INTEGRATING STATGRAPHICS CENTURION XV INTO A SIX SIGMA PROGRAM

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Introduction

This white paper discusses how integrating the STATGRAPHICS *Centurion* statistical tools into a Six Sigma program can provide ongoing benefits across an enterprise. Starting with a brief overview of the Six Sigma philosophy, the discussion then focuses on how the analytical and reporting tools within the STATGRAPHICS *Centurion* software can be used to implement key components of the Six Sigma approach.

What is the Six Sigma Philosophy?

The "Six Sigma" quality approach was pioneered in the 1980s by Motorola in response to a rising tide of global competition. Following a top-to-bottom analysis of its business operations, Motorola adopted a set of processes geared toward reducing the time required to take a product from concept to manufacture while simultaneously reducing the defects in products distributed to its customers.

Since then the Six Sigma approach has become a widely used management strategy for initiating a comprehensive review of all the processes a company undertakes to create, market, and support its products and services. A rule-of-thumb is that average processes operate at a three-sigma level; best-in-class at six sigma. Generally, the fundamental objective is that products and processes experience only 3.4 defects per million opportunities.

The benefits of a successful Six Sigma program are many: cost savings, productivity gains, improved production cycle times, reduction in errors, and elimination of unnecessary work. Better processes drive top-line growth, increase operating margins, and reduce working capital and spending.

Implementing Six Sigma

From the STATGRAPHICS *Centurion* perspective, implementing a Six Sigma program means giving a company's employees the most powerful statistical tools available to achieve their goals. These tools should serve both as a guide for improving processes by identifying trends away from set quality standards and as an archive for storing process information for future reference.

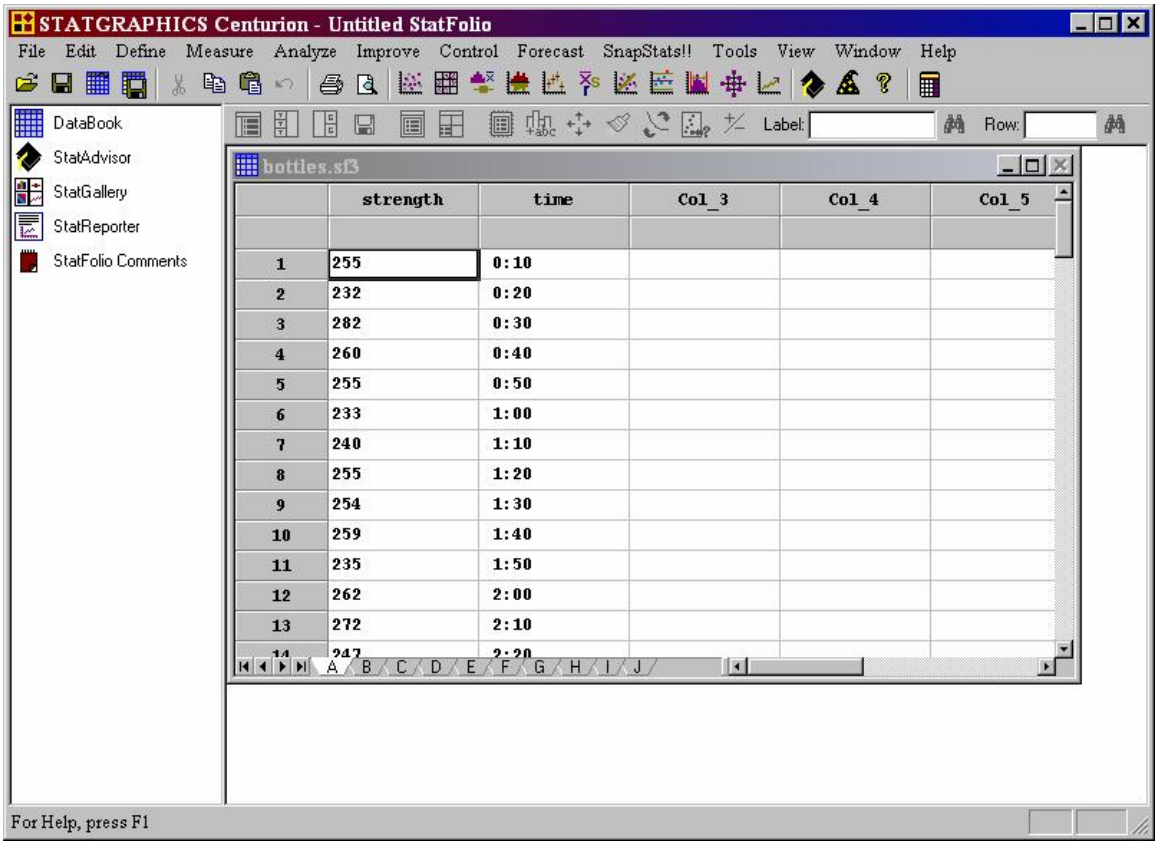
A company committing itself to a Six Sigma quality program must put in place an intensive training program for key executives and staff. In turn, these people learn to (1) organize and effectively lead the deployment of the program, and (2) implement and use statistical tools in their business-improvement efforts.

The STATGRAPHICS Centurion Statistical Toolkit

An important goal of this white paper is to illustrate the impact that using STATGRAPHICS can have within an organization. Six Sigma training involves teaching employees how key statistical tools are combined and sequenced to form a methodical and repeatable process for solving vital manufacturing, engineering and administrative problems. These tools should help users gain a better understanding of descriptive statistics and the relationship between variables.

Since its development in the early 1980s, STATGRAPHICS has concentrated on providing statistical tools that can be used both to (1) design quality into products, and (2) ensure that acceptable quality is maintained throughout the production process. This approach fits well with the broad Six Sigma mandate to develop an in-depth understanding of the philosophy as well as the theory, tactics, strategy, and application tools.

