Next Generation SPC Software for Manufacturers of Electronics

INTRASTAGE

On January 21, 2010 Toyota announced a world-wide recall of eight car models due to a quality defect. This recall dropped its stock price from $90 to $73 by February 3rd, a loss of $26.5 Billion in market capitalization. On top of this were the direct recall costs of $5 Billion and loss of sales due to the production halt. Although unusual for a quality driven company such as Toyota, all companies have bottom line effects related to product quality.

Figure 1: A chart of Toyota's share price from end of 2009 to June 2010

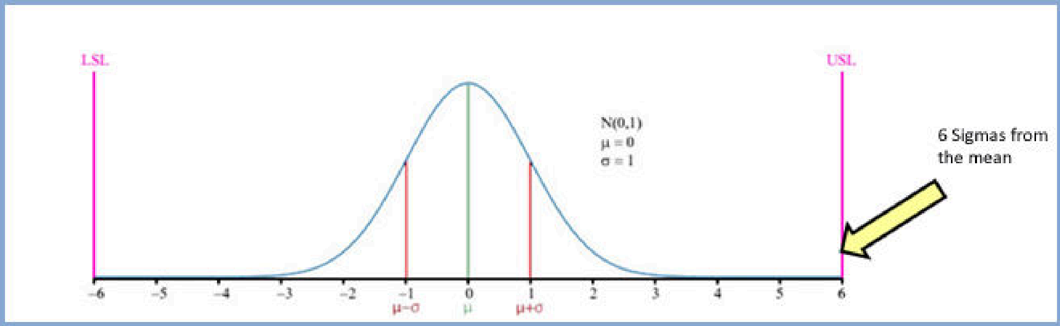
Pick any industry and you can find companies that are affected by recalls, warranty events and adverse customer reactions related to product quality. Consider Medtronic, whose pacemaker product line had a recall in 2005. In that year, Medtronic's warranty claims rate more than doubled.

In this whitepaper, we will explore a new way to use SPC (Statistical Process Control) as a method to "early detect" and rapidly catch quality issues before they trigger a recall or warranty return problem. We will talk about CP/CPK within the scope of 6-sigma practices and combined with new software technology (such as IntraStage) can solve a whole new class of quality problems. Today, attention to product quality is no longer a backroom activity. It is now a competitive weapon to retain customers and highlight differentiation.

Basics of Six Sigma and CP/CPK

The term "Six Sigma" comes from a field of statistics known as process capability studies. It is a set of practices used to improve manufacturing processes and eliminate defects. Processes that operate with "six sigma quality" over the short term are assumed to produce long-term defect levels below 3.4 defects per million opportunities (DPMO).

For example, if you manufacture 1 million parts or products and only 3.4 or less are defective, then you have achieved six-sigma quality.

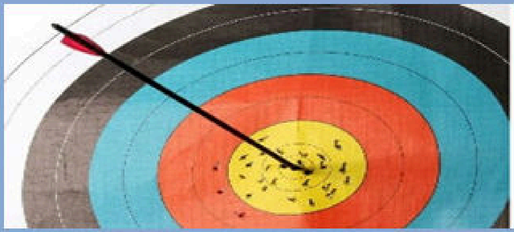


Within Six-sigma there are two terms which are commonly used to characterize how a process is performing – CP/CPK.

C_p: Tightness of the measurements around the mean. Shows the potential of the process to be capable.

CP_K: How the measurement mean is trending towards the limit. Shows the actual capability of the process

An analogy would be to look at an archery target: how close the arrow markings are clustered to each other measures CP (CP of greater than 1.33 is considered good) and the closer this cluster is to the center of the bulls-eye the better its CPK (greater than 1.33 is good). this cluster is closer to the center of the bulls-eye the better its CPK (greater than 1.33).



For those readers in learning more about Cp or CPk please visit Wikipedia (http://www.wikipedia.org/) as a good start.

