Whitepaper

InfinityQS®
Quality Re-imagined

Enlightened SPC for Modern Manufacturing

Can your SPC solution keep up with today's manufacturing demands?

Today's manufacturers must manage ever-expanding levels of process sophistication while facing increased pressure from both competitors and customers. Statistical process control (SPC) software provides the means to monitor and improve process and product quality—or does it?

The Evolution of Intelligent Requests

Modern manufacturers produce more products across more lines (or more sites) than ever before. To optimize your processes and produce the highest quality products, you need insight into the behavior and quality of the twenty-first century manufacturing plant:

- How does a specified machine operate across multiple part setups?
- Which machine, or set of multiple available machines, produces the best output for single parts? Which machine, or set of multiple available machines, produces the best output for single parts?
- How does a machine operate across settings?
- Which production line is most efficient and effective?
- Are multiple characteristics of the same part all in control?

Many SPC software providers claim to support this type of functionality. But if getting this information requires constantly exporting, importing, and manipulating data outside of your SPC software, how much functionality are you really getting?

The Problem with Old-Fashioned SPC

Originally, SPC was performed using pencil and paper. With the advent of SPC software that could store thousands of data points to one file, those paper charts were transformed into computer files: one file for each part. That meant a multitude of files, but it was a vast improvement over hand calculations and let manufacturers quickly chart and summarize part data. Each part profile contained data for that part's monitored characteristics:

- Part number
- Measured characteristics
- Specification limits
- Subgroup size
- Tag fields (e.g., machine serial number, lot, operator name)

Life was good for SPC practitioners—for a while.

A Missed Opportunity

With the introduction of relational databases, separate files were no longer necessary to house data from different parts. Accordingly, some SPC companies modified their software to write all data to one centralized database on a shared server. This approach was far superior to managing individual files.

Yet when these SPC software companies converted from files to a database, they missed a major opportunity: abandoning the old part profile-based logic in favor of a far more powerful and flexible data organization. Instead, they chose a simple upgrade path for their existing Microsoft DOS (Direct Operating System) users, one that offered a familiar logic and easy conversion of legacy SPC files. They maintained the same file-based logic even though new database products supported more modern, sophisticated functionality. In these SPC software solutions, part profiles (aka *part groups*) were—and still are—defined in the top hierarchy of the database. All characteristics, specifications, control limits, tag fields, gauge setups, and so on are configured within each part profile.

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Unfortunately, this organization promotes the same limitations as storing the data for each part in a separate file. Data for each part is stored to separate locations within the database. Thus, querying and analyzing data across part profiles can be a clunky process—if it is possible at all.

A Frustrating Tradeoff

Given today's ever-increasing demands on shop floor data, what seemed like a logical path when relational databases were new has become a massive nightmare. Even as SPC software developers add features and improvements to their offerings, the underlying data organization and setup logic keep manufacturers trapped by some of the same restrictions as the paper charts of old.

When storing data using this conventional file-logic method, you are always faced with a tradeoff: your files must be either part specific or process specific. No matter how many features most SPC software might offer, if the underlying code writes data to a database using a file-based structure, this tradeoff between part control and process control must exist. Given this choice, most manufacturers stick with a part-specific organization, deciding that customer Cpk reports are more important than organizing around a process hierarchy.

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Limited Flexibility

In an attempt to keep up with modern data demands, some SPC software companies have added the ability to set up short-run files (i.e., short-run groupings within the database), in which multiple parts can be incorporated into one part profile. These short-run files can theoretically provide process control across multiple parts.

But there's a catch: few changes can be made after these short-run files are configured. So before you set up the file structure, you need to know which types of comparative analyses you will need.