STATGRAPHICS *Centurion* is one of the few available statistical software applications that is flexible enough to provide entry-level access for virtually everyone within a company, while still ensuring that high-level statistical algorithms are available for addressing complex issues and calculations. It is a statistical software package that will serve a range of users from machine operators and shop floor supervisors to design and process engineers.



To provide this wide latitude of functionality, STATGRAPHICS *Centurion* incorporates a number of unique features:

StatWizard -- A tool to guide novice or casual users through the creation of an analysis from the selection of data to the choice of analytical options.

StatAdvisor -- A feature that provides short and easy-to-understand interpretations of all the reports and graphs in a statistical analysis.

StatFolios -- The main mechanism within STATGRAPHICS *Centurion* for saving information about analyses and their related data. An alternative to a macro language, this dialog-box driven approach allows users to save a single analysis or a combination of analyses that can encompass the most complex calculations.

StatGallery -- A special tool for archival and report-generation purposes. Up to nine graphics panes can be arranged on a single page. An overlay feature allows users to create compound graphics. This is an ideal tool for comparing month-to-month or year-to-year data.

StatReporter -- A reporting tool that is accessible from within a STATGRAPHICS *Centurion* session. Users can combine tables, graphs and their own notes into a personalized report. Using the Paste-Link feature, the StatReporter information updates whenever you update the linked analysis.

StatPublish -- A reporting tool that allows output to be saved in HTML format on a server so that anyone within the organization can view the results using only a web browser.

These features, plus others, embrace a new way of thinking about completing tasks quickly and efficiently. They can be a powerful force in decision making or empowering employees.

The following sections provide explanations and examples of how various analyses support multiple aspects of the goals of a Six Sigma implementation: methods for monitoring, controlling, and improving a process through statistical analysis.

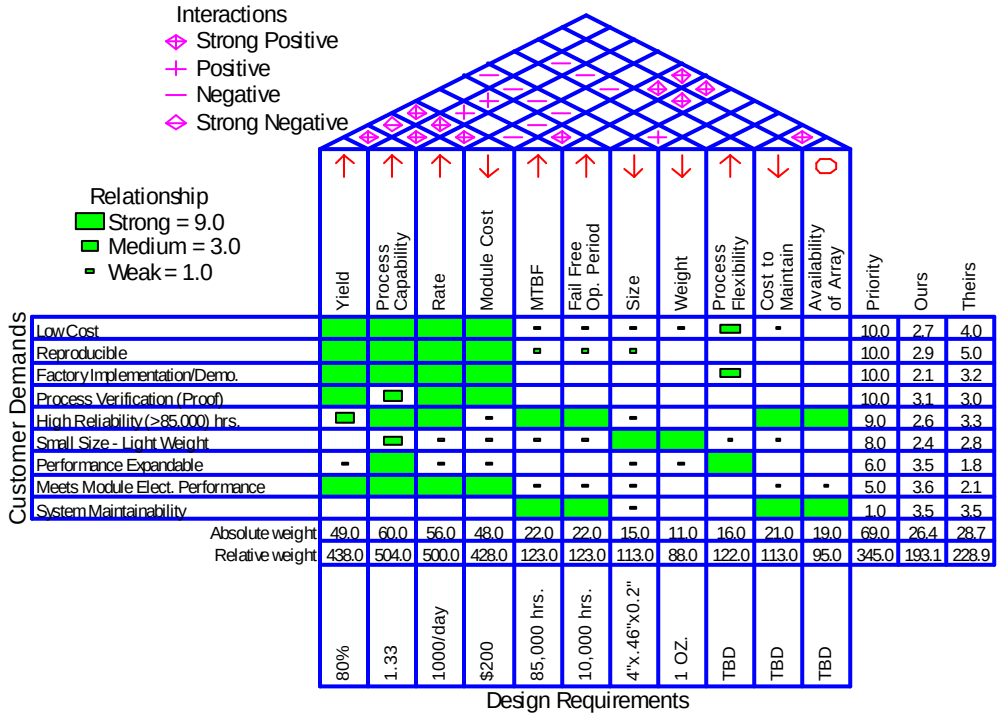
DMAIC Menu

The Six Sigma menu option in STATGRAPHICS *Centurion* organizes the statistical procedures into sections according to the Six Sigma DMAIC strategy. DMAIC groups the activities in a typical Six Sigma program into 5 phases: *Define*, *Measure*, *Analyze*, *Improve*, and *Control*.

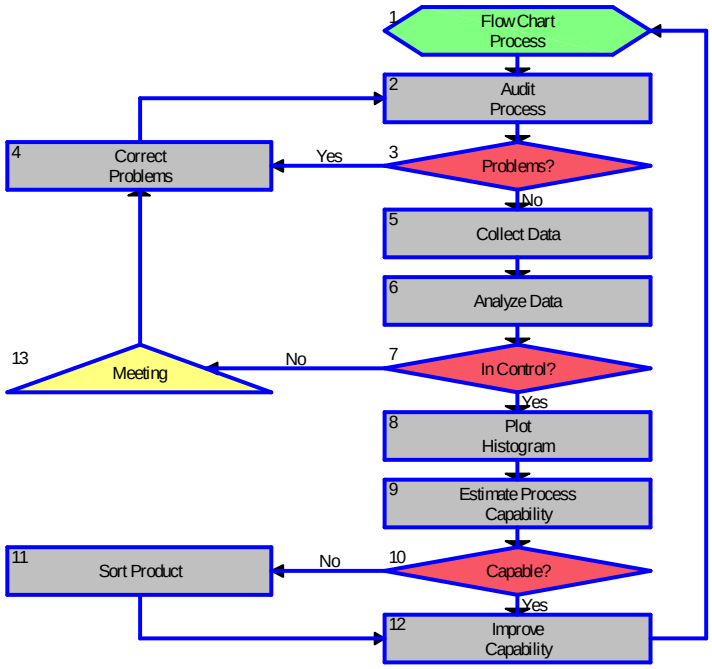
Define

The first phase in applying Six Sigma is to define the needs of one's customers and to determine the relationship between those needs and key process parameters. The key STATGRAPHICS procedures in this phase are:

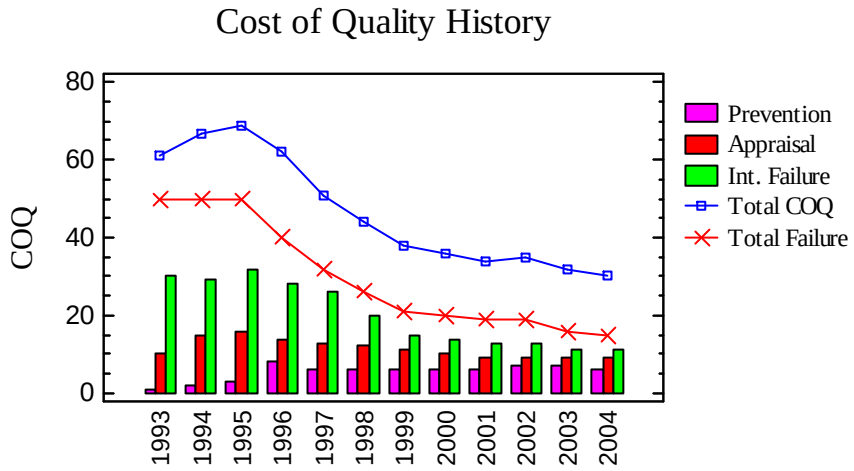
Quality Function Deployment - creates and displays a QFD matrix in the form of a "House of Quality". QFD is a customer-driven planning process by which products and services are matched to the needs of customers. Beginning with a set of customer needs, design requirements are established and the relationships between the needs and requirements identified.



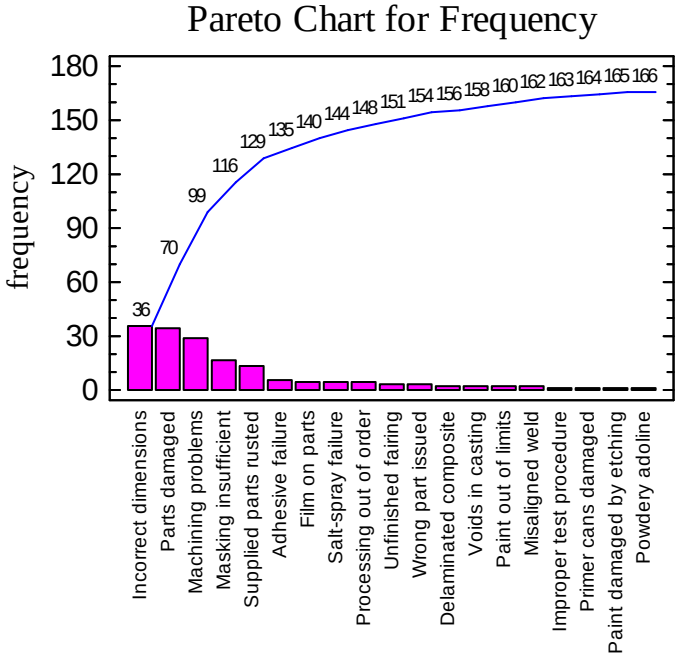
Process Map - used to map the critical steps involved in process development, in reengineering efforts, in monitoring quality, and in many other areas.



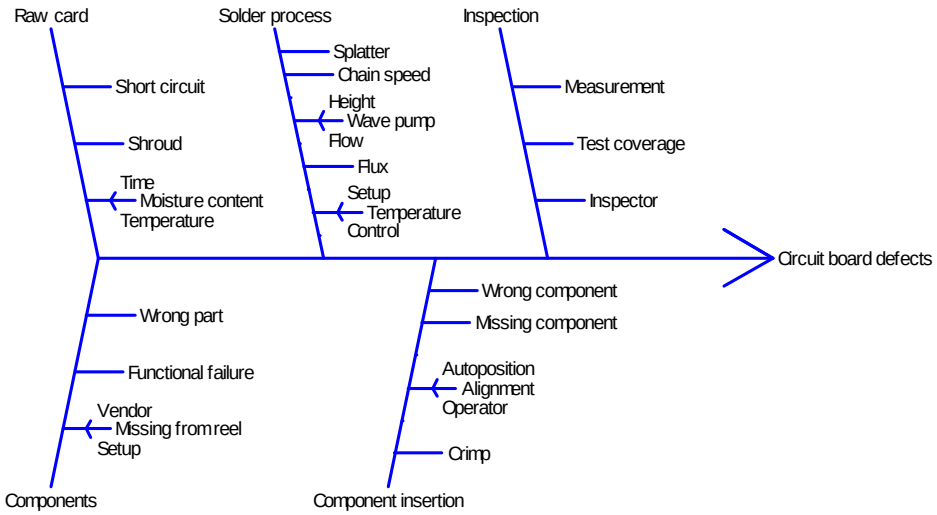
Cost of Quality Trend Analysis - illustrates the costs of poor quality by constructing a chart displaying prevention, appraisal, and failure costs over time. In addition, statistical runs tests are performed to determine whether or not significant trends exist in any of those time series.



Pareto Analysis - a statistical procedure that seeks to discover from an analysis of defect reports or customer complaints which "vital few" causes are responsible for most of the reported problems. The old adage states that 80% of reported problems can usually be traced to 20% of the various underlying causes. By concentrating improvement efforts on rectifying the vital 20%, you can have the greatest immediate impact on product quality.



