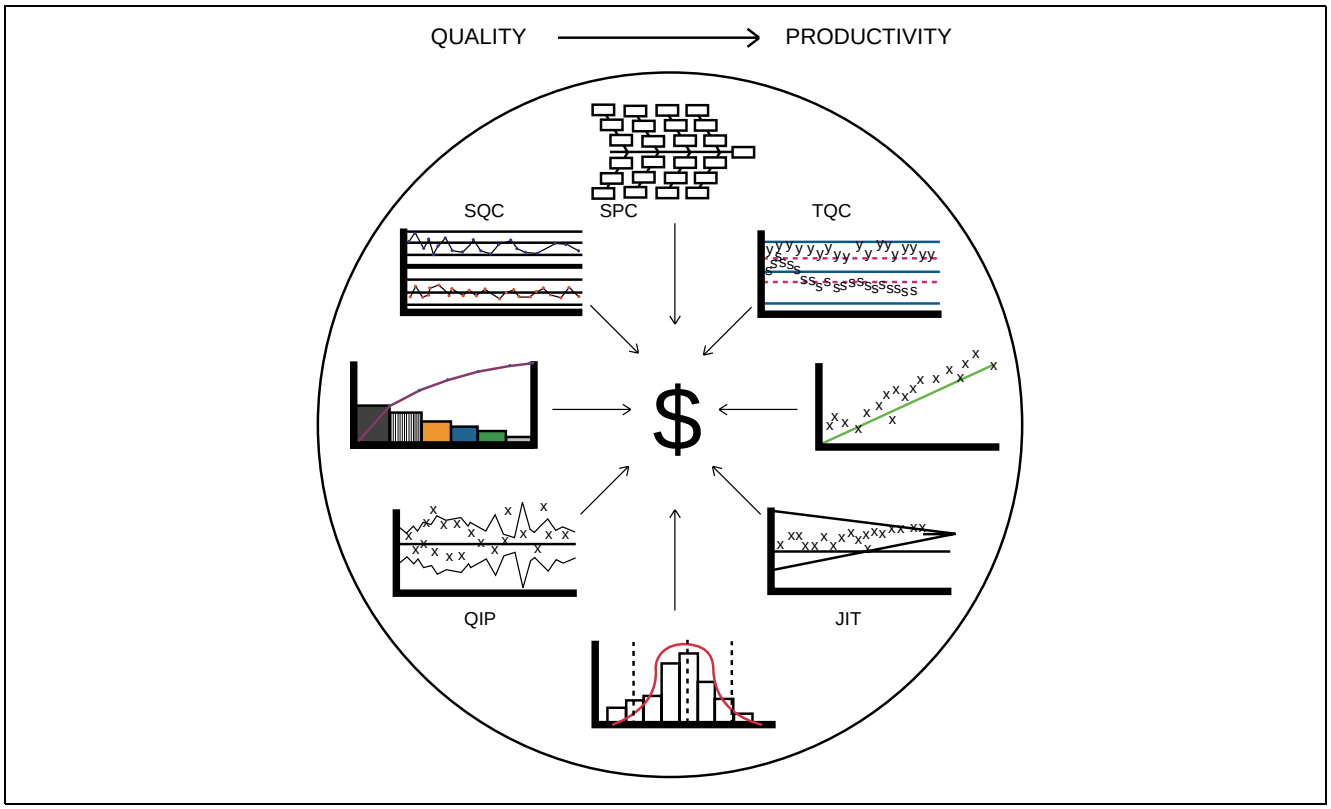
I/A Series® Software
FoxSPC.com Statistical Process Control



INTRODUCTION

FoxSPC.com provides on-line displays of charts and other Statistical Process Control (SPC) tools for process variables. With FoxSPC.com, you can configure different charts for each variable and test some charts against *Statistical Control Rules* to determine the *not in statistical control* state of a variable.

A significant feature of I/A Series FoxSPC.com is real-time monitoring. You can configure real-time monitoring for rule violations on certain chart types and can also receive alarm status notification on the monitored charts.

You can filter data for specific batch or product types, or filter out bad data. Cause and Effect Diagrams (CEDs) can be configured with charts and text for operator use or for diagnostic studies. These displays can also be linked to each other. Thus, you can create a multi-level hierarchy by drilling down to lower levels of detail, isolating problem causes and taking the appropriate corrective action.

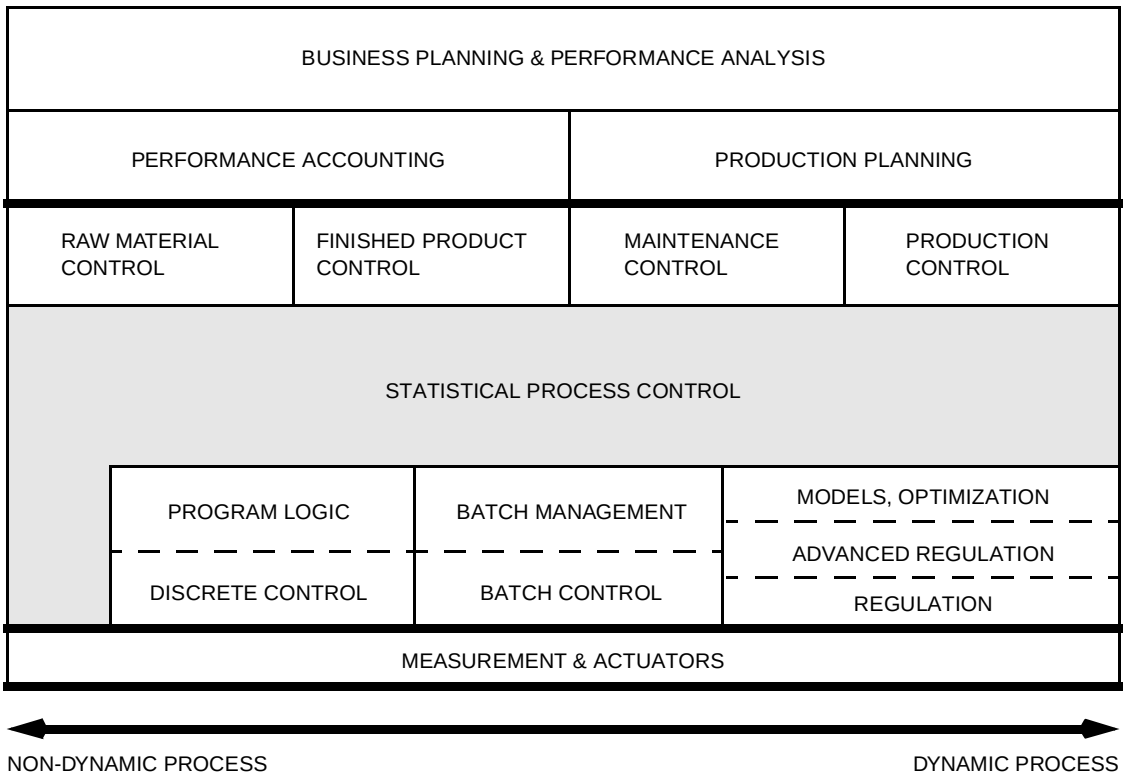


Figure 1. Relationship to Other Process Operations

Where FoxSPC.com Fits in Your Plant Operation

Figure 1 shows where FoxSPC.com fits in relation to other process plant operations or facility management functions, such as production planning, performance accounting , and statistical process control.

Consider the spectrum of processes from non-dynamic processes such as automobile manufacturing to processes like dynamic oil refining. FoxSPC.com applies directly to the measurements and actuators of the non-dynamic processes, while for dynamic processes it applies at the point where the variables have been made essentially steady state by traditional process control. In general, FoxSPC.com provides open loop advisory capability for the analysis of quality problems in a plant.

FoxSPC.com is applicable at steady state, where the variations in process and quality variables are predominantly random.

FoxSPC.com supports on-line, on-demand analysis capability of all process variables that are collected by distributed historians in an I/A Series system. This includes manually entered data and archive or playback (restored) data for all distributed historians.

Figure 2 is a functional overview diagram of FoxSPC.com.

Distributed historians in the I/A Series system collect and store in databases the value, date/time, and status of plant variables. These databases are referred to as real-time databases.

The real-time databases are always tied to the current time. When FoxSPC.com charts and other analysis tools are requested, they automatically access data from the current time backward to some time in the past. This allows the operator to take timely corrective action.

When requested for display and analysis, the FoxSPC.com charts and other tools access variables from the current time as far back as required by the subgroup size, type, and number (count). Once a chart is displayed, you can move both forward or backward in time by one subgroup or half of the chart and then redisplay the chart. You can also change the starting time of data access, either temporarily or permanently via on-line reconfiguration. Thus, you can readily move on-line through the whole history of a charted variable.

Multiple process variables on FoxSPC.com charts can be monitored in real time. When a key process variable begins to deviate from the preconfigured statistical control rules, an alarm is generated to alert plant operators. Charts configured for real-time monitoring are checked periodically regardless of whether they are currently being displayed.

FoxSPC.com uses the following four types of information:

- Quality Variables – Examples are viscosity, composition, density, melt index, and brightness. They are used in Xbar and Range, Xbar and Sigma, Individuals, CUSUM, and Cumulative Sum charts to monitor product quality.
- Causal Variables – Examples are flow, temperature, pressure, and feed composition. They are used in Xbar and Range, Xbar and Sigma, Individuals, CUSUM, and Cumulative Sum charts to monitor and determine the cause of poor product quality.
- Attributes – Examples are sample size and fraction and number of defective items, and unit size and number of defects and defects per unit. They are used in P, NP, C, and U charts to monitor end (final) product and overall process performance.
- Causal Relationships – These consist of text information. They are organized and displayed in CEDs.

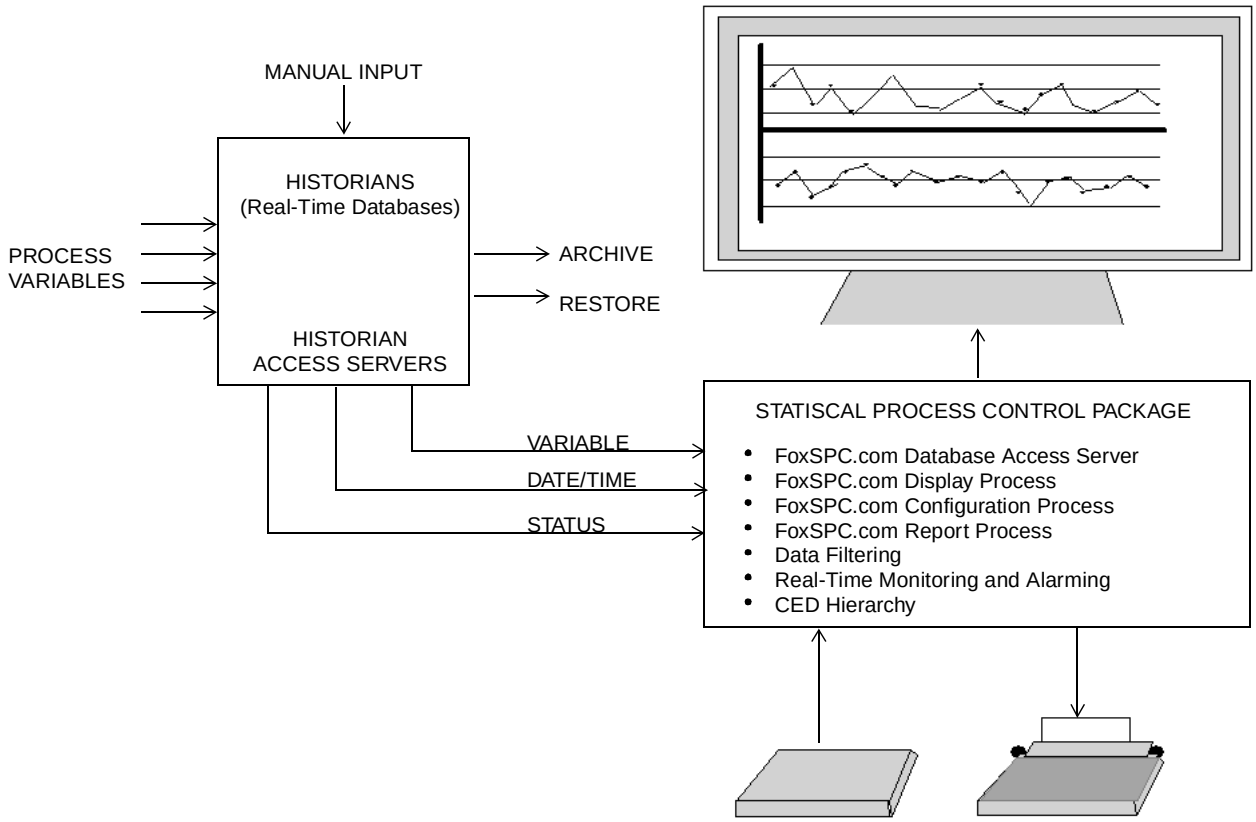


Figure 2. FoxSPC.com Functional Overview

FoxSPC.com TOOLS

FoxSPC.com charts and other analysis tools access data from real-time databases that consist of quality and causal variables, attribute variables, and causal relationships. Therefore, FoxSPC.com tools can be classified according to variable and analysis types as follows:

FoxSPC.com Tools for Quality and Causal Variables

Tools to analyze and monitor individual samples are:

- Individuals Histogram
- Individuals Chart
- Scatter Diagram for Auto-Correlation.

