Whitepaper

The 5 Key Benefits of Statistical Process Control

Using statistical process control to reduce the cost of quality and improve the bottom line.

Statistical Process Control (SPC) starts on the shop floor with an operator's tool called a control chart. Control charts provide immediate feedback to operators, enabling them to assess production line performance, be alerted to significant process changes, reduce manufacturing variability, and ensure product consistency. ***However, control chart usage should not define the entirety of a successful statistical process control deployment.***

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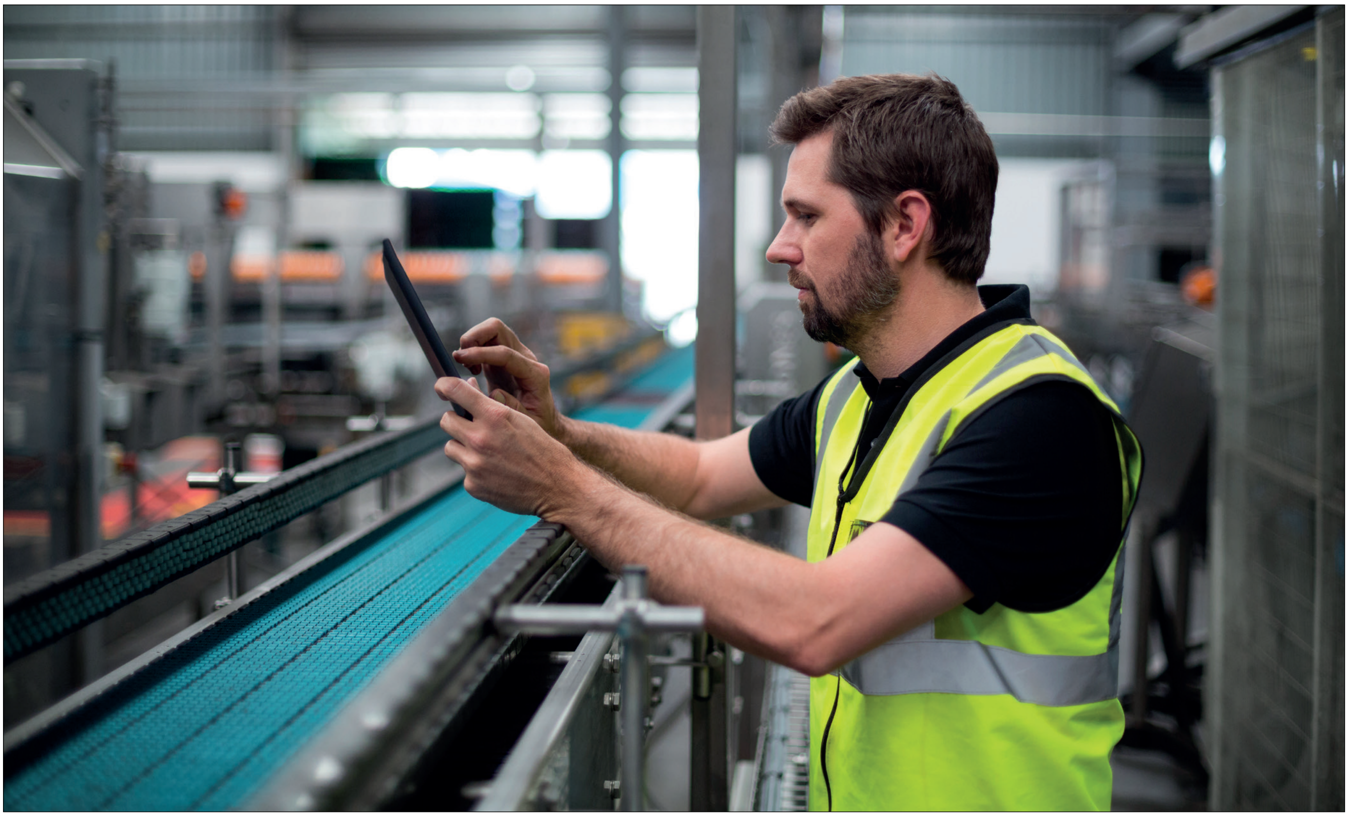
While SPC begins on the shop floor, the most successful deployments are those where data were used by engineers, quality professionals, and managers to make extensive, high-level improvements across their operations. And in those situations, control charts were rarely used. Yes, data were gathered on the shop floor and used by operators to control processes. But that same data can be re-purposed and aggregated across processes, products—even plants—to generate high-level insights that quality professionals could never produce using control charts or older software technologies.