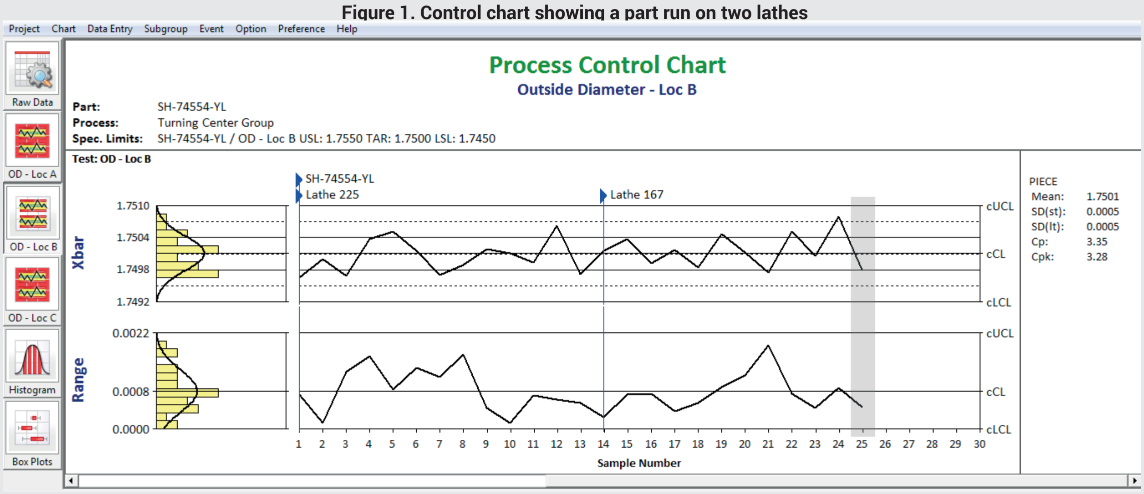
Also, if more than one machine runs the same part, that part will eventually show up in multiple short-run process files. When you're ready to generate customer Cpk reports, the software will need to go into each file, cherry-pick specific parts, and combine them on another chart for the customer—a challenging and sometimes impossible task.

With these types of constraints, you'll need to forget about flexibility. Forget about producing process control charts that require data from multiple part profiles or across multiple part groups. In short, forget about using your SPC software to gain true process knowledge, business efficiencies, and product quality improvements.

No Way Out

Think this talk of tradeoffs is overly dramatic? Suppose you've set up a part profile within your SPC software. After defining the necessary fields, you begin collecting and charting data. A few days pass, and you need to run the part again—but this time, the part is set up on a different machine (i.e., Lathe 225 instead of Lathe 167). But this switch should be no problem, because you anticipated that the part would be run on multiple lathes. That's why you set up the machine number as a tag field. You begin collecting more data, starting with sample 13. The resulting control chart (Figure 1) contains data from both machines.

Figure 1. Control chart showing a part run on two lathes



But something doesn't look right. The problem is that different processes produce different statistical results. Mixing data from two different processes on the same control chart is a huge statistical problem. Even if identical, different machines should be expected to have different levels of performance. Therefore, performance measured in terms of central tendency and variability should be expected to be different also. The bottom line is that one should never place data from two different machines on a single control chart. It's not just bad practice—it's bad statistics.

Is Your SPC Software Stuck in the Past?

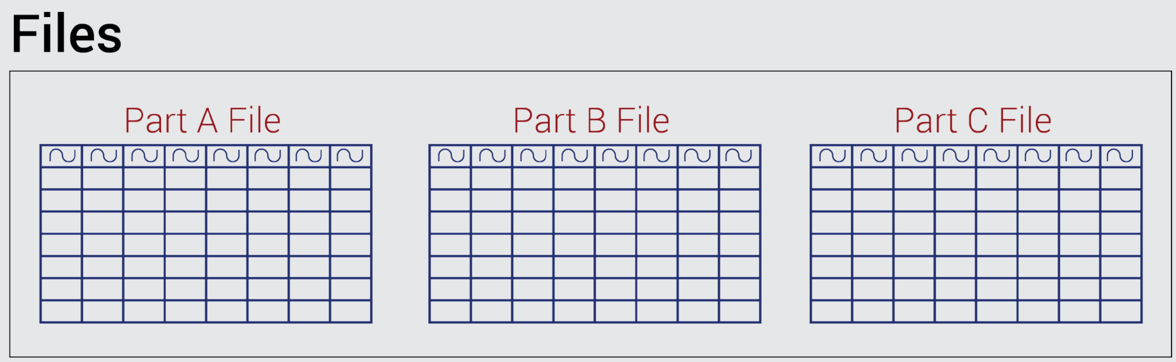
Do you keep saving data from different machines in the same part profile, or do you bite the bullet and set up separate files for each part/machine combination? Mixing machines in the same part profile keeps all the data from the same part in one place but makes your control charts suspect and compromises the validity of the resulting Cp/Cpk ratios. But setting up separate part profiles for each part/machine combination is not practical. For a plant with 12 machines and 100 part numbers, you'd need to create 1,200 part profiles. That's time-consuming for an administrator. But imagine asking an operator to sort through 1,200 files to find the exact one they need. Searching, sorting, and locating a specific file among 1,200 can be problematic for operators and time-consuming as well.