Tools to analyze and monitor subgrouped samples are:

- Xbar Histogram
- Xbar and Range Chart
- Xbar and Sigma Chart
- CUSUM Chart
- Cumulative Sum Chart.

FoxSPC.com Tools for Attribute Variables

Tools to monitor fraction and number defects are:

- P Chart
- NP Chart.

Tools to monitor defects and defects per unit are:

- C Chart
- U Chart.

FoxSPC.com Data Filtering

FoxSPC.com data filtering ignores bad or unwanted variable data in SPC calculations.

- Data filtering is controlled by up to four separate variables.
- SPC data can be filtered by product, batch or lot ID.
- Ignored data can be charted as yellow triangles or removed completely.

FoxSPC.com Tools for Cause and Effect Analysis

These tools are:

- Scatter Diagram for Cross-Correlation
- Pareto Diagram
- Cause and Effect Diagram.

PLANT ORGANIZATION USING CAUSE AND EFFECT DIAGRAMS

Figure 3 shows the Cause and Effect Diagram, which is also called the Fishbone diagram because of its structure. The CED is used to document and classify the relationships between effects and their causes. The head of the fish indicates a specific effect whereas the labels on the bones indicate the causes.

For distributed control and information systems supported by communication networks, the CED not only documents the effect and its related causes, but also serves as a dynamic information access mechanism. You achieve this by linking charts, text files, or other CEDs to each cause and effect box.

The ability to link cause and effect diagrams to other cause and effect diagrams lets you build up a hierarchy of cause and effect relationships that mirror the complexity of plant organizations. Each cause and effect box is an active screen area for accessing related charts and text. These boxes are selected by touchscreen, mouse, or trackball.

Multi-level CEDs

Hierarchical CEDs give the operator a diagnostic tool that mirrors the hierarchical organization of a complex, multi-process plant. The lowest level of CEDs might reflect the individual components of one process or machine. The next level might cover all the production processes for a single line or product. The top level might encompass the entire building or plant. When a problem arises, for example, a quality variable for a product is out of control, the operator can “drill down” to successively more detailed levels of CEDs until the cause is determined.

The text files provide information for the operator about a cause variable and its effect, and guidance for corrective action.

You can attach any of the FoxSPC.com charts and analysis tools that use the real-time databases to the cause and effect boxes.

In Figure 3, the effect box represents the effect, and cause boxes 1 through 24 represent the causes. Each box is labelled so it can be identified.

You can link as many as four charts, other CEDs and/or text files to the effect box and to each cause box.

If only one chart, CED, or text file is linked to a box, selecting the box displays the linked object. If more than one object is linked to a box, selecting the box displays a menu which lists the names of the linked charts, CEDs and text files that you can select for display.

You can also divide a typical plant or process into areas and units. Therefore, you can configure the CEDs for the plant, areas, and units.

OTHER FoxSPC.com FEATURES

Other main features of Foxboro's FoxSPC.com are:

- Three ways of forming subgroups for chart calculations:
  - Size – Divide a group of values into consecutive subgroups of size n
  - Size n, skip m – Choose n consecutive values for the subgroup, and then, skip m consecutive values
  - Moving the subgroups of size n.
- Up to 11 statistical control rules per chart to determine *out of statistical control* states in chart displays
- Chart points that violate one or more rules are displayed as oversized, red-colored symbols (which appear as grey dots in Figure 4 on page 6)
- Chart overlay that displays rule violations, chart calculations, and other parameters
- User-entered notes for a specific chart and time are available from chart displays and reports. See Figure 4.

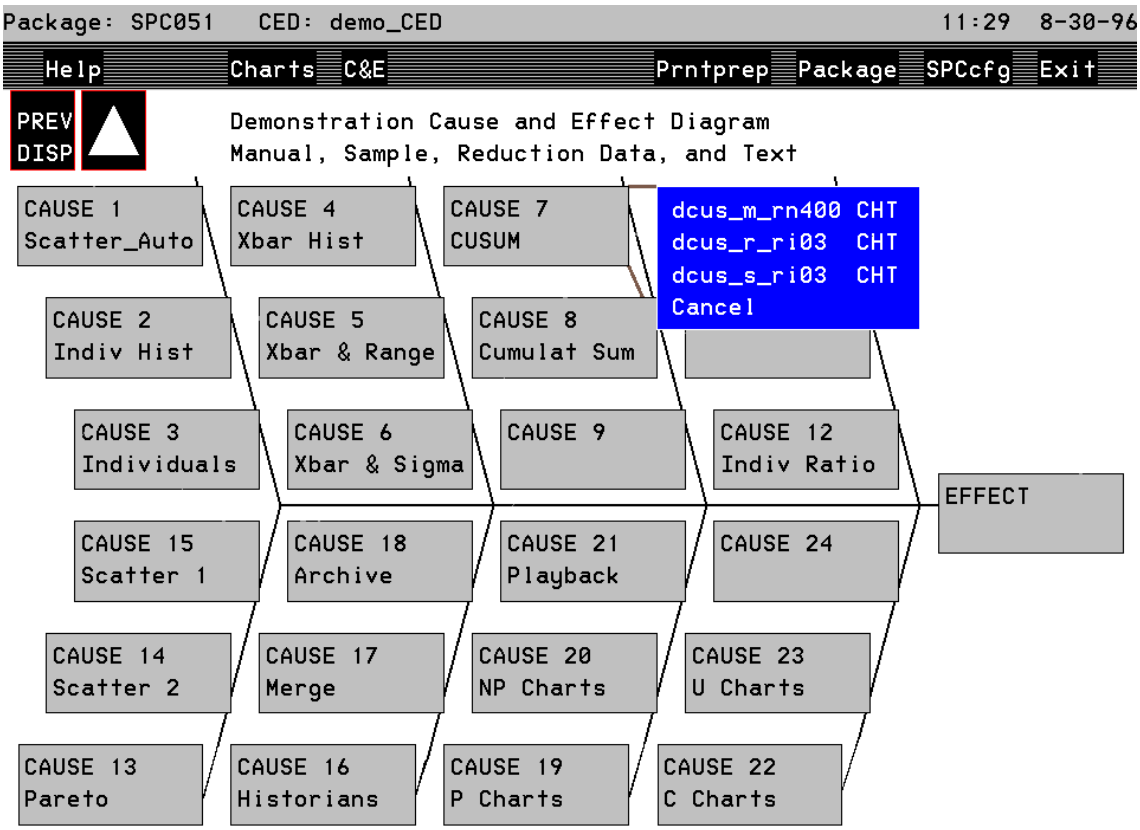


Figure 3. Cause and Effect Diagram

- Access to Historian data in basic sample and extended sample files, reduction groups, and user-entered data
- PC and Web clients
- Monitoring for rule violations and alarming.
- Data filtering
- Chart movement backward or forward in time throughout the database
- On-line reconfiguration of certain chart parameters on the chart display, either temporarily or permanently
- Mathematical transformations on collected variable samples
- Option to build charts for the ratio of two variables or for data sets formed by merging samples from several variables
- Official and/or calculated values for the mean and standard deviation to evaluate rules and compute limits
- Optional display of the target, upper, and lower specification limits on the chart
- Generation of screen images and reports containing charts, raw values, calculated values, and notes
- Configuration of charts and CED displays, with on-line configuration editing and reporting
- Individuals Histogram for determination of normality and calculation of process capability indices for individual samples
- Xbar Histogram for determination of normality and calculation of process capability indices for subgroup mean values
- Scatter diagram for cross-correlation of variables with optional time shift
- Scatter diagram for auto-correlation of a variable with selected time shift
- Pareto diagram that plots the number of occurrences of rejection and the percent contribution for up to 16 causes of rejection for a product.

To evaluate the rules and compute the control limits, you can use official or calculated values for the mean and/or standard deviation.

Official values are obtained for a variable by moving in time through the database, selecting a set of samples as the *standard set* to judge the future, and computing the required official values.

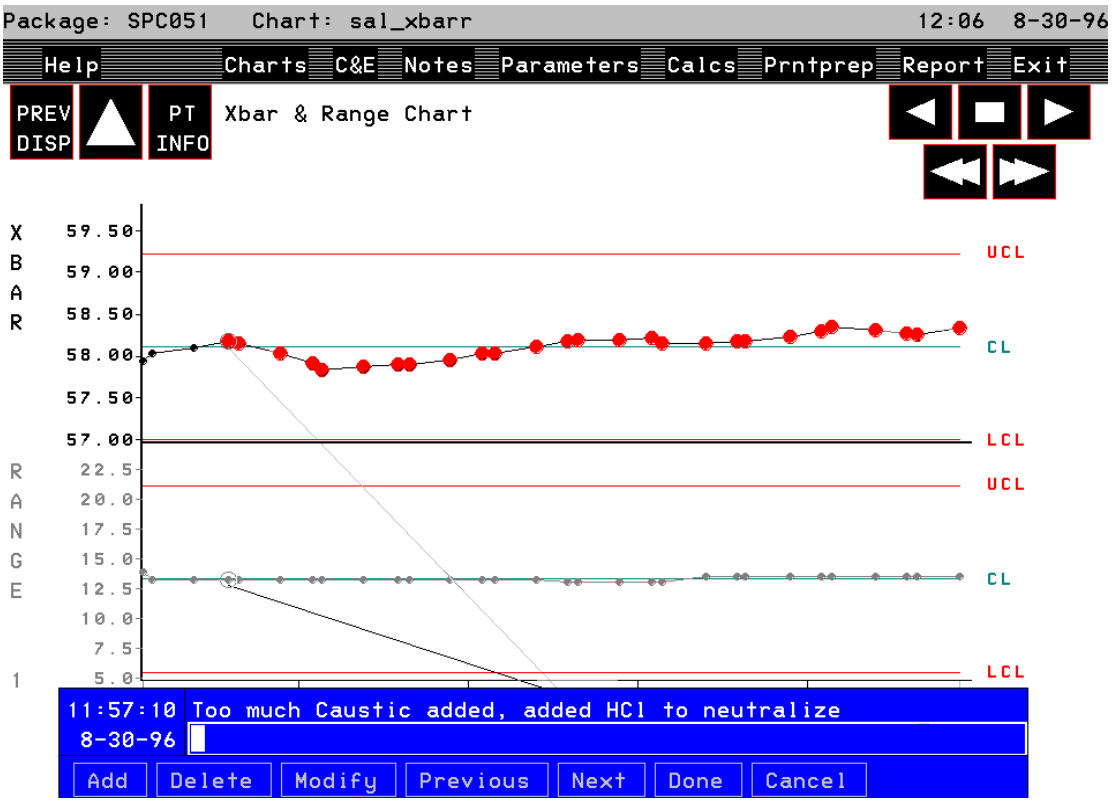


Figure 4. Xbar and Range Chart with Rule Violation and Note

Mathematical transformations are useful when the variable itself is not normally distributed, but a function of the variable is normally distributed. For example, a log-normal distribution is transformed to normal via the natural log function.