One of the biggest mistakes organizations make is relegating SPC solely to the shop floor. Intelligently leveraging the data and information generated by an SPC system can improve business performance across an entire enterprise. In addition to dramatically lowering overall costs and improving efficiencies at the plant level, SPC can allow organizations to assess quality across the all their operations, enabling the identification and prioritization of strategic improvements that can result in great competitive advantage.

This white paper is written to highlight traditional, as well as modern, benefits of SPC that are accessible through advanced, affordable technologies such as Software-as-a-Service (SaaS).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1. Instantaneous Operator Feedback and Actionable Information

Again, it all starts on the shop floor with operators who use control charts. After periodic data collection, feedback is provided to operators as collected data is transformed into plots on a control chart—a picture of their data. It is likely that the operators will have multiple control charts to manage a variety of product features and characteristics (e.g., width, height, length, diameter), as well as process-specific features such as spindle speeds, temperatures, and dwell time.

The control chart tells operators if any of those features are significantly changing or remaining the same. Control chart usage is similar to how healthcare providers use an electrocardiogram (or EKG). An EKG is a means of measuring the electrical activity of heartbeats and provides healthcare providers with a means of viewing abnormal spikes or lapses in rhythm—anything too high or too low could indicate a health issue. Likewise, control charts enable operators to assess the health of their machinery. They alert operators when abnormal situations occur that could negatively affect the quality of the products they produce.

For example, say an operator works in a factory making chocolate candy bars. To the operator and to the company, bar weight is critically important. Too little weight and regulatory agencies and consumers become unhappy. Yet, candy bar weights higher than what's stated on the package are considered "giveaways," causing manufacturing costs to increase and profits to fade. In other words, weights need to be just right—not too heavy or too light—meaning the machines that make those bars need to be carefully controlled.

If the weights drift too low, spike too high, or change abruptly, then that information is immediately made available to an operator. Then, because the information is provided in real-time, operators can act upon the information right away, facilitating the prevention of potentially bigger issues (and costs) in the future.

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2. Enhanced Problem-Solving Abilities

Instantaneous feedback from control charts enables operators to determine how a production line is running and if the weights and other critical characteristics are consistent with historical performance. But there's more to learn from the data. Specific plot point patterns help operators and quality managers determine the type and source of problems they are encountering, thereby enhancing the ability to solve problems and understand process behavior.

For example, if a plot point suddenly exceeds a control limit, operators know that something atypical has happened, and immediate action is required to address what changed. If plot points have steadily increased or decreased over time, it indicates a gradual change in the process that could be the result of a completely different underlying issue. The different patterns and events highlighted by control charts are clues that empower operators, engineers, and quality professionals to effectively solve problems.

A folding carton company (think cereal boxes), located up in the northeastern corner of the country, was a vendor to a large consumer goods company. A customer was unhappy because the boxes received from the company were causing shutdowns in their own machines. The issues had compounded to the point that the customer began charging thousands of dollars per hour for downtime that resulted from the folding carton company's quality problems.

To address these quality issues, the company deployed SPC and control charts on their folder-gluers—the last important step in folding carton manufacturing. The operators had been trained in SPC several days before the deployment. A shop floor operator was running one of the folder-gluers when something interesting happened.

The machine operator was monitoring a couple of critical carton parameters and he plotted a point on a chart that fell below the control limit, indicating a significantly-lower-than-expected value. He immediately popped his head up, turned, and looked intently at the machine. He frowned and said, "That's weird. If the value is that low, then the machine should be jammed, but it's not."

He was encouraged to follow his instincts and more closely inspect his machine. He put down his tools and walked around the end of the folder-gluer; there he knelt and looked under the machine, where he thought the jam should be. Surprisingly, he found a small jam that, while impossible to see from far away, was causing a significant reduction in the performance of a critical product feature.