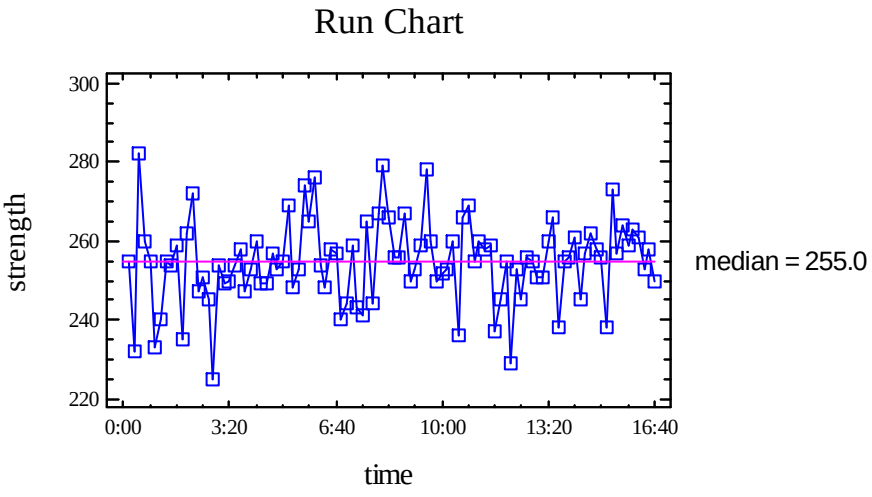
Cause and Effect Diagrams - illustrates the causes of a problem or effect by creating a diagram resembling the skeleton of a fish. It is often used to help identify the factors that need to be corrected. The diagram may also be used to display the variables that have an effect on a response that is to be optimized.



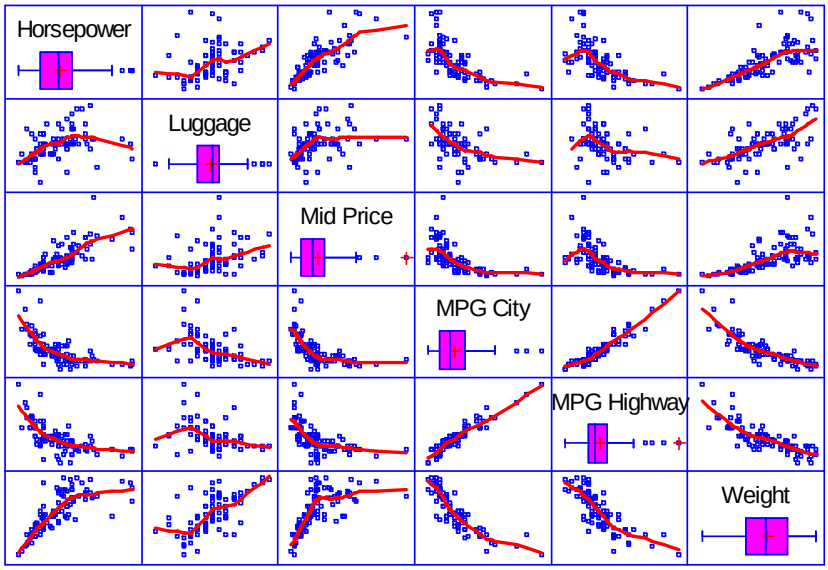
Measure

The second phase in the DMAIC strategy is one in which measurements are taken of process performance. The resulting data is displayed in different ways to show how well the process is operating.

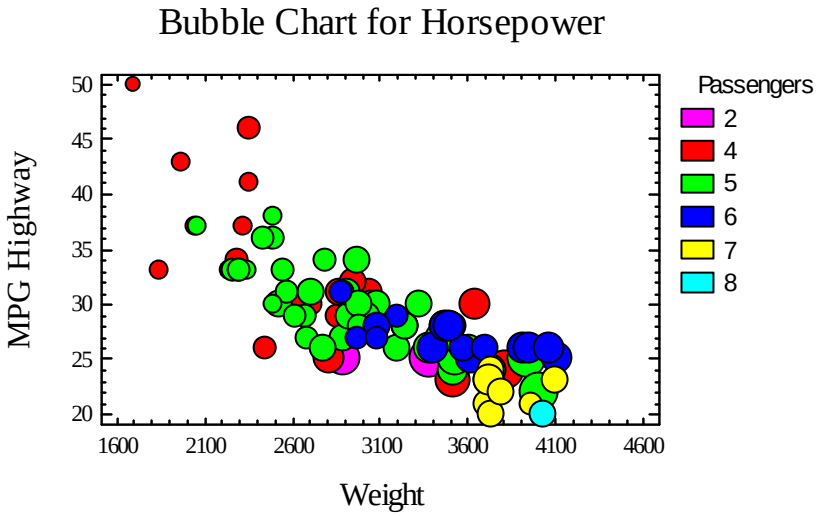
Run Chart - plots data in sequential order. Tests may also be performed on the data to determine whether they represent a random series, or whether there is evidence of mixing, clustering, oscillation, or trending.