As an aid to the operator, FoxSPC.com chart displays perform up to 11 statistical-control-rule checks and inform the operator if the plotted data is *out of statistical control* as well as monitoring and alarming for up to three rule violations.

First, you select and observe the charts for a product quality variable and interpret them. Next, you use the CEDs to access variables that cause *out of statistical control* states. Then, you observe the charts for those variables and implement the necessary control actions.

Typical control actions consist of:

- Changing appropriate variable set points and/or targets
- Retuning the controllers, and modifying associated control functions
- Improving control of upstream units to minimize the introduction of systematic variation into the downstream process.

FoxSPC.com CHARTS AND TOOLS

FoxSPC.com provides 13 types of charts and tools:

- Individuals Chart
- Xbar and Range Chart
- Xbar and Sigma Chart
- Cumulative Sum Chart
- CUSUM Chart
- Individuals Histogram
- Xbar Histogram
- P Chart
- NP Chart
- C Chart
- U Chart
- Scatter Diagram
- Pareto Diagram

FoxSPC.com charts and tools define all information necessary to:

- Retrieve collected process data for ratioing, merging, transformation, and subgrouping
- Perform the statistical calculations appropriate to the chart type
- Plot and display the results
- Apply statistical control rules to the data to determine when the variable is *out of statistical control*
- Monitor and generate alarms for up to three rule violations.

The chart display presents the chart, as configured, and allows the operator or analyst to:

- Display chart help text
- Display chart parameters
- Change chart parameters, either temporarily or permanently
- Display the results of internal chart calculations
- Change screen background color to white for printing
- Print a standard chart report.

Optionally, you can display the target and upper and lower specification limits on the chart.

In the charts, the central line (mean) is labelled CL, when calculated from the data. When based on the official mean, it is labelled OCL.

In the charts, the upper and lower control limits are labelled UCL and LCL, when based on the calculated sigma. When based on the official sigma, they are labelled OUCL and OLCL.

Individuals Chart

Figure 5 shows the Individuals chart. It is a plot of a group of individual measurement values versus time or subgroup, together with their mean and the upper and lower control limits. The subgroup size is always **1** for this chart.

The software can calculate the mean and control limits from the actual data, or it can base them on *official values* of the mean and standard deviation (sigma).

When the chart is displayed, the software checks up to 11 preconfigured rules for violations and displays the results (rules violated by which subgroups).

The software monitors up to three of these rules, and generates an alarm when a violation occurs.

You can also display the target (TAR), upper specification limit (USL), and lower specification limit (LSL) on the chart, along with the calculated or official central line (mean) and calculated or official control limits.

You can apply any one of the variable transformations listed under *Functional Specifications* on page 26 to the values for this chart, except for merge.

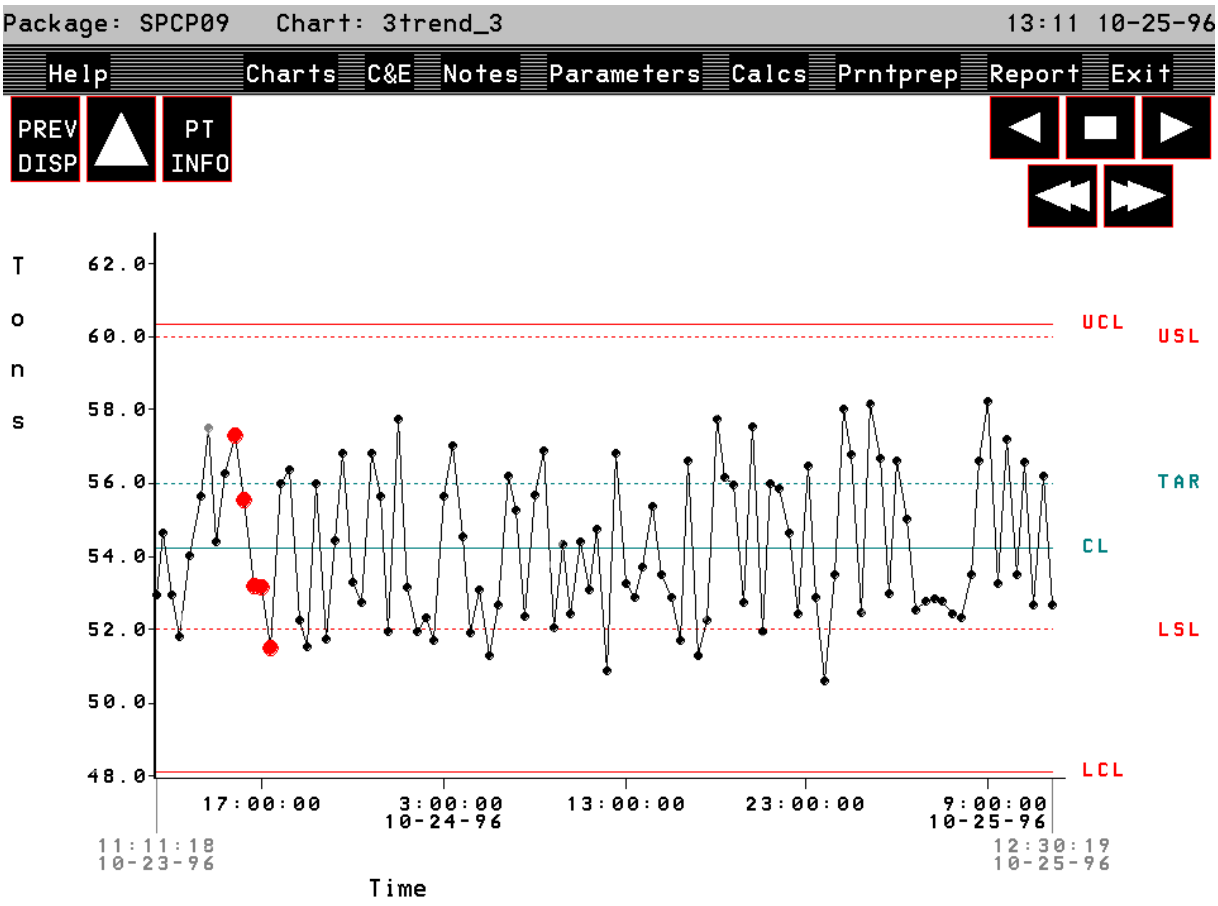


Figure 5. Individuals Chart

Xbar and Range Chart

Figure 6 shows the Xbar and Range chart, which is a double chart. The upper chart is a plot of subgroup mean values versus time or subgroup, together with their mean value (the grand mean), and the upper and lower control limits.

The lower chart is a plot of subgroup range values versus time or subgroup, together with the range mean and the range upper and lower control limits.

The software can calculate the mean and control limits from the actual data, or base them on *official values* of the Xbar mean and range mean.

When the chart is displayed, the software checks up to 11 preconfigured rules for violations and displays the results (rules violated by which subgroups).

The software monitors up to three of these rules, and generates an alarm when a violation occurs.

You can also display the targets, upper specification limits, and lower specification limits on the chart, along with the calculated or official central lines (means) and calculated or official control limits.

You can apply any one of the variable transformations listed under *Functional Specifications* on page 26 to the values for this chart.

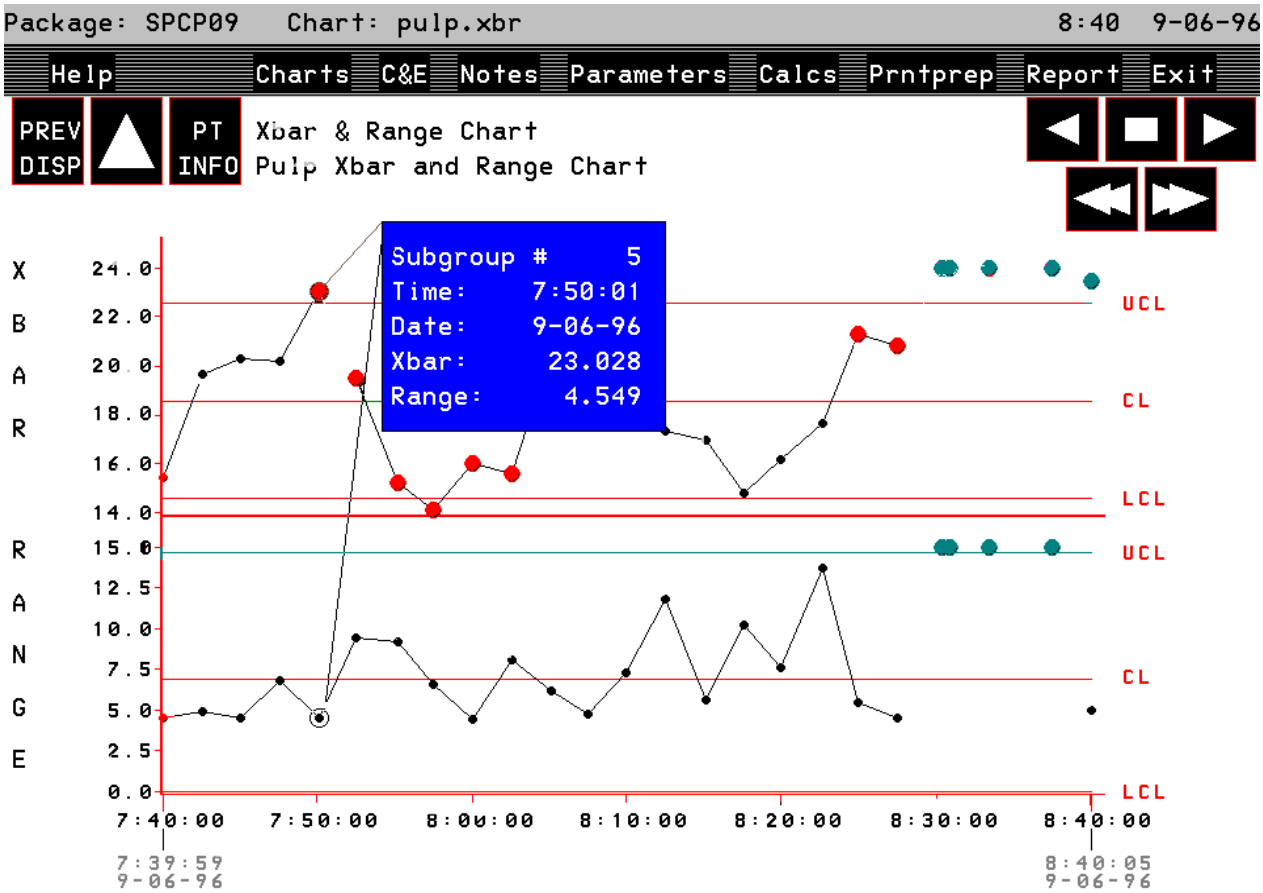


Figure 6. Xbar and Range Chart

Xbar and Sigma Chart

Figure 7 shows the Xbar and Sigma chart, which is a double chart. The upper chart is a plot of subgroup mean values versus time or subgroup, together with their mean value (the grand mean), and the upper and lower control limits.

The lower chart is a plot of subgroup sigma values versus time or subgroup, together with the sigma mean and the sigma upper and lower control limits.

The software can calculate the mean and control limits from the actual data, or base them on *official values* of the mean and sigma.

When the chart is displayed, the software checks up to 11 preconfigured rules for violations and displays the results (rules violated by which subgroups).

The software monitors up to three of these rules, and generates an alarm when a violation occurs.

You can also display the targets, upper specification limits, and lower specification limits on the chart, along with the calculated or official central lines (means) and calculated or official control limits.

You can apply any one of the variable transformations listed under *Functional Specifications* on page 26 to the values for this chart.

