	4/25/2002 11:3	
🗒 Gruppierunggeom.Objekte	1KB	DEF File	4/25/2002 11:3	
🗒 LinienundLogischeVerknüpfun	1KB	DEF File	4/25/2002 11:3	
🗒 LogischeVerknüpfungen	1KB	DEF File	4/25/2002 11:3	
🗒 PC-01QCC,H,PP,FS(3)-QRK,H	26KB	DEF File	6/10/2002 10:1	
PC-02QCC,FS(3)-QRK,KW(3)	25KB	DEF File	6/10/2002 10:1	
PC-03H,PP,FS(1)-H,WN,KW(3)	23KB	DEF File	6/10/2002 10:1	
🗒 PC-04Results-Auswertungserg.	22KB	DEF File	6/10/2002 10:1	
🗒 PC-05Indiv.Values-Einzelwerte	21KB	DEF File	6/10/2002 10:2	
🗐 PC-06Indiv.valuesall-EW-kom	16KB	DEF File	6/10/2002 10:3	
🗒 PC-07BoxPlot,C-Value-Boxplot	10KB	DEF File	4/25/2002 3:00:	
🗒 PC-08Char.Statistics-Übersicht	8KB	DEF File	6/10/2002 11:1	
🗒 PC-09SummaryChar.IndivÜb	14KB	DEF File	6/10/2002 11:1	
PC-10TestProc.SG-Testverf.SP	8KB	DEF File	4/25/2002 2:51:	
🗒 PC-11PartsProtocol-Teileproto	15KB	DEF File	6/10/2002 11:1	14
	0// 0	NFF F1	1 105 10000 0.05	

File Edit Module Individuals File new Open... Part selection Read from data base Merge files Change / Add Save Save as... Save to database Save graphic as metafile Save graphic as bitmap Save graphic as JPG file Print current window Printer Setup Form designer Report preview Print report Exit

After highlighting the chosen report, check the box for "current characteristic only." If this is not checked, qs-STAT will print the chosen report for all active characteristics in the file.

PC-01 is a one page report including a Quality Control Chart (QCC), Histogram (H), Probability Plot (PP), and Form Sheet 3 (FS3). This report can be seen on the following page.

Some of the other reports such as "PC08 Char. Statistics" are summary reports that give details for all characteristics on one page.

Additional reports can be created by the user with the help of the Form Designer.





PC-01 QCC,H,PP,FS(3)



Objective:

The goal of this task is to demonstrate the recording data Ø Parts, interface and graphical features of the Measurement Characteristics. System Analysis Module (MSA). Three common gage studies will be outlined with a demonstration of how to configure gs-STAT for each. Typical requirements and graphics used in determining the capability of a measurement system will be discussed.

Background Information:

gs-STAT MSA module has been designed to comply with related company standard and other industry specifications for measurement system acceptance studies. The following three gage studies are the most common and will be discussed at length: Type 1, Type 2, and Type 3 Study. Note that additional gage studies have been incorporated into gs-STAT but will not be discussed at this time. Refer to your company's specifications for further details.

Highlights:

Values Masks

☑ Data Handling

☑ Type 1, 2, 3 Study

Value charts – **Deviations / Variations**

☑ Cg / Cgk





Type 1 Study -

Accuracy, Repeatability & Short Term Stability Typically: 1 Part (known value), 50 Trials



Accuracy is the difference between the average of the measured values and the true value of the master.



Repeatability checks whether a gage can read the same value over and over again.





Stability measures the change in the average over time and for this reason is typically used in production phase.

Type 2 Study – Repeatability & Reproducibility (R&R) Typically: 10 Parts, 3 Operators, 3 Trials



Reproducibility is a measure of the overall variation with respect to the overall average.

Reproducibility checks whether multiple operators can reproduce the same gaged results as one another.

Type 3 Study – Repeatability (special case of a Type 2, for a gage with NO Operator Influence) Typically: 25 Parts, 2 Trials

Version: 1

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Task:

Using the feature Hole #301 Diameter from the part sketch above, create a file in MSA module for a Type 1 study and view the results.

As a separate task, create a file for a Type 2 Study of the same feature and view these results.