Even worse, what would an operator do if the data from one part resides in multiple files? And when multiple parts reside in multiple different files, how does an administrator run customer Cpk reports? Both could be daunting tasks.

How can you determine whether a given SPC software product uses outdated file logic and will force you into this no-win choice? To tell if your SPC software has this legacy problem, ask yourself two questions:

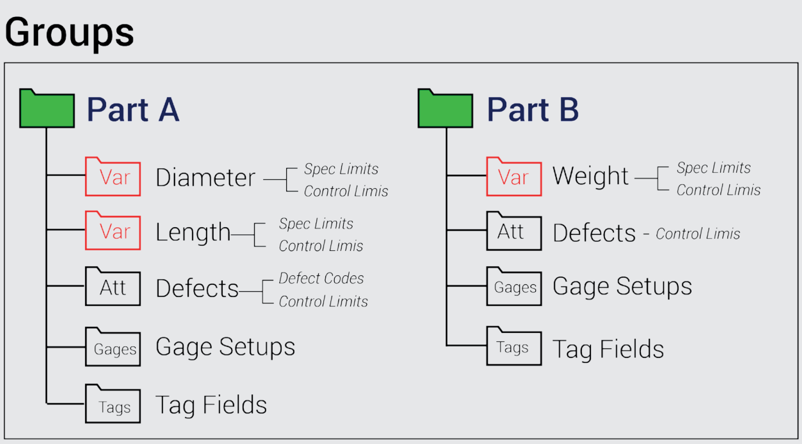
First: Does the SPC software use multiple files to house measurement data from different parts or processes **(Figure 2)**? If so, the software may have the problem.

Figure 2. Flat file SPC software, with a separate file for each part



Second: Is the software structured so that a part (or process) is at the top of the hierarchy, with test characteristics, specifications, control limits, and tag fields configured under the part profiles **(Figure 3)**?

Figure 3. Multiple independent part profiles in an SPC database



If you answered "yes" to either of these questions, your SPC software is stuck in the past. Both conditions are identical in logic.

Thoroughly Modern SPC

Does a solution to this old-school problem exist? Yes. SPC software that delivers true process control ditches the old paper-based logic in favor of a modern approach. Rather than part profiles, imagine a table within a normalized relational database. This table is filled with raw measurement values: each value (i.e., each row in the table) is related to items (e.g., parts, processes, test characteristics, tag fields, defect codes) in other tables.

Under this data-storage method, no rigid relationships are stored in the database. The part no longer sits at the top of the hierarchy. Neither does the process. Instead, three tables share the top spot:

› Part

› Process

› Test

This setup is known as a PPT structure. With this method, there are no files. Each data value in the database is related to a part, a process, and a test characteristic **(Figure 4)**. Any user who queries the database has full control over how to send data to the database and how to retrieve the data for display. There are no hierarchical restrictions related to either part or process.

Figure 4. Database table containing all measurement values, each identified with a part, process, and test