Generally, he had relied on cursory visual evaluations of the machine to assess whether or not there was a jam. The machine was running cartons that would result in problems at the customer's plant, but the folder-gluer was not acting like it typically would with that type of problem. The bottom line is this: the information from the control chart indicated there was an issue, which, coupled with the operator's experience, told him where to look to uncover the problem. Being new to SPC, the operator was shocked. He was amazed that the control chart told him not only that the machine had a problem, but where he should look to discover it.

The whole situation was a very positive experience for all the folder-gluer operators. If they had not been checking critical features every 30 minutes and using SPC to control the process, the issue could have gone unnoticed indefinitely. By combining the information from the control chart with his own manufacturing knowledge, the operator quickly resolved the problem and prevented a very expensive situation from getting much, much worse.

Further, because the situation was discovered before packing and shipping, none of the defective cartons were received by the customer. Unnecessary customer downtime and the associated thousands-of-dollars-per-hour fees were avoided. By using the instantaneous feedback and actionable information from SPC, the operator minimized costs and prevented a costly issue from ballooning into an expensive customer problem.

By using instantaneous feedback and actionable information from SPC, operators can minimize costs and prevent costly issues from ballooning into expensive customer problems.

3. Product Consistency Now and Over Time

Product uniformity is extremely important to manufacturers—not only for cost savings from prevention of scrap, rework, and overfill, but also to ensure ongoing customer satisfaction and compliance with regulatory standards.

A major manufacturer of automobile transmissions encountered a spike in warranty claims for transmission problems about two years after the rollout of a new vehicle. Upon investigation, the quality team determined that the transmissions were being made in two different locations. While the quality guidelines were identical, the machinery used to manufacture the products was different in each plant.

Inspection of transmissions and their detail parts from each location revealed that all the transmissions from both plants were within specification limits. However, critical dimensions of various parts from the transmissions from Plant A were much closer to engineering targets and exhibited very little variation. However, the transmissions from Plant B showed far greater variation, even though all parts fell within the specification limits. Again, none of the transmissions contained out-of-specification parts, and yet Plant B had significantly higher warranty claims than Plant A.

Generally, target values (as identified within specification limits) are a design engineer's preferred dimension that, when manufactured to target, generate the best form, fit, or function for the part. In other words, the preferred, ideal manufactured value is the target. Upper and lower specification limits are considered acceptable deviations from the target—yet the target is still preferred. Engineering designs work best when parts are manufactured close to targets, as they tend to fit better with mating parts. With a better fit, gears and shafts in transmissions slide together more smoothly and tend to not cause interference fits and related warranty failures like the ones in the transmissions with parts with higher variations. The moral to this story? Minimize variability around target to increase product quality and consistency—exactly what SPC helps manufacturers do.

Moreover, by reducing variability around the target, small changes in machine performance lessen the possibility for parts to fall out of specification, thus preventing potential downtime, scrap, and rework. Minimizing product variation reduces the probability of creating bad parts and increases confidence in a machine's ability to produce consistent products—even with more challenging tolerances.

When this level of consistency is achieved, products on those lines don't have to be inspected as often, thereby minimizing inspection costs. The bottom line is that SPC helps companies continuously reduce product variability and improve consistency while reducing the potential of warranty claims.

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4. Lower Your Costs of Quality – Even When Nothing is Out of Spec

Ever heard of a manufacturing operation that is so good that it doesn't produce out-of-spec products? While unusual, they exist. These organizations are generally satisfied with their performance and believe there is little they can do to improve it. Yet, some of the greatest bottom-line quality results I have experienced have been while working with these types of companies. Even if everything is produced within specifications, there are still big opportunities for reducing costs.

Spec Limits vs. Target: Where to Focus

Engineers define specification limits as a means of defining customer requirements. Spec limits are also created to provide guidance for the fit, form, or function of product characteristics. Technically, if parts are manufactured within the specific upper and lower limits, the final product should function as intended.

What about the Target? Generally, Targets represent the ideal dimension, or the size, of the feature that is preferred. Since perfection is unobtainable and variation is inherent in all manufacturing processes, upper and lower specification limits represent the amount of allowable variation before fit, form, or function will either degrade or fail.