Cumulative Sum Chart

Figure 8 shows the Cumulative Sum chart, which displays the cumulative deviation of the subgroup mean from the target value.

The chart control limits are in the form of a *V-mask* that provides a two-sided decision criteria similar to the 3-sigma limits of the Xbar chart.

The software can calculate the standard deviation of the mean values from the actual data, or base them on *official values* of the mean and sigma.

You can apply any one of the variable transformations listed under *Functional Specifications* on page 26 to the values for this chart.

CUSUM Chart

Figure 9 shows the CUSUM chart, which displays the cumulative deviation of the subgroup mean from the target value, divided by the sample standard deviation of the subgroup.

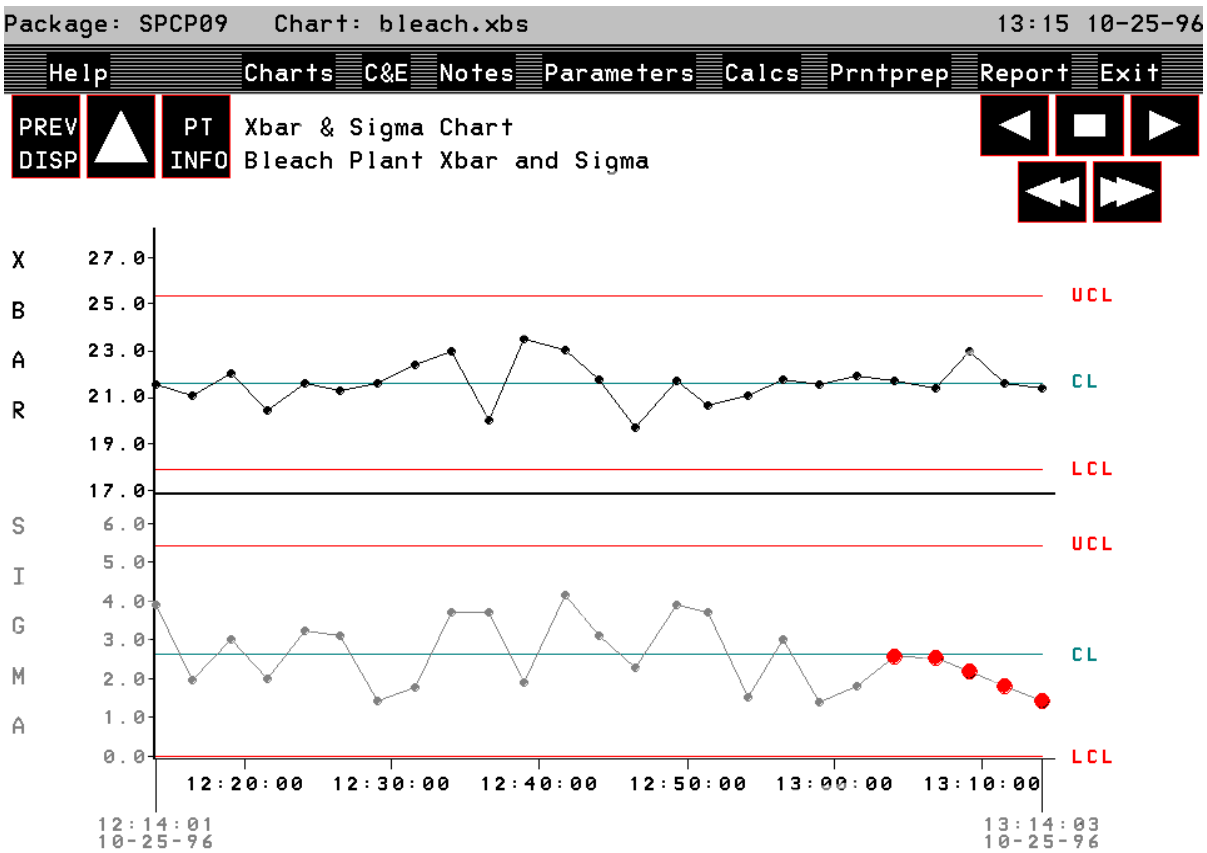


Figure 7. Xbar and Sigma Chart

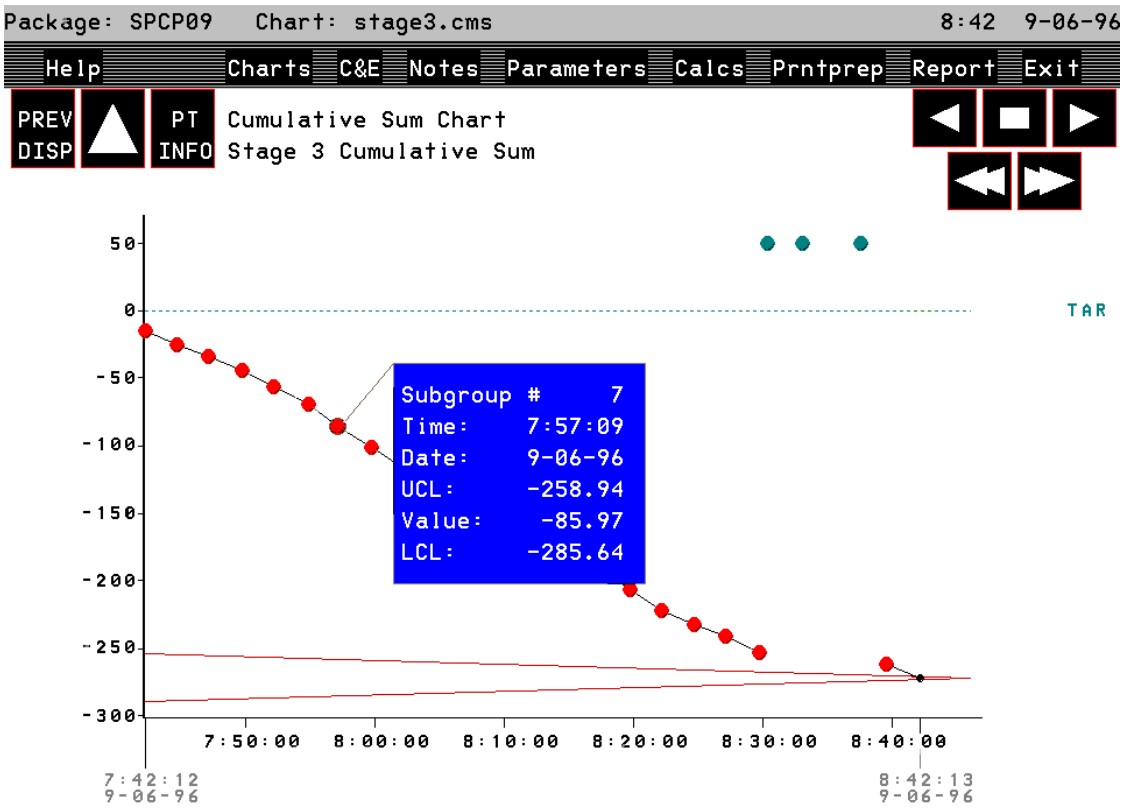


Figure 8. Cumulative Sum Chart

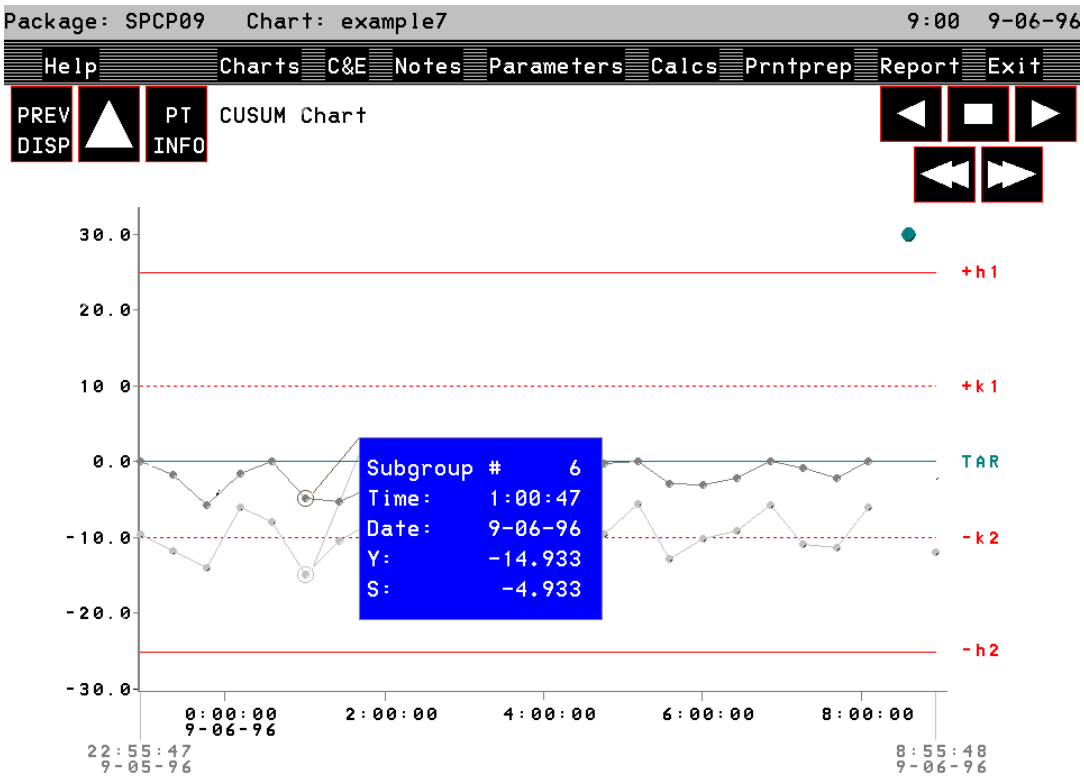


Figure 9. CUSUM Chart

This chart is a plot of *S* and *Y* versus time or subgroup where:

S = cumulative deviation value

Y = [(subgroup mean) - target] + standard deviation.

The chart also shows the target value (TAR), decision intervals (h1 and h2), and slack values (k1 and k2).

You can apply any one of the variable transformations listed under *Functional Specifications* on page 26 to the values for this chart.

Individuals Histogram

Figure 10 shows an Individuals Histogram with the normal curve superimposed. This chart is a frequency distribution of a set of data. It is a plot of the count of points as a function of value.

The software calculates the standard deviation of the data and uses this value and the mean to plot the superimposed normal curve.

This chart also shows the target (TAR), upper specification limit (USL), and lower specification limit (LSL). You enter these values.

You can use the Individuals Histogram for process capability analysis and determination of the normality of data. The software calculates the standard capability indices, as well as mean, standard deviation, skewness, kurtosis and percent out of specification.

You can apply any one of the variable transformations listed under *Functional Specifications* on page 26 to the values for this chart, except for merge.