The descriptions, tolerances and measured values for both the Type 1 study and Type 2 study are as follows:

Part No.	54321
Part Descr.	Op. 20 Block
Char. No.	H301D
Char. Descr.	Hole 301 Diameter
Nominal	
USL	14.400
LSL	14.150
Units	mm



Additional Information:

Type 1 Study					
Resolution	0.001				
Actual value	14.275				

Block	Hole 301 Diameter
1	12.270
2	14.284
3	14.293
4	14.284
5	14.269
6	14.281
7	14.272
8	14.280
9	14.261
10	14.282
11	14.283
12	14.270
13	14.262
14	14.269
15	14.273
16	14.267
17	14.272
18	14.262
19	14.272
20	14.276

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Additional Information:

Type 2 Study				
Resolution	0.001			
# parts	5			
# operators	2			
# measurements (trials)	3			

	<u>(</u>	Operator 1 Operator			2	
Block	Meas. 1	Meas. 2	Meas. 3	Meas. 1	Meas. 2	Meas. 3
1	14.263	14.273	14.269	14.285	14.278	14.281
2	14.278	14.244	14.292	14.28	14.276	14.275
3	14.269	14.242	14.296	14.249	14.267	14.278
4	14.252	14.276	14.261	14.254	14.269	14.284
5	14.272	14.25	14.241	14.258	14.265	14.258

Procedure:

Module Individuals Values N Sample Analysis Process Capability Analysis Measurement System Analysis Reliability Analysis 1. Switch to the Measurement System Analysis Module, then select "File new." Create one new characteristic for a Type 1 Study.





2. Input the appropriate Part / Characteristic information.

Q Characteristic	s				
Characteristic					
Number H301D	Description Hole 301 Diameter	1	Nominal Value	Unit mm	Decimal Pl.
Recording Type manual	Events Catalog		Up.Spec.Lim. 14.400	Up.Allowance	Up.nat.bound.
			Lo.Spec.Lim. 14.150	Lo.Allowance	Low.nat.bound.
Gage					
Number	Description		Up.Plaus.Lim.	Lo.Plaus.Lim.	Process Var.
Group	Test Location		Master	-	\frown
Resolution			Number	Description	Actual value
Remark			Evaluation Type Type-1 Study		
				No. of Ref. Meas.	•

For a Type 1 Study, the Resolution and the Actual value must be recorded in order to calculate the capability of the measurement system.

Resolution is the smallest scale graduation or digital unit of the measurement device.

Typical requirement for the resolution is:

Resolution / Tolerance * 100% < 5%

(resolution is less than five percent of the total tolerance)

Actual value is the known value of the master part that is being measured repeatedly.

- 3. In the Value Mask, type in the measured values for the 20 blocks.
- 4. Click the "Execute evaluation" icon to calculate the results for this measurement system. Close down the three masks and open a Value chart Individuals.





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On the value chart, the Upper and Lower specification limits are turned off. This is because a Type 1 Study refers to the master value $(x_m) \pm 10\%$ Tolerance.



Individuals	Values
Value chart	F2
Value plot	F3
Histogram	F4
Probability p	lotF5
lin. regressi	on 🕨

5. The Value Plot (Individuals pull down menu) can be used to check the gage resolution. Each green arrow is a measured value.



A typical requirement for gage resolution is less than 2% of Tolerance is acceptable.

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6. To check the Stability of the measuring system, open a Quality Control Chart.



The chart will show both the moving average and moving standard deviation. This can be seen at the top or bottom of the graphic, $n=1\rightarrow 2$. For stability we are only interested in the moving average chart.

7. Turn off the moving standard deviation chart using the "Special" icon and click the "Display location and variation chart" icon. Then select the icon that only shows X_{bar}.





Part no.	=	:	54321	Pa	rt descr.	= (Dp. 20 Bl	ock	
Char.No.	=	ł	H301 D	Ch	ar.Descr.	= Hole 301 Diameter			
	Drawing Values			Collected Values			Statistics		
×m	-	14.27500				⊼g	=	14.27410	
LSL	=	14.150	×mlag	=	14.261	sg	=	0.0085711	
USL	-	14.400	×maxg	=	14.293			0.000000	
Т	=	0.250	Rg	=	0.032	$ AC = X_g - X_m $	-	0.000900	
			n _{tot}	=	20	n _{e#}	=	20	
	0.2xT								
	$C_g = \frac{1}{4 \times s_g}$		=	1.46	0	1.3	3		
	0.1×	$(T - \overline{X}_{g} - X_{m})$							
	C _{gk} =	2xsq	=	1.41	Ó	1.3	3		
								1	
	%RES		=	0.40%	0	5			
	Measurement system capable (RES,Cg,Cgk)								
		Q-DAS (L	ettraden V2.1) ne	ue Messsy	steme (ANOV)	A): Vertahren 1			

8. Open Form 1 to view the capability indices C_g / C_{gk} .

Form 1 shows the calculations for C_g / C_{gk} as well as the requirements which are set at 1.33 for this configuration of evaluation. The green bars and smiley face show that the measurement system is capable based on C_g , C_{gk} and resolution.