	Sgrp Time	Size	Part	Process	Test
1	2017/08/07 14:01:18	3	SH-74554-YL	Lathe 167	OD - Loc A
2	2017/08/07 14:01:18	3	SH-74554-YL	Lathe 167	OD - Loc B
3	2017/08/07 14:01:18	3	SH-74554-YL	Lathe 167	OD - Loc C
4	2017/08/07 14:01:18	3	SH-74554-YL	Lathe 167	OD - Loc C
5	2017/08/07 14:01:18	3	SH-74554-YL	Lathe 167	OD - Loc C
6	2017/08/07 14:01:18	3	SH-74554-YL	Lathe 167	OD - Loc A
7	2017/08/07 14:01:18	3	SH-74554-YL	Lathe 167	OD - Loc A
8	2017/08/07 14:01:18	3	SH-74554-YL	Lathe 167	OD - Loc B
9	2017/08/07 14:01:18	3	SH-74554-YL	Lathe 167	OD - Loc B
10	2017/08/07 14:00:54	3	SH-67222-BL	Lathe 167	OD - Loc C
11	2017/08/07 14:00:54	3	SH-67222-BL	Lathe 167	OD - Loc C
12	2017/08/07 14:00:54	3	SH-67222-BL	Lathe 167	OD - Loc B
13	2017/08/07 14:00:54	3	SH-67222-BL	Lathe 167	OD - Loc B
14	2017/08/07 14:00:54	3	SH-67222-BL	Lathe 167	OD - Loc B
15	2017/08/07 14:00:54	3	SH-67222-BL	Lathe 167	OD - Loc A
16	2017/08/07 14:00:54	3	SH-67222-BL	Lathe 167	OD - Loc A
17	2017/08/07 14:00:54	3	SH-67222-BL	Lathe 167	OD - Loc A
18	2017/08/07 14:00:54	3	SH-67222-BL	Lathe 167	OD - Loc C
19	2017/08/07 14:00:52	3	SH-67222-BL	Lathe 167	OD - Loc C
20	2017/08/07 14:00:52	3	SH-67222-BL	Lathe 167	OD - Loc C
21	2017/08/07 14:00:52	3	SH-67222-BL	Lathe 167	OD - Loc C
22	2017/08/07 14:00:52	3	SH-67222-BL	Lathe 167	OD - Loc B
23	2017/08/07 14:00:52	3	SH-67222-BL	Lathe 167	OD - Loc B

The benefits of a PPT structure fall into three distinct categories:

- Setup
- Data entry
- Data display and analysis

Benefit 1: Setup

Part numbers, processes, test characteristics, specification limits, control limits, defect codes, assignable cause and corrective action codes, traceability fields and employee names … everything is written to separate tables in the database. Combinations of items are related only at the subgroup level; that is, only when data is entered into the database, and only for one subgroup. No preconceived relationships need to be configured in this database.

Data collection can be as flexible as product coming off the line. When necessary, each collected value, even from within a single data collection session, can be related to a different part, process, and test. This is critically important, especially when collecting data against assembled finished goods.

For example, for a glass container, operators might inspect the label, the lid, the contents, and the condition of the glass. The quality of each of these "component parts" is controlled by different processes. Troubleshooting is far more efficient when the data values are properly assigned to the appropriate PPT combination.

Benefit 2: Data Entry

Data-entry users (such as shop-floor operators) can click a single button or select an image on a dashboard to select the part they want to measure. Manufacturers who make hundreds or thousands of different parts on lots of different production lines no longer require operators to sift through thousands of files to complete their jobs. Instead, operators can select the specific part, process, and test from lists. At the same time, they can even select a process or a different test for each data collection. You can also link control charts to the selections that are made during data entry. Therefore, if an operator selects a different part during data entry, all charts dynamically change to the newly selected part.

Suppose that overall length/Part A was the last entered subgroup. The control chart shows the current and historical length measurements from Part A. But if during the next data entry, the operator selects Part B and measures diameter, the chart dynamically switches to show the current plot point and historical data for diameter/Part B. This type of change is possible because the charts can be linked to selections made by the operator.

If an operator changes the part, process, or test during data entry, the chart automatically switches its data selection to match the most recent part/process/test data-entry combination. Theoretically, no matter how many part/process/test combinations exist, only one data-entry procedure is required; you no longer have to know the types of comparative analyses you will need before you set up your file structure.

Benefit 3: Data Display and Analysis

Because charts are not tied to any predefined part profile or configuration, they are open to display any conceivable part/process/test combinations. Simply open a chart's data selection and pick any combination of databased items to include in, or exclude from, the graph. The available data is not determined by how data got into the database, so multiple parts can be displayed on the same chart—even if some part data are collected in real-time across multiple workstations while other part data are imported from a supplier-provided text file, and so on.

What does this mean, in practical terms? One user might want to directly compare how a particular machine creates an outside diameter, regardless of the part number or feature size.