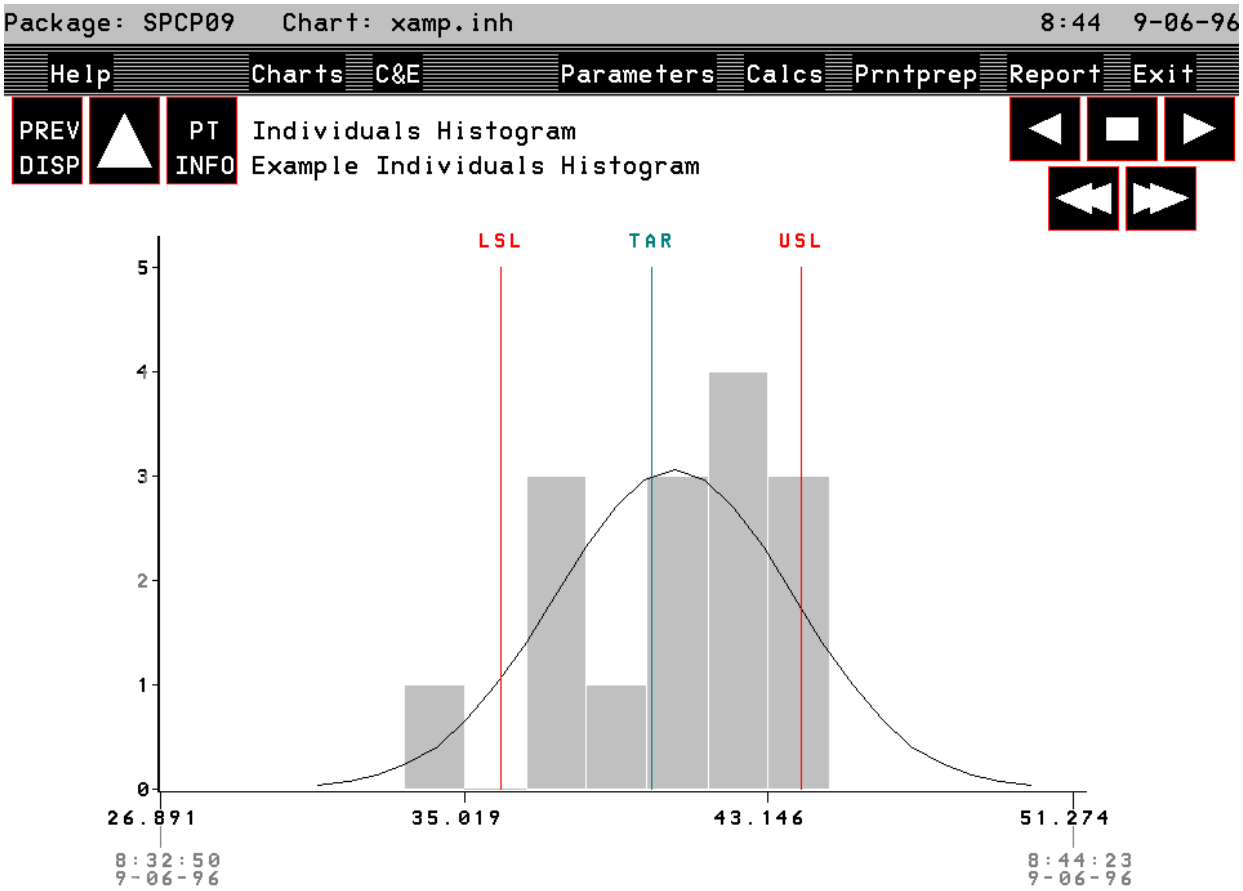


Figure 10. Individuals Histogram

Xbar Histogram

Figure 11 shows an Xbar Histogram with the normal curve superimposed. This chart is a frequency distribution of a set of subgroup means. It is a plot of the count of means as a function of value.

The software calculates the standard deviation of the data and uses this value and the mean value to plot the superimposed normal curve.

This chart also shows the target (TAR), upper specification limit (USL), and lower specification limit (LSL). You enter these values.

You can use the Xbar Histogram for process capability analysis and determination of the normality of data. The software calculates the standard capability indices, as well as mean, standard deviation, skewness, kurtosis and percent out of specification.

You can apply any one of the variable transformations listed under *Functional Specifications* on page 26 to the values for this chart.

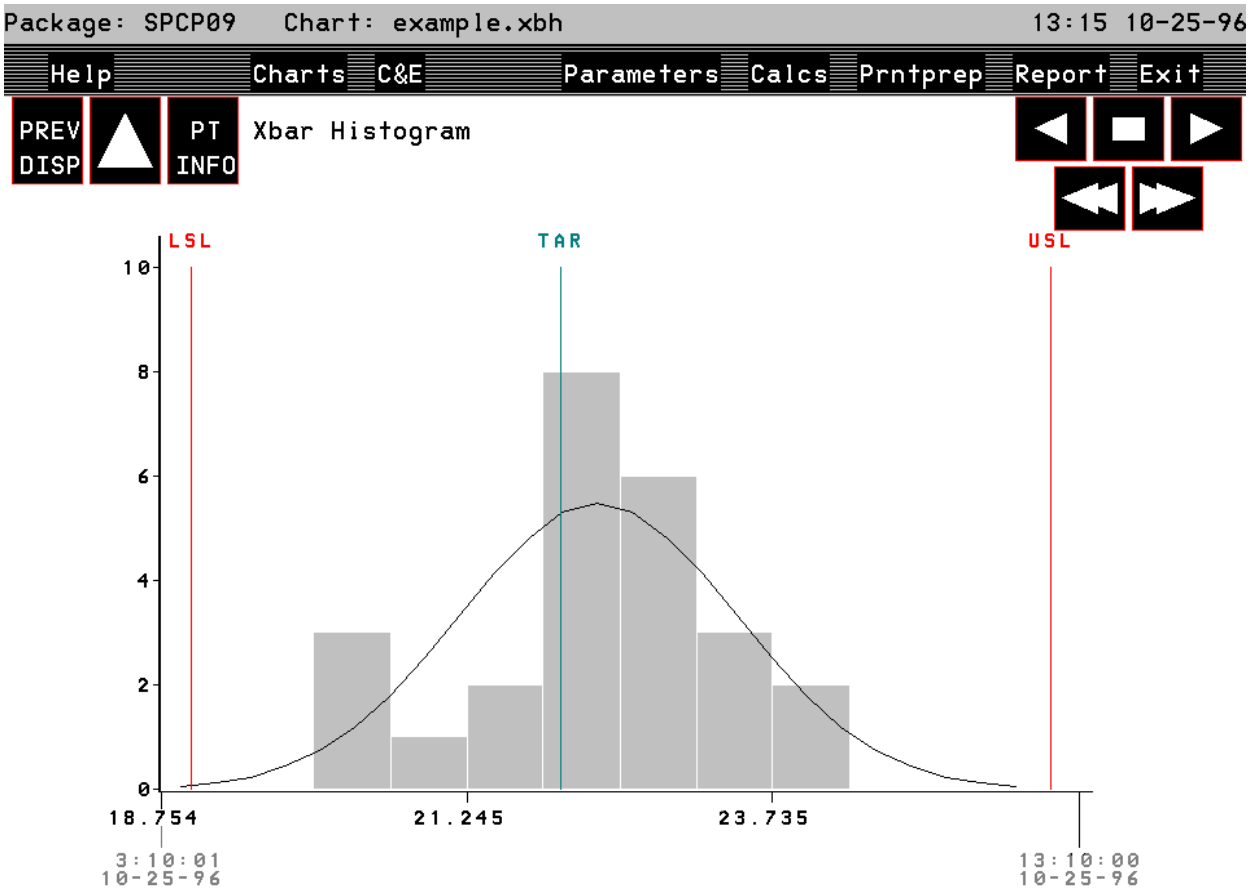


Figure 11. Xbar Histogram

P Chart

Figure 12 shows the P chart. It is a plot of the fraction of defective items versus time or subgroup, together with the mean value and upper and lower control limits.

The P chart is useful when the number of tested items varies from sample to sample, that is, subgroup to subgroup. When the number of tested items per subgroup is constant, the NP chart shown in Figure 13 is used instead of the P chart.

Optionally, you can plot percent defective instead of fraction defective.

The software can calculate the mean and control limits from the actual data, or it can base them on *official values* of the mean and sigma.

When the chart is displayed, the software checks up to 11 preconfigured rules for violations and displays the results (rules violated by which subgroups).

The software monitors up to three of these rules, and generates an alarm when a violation occurs.

You can also display the target (TAR), upper specification limit (USL), and lower specification limit (LSL) on the chart, along with the calculated or official central line (mean) and calculated or official control limits.

This chart does not use any variable transformations.

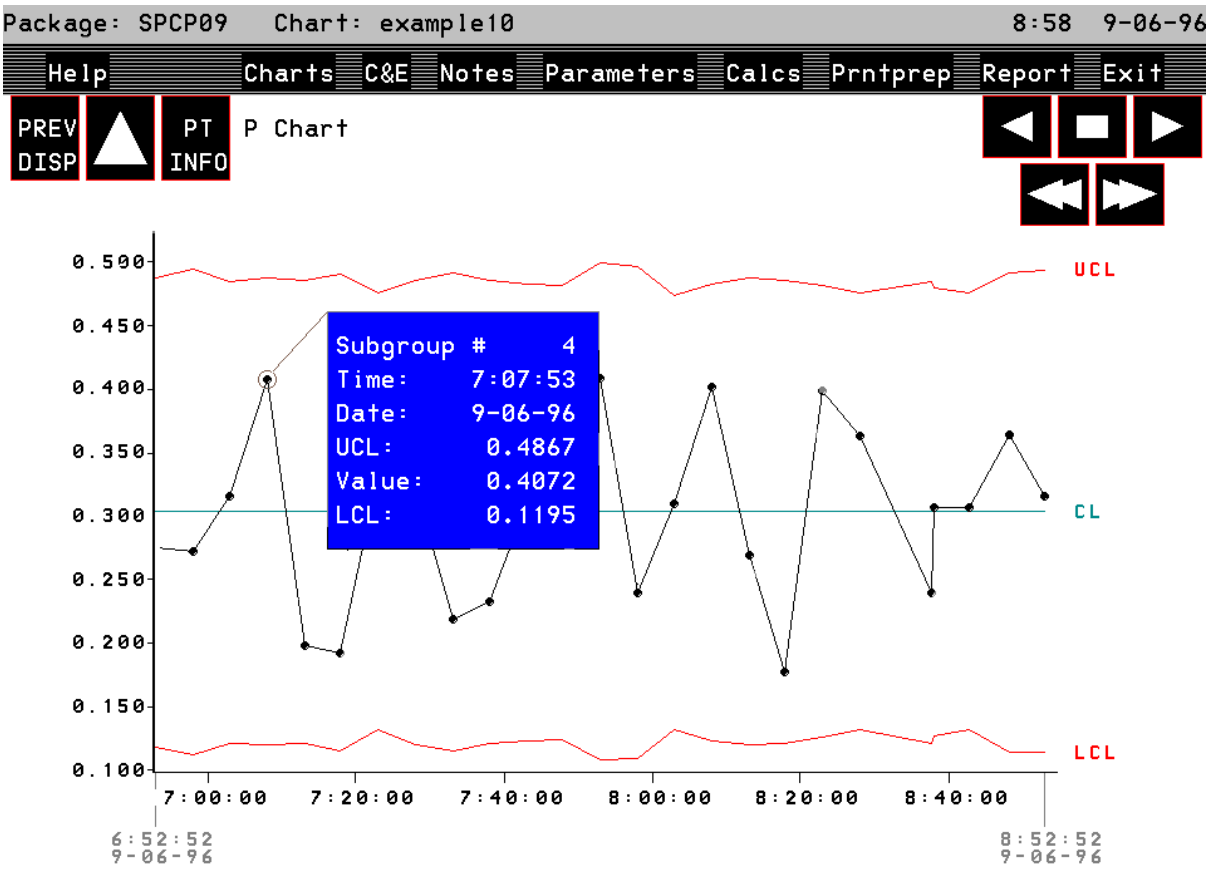


Figure 12. P Chart

NP Chart

Figure 13 shows the NP chart. It is a plot of the number of defective items versus time or subgroup, together with the mean value and the upper and lower control limits.

The NP chart is useful when the number of tested items per subgroup is constant, as specified by the subgroup size parameter. When the number of tested items per subgroup varies, the P chart is used instead of the NP chart.

The software can calculate the mean and control limits from the actual data, or it can base them on *official values* of the mean and sigma.

When the chart is displayed, the software checks up to 11 preconfigured rules for violations and displays the results (rules violated by which subgroups).

The software monitors up to three of these rules, and generates an alarm when a violation occurs.

You can also display the target (TAR), upper specification limit (USL), and lower specification limit (LSL) on the chart, along with the calculated or official central line (mean) and calculated or official control limits.

This chart does not use any variable transformations.