Barriers to Using SPC Effectively in the Electronics Design and Manufacturing Industry

As electronic products have increased in complexity from the invention of the transistor in the 1960's up to today, so too has the volume of testing needed to ensure quality. A typical aerospace, semiconductor or medical electronic product is now being tested with hundreds of tests and generating gigabytes of data in different formats.

In a typical product life cycle, this test data can be generated from different ATE (Automatic Test Equipment) stations within a company from R&D, Manufacturing functional areas or from Suppliers and in the Field. The biggest barrier to using SPC effectively in these environments is the sheer collection and aggregation of this test data into a form which can be easily mined for performing SPC calculations. Today in most organizations, this is done manually with spreadsheets which can cost days of productivity.

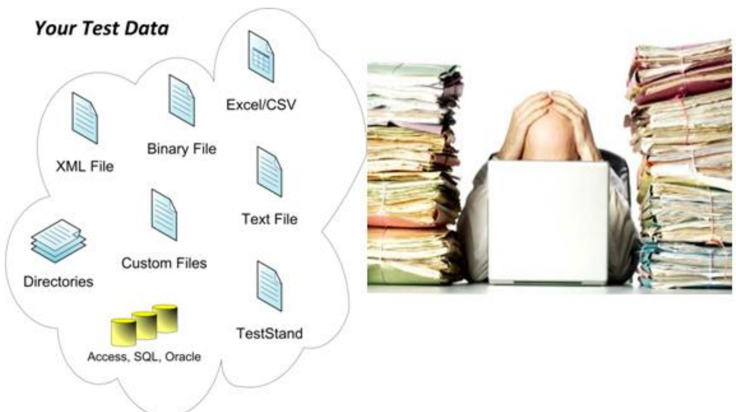


Figure 1: Typical environment of manually compiling test data

Software solutions like IntraStage which can automatically retrieve and securely store that test data can dramatically lower this barrier and give you the ability to apply SPC to get insight into product quality never achieved before. Once this barrier is overcome, Use Cases like the following become possible:

- Rapidly improve product yield
    - Data mine all of your test data to get SPC alerting on which processes need the most attention now
    - Quickly use filters and Cpk calculations to isolate root causes
- Tuning engineering limits rapidly during New Product Introduction

SPC Alerting in steady state manufacturing

Yield is one of the most important and visible parameters when measuring the effectiveness of manufacturing. Manufacturing yield problems can cause scrap, excessive rework, shipment delays, and may point to inherent design flaws in the product. All manufacturing companies track this yield data in some form, generally with a manual entry process, which prevents the capabilities to deep dive into problems. With the complexity of electronics increasing and hence the amount of data generated increasing, finding root causes for yield problems is more difficult than ever before. Most companies spend too much time in fire-fighting mode, and when proactive steps are taken to discover root causes, they have insufficient engineering resources to close the loop.

One of the first steps in being proactive on anticipating possible yield problems is being able to aggregate the test data into a centralized database. Once there, SPC techniques can be applied to any of the test measurements, giving real-time insight which was not possible before.

For example, one way to proactively anticipate yield problems is to automatically get alerted when measurement Cpk values fall below a threshold level. **Figure 2** shows a ranking of test measurements according to the severity of its CpK and CP values. As you can see, the measurements in red indicate measurements that are trending towards specification limits or becoming more dispersed. In both cases, the software instantly alerts quality, manufacturing or test engineers of the biggest trouble spots, where they can focus, determine root causes, and take appropriate action. If these issues were ignored, they may eventually lead to yield problems.

