How To

How to Improve First Time Yield

There is little debate over the importance of First Time Yield (FTY, a.k.a. "First Time Through" or "First Pass Yield") in a manufacturing operation: eliminating scrap, minimizing re-work, reducing cycle times, all have a significant impact on the final product cost. Therefore it is essential to optimize critical manufacturing processes to ensure FTY is maximized – to do this quickly and effectively requires a systematic, scientific approach. This article describes a simple five step procedure that helps maximize and maintain manufacturing yields.

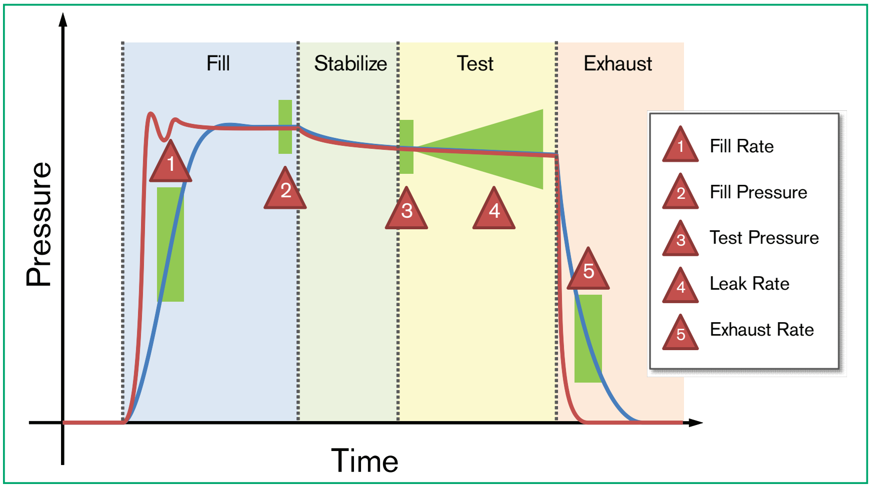

Figure 1: Schematic illustration of a pair of leak test waveforms overlaid on a single plot. The blue curve shows the behaviour of a "good" part while the red curve represents an example where a blockage on the inlet path is interfering with the flow of air to the cavity under test. This is reflected in the more rapid rise in the pressure signature during the fill cycle, as well as the rapid decay during the exhaust cycle, neither of which would be revealed by a traditional two point leak-rate measurement. In total, five separate tests are indicated in this example, where tests 1 and 5 would be effective in detecting the blockage defect present in this example.

The first step towards improving FTY is to map the end-to-end manufacturing process, identifying the critical steps that have the greatest impact on the final product quality. Typically, this involves examining the yields at each section or area in an assembly operation and identifying those that have the largest impact on the overall product quality. Earlier operations typically generate greater total savings and should therefore be prioritized.

Step 2 is the development and implementation of a comprehensive end-to-end monitoring and test strategy that will help drive up FTY. This requires a test methodology that will reliably identify process abnormalities or product defects at each critical process. In general this is best accomplished through in-process monitoring, as opposed to relying on end of line testing, where the defect may no longer be detected. While in some simple cases a one or two-point measurement will suffice, affordable technology now exists that can measure and archive a process signature for each step, providing a more detailed analysis and consistent discrimination between passes and fails. For example, when leak testing a critical component, instead of saving only the final leak rate in cc/minute, it is possible to store the entire leak decay signature. In this case, valuable information can be derived from the "fill" or "exhaust" portions of the curve or from the shape of the decay signature itself, resulting in a far more accurate and reliable test. Figure 1 illustrates an example where analysis

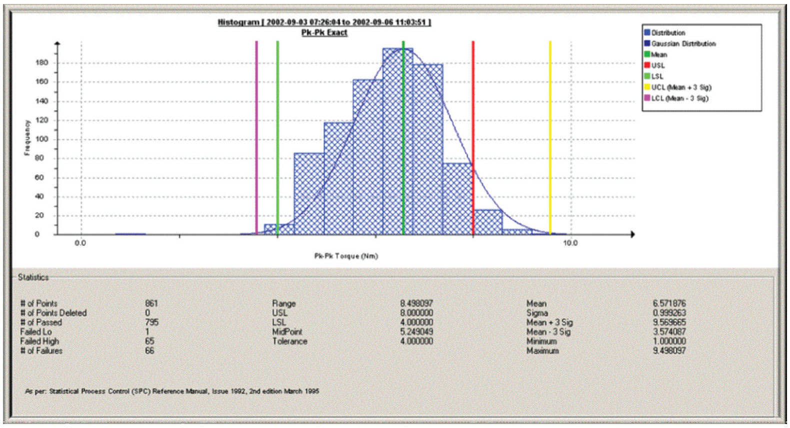

Figure 2: Example of yield analysis based on parametric data extracted from process signature waveforms in QualityWorX analytical database. By manipulating both the raw process signature data and the test criteria in an offline database, the test can be quickly optimized to maximize throughput while minimizing false fails.