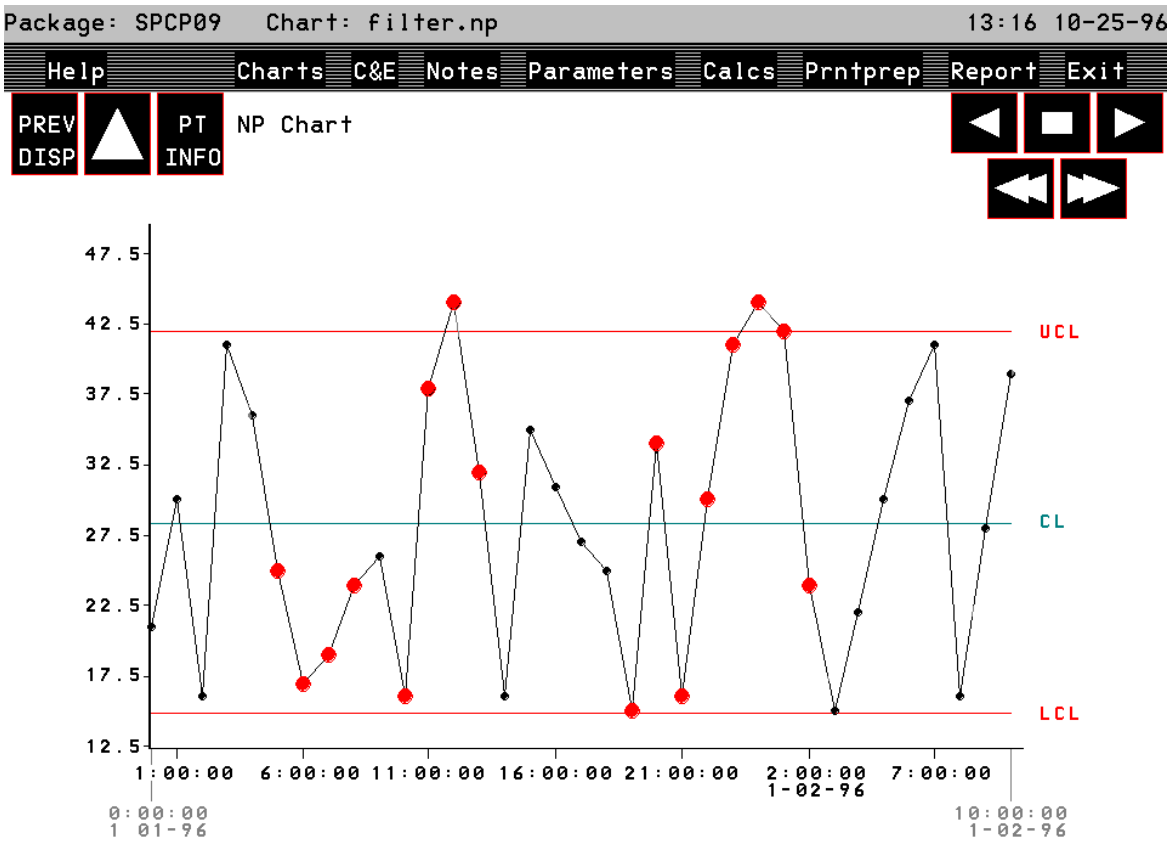


Figure 13. NP Chart

C Chart

Figure 14 shows the C chart. It is a plot of the number of defects versus time or subgroup, together with the mean value and the upper and lower control limits.

The C chart is useful when the unit size is constant. An example is the number of defects in a yard of cloth, where the unit size is a yard of cloth every time. When the unit size varies, the U chart is used instead of the C chart. See Figure 15 on page 18.

The software can calculate the mean and control limits from the actual data, or it can base them on *official values* of the mean and sigma.

When the chart is displayed, the software checks up to 11 preconfigured rules for violations and displays the results (rules violated by which subgroups).

The software monitors up to three of these rules, and generates an alarm when a violation occurs.

You can also display the target (TAR), upper specification limit (USL), and lower specification limit (LSL) on the chart, along with the calculated or official central line (mean) and calculated or official control limits.

This chart does not use any variable transformations.

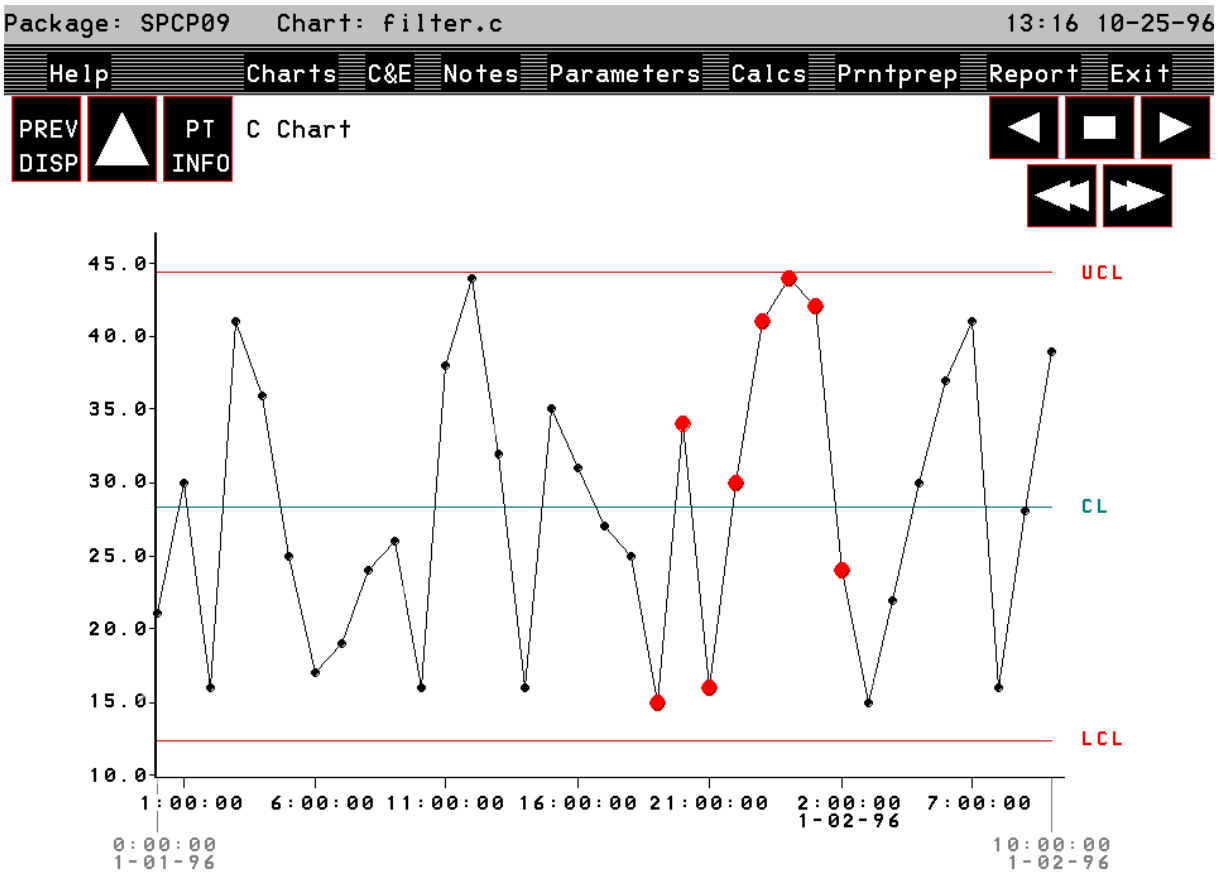


Figure 14. C Chart

U Chart

Figure 15 shows the U chart which is a plot of the number of defects per unit versus time or subgroup, together with the mean value and the upper and lower control limits.

The U chart is useful when the unit size varies. An example is the number of defects per yard of cloth where the unit size is 1 yard of cloth for the first subgroup, 1.35 yards of cloth for the second subgroup, etc. When the unit size is constant, the C chart shown in Figure 14 is used instead of the U chart.

The software can calculate the mean and control limits from the actual data, or it can base them on *official values* of the mean and sigma.

When the chart is displayed, the software checks up to 11 preconfigured rules for violations and displays the results (rules violated by which subgroups).

The software monitors up to three of these rules, and generates an alarm when a violation occurs.

You can also display the target (TAR), upper specification limit (USL), and lower specification limit (LSL) on the chart, along with the calculated or official central line (mean) and calculated or official control limits.

This chart does not use any variable transformations.

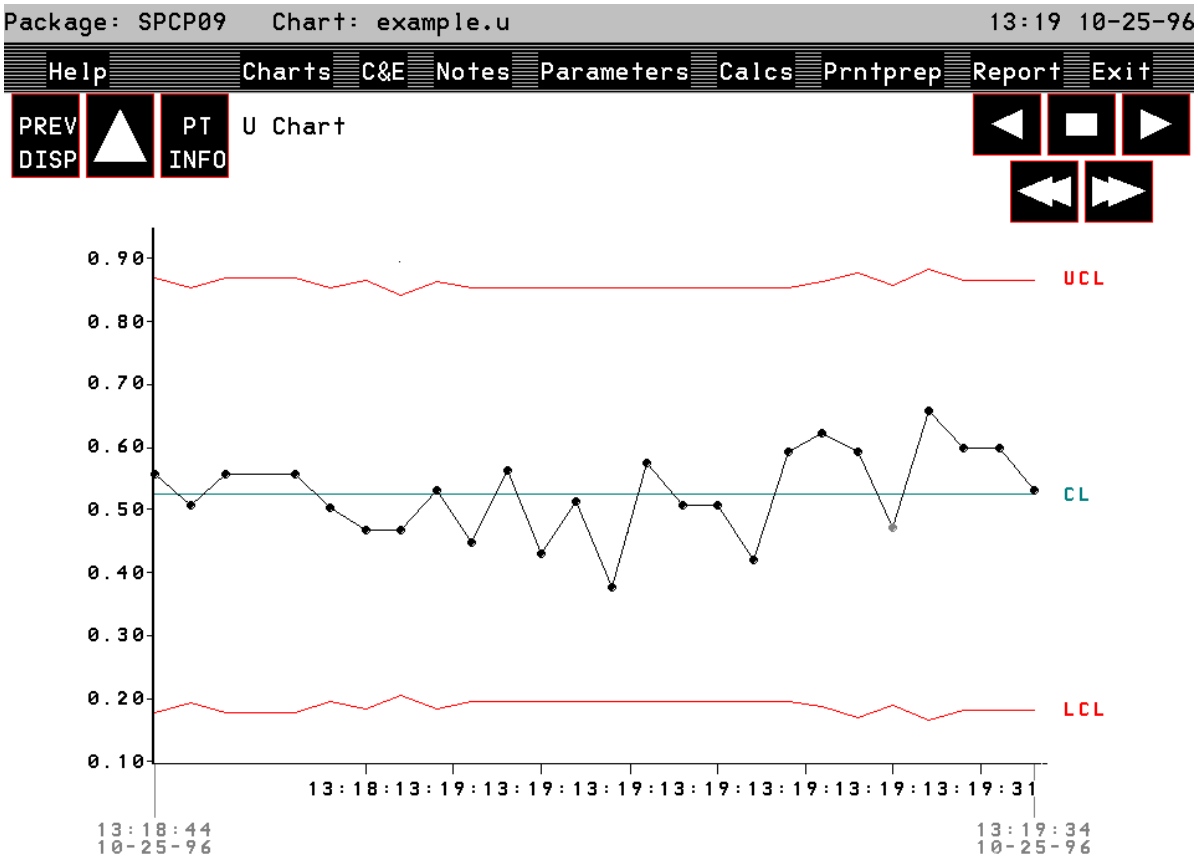


Figure 15. U Chart

Scatter Diagram

Figure 16 shows the Scatter Diagram. This diagram is a plot of one variable against another or itself, with a computed linear regression line superimposed on the plot. This diagram displays, graphically and with a computed value, the cross-correlation between two variables or a variable's auto-correlation. An optional time shift compensates for the time delay between these variables.

The Scatter Diagram provides a visual display of the correlation between the two variables. The software computes and displays the value of the cross-correlation coefficient to provide a quantitative measure of the correlation between the variables. The software also computes and plots a linear regression line on the diagram.