If these calculations or requirements do not meet your company's standards, you can make changes in the "Configuration of Evaluation."





One of the standard reports for a Type 1 Study can be seen below. It contains the Value chart Individuals, the raw data and the Form sheet. This can be found under File – Print report.



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9. For the second part of the task, create a new file for a Type 2 study of the same feature. Fill in the appropriate Parts, Characteristics, and Values Mask information.

Characteristics				
Characteristic				
Number H301D	Description Hole 301 Diameter	Nominal Value	Unit	Decimal PI.
Recording Type manual	Events Catalog	Up.Spec.Lim. 14.400	Up.Allowance	Up.nat.bound.
		Lo.Spec.Lim. 14.150	Lo.Allowance	Low.nat.bound.
Gage				
Number	Description	Up.Plaus.Lim.	Lo.Plaus.Lim.	Process Var.
Group	Test Location	1-		
Resolution 0.001				
Paradi		Evaluation Type	No.Meas.	Number of Operators
			_	
		Number of Parts	No. of Ref. Meas.	
		l 🔽 🔽	L T	

Q \	/alue						×
Part				Characteristic			
Number Description 54321 Op. 20 Block			Number Description H301D Hole 301 D		liameter		
	Operator 1			Operator 2			
	Measurement 1	Measurement 2	Measurement 3	Measurement 1	Measurement 2	Measurement 3	
1	14.263	14.273	14.269	14.285	14.278	14.281	
2	14.278	14.244	14.292	14.280	14.276	14.275	
3	14.269	14.242	14.296	14.249	14.267	14.278	
4	14.252	14.276	14.261	14.254	14.269	14.284	
5	14.272	14.250	14.241	14.258	14.265	14.258	
6							
7							
8							
9							-
						•	


- Page 13 of 15
- 10. After completing all the recording data setup, click the "Execute evaluation" icon to calculate the results for this measurement system. Close down the three masks and open a Value chart Individuals.



The Value chart shows the measured values per operator (A & B), per part (1-5), and per trial. There are three X's at value 1A for the three trials.

11. From the "Values" pull down menu open the Value chart - Deviations and the Value chart – Variation.



Value chart Deviations

Values Numerics

Value chart 🕨

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QCC

Averages

Deviations

Variations



The Deviations and Variations charts both compare the operator variation to overall part average.

- On the Deviations chart the dashed, colored lines are the individual trials per operator and the two solid red lines in the middle are the individual operator part averages.
- The Variations chart is displayed so that the three trials of part 1, operator A are directly compared to the three trials of part 1, operator B.



Value chart Variations

12. For a Type 2 Study, the criteria for a capable measurement system is based on the %R&R. A typical requirement is that the %R&R is less than 20%. This is best displayed on Form 3.

Part no.	= 54321		21	Part descr		=	Op. 20 Block	
Char.No.	= H30		1D	Char.Desc	r.	-	Hole 301 Diameter	
	Variance		Standard dev.					
Repeatability	0.000196		0.0140	EV =	0.0564 ≤ 0.0722	≤0.100	%EV = 28.87%	
Reproducibility	0.00000786		0.000887	AV =	0.000 ≦ 0.00457	≤ 0.606	%AV = 1.83%	
Interaction	0.000		0.000	IA =	0.000		%IA = 0.00% <	
Repeatability & Reproducibi	0.000197		0.0140	R&R =	0.0702 ≤ 0.0723	≤ 0.616	%R&R = 28.92%	
Tolerance	Tolerance = T		= 0.250	Confidence interval =			1-α =	95.000%
Resolution		-	%RES	= 1	0.40%	0	5	
Repeatability & Reproducibility =		%R&R	= 2	28.92%	0	20		
Overall evaluation =		=	The requirements were not met (RES, <u>R&R</u>)					
Q-DAS (Leitfaden V2.1) neue Messsysteme (ANOVA): Verfahren 2								



A standard report for a Type 2 Study is seen below. This report contains the Value chart Deviations, the raw data and the Form sheet.