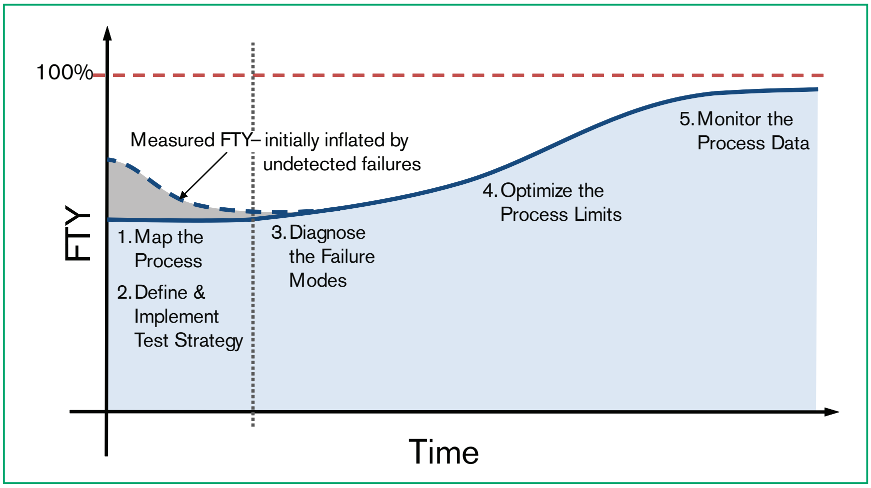

Figure 3: Illustration of the 5 step process for optimizing and maintaining FTY. The dashed blue line indicates the measured FTY, which may initially be artificially inflated by undetected failures resulting from an underperforming test strategy.

of the entire signature provides insight that a simple two-point measurement cannot.

Step 3 is the root cause determination of common failure modes, which is essential to eliminating or minimizing any related failures and therefore improving yields. In many cases one can quickly highlight process anomalies and identify the root cause by examining the in-process manufacturing data and comparing overlays of "good" and "bad" process signature waveforms. In addition, cross-correlation against data from other operations can reveal interactions that may otherwise be difficult to diagnose. Histograms and Pareto style plots can also provide valuable insight into how the defect manifests itself, which in turn can be used to determine root cause. Having this ability to access and analyze all of the manufacturing data minimizes the need for expensive and time-consuming destructive testing or other post-process analytical methods.

Step 4 is the definition and optimization of the pass/fail criteria. Proper optimization of the process limits is critical to achieving a high FTY: too tight and a mountain of false failures is created; too loose and downstream yields crash or product quality suffers. The best approach is to perform a "what-if" yield analysis on a database of stored process signature waveforms that contains a population of both "good" and "bad" parts – this can be done quickly with an advanced analytical database such as Sciemetric's QualityWorX, as illustrated in Figure 2. By eliminating the guesswork and long cycle times of a traditional trial-and-error approach, this method dramatically improves both the speed and accuracy of the optimization cycle.

The final step is to monitor and record the process data on an on-going basis to ensure that yields are maintained, and to drive continuous improvements. Traditional SPC monitoring is an essential tool for ensuring that process drift is detected early, enabling corrective actions to be applied proactively. In addition, the process signature waveforms are invaluable in identifying and diagnosing new failure modes, enabling an on-going cycle of continuous yield improvement. This requires easy-to-use, real-time software tools that allow manufacturing and quality engineers to perform this type of analysis on a daily basis.

To summarize, FTY can be optimized and maintained by following a simple 5 step method:

- MAP the process
- DEFINE the test strategy
- DIAGNOSE the failure modes
- OPTIMIZE the process limits
- MONITOR the process data

By placing an emphasis on in-process data collection and analysis, this approach eliminates guesswork and ensures that the manufacturing process is optimized quickly and effectively.

For more information, please contact:
Sciemetric Instruments, Inc.
359 Terry Fox Drive, Suite 100
Ottawa, Ontario, Canada
K2K 2E7
Toll Free Telephone: (877) 931-9200
Tel: 613-254-7054
www.sciemetric.com
inquiries@sciemetric.com