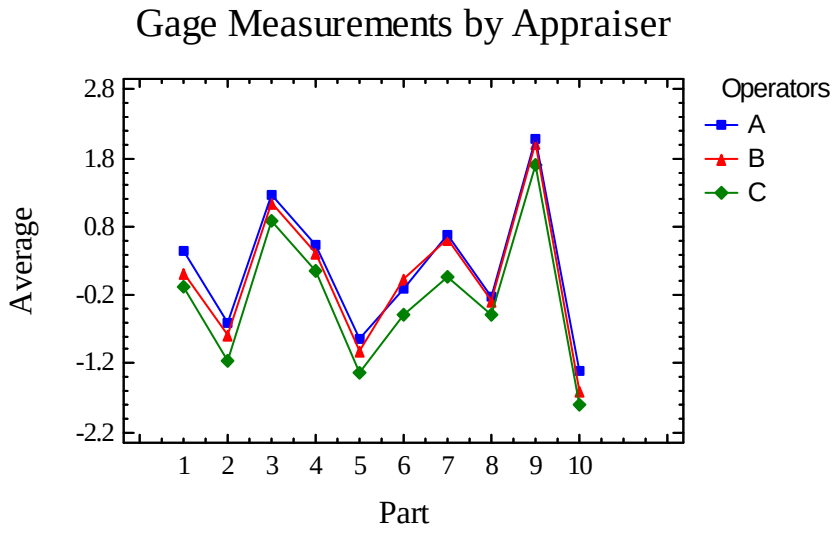
Scatterplots – plots of raw measurement data. When multiple variables have been measured, a matrix plot can be very helpful. The diagonal of the matrix contains box-and-whisker plots for each variable. The off-diagonal positions contain 2-variable scatterplots for all pairs of variables. From the plot, one can often detect relationships amongst the variables, the presence of outliers, and other interesting features of the data.



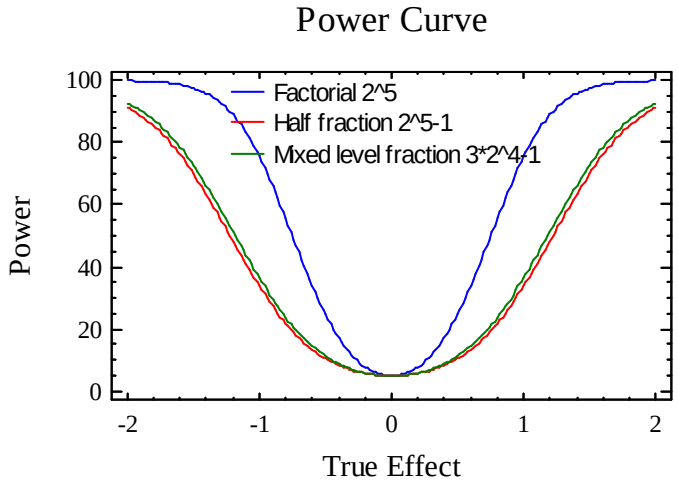
Exploratory Plots – used to illustrate different aspects of the data. A bubble chart plots two variables on the axes and displays the values of two others through the color and size of the points.



Gage Studies – used to estimate the repeatability and reproducibility of a measurement system. It also estimates important quantities such as the total variation, the precision-to-tolerance ratio, the standard deviation of the measurement error, and the percent of study contribution from various error components. Before embarking on any Six Sigma program, it is vital to insure that one's measurement system is able to measure adequately the variables that are critical to process quality.



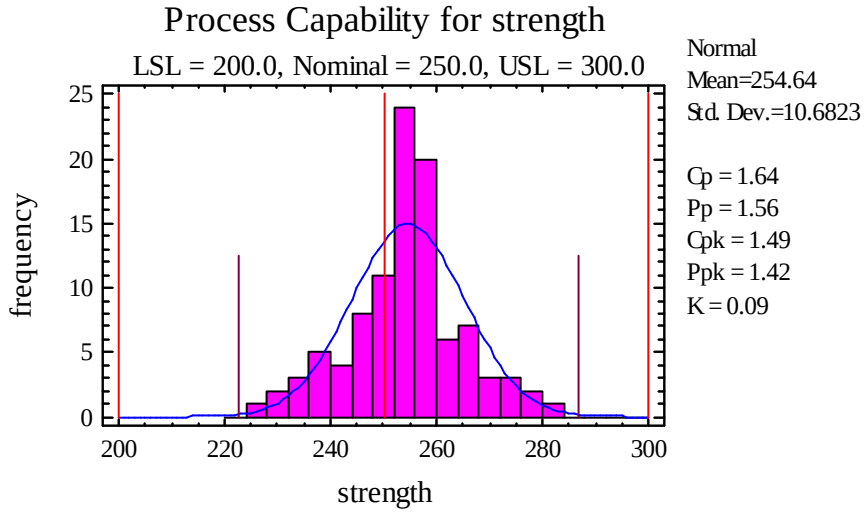
Sample Size Determination – calculates the required sample size for describing a process, for comparing two or more alternatives, for constructing a control chart, or for designing an experiment. Finding the amount of data needed so that the statistical procedures will have sufficient power while staying within budget is of obvious importance.



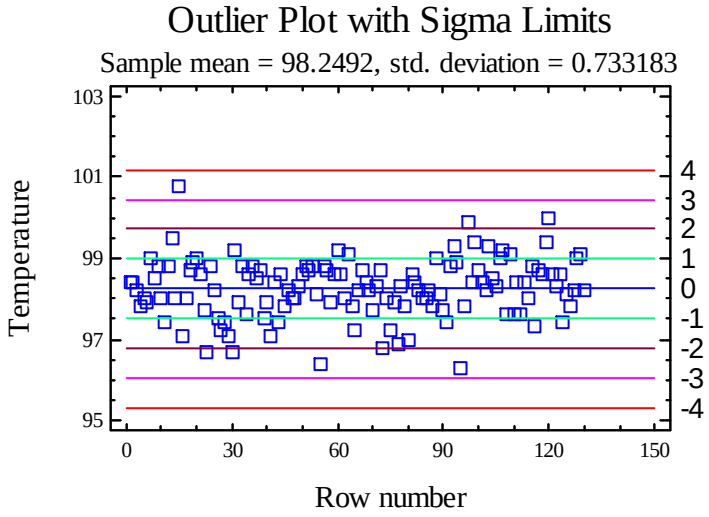
Analyze

The third phase in the DMAIC strategy is one in which statistical methods are used to analyze the data collected in the Measurement phase.