Another user who wants to determine which machine runs outside diameters the best might want to create a box-and-whisker plot that displays all the machines that produce outside diameters.

Both users can achieve these goals, on one chart, without having to export or manipulate the data manually or in another software program. Unlike conventional hierarchy, the PPT database method provides an endless number of query possibilities, limited only by the user's imagination.

An SPC Solution for Modern Times

InfinityQS has never stored data using flat-file logic. InfinityQS SPC software uses the PPT structure not only for saving and retrieving data, but also for defining control limits. You can store a different set of control limits for each part/process/test combination.

Reconsider the two-process dataset example used earlier. InfinityQS allows you to display both processes on the same chart **(Figure 5)**.

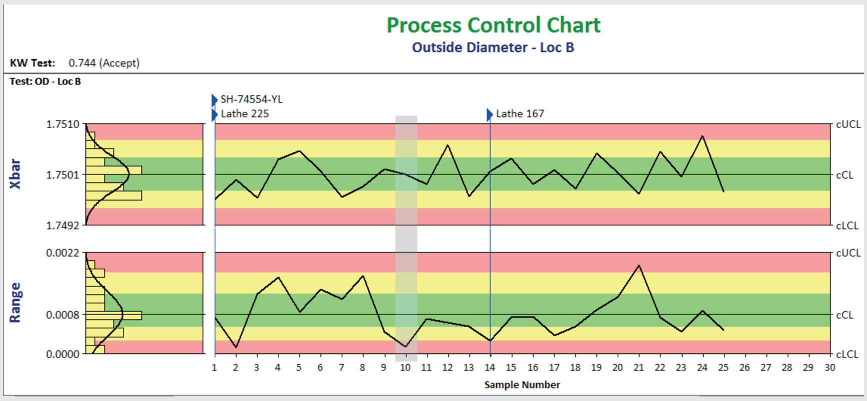


Figure 5. Charting a part run across two processes

If the two processes are similar, the processes share the same control limits. But otherwise, InfinityQS automatically changes the control limits whenever a process changes.

Note that the KW test—a non-parametric statistic used to verify whether the variability across both processes is similar—rejects the chart, with a probability value of 0.009. This value indicates that there is a 99.1% chance that the two processes' variability differs. Therefore, the correct way to display this data is to use separate control limits for each process **(Figure 6)**. In the correct display, you can clearly see the differences between Lathe 167 and Lathe 225.

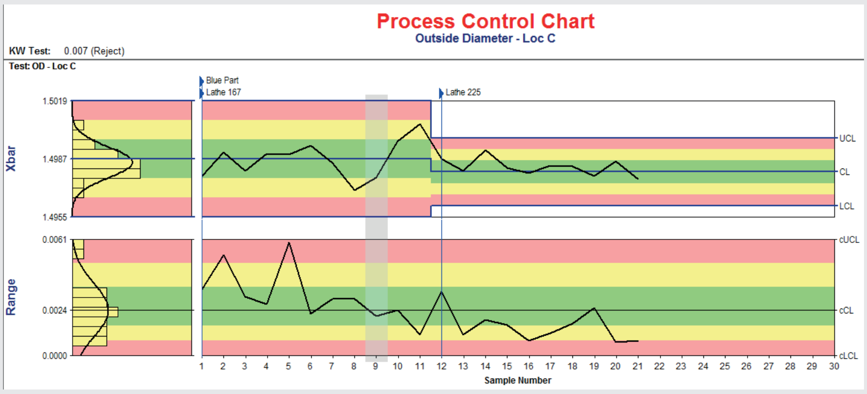


Figure 6. Automatic switch to accurate display of part run across two processes

But this chart is not a process control chart; it is merely a part control chart. To see process control, you need a way to display all the parts that are run on a machine, regardless of feature size.

Fortunately, this type of chart **(Figure 7)** is easily managed within InfinityQS because of the way this SPC software stores data. You can produce a standardized control chart that plots data in units of standard deviation. For example, the chart in Figure 7 shows how two parts, with different nominal sizes, ran on Lathe 167. InfinityQS supports hundreds of specialized control charts.