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ORGANIZING TEST DATA FOR A CHAOTIC WORLD

Measurement SPC Table

Report Run at: Oct 27, 2010 10:42 AM

Start Date	Sep 02, 2009 12:00 AM	**End Date**	Oct 27, 2010 12:00 AM
Product Line - Process	Military Radio - Final Assembly	**Event Name**	RF Test
Test Name	All	**Model**	All
User	All	**Station**	All
Meta Name	All	**Meta Value**	All
First/Last Tested	All Tested	**Result Type**	Passed

Test Name	Measurement Name	Cpk	Cp	LSL	USL	StdDev	Avg	MeasCnt	Cpkl	Cpku	Var (σ2)
Receiver Test	Rx Sensitivity	0.31	0.87	3.000e+000	4.000e+000	1.916e-001	3.823e+000	112	1.43	0.31	3.638e-002
Receiver Test	ACLR	0.42	1.22	1.800e+000	1.900e+000	1.370e-002	1.883e+000	71	2.01	0.42	1.851e-004
Receive Sensitivity	CommLink	0.45	0.54	0.000e+000	2.000e+000	6.122e-001	1.182e+000	1775	0.64	0.45	3.746e-001
Transmitter Test	Tx Power - High	0.51	0.54	3.000e+001	3.200e+001	6.225e-001	3.096e+001	29	0.51	0.56	3.742e-001
Transmit Power	CommLink	0.66	1.79	0.000e+000	2.000e+000	1.858e-001	1.634e+000	1760	2.93	0.66	3.452e-002
Receive Sensitivity	Rx Sens	0.80	0.85	1.500e+001	2.500e+001	1.959e+000	2.028e+001	1132	0.90	0.80	3.834e+000
Transmitter Test	Tx Power - Low	1.23	1.23	5.000e+000	6.000e+000	1.350e-001	5.499e+000	110	1.23	1.24	1.807e-002

Figure 2: A quick snapshot view of those measurements

Figure 3 is another way to look at CP/CPK by looking at trouble measurements and highlighting the trend of those measurements over time. By looking for unexpected discontinuities in CP/CPK over time, engineers can focus in on that period and determine what had changed from the previous time period.

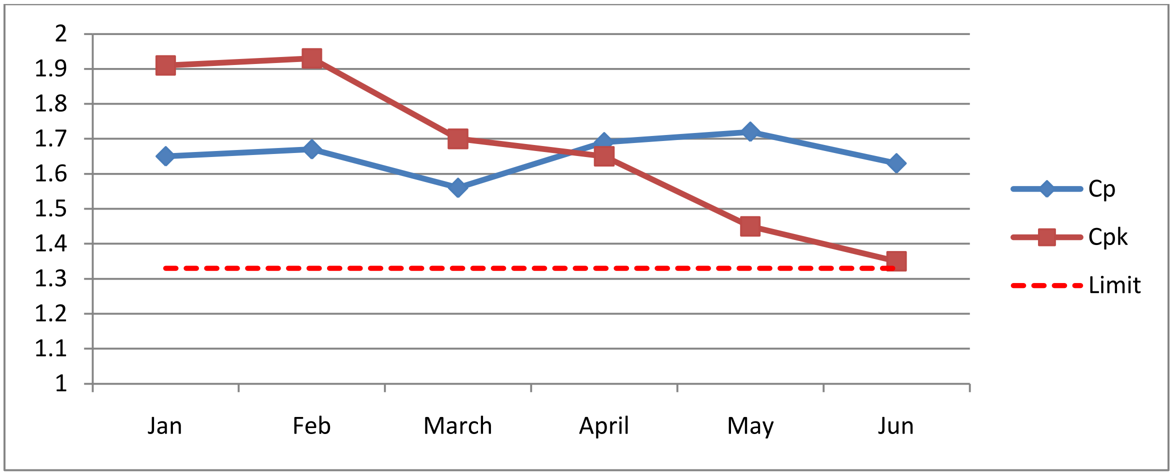

Figure 3: A trend chart of CP/CPK over time.

Using Filters to Isolate Root Causes

Once a high level view of which measurements need attention are determined, the next step is to troubleshoot and to find root causes through a data mining interface.
By using the data inherited from the testing process, this is possible by using filters to narrow down where the problem area. For example in **Figure 4**, you can see a variety of drop down filters which allow the engineer to look at Model, specific tests, Operators, Stations or any Meta value (meta values are descriptors of the test such as Firmware version #, temperature etc) to quickly root cause where the trouble spots are.