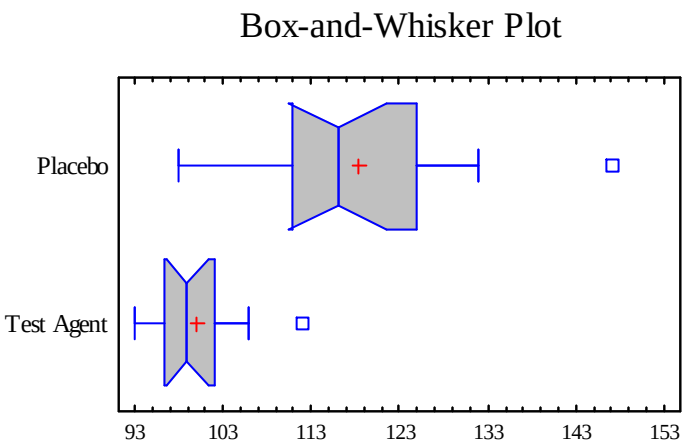
Capability Analysis – compares a sample of measurements collected from a process to established specification limits for that variable. An estimate is derived of the percentage of items likely to be out of spec. Also calculated are a variety of capability indices that compare the observed performance to the specification limits. Methods are available for handling data from both normal and non-normal distributions.



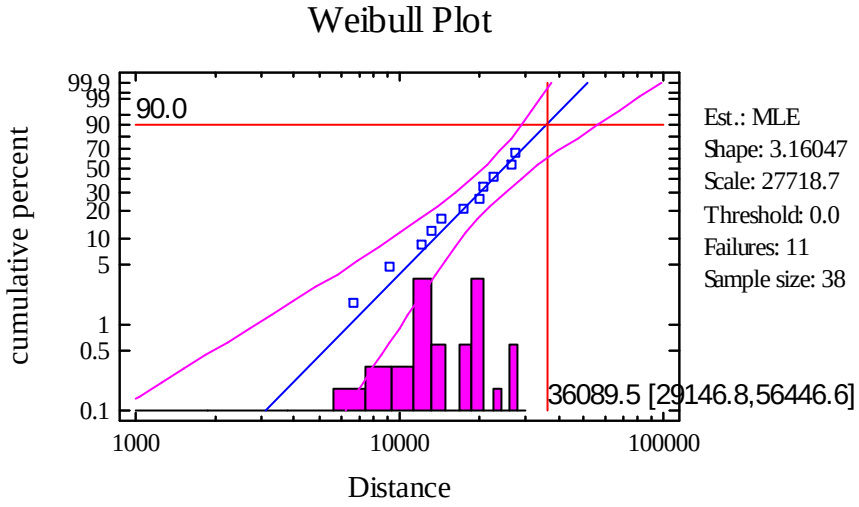
Outlier Identification – helps determine whether or not a sample of numeric observations contains outliers. An "outlier" is an observation that does not come from the same distribution as the rest of the sample. Both graphical methods and formal statistical tests are provided.



Comparison of Two Samples – performs statistical tests to determine whether or not there are significant differences between the populations from which the two samples were taken. Such tests are widely used, as when comparing a new treatment with an old treatment, when comparing a test agent against a control, or when comparing performance at two different locations.



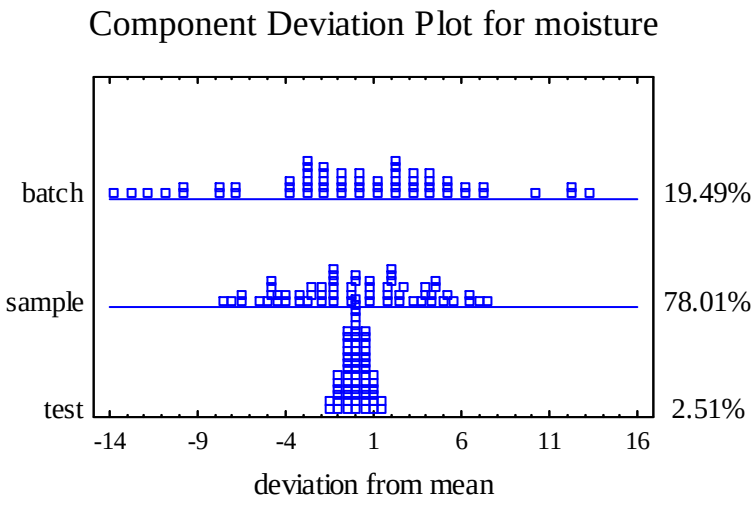
Weibull Analysis – used to analyze data representing lifetimes or times until failure. The data often include censoring, in which some failure times are not known exactly due to removals of items from the test. Estimates of critical quantities such as the 90th percentile (P90 value) can be obtained together with confidence limits.



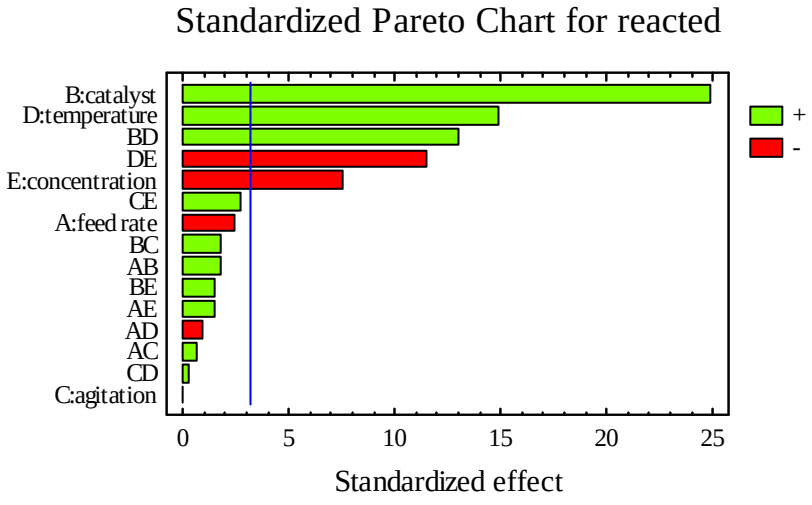
Improve

After analyzing the current state of a process, the next stage seeks to improve its quality. This stage involves the construction of statistical models expressing the relationship between key quality measurements and controllable factors. A vital technique at this stage is the statistical design of experiments, which insures that the most information possible is obtained from the smallest expenditure of time and money.

