Capability Control Chart Design Statlet

statgraphics 18® centurion

Revised: 10/10/2017

Summary

This Statlet assists analysts in determining how large samples should be when constructing capability control charts. *Capability control charts* monitor processes which have been shown to be stable and capable of producing results that yield small numbers of nonconformities.

Capability control charts may be constructed for::

1. The short-term capability index C_p.
2. The long-term capability index P_p.
3. The short-term capability index C_{pk}.
4. The long-term capability index P_{pk}.
5. The proportion of nonconforming items.
6. The rate of nonconformities.

For more information on such charts, refer to the documents titled *Capability Control Charts for Variables* and *Capability Control Charts for Attributes.*

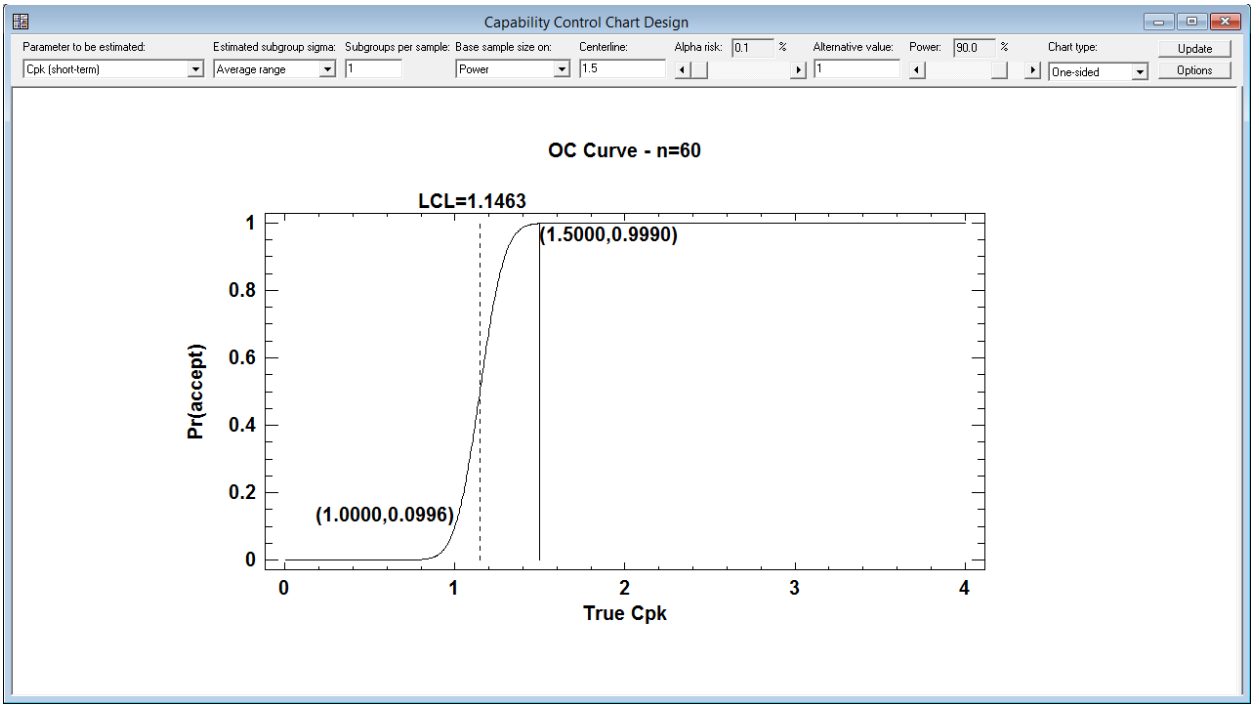
Sample StatFolio: *capchartdesign.sgp*

Sample Data

None.

Analysis Window

To execute the procedure, select *Statlets – Sampling – Capability Control Chart Design* from the Statgraphics menu. This will display an analysis window similar to that shown below:



It is assumed that a total of *n* observations will be collected from the process being monitored at each time period in order to create the capability control chart. The *n* observations may be collected by obtaining *n* individual samples, each of size 1, or *m* subgroups may be collected which when combined yield *n* observations. The purpose of the procedure is to determine a reasonable value for *n*.

The toolbar contains a number of controls that allow you to specify desired options:

- **Parameter to be estimated**: the parameter to be plotted on the capability control chart. The list includes capability indices, the proportion of nonconforming items, and the rate of nonconformities.

- **Estimated subgroup sigma**: for short-term capability indices such as C_p and C_{pk}, the method used to estimate the short-term within-subgroup standard deviation. This field is ignored if the "Subgroups per sample" field is set to 1, which indicates that data will be collected as individuals rather than in subgroups.