The software can also plot a variable against itself on the Scatter Diagram, thus showing, graphically and with a computed value, its auto-correlation. You can configure the diagram for different time delays to display the computed auto-correlation of the variable.

You can apply any one of the variable transformations (except for merge), listed under *Functional Specifications* on page 26 to the values for this chart. The ratio transformation allows you to plot one variable against the ratio of two other variables or the ratio of two variables against the ratio of two other variables.

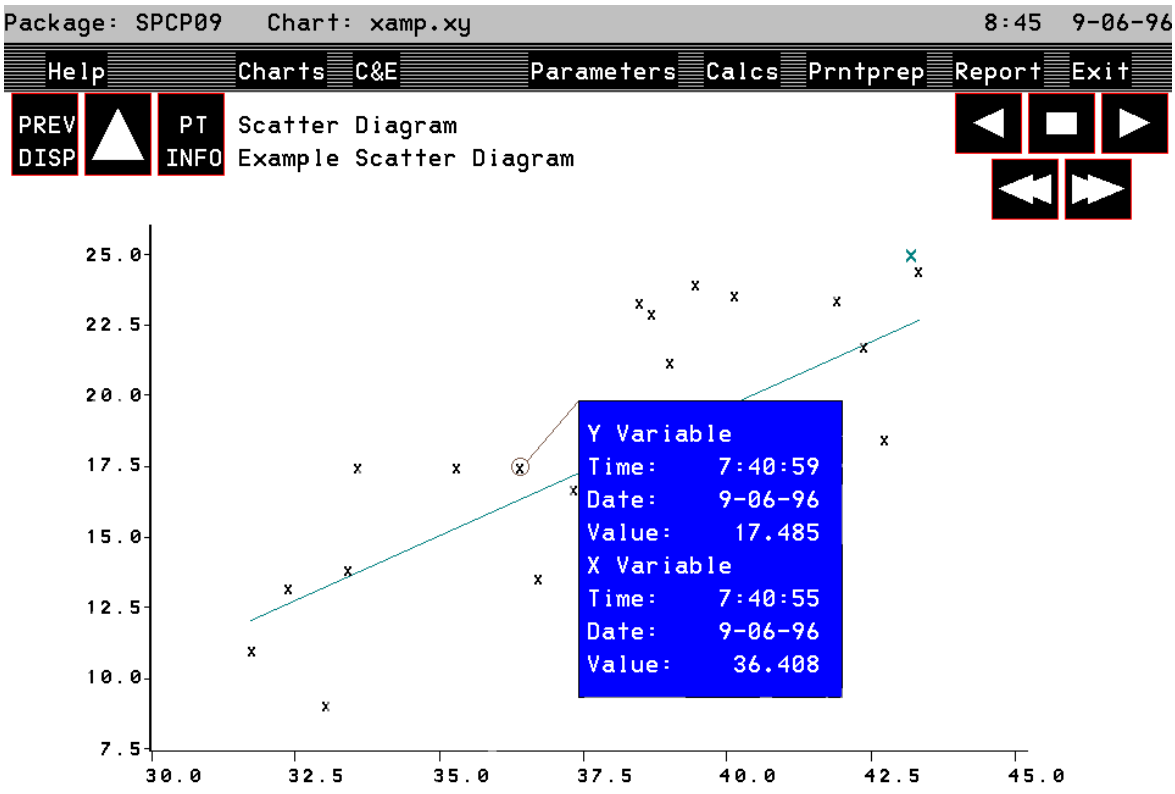


Figure 16. Scatter Diagram

Pareto Diagram

Figure 17 shows the Pareto Diagram which graphically displays, in order of priority, up to 16 causes of rejection for a product. This diagram plots the number of occurrences of rejection and percent contribution, both charted versus cause of rejection.

The software can also plot the sum of occurrences for any given period of time, for example 30 days, using a Pareto Diagram. It provides weighting coefficients to convert the number of occurrences to whatever is desirable, including dollars.

The Pareto Diagram is most commonly used for attribute variables. It has two y-axes.

The y-axis on the left is for the number of occurrences of product rejection versus causes for rejection, in order of priority. It is associated with the bar graph.

The y-axis on the right represents cumulative percent contribution for the same causes of rejection, and it is associated with the curve with the ● symbol.

You enter the number of causes for rejection and the name for each cause during chart configuration.

This chart does not use any variable transformations.

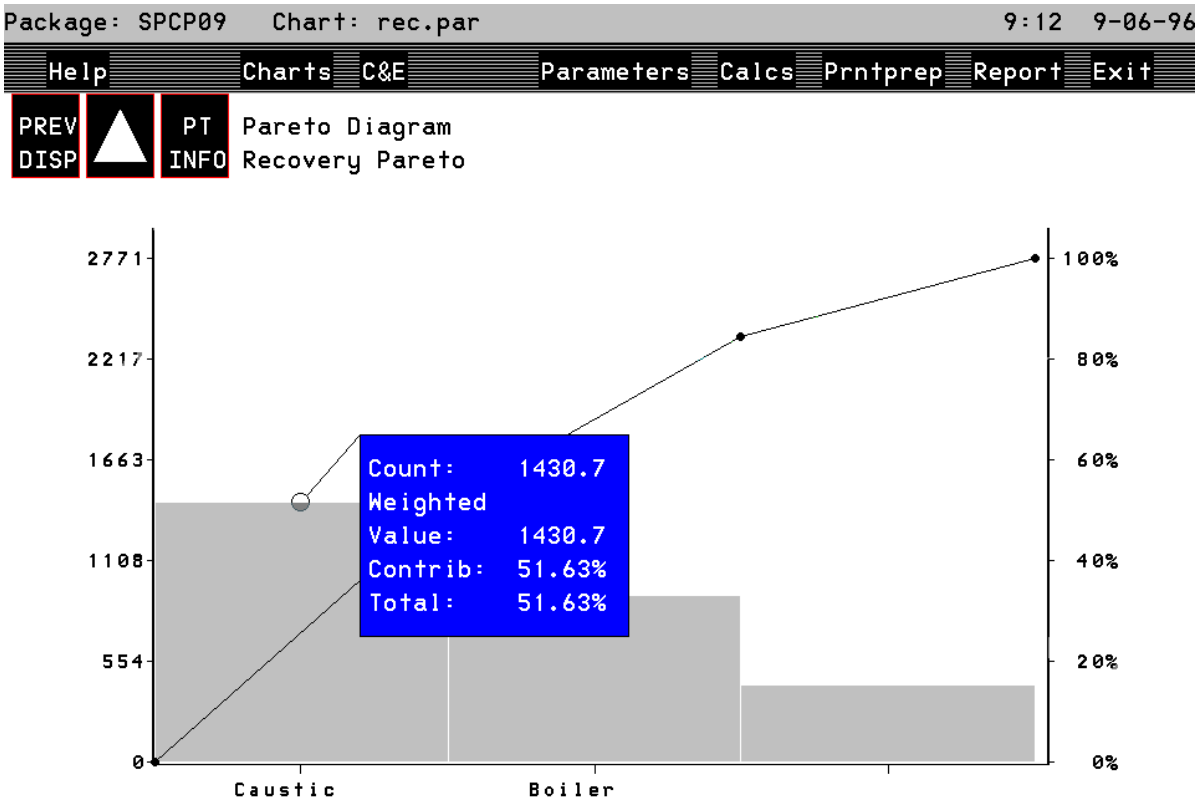


Figure 17. Pareto Diagram

DATA COLLECTION AND ACCESS

The Historian performs the data collection. FoxSPC.com accesses the following Historian data:

- Basic and extended sample data
- Reduction group data
- Manual entry group data
- Archive or playback (restored) files for any of the above.

For sample data, which is collected on a change-driven basis, FoxSPC.com builds charts with the collected data, converted to periodic values, based on the sample period for the chart.

Because reduction group data is collected periodically, FoxSPC.com treats it as periodic data in the charts.

User-entered data istreated as nonperiodic values.

FoxSPC.com accesses collected samples in four ways:

- From start time/date, number of subgroups backward in time
- From start time/date, number of subgroups forward in time
- From start time/date, a time span backward in time
- From start time/date, a time span forward in time.

The start time/date defaults to the current system time/date.

For charts that require them, there are three ways of forming subgroups for chart calculations:

- Size n – Divide a group of values into consecutive subgroups of size n
- Size n, skip m – Choose n consecutive values for the subgroup, and then, skip m consecutive values
- Moving Subgroups of Size n – Given the group of values $X_1 ... X_N$, the j^{th} subgroup of size n where J = 1...N, is formed with the values X_{J+I-1}, where i = 1...n.

REAL-TIME MONITORING AND ALARMING

The I/A Series FoxSPC.com (50 Series) software package provides real-time monitoring and alarming capability for the following chart types:

- Individuals
- Xbar and Range
- Xbar and Sigma
- CUSUM
- P
- NP
- C
- U.

The FoxSPC.com monitor process executes periodically, monitoring charted Historian sample and manually entered data variables for out of statistical control conditions.

During each chart's monitor period, the monitor obtains sufficient data from the Historian to check the latest subgroup of samples for rule violations.

Rule violations result in alarm status changes for charts configured for monitoring. When a status changes, an alarm message is sent to the configured printer and the I/A Series alarm display is updated with the latest alarm information.

With the exception of CUSUM charts, which use a configured decision interval **h**, each monitored chart may use up to three rules chosen from the 11 FoxSPC.com *standard* "Statistical Control Rules for Charts" on page 26.

A CED box turns red when a chart to which it is linked goes into an alarm condition. The text foreground of the linked menu item also turns red.

Charts may be configured to be monitored as frequently as once per minute.

Alarms can be acknowledged or deleted from this display.

The I/A Series alarm display is updated once per minute.

The FoxSPC.com Real-time Monitor and Alarm Package can monitor and relay alarm status on the following types of charts:

- Individuals
- Xbar and Range
- Xbar and Sigma
- CUSUM
- P (Fraction defective for variable number of tested items)
- NP (Number of defects for constant number of tested items)
- C (Number of defects for constant unit size)
- U (Number of defects per unit for variable unit size).

CONFIGURATION

FoxSPC.com is configured from a workstation using the FoxSPC.com configurator which interacts with the user via workstation displays and updates the FoxSPC.com definition files via an access server.

The FoxSPC.com configuration environment provides the following selectable options:

- Display configuration help text
- Display list of charts that have been configured
- Display list of CEDs that have been configured
- Generate Foxboro defined configuration reports
- Repack FoxSPC.com configuration files
- Display list of available FoxSPC.com packages in the system
- Go to FoxSPC.com operation
- Exit FoxSPC.com configuration.

Chart Configuration

You configure each chart as a separate, named instance of one of the supported chart types. You can add, modify, copy, delete, and report chart definitions. You can configure certain types of charts for real-time monitoring and alarming.

Chart definitions provide all information necessary to:

- Retrieve collected process data
- Ratio, merge, or transform the data
- Subgroup the data
- Filter the data
- Perform calculations appropriate to the chart type
- Plot and display results of these operations
- Check rules for *out of statistical control* state
- Monitor and relay alarm status appropriate to the chart types.

You do not needto configure Historian variables in the Historian prior to FoxSPC.com chart configuration.

Cause and Effect Diagram Configuration

You configure each CED as a separate, named definition. The definition specifies the number, position, and title of boxes in the CED, as well as the charts, CEDs, and text files linked to the boxes. You can add, modify, copy, delete, and report CED definitions.

Cause and Effect Diagram Displays

CED displays provide the following selectable options:

- Display CED help text
- Display chart selected from list of configured charts (charts being monitored are shown in yellow)
- Display CED selected from list of configured CEDs
- Change screen background color to white for printing
- Display list of available Statistical Process Control packages in the system
- Go to FoxSPC.com configuration
- Exit FoxSPC.com operation
- Return to previous CED or chart display.