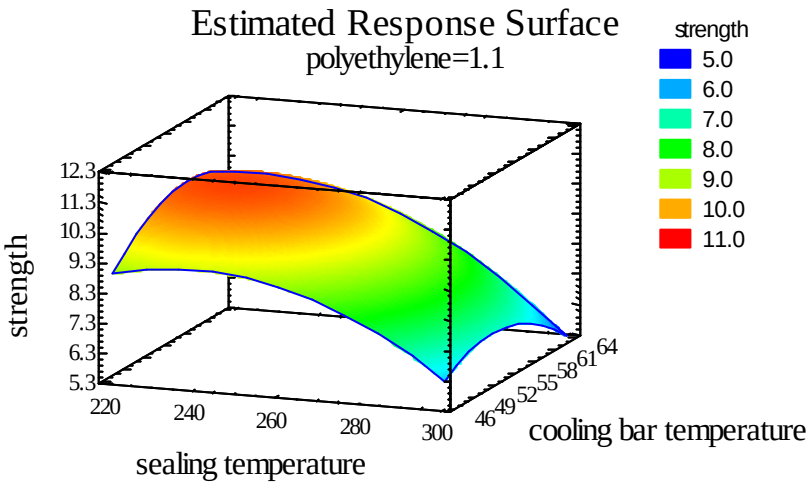
Variance Components Analysis – experiments designed to estimate the contribution to the variance of a process introduced at different points in the process. Such experiments are often performed to determine where to focus subsequent experiments in order to have the biggest impact on overall process variability.



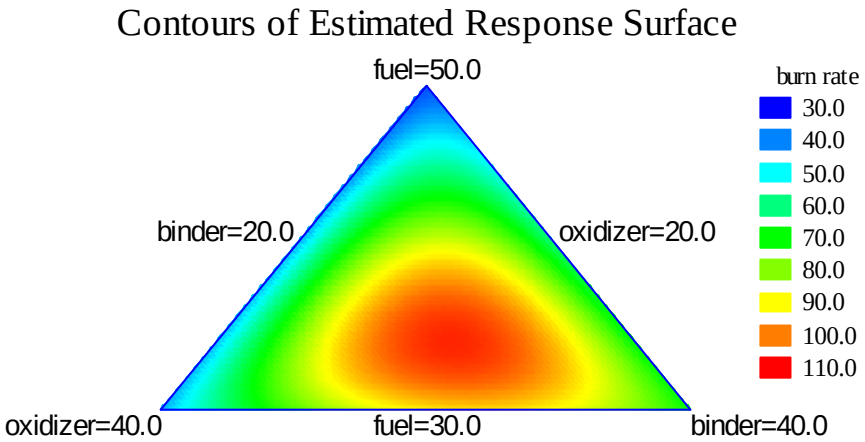
Screening Experiments – used to identify the factors that have the greatest impact on the quality of goods and services. These experiments usually involve many factors, some of which may interact with each other.



Optimization Experiments – used to find the ideal combination of controllable factors. The output of these experiments is a statistical model that can be graphed and mathematically optimized.



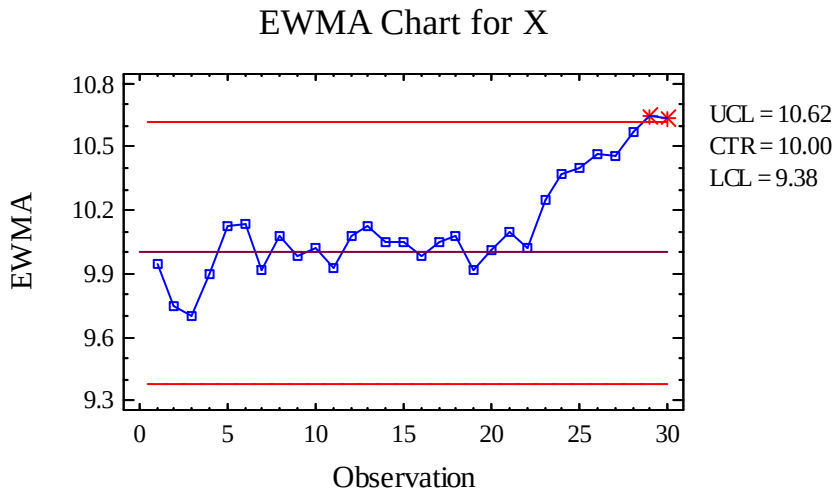
Mixture Designs – used to find optimal percentages of the components in blending problems. Special designs are needed due to constraints imposed on the sum of the components.