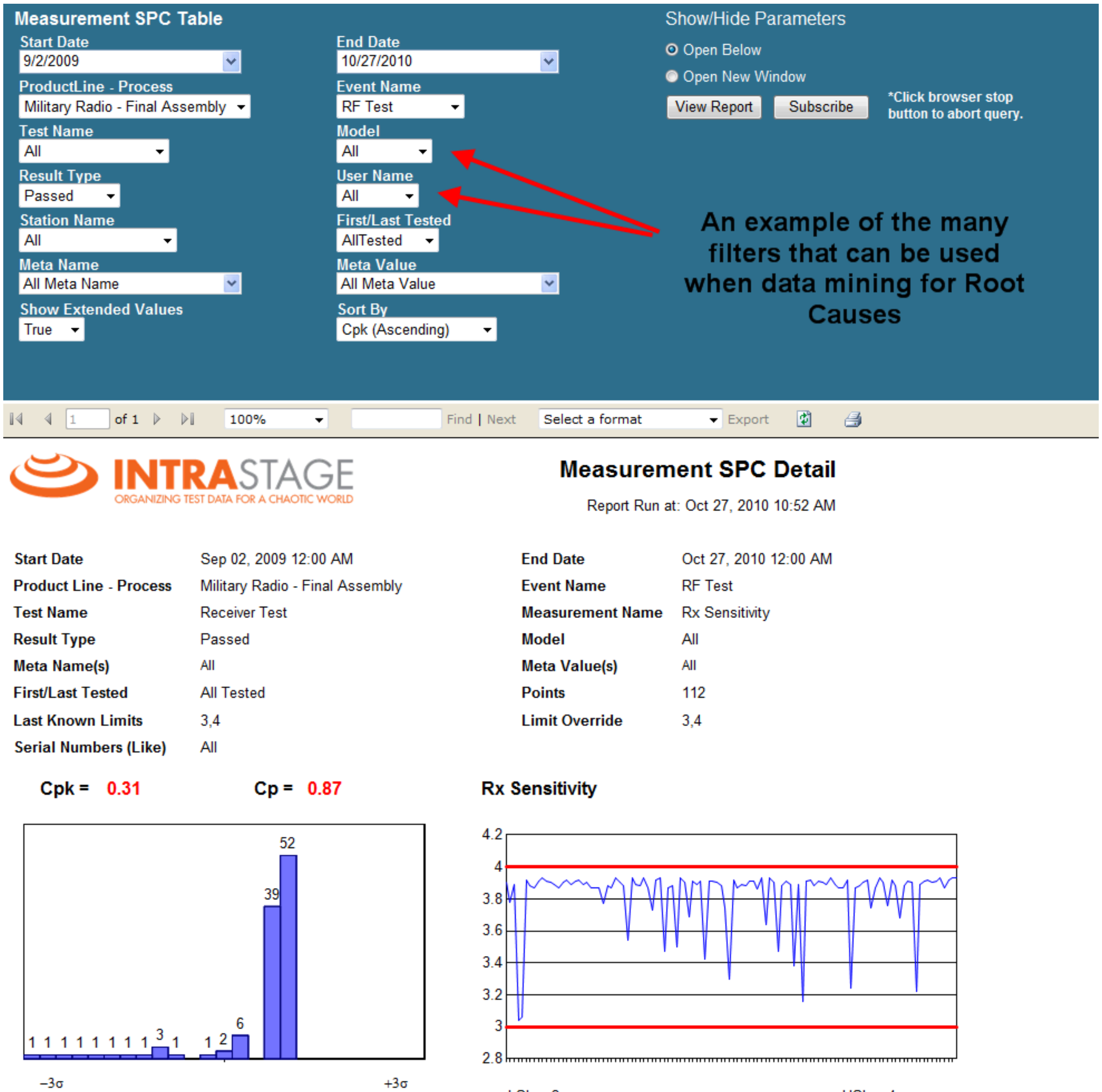

Figure 4: Filtering and data mining to find root causes

Tuning Engineering Limits during New Product Introduction

New Product Introduction or NPI is a term commonly used to describe the process after a product design has emerged from R&D and is getting ready for initial manufacturing. Part of this NPI process is for the design engineer to get an understanding of the design tolerances of the product.