- **Subgroups per sample:** the number of subgroups collected at each time period. If the data will be collected as individuals, set this field to "1".

- **Base sample size on**: specifies the goal from among the following choices:

    1. **Power**: indicates that the sample size should be determined in order to control the power of the chart. "Power" is defined as the probability that a plotted value will be outside of the control limits when the parameter being charted actually equals the "Alternative value".

    2. **Average run length**: indicates that the sample size should be determined in order to control the average number of samples that need to be collected before a plotted value falls outside of the control limits when the parameter being charted suddenly shifts to the "Alternative value".

- **Centerline:** the location of the centerline of the capability control chart. This value is considered to be the standard value where the process is normally assumed to operate.

- **Alpha risk**: the probability that a plotted value will fall outside of the control limits when the actual value of the parameter being plotted equals the value specified by the centerline. A standard "3-sigma" control chart has an alpha risk equal to 0.27% if two-sided and 0.135% if one-sided.

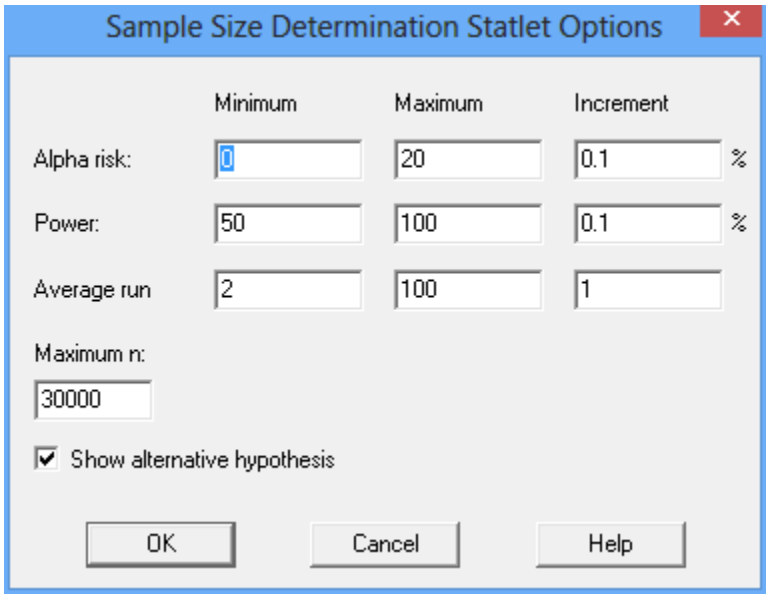
- **Alternative value:** the value of the parameter being plotted at which the power or average run length will be controlled.

- **Power:** if *Base sample size on* is set to "Power", the probability that a plotted value will be outside of the control limits when the parameter being charted actually equals the "Alternative value".

- **ARL:** if *Base sample size on* is set to "Average run length", the average number of samples that will need to be collected before a plotted value falls outside of the control limits when the parameter being charted suddenly shifts to the "Alternative value".

- **Chart type**: whether the chart has both upper and lower control limits or only one limit.

- **Options**: displays a dialog box with additional options:



The *Options* dialog box is used to control the minimum value, maximum value, and increment of the Statlet scrollbars. It also specifies:

- **Maximum n:** the largest sample size considered. If the specified conditions cannot be satisfied at that *n*, no solution is given.

- **Show alternative hypothesis:** whether or not the alert probability at the alternative hypothesis is displayed on the graph.

Example

The window displayed earlier shows the solution to the following problem:

> "Find the sample size *n* required to create a capability control chart for C_{pk} with only a lower control limit (LCL). Assume that the data will be collected as individuals and that the short-term sigma will be estimated using the average moving range. The expected value of C_{pk} = 1.5. At that value, we desire a false alarm probability of 0.1%. Collect enough data that there will be a 90% chance of getting an alert (a point below the lower control limit) if the actual C_{pk} falls to 1.0."

Output

The output of the Statlet shows several important results:

1. The title of the graph shows the **sample size *n*** required to meet the specified conditions. For the example, a sample of *n* = 60 observations is required.

2. The plotted **OC (Operating Characteristic) curve** shows the probability of getting a point at or above the LCL as a function of the true value of C_{pk}.

3. The calculated probability of getting an alert is displayed at the specified value of the alternative hypothesis. In the example, the probability of getting a point at or above the LCL when $C_{pk} = 1.0$ is approximately 9.96%.

Calculations

Information about the calculations performed may be found in the following PDF documents:

1. *Capability Control Charts for Variables*

2. *Capability Control Charts for Attributes*

The required sample size is determined by starting at $n = 3$ and increasing it until the specified conditions are met.