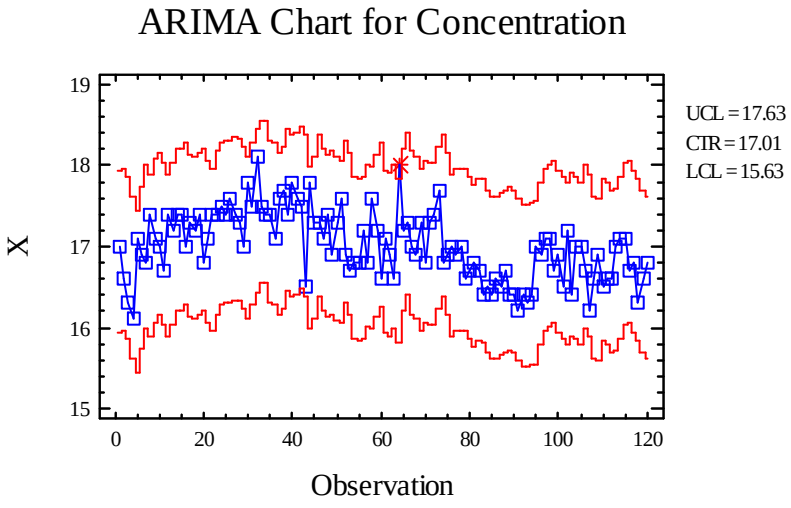
Control

Once process improvements have been made, it is vital that real-time monitoring be put in place to insure that the system does not return to its earlier behavior. Phase II control charts that plot data in real-time are important tools in this phase. Forecasting future behavior is also important, so that corrective action may be taken before problems arise.

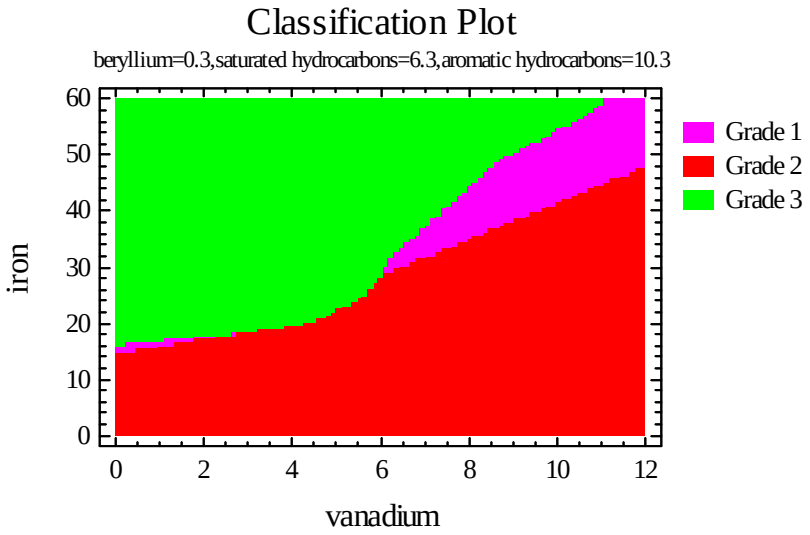
EWMA Control Charts – plots a weighted moving average of recent observations collected from the process. Such charts are generally superior to simple X Charts or X-bar Charts, since they can detect small shifts from the target mean more quickly.



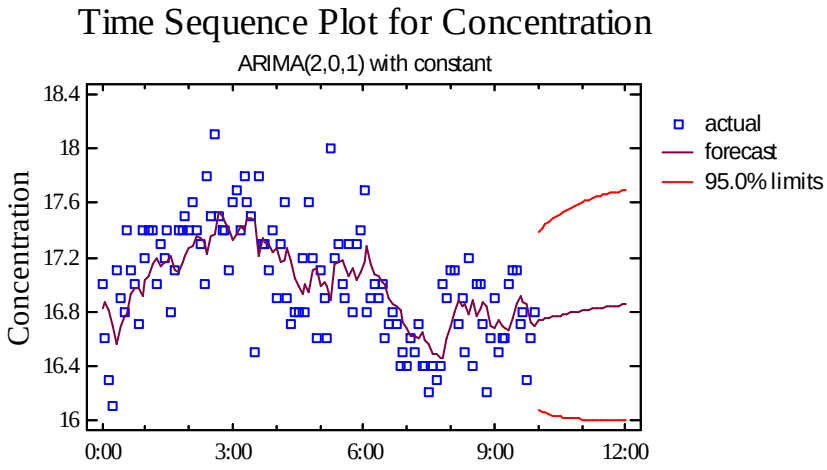
ARIMA Control Charts – used to monitor processes which are sampled at short increments of time. In such cases, consecutive observations are often serially correlated, so that typical control charts that assume independence between consecutive observations give too many false alarms.



Neural Network Classifiers – a nonparametric method for classifying observations into one of *g* groups based on *p* observed quantitative variables. When the quality of a product depends on multiple variables, separating good items from bad items often requires such a multivariate approach.



Automatic Forecasting – used to predict future behavior of a process so that adjustments may be made if needed. Automatic procedures fit many different statistical models and select the one that fits the historical behavior most closely.



Conclusions

To compete in the world market, companies have to move toward a Six Sigma level of performance. The preceding has been a very brief overview of a few of the more than 150 statistical tools available in STATGRAPHICS *Centurion* XV that can help achieve that goal.

In practice, integrating STATGRAPHICS *Centurion* into a Six Sigma program should translate into cost reduction and profit improvement because:

- It helps define specification limits and set realistic tolerances for machines and process variables through the use of capability indices.
- It helps companies set up a plan of action for processes that highlight out-of-control conditions and helps establish preventive maintenance controls to ensure that products meet specification requirements.
- It helps provide prevention plans during production with techniques for establishing and controlling critical machine parameters and product characteristics.
- It provides techniques that can reduce setup and process variability, and helps to standardize the use of SPC methodology.
- It contains methodologies for optimizing processes; for example, Design of Experiments techniques to identify and reduce causes of variation and to improve product/process manufacturability, design, quality, and functionality.

STATGRAPHICS *Centurion* can be an important component of any company's Six Sigma program. The combination of text and graphical information, accessed through an easy-to-use interface, addresses the largest impediments to success for any Six Sigma program by keeping all employees in the company engaged in the process of quality assurance. STATGRAPHICS *Centurion* provides Six Sigma statistical analysis and reporting for everyone.