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Partners in Continuous Improvement

Recalculating control limits: From tedious time consuming task to opportunity for improvement

A recommendation for new indices

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Recalculating control limits: From tedious time consuming task to opportunity for improvement

When applying control charts it is common practice to establish the control limits based on the process capability study and then use fix limits on the chart during production.
This method is also frequently applied in SPC software programs. The advantage of using fixed limits is that limits can be calculated over a time period where the production was running stable, then that period can be used as a benchmark for future production.

However, in real life there are always changes in the process, which result in the fixed control limits becoming invalid.
If the process improves, fixed limits remain too wide and control charts will not properly register signals for out of control (thereby accepting when false - beta error is induced). As a result, process improvement and opportunities to reduce sampling frequency are overlooked.

If the process becomes worse due to machine wear, changes in material etc. the control limits are too narrow. This results in the SPC system reporting control chart points out of control that should not be, if the control limits were naturally calculated (rejecting true – alpha error is increased). This will cause frustration and reflect poorly on SPC methodology in the plant, because our SPC tools are improperly signalling problems, thereby causing operators and staff to waste time addressing conditions, which are simply part of common process variation and therefore the responsibility of management.

Control limits can be managed to prioritise the efforts of operators and help allocate limited resources on the shop floor. This is done by setting control limits at 3 sigma for critical characteristics and perhaps 4 or 5 sigma for less critical characteristics or characteristics with a high Ppk value.

There are good reasons to set control limits at particular values, but they should be re-evaluated regularly depending on production volume, but at least once every 3 months to minimize both alpha and beta error in control chart analysis. The number of control charts in use at most companies causes this regular control limit re-evaluation to be a daunting task. However, it can be automated very easily and it can be automated in a way that it will even help to identify which control charts need their control limits recalculated.

New indices: Pl and Plk

For this job we like to introduce 2 new indices for the performance of the limits: Pl and Plk.

Pl = (Stored UCL - Stored LCL) / (Calculated UCL - Calculated LCL)

Plk = the minimum of:
(Stored UCL - calculated grand average) / 0.5 * (Calculated UCL - Calculated LCL) and
(calculated grand average - Stored LCL) / 0.5 * (Calculated UCL - Calculated LCL)

If the fixed control limits are the same as the calculated limits the Pl and Plk indices are equal to 1. An index higher than 1 indicates that the process has improved and the limits are too wide. An index smaller than 1 indicates the process has become worse and the limits are too narrow. In the report which can be created from the database you should be able to set alarms if an index is outside a specific range. We recommend that the Pl and Plk index should never be less than 1. In that case, control limits can easily generate out of control signals, which may not be present (alpha error).
The report also allows you to set upper Pl and Plk limits or alarms for groups of characteristics. For example, critical characteristics with a Ppk value not exceeding 1.67 the control limits should be at 3 sigma and the Pl and Plk indices should not exceed 1.2. For less critical characteristics or characteristics with a Ppk value which exceeds 3 the Pl and Plk indices may be higher than 1.2.
By running the report for groups of characteristics the user can quickly identify if “frozen” control limits need to be adjusted.

The report

When creating the report there are additional considerations. The Pl and Plk indices should not be calculated when less than 25 subgroups exist. It is also useful to know the number subgroups exceeding calculated limits since these can significantly affect control limit calculation and invalidate even calculated control limit application.

An example of a report is shown below.

Calculated and Stored Control Limits Print Date 09/30/02

Line: Print Groups CRITICAL Selection: 125 Subgroups Xbar limits use Xbar Moving Range

Part Characteristic	LSL	USL	Nr	OOS	Avg	Pp	PPK	Date	Owner	Stored Limits LCL	Stored Limits UCL	Calculated Limits LCL	Calculated Limits UCL	OOC	Pl	Plk	Alm
DATALYZER																	
CHAR 1	0.00	1.00	125	0	0.5130	0.57	0.55	01/01/02	MS	0.25	0.80	0.121	0.905	0	0.70	0.67	1 2 4 5
					0.6768					0	1.21	0.000	1.431	0	0.85	0.75	

Total characteristics reviewed: 1 Characteristics with alarms: 100.0%

Alarm 1: Pl avg > 1.2 or < 1 Alarm 2: Plk avg > 1.2 or < 1 Alarm 3: CL Date > 25 months ago

Alarm 4: Pl mg > 1.2 or < 1 Alarm 5: Plk mg > 1.2 or < 1 Pl and Plk calculated after 29 Subgroups

All necessary information to analyse whether control limits need to be adjusted can be found in the report. For this characteristic all alarms are present.
By implementing such a report the tedious task of analysing control charts for validity of the limits is eliminated and the resulting report can be used as a tool to keep the process of continuous improvement on track.

For more information: www.datalyzer.com