There are many definitions of quality, but the one that many professionals use is this: Quality is minimizing variation about the Target. So, instead of obsessing about products fitting within specification limits, manufacturers should consider doing everything they can to get closer and closer to target.

If that were the goal, then the motivation would be to search for, uncover, and remove the sources of variation present in every manufacturing operation.

By continually reducing variation around the target, product quality increases, costs are reduced, and it's less likely that out-of-specification products will be produced, thereby lowering overall costs of quality. Thus, the key to reducing variation and improving long-term product quality is focusing efforts on hitting targets, rather than being content with making products that are in spec.

Take for example a spirits manufacturer I worked with who was originally skeptical about using SPC. Their rationale? "We haven't had any products fall out of spec for this entire year. So, what could be improved?"

Their production lines utilized 30-plus rotary head fillers that could fill thousands of bottles in one hour—a very fast and efficient process. But, as previously discussed, not all machines are identical, so it was logical to want to understand how machinery varied and the resultant variability in product quality. Of course, the company had to meet the minimum fill volumes as stated on the bottles, whether 750 milliliters, 500 milliliters, or one liter. Because the liquid spirits filling the bottles were so expensive to produce, they also tried to minimize overfill.

To understand fill volumes, the operator randomly selected five filled bottles off the line every 30 minutes. Filled bottles were weighed, tare (unladen) weights were subtracted, and fill volumes were calculated. Over several weeks of data collection, the quality team was proud to report—as expected—that no fill volumes exceeded either the upper or lower specification limit. Everything was in spec.

Yet the plant manager was adamant about cost savings. He implored the team to seek out cost reductions wherever they might be found. When the data was closely examined, it was discovered that every bottle was not only within specification limits, but every bottle was also overfilled. None of the bottles was overfilled to the point of spillage or waste, but overfilled nonetheless. 755 milliliters of a spirit in a 750-milliliter bottle is happy news for the consumer, but it's lost money for the manufacturer.

To better understand overfill, the quality team turned to software to analyze the variables that could affect fill performance. Statistical tools such as Box and Whisker charts (and others), were used to analyze fill volumes by machine, fill head, shift, day of the week, product code, and other variables. Basically, the data were aggregated over a long period of time, then scrutinized in various ways to uncover where unnecessary manufacturing variability existed and the resulting effect on fill volumes.

Unsurprisingly, a great number of significant sources of variability were uncovered. For example, every fill head performed slightly differently, resulting in inconsistent fill volumes from one head to the next. Further, there were differences in fill volumes from one shift to the next and from one bottle size to another. The team endeavored to control the primary sources of variation in order to reduce overall fill volumes.

Standard Operating Procedures (SOPs) were put in place, fill heads were adjusted, and maintenance items were identified to decrease variation, ensure consistency, and reduce the overall amount in each bottle without going below the minimum stated volume. In the end, the savings from overfill alone exceeded $800,000 a year on a single production line. Similar savings applied across all of the plant's production lines would save them an estimated $20 million dollars a year—savings enjoyed from products that never exceeded a specification limit.

It's clear that one of the great opportunities for quality improvement is the analysis of forgotten data—that which falls within specification limits. For this bottler, nothing was out of spec. No waste, no scrap, no concern with exceeding specification limits. And yet, the savings for just one plant were extraordinary.

5. Pinpoint Opportunities for Improvement Across the Enterprise

One of the key learnings from the spirits company discussed above is that the management team had no idea they were overfilling as much as they were. And they had no idea that they could save so much money. The information was hidden from them because they felt that, since everything was in spec, there were no additional opportunities to improve. The data were there, they just didn't look at them.

That's fairly common. Unless shop floor quality data indicates a problem, the data are all but ignored by quality teams, engineers, and managers. When organizations make the mistake of relegating SPC solely to the shop floor, they eliminate the possibility of making huge improvements—like those experienced by the spirits company. There is rich information contained within data that have been collected on the shop floor. Organizations just need to regularly review that data to generate huge potential gains in quality and cost.

Not only does the use of SPC enable companies to uncover previously unknown information, but if they roll up the data across multiple production lines, they (whether plant floor managers or corporate quality professionals) can pinpoint and prioritize opportunities for improvement across their entire operations.