For example, an aerospace RF product may have hundreds of measurements taken as it moves through different phases of manufacturing. Each measurement can vary depending upon sub-component part tolerances, temperature, assembly, etc. Capturing and aggregating this data is the first step to effectively specify the test limits.

Figure 5 shows an example of a fictitious measurement which is very near its upper engineering limit with a CpK value of 0.56 (companies generally want values above 1.33). Very rapidly, a design engineer can visualize this measurement and use “what if” scenarios around new engineering limits. IntraStage has a particular feature called “limit override” which allows the engineer to experiment with the right limits to see which high and low limits would be necessary to achieve a desired CP or CPK value.

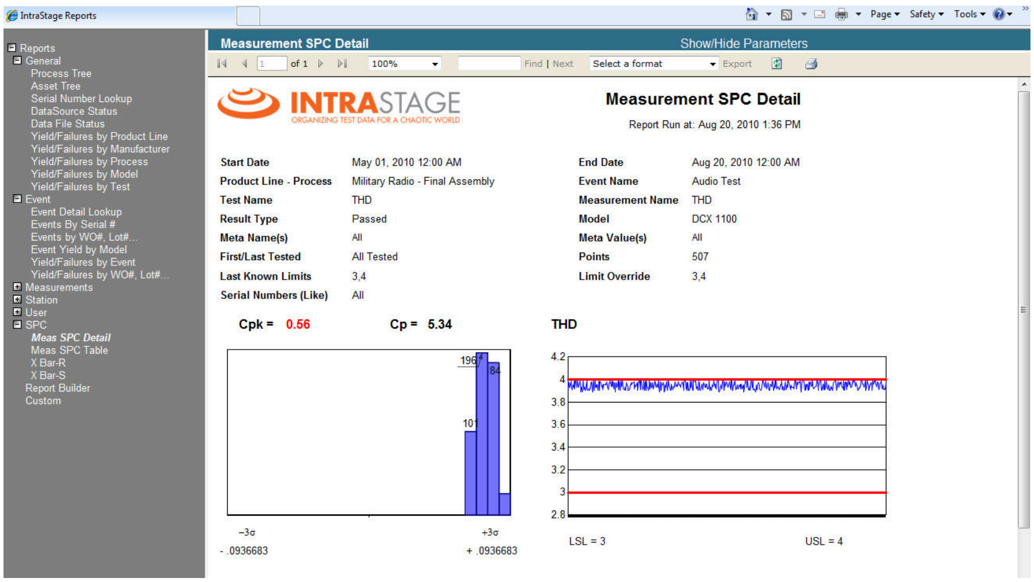

Figure 5: A trend of a particular measurement which shows it is nearing its upper limit.

Conclusion and Summary

As we have discussed in this whitepaper, traditional SPC has never been fully exploited as an analytical technique in the Electronics manufacturing industry primarily because of the extreme volume of measurements and test data that is generated. With commercial database technology, such as IntraStage, companies now can automatically retrieve and store that test data with a 10X economic saving compared to manual methods. This industry inflection point is opening up new techniques and Use Cases in improving yield and overall product quality. In this paper, we have only outlined a sample of those Use Cases, including Tuning of Limits and Anticipating Yield Problems.

For more in-depth information on this and other Use Cases, please contact IntraStage at: info@intrastage.com or +1-888-255-2813

About IntraStage

IntraStage is a Quality Management Software provider for companies who design and manufacture electronic products. We provide SPC, Yield and test data analytical tools by automating the retrieval, storage, mining and reporting of R&D, Manufacturing, Supplier and Field test data.

Our clients choose us because we seamlessly integrate test data from different sources, lower their product design, manufacture and return costs by finding quality trends more quickly and accurately. Fortune 100 companies rely on our business intelligence to keep them competitive when product quality and customer satisfaction are key differentiators.

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