Chart Displays

Chart displays provide the following selectable options:

- Display chart help text
- Display chart selected from list of configured charts (charts being monitored are shown in yellow)
- Display CED selected from list of configured CEDs
- Display chart point information
- Display/enter chart notes (not in Scatter, Pareto, or Histogram charts)
- Display calculated values for chart parameters
- Display/change chart configuration parameters, either temporarily or permanently
- Stop/Start Real Time Monitoring button
- Move chart data backward or forward in time by one subgroup or half of the chart
- Change screen background color to white for printing
- Print selected operation report from list of standard chart reports
- Exit FoxSPC.com operation
- Return to previous chart or CED display.

FoxSPC.com performs the following operations to generate the chart display:

1. Retrieves variable samples for the chart:
   - When the chart is configured for a desired number of variable samples, FoxSPC.com computes the number of variable samples, based on the configured subgroup size, number of subgroups, and subgrouping method.
   - When the chart is configured for all available samples for a specific time span, FoxSPC.com retrieves all sample values collected within this time span and forms subgroups for these.
2. Performs the configured variable transformation (if any) on the samples.
3. Forms subgroups according to the configured subgrouping method.
4. Data filtering.
5. Performs the appropriate statistical calculations.
6. Plots the results using the configured plot line type.
7. Performs any configured statistical control rule checks, and then plots the points in violation as oversized, red dots.
8. Monitoring and alarming.

REPORT GENERATION

FoxSPC.com provides a set of predefined configuration reports that are requested via the Reports field in the top menu bar of FoxSPC.com configuration displays.

FoxSPC.com also provides operational reports that are requested via the Reports field in the top menu bar of chart displays.

For example, you can call up a chart for display, change its parameters, and generate a report consisting of tables of raw and calculated values and notes for the selected time period. You can also obtain a hard copy of the plotted chart by using the Prntprep field in the top menu bar of the chart display in conjunction with the I/A Series print screen function.

SYSTEM CONFIGURATION

The FoxSPC.com software executes on the following Solaris-based 50 Series and 70 Series stations:

- Application Processor in conjunction with a Workstation Processor
- Application Workstation (AW) which can host WPs.

FoxSPC.com residing on an AP can service all WPs hosted by the AP. FoxSPC.com configuration and displays are performed locally within the AP/WP cluster. Process data is accessed from any Historian database in the I/A Series network. See Figure 18.

The FoxSPC.com software package can access data from the local Historian (database) and all remote Historians (databases) in the I/A Series network.

WINDOWS CHART CONFIGURATOR

The configurator allows chart configuration and adjustment from any machine with access to the FoxSPC.com server.

PC AND WEB CLIENTS

PC client stations can access FoxSPC.com displays over an Ethernet TCP/IP local area network. PC clients can run under Microsoft Windows 95/98, or Windows NT 4.0 operating systems.

An optional Web server can be added to the network to allow remote access to FoxSPC.com displays using Netscape Navigator or Microsoft Internet Explorer over the Internet or a corporate intranet.

REAL TIME FoxSPC.com SYSTEM ARCHITECTURE

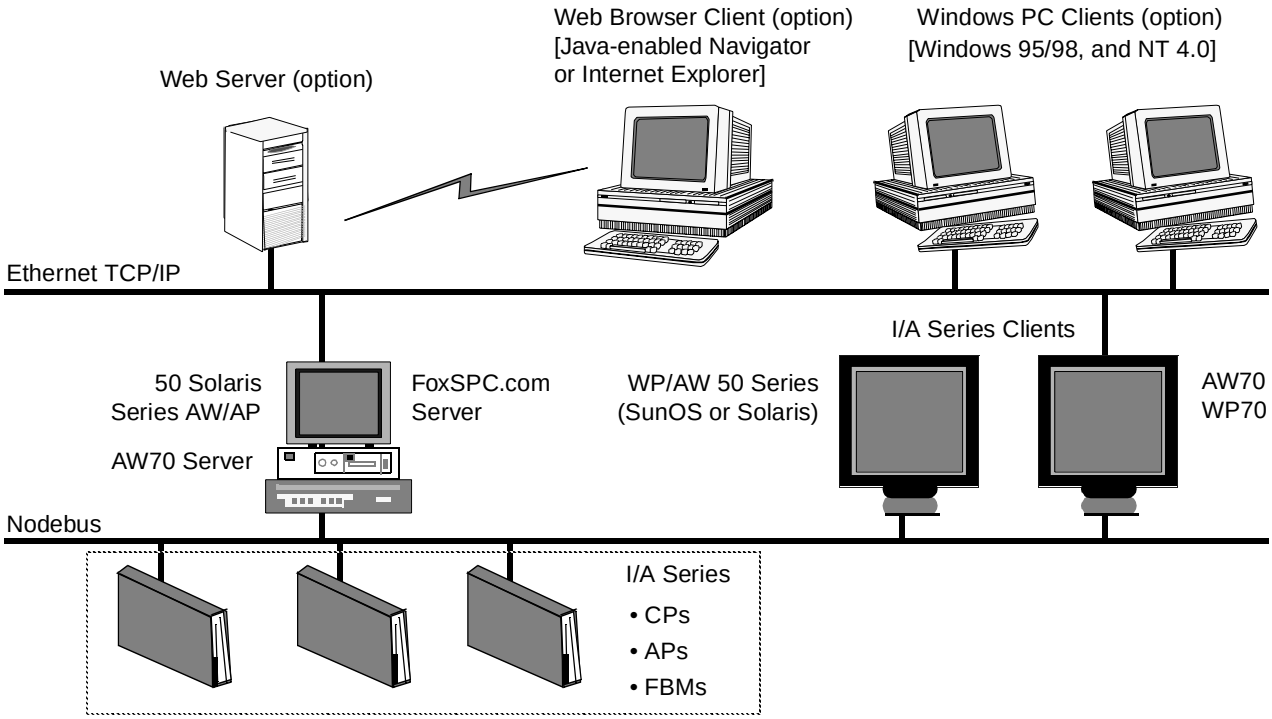


Figure 18. Diagram of System Architecture

FoxSPC.com PRODUCT STRUCTURE

FoxSPC.com uses client server architecture as shown in Figure 18. The product is structured to be cost effective and to accommodate the needs of most applications. The product structure requires one SPC server and can accommodate any combination of I/A Series UNIX, Windows, or Internet/intranet clients. When you order at least one SPC server, the appropriate number and type of clients should be specified.

Foxboro also offers a packaged solution that includes all hardware and software needed to put a SPC system on the Internet or intranet. The packaged solution includes complete installation and testing of software on the server. The following paragraphs are a description of the available product components.

FoxSPC.com Server Software

The FoxSPC.com server provides all the software needed to configure SPC charts, CEDs, and other SPC tools. It also includes software needed to support all of the connected I/A Series UNIX clients that are connected to the Nodebus. No additional software is needed for I/A Series UNIX clients. Software is also included to provide client license validation to support other software client types. At least one SPC server is needed to support a FoxSPC.com system.

FoxSPC.com Windows Clients Software

FoxSPC.com Windows clients will run on Windows 95/98, or Windows NT 4.0. From a Windows client, users have access to the full range of SPC charts, CEDs and other SPC tools. The Windows client look and feel are similar to the UNIX client with small changes in color, menus and fonts. Placement and behavior of buttons, however, are more consistent with the Windows environment.

When using the FoxSPC.com Windows client, data can be exported to spreadsheets, wordprocessors and other Windows DDE applications. Data that is transferable includes all plotted data values, and SPC calculation results (target, sigma, cpk, etc.) for any displayed chart.

FoxSPC.com Windows clients are sold as *named user* licenses. A *named user* can log onto the system from any PC that is connected to the TCP/IP information network as long as the correct user name and password are entered.

The Windows clients do not allow users to do SPC configuration. On allowable chart types, users have access to the parameters, calculations and other functions. Items can be changed by a user on an ad hoc basis but the changes can not be permanently saved. The alarm state of a chart or CED is shown when a display is called on a Windows client but new alarms that occur will not update the display. The Windows client does not directly support printing except for print screen functions.

FoxSPC.com Internet/Intranet (Web) Server Software

FoxSPC.com can also be accessed over the Internet or a company Intranet. The FoxSPC.com software allows the same functionality as the Windows clients. The Internet/intranet server software can be loaded on the SPC server or another server. This software makes all of the SPC client functions available for a user supplied Web server.

FoxSPC.com Web licenses are sold as *named user* licenses. A *named user* can log onto the SPC Web server but is allowed access only if a correct user name and password are entered.

FoxSPC.com Internet Packaged Solutions

Foxboro can, as an option, provide a fully loaded and tested FoxSPC.com Internet/intranet server including the hardware.

FoxSPC.com Engineering Services

Foxboro can supply on-site engineering services to install a basic FoxSPC.com software package and provide basic FoxSPC.com user training. FoxSPC.com Web enabler software installation can also be provided on site.

SYSTEM REQUIREMENTS

FoxSPC.com is available on the following platforms:

FoxSPC.com Servers

- Solaris operating system
- I/A Series AP/AW51B, C, D, or E with an information network connection using a second Ethernet port
- I/A Series AW70
- 32 MB RAM, minimum. Additional clients will require more memory
- 30 MB of hard drive, minimum.

Clients - Personal Computers

- Pentium or 486 class PC
- Windows 95/98, or Windows NT 4.0
- 16 MB RAM, minimum
- Network interface card for Windows clients and Win-Socket compliant TCP/IP software.

Clients - Web

- Java-enabled Web browser (Netscape Navigator or Microsoft Internet Explorer)

Clients - I/A Series

- I/A Series software Version 4.1 or higher on AW51 or WP51 or AW70A, B, C, D, or E running Solaris with an information network connection which uses a second Ethernet port
- 12 MB RAM, minimum
- WP30 systems are not supported, but can be upgraded to the I/A Series 50 via The Foxboro Company Advantage Program
- AW/WP51 and AW70 systems must communicate to the FoxSPC.com server via the Nodebus.

FUNCTIONAL SPECIFICATIONS

FoxSPC.com Tools

- Individuals Chart
- Xbar and Range Chart
- Xbar and Sigma Chart
- Cumulative Sum Chart
- CUSUM Chart
- Individuals Histogram
- Xbar Histogram
- P Chart
- NP Chart
- C Chart
- U Chart
- Scatter Diagram
- Pareto Diagram
- Cause and Effect Diagram.

Statistical Control Rules for Charts

UP TO 11 RULES PER CHART

Rule 1	1 point outside ±3 sigma of the central line.
Rule 2	3 consecutive points jumping ±3 sigma or more.
Rule 3	2 of 3 consecutive points above +2 sigma or below -2 sigma from the central line.
Rule 4	4 of 5 consecutive points above +1 sigma or below -1 sigma from the central line.
Rule 5	8 consecutive points above the central line.
Rule 6	8 consecutive points below the central line.
Rule 7	5 consecutive points increasing in value.
Rule 8	5 consecutive points decreasing in value.
Rule 9	15 consecutive points within ±1 sigma of the central line.
Rule 10	8 consecutive points outside ±1 sigma of the central line.
Rule 11	After a jump of ±3 sigma, 3 consecutive points within ±0.75 sigma of the jump point.

Variable Transformation Options(1)

TYPE 0	None
TYPE 1	$y = c_1 x$
TYPE 2	$y = c_1 (\log_e x)$
TYPE 3	$y = c_1 x + c_2$
TYPE 4	$y = c_1 \exp (c_2 x)$
TYPE 5	$y = c_1 \sqrt{x}$
TYPE 6	$y = x^{c_1}$
RATIO	$y = c_1 (x/z)$
MERGE	Merge up to 8 variables so that each subgroup contains one sample from each variable.

Input Historian Data

- Basic and extended samples
- Reduction group data
- Manual entry data
- Archive or playback data.

Installation

One FoxSPC.com per 50 Series station

Printer Requirements

CONFIGURATION REPORTS
Dot-Matrix or Color Ink-Jet (PaintJet) Printer
PRINT SCREEN FUNCTION
Color Ink-Jet (PaintJet) Printer

(1) In transformation equations, x and z are variable values. C_1 and C_2 are user defined constants.

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