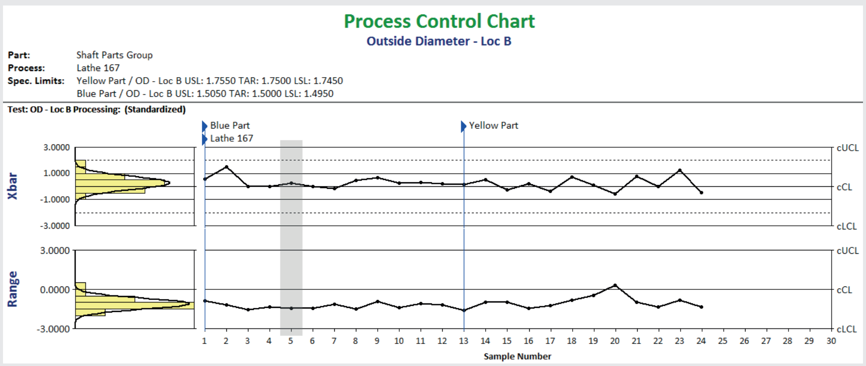


Figure 7. True process control chart

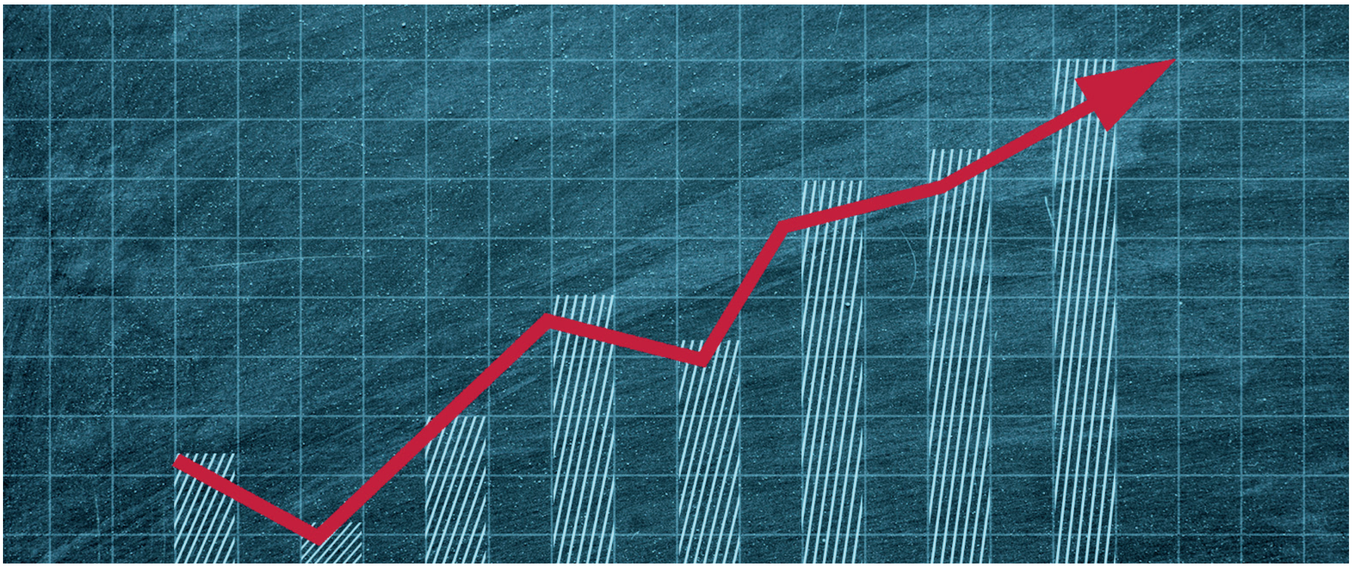
With InfinityQS, you get the best of both worlds: part control analysis for your customer reports and process control analysis for yourself. No more dilemmas, no more compromises.

InfinityQS®
Quality Re-imagined

Modernize Your SPC Software—and Your Control Capabilities

If your SPC data collection consists of monitoring processes dedicated to only one part, or you're interested in tracking only outgoing part quality, you might not need modern SPC software.

But if your SPC deployment requires you to monitor multiple processes or to produce different products with unique characteristics and specifications, different raw materials, and different expected levels of variability, then you need SPC software that is based on the PPT logic. Until you make that change, you can never gain the quality information that you need.



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