When companies roll up and aggregate data in this way, they are no longer just comparing product-to-product and line-to-line, but also plant-to-plant. In any SPC deployment, shop floor quality data are gathered on critical characteristics across the company. In smart manufacturing facilities, all the data are entered into a database—data from each quality check on each production line of each product code in each facility across the manufacturer's entire operation. Quality professionals, Six Sigma teams, and engineers can mine those data for insights about overall operations. These data paint the bigger picture of quality across the enterprise and the results can be extraordinary.

A packaging manufacturer was going to shut down one of its plants because its quality was the worst of more than 20 operations. The closure would have put hundreds of people out of work in a small community that couldn't afford such a hit. Instead, management decided to install SPC software at the plant and see if there was any chance to improve quality. By measuring critical characteristics and key performance indicators across all production lines and product codes in the facility, the management team uncovered a rich stream of information that revealed insights for how to quickly and effectively eliminate their quality problems. As a result, within just four months the plant had all but eliminated defects in its finished products.

Aggregated, summarized data provides the "big picture of quality" to those who can drive big change and improvement across all plants.

By summarizing the shop floor data and evaluating the big picture, plant management discovered high-level issues—as well as lots of improvement information—which enabled them to concentrate their efforts and improve quality on many levels. The result? The plant went from "worst to first" in quality across the entire corporation.

Within that four-month period the plant reduced their overall parts per million (PPM) defect levels from highest to lowest as compared with all other plants. As a result, the plant was saved from closing, and their customers, impressed with the gains in quality, began ordering more products from the plant. It was a win-win situation for customers, management, employees, and the entire town.

Improving quality makes any company more competitive, enhances its reputation with customers, reduces warranty claims and customer services calls, and increases profitability.

The plant became the model for how to dramatically improve business performance through the use of quality intelligence.

Imagine, though, if the company had done this across all their plants. They would have been able to gather quality insights across the corporation, enabling the management team to prioritize capital improvements and deploy quality resources where the greatest gains could be had in the shortest amount of time. Doing so would provide the management team with a strategic advantage for generating cost savings that would help the entire company improve its performance—and its bottom line.

That's the power of aggregated, summarized data. It provides the "big picture of quality" to those who can drive big change and improvement across all plants, even into the supply chain.

The most successful organizations regularly perform high-level data aggregation and reporting. It's a profitable endeavor, and it assures management that the most important quality issues are being identified and dealt with in an expeditious, intelligent manner. The more that SPC is applied to aggregated, high-level data, the bigger the return and the larger the benefit. And yet many companies do not understand that, with today's technology, valuable statistical analyses can be easily applied to corporate data—since SaaS systems typically house data from multiple plants in a single database repository. That means data access is easy, analysis is simple, and like several of the examples reviewed in this white paper, the bottom line benefits can be transformative.

Because of the daily "fire-fight" of quality, high-level data aggregation and analysis is not commonplace. Manufacturers need to make it a habit. They need to realize that it's okay to hit the pause button, step away from the daily fires, and aggregate the data that they already have. They need to do this on a regularly-scheduled basis. Some do it weekly, others on a monthly interval, and still others only once per quarter. Regardless, regularly-scheduled data analysis meetings like these can bring great benefits to an organization, and help demonstrate that forgotten data can be profitable. It's a matter of switching from a micro to a macro view of quality: rather than focus solely on the plant floor, simply re-purpose that data by aggregating it across multiple production lines, products, and plants.

InfinityQS®
Quality Re-imagined

The difference in cost savings alone will justify any quality investments. Improving quality makes any company more competitive, enhances its reputation with customers, reduces warranty claims and customer services calls, and increases profitability. Uncovering opportunities for cost savings, waste reduction, and overall improvement results in direct increases to a company's bottom line.

If you're not sure where find the greatest opportunities for improvement, or just don't know where to start, we can help.

InfinityQS has SaaS quality solutions, industrial statisticians, and Six Sigma Black Belts on staff who can take a cross-section of your data, aggregate it with our Enact™ Quality Intelligence platform, and pinpoint specific opportunities that will help you make a difference at your company.

Want to learn more? Visit www.infinityqs.com/enact to see Enact in action.

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