Perfect Quality for Free?!?

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Keywords: quality, reliability, problem-prevention, proactive, field failures

Abstract
The author describes a new challenge of providing perfect quality to customers. A pragmatic interim interpretation of perfect quality is given. Skyworks Solutions' perfect quality plan is outlined.

INTRODUCTION

The electronics world continuously strives for innovation and improvement. The goal is to make everything better: better in performance, functionality, look and feel, ease of use, cost, quality, etc. In every area, manufacturers aim for perfection in order to realize substantial -- if not quantum-leap improvements that can be leveraged to outperform the competition.

Even as it aims for perfection, however, the industry generally has not truly believed that perfect quality is a realistic performance goal. This belief is now changing. Many semiconductor suppliers and others have been asked by commercial customers to provide "perfect quality" for the products they supply. These commercial customers don't just mean "better-than-before" performance – they literally mean perfect performance. Suppliers are expected to submit plans outlining how they will achieve this ultimate quality deliverable. The customer then continuously monitors and audits the progress toward this goal.

Skyworks frequently receives this type of mandate from its customers. This presentation will explore how Skyworks pragmatically sets an initial perfect quality goal, and then takes a disciplined set of steps in order to achieve it.
Our initial interpretation of perfect quality is that a product performs in compliance with data sheet specifications throughout the predefined product life. In simple terms, an *end user* would not experience any failure related to this product during the specified life of this product. Or, more specifically, the user would experience no *field* failures for this product during the specified life of this product. As another example, the definition of perfect quality might be that there will be no field failures during the warranty period of an end product.

perfect quality = no field failures

The semiconductor industry is intimately familiar with this definition of perfect quality. Integrated circuits are used in medical applications where a single failed part could result in serious injury or death. The industry has come to expect similarly flawless product performance in space and defense applications. The automotive industry has also long demanded no less than perfection from their IC suppliers. The list of industries requiring perfect quality is not a short one.

FOR A PRICE, WE CAN AND WILL DELIVER PERFECT QUALITY.

The semiconductor industry knows how to prevent field failures, and many suppliers have consistently delivered this level of perfection for mission-critical applications. It starts with a "design for quality and reliability" mindset that applies to both product design and process development. Every critical step of the manufacturing process is monitored and controlled. We test and inspect. We perform reliability stress screens as needed. Everyone in the supply chain complies until the final product -- whether it is for a heart pacemaker or a spacecraft -- is complete. The tradeoff for such perfect quality is high cost. Perfection does not come free.

The global semiconductor industry has made great strides in quality improvement over the last two decades. Defect levels used to be measured in percentages. They are now measured in parts per million (PPM). The industry internalized the fact that cost reduction does not come without good -- and more importantly, consistently good -- quality. As a result, quality improvements are made every day.

Perfect quality, however, has generally only been available to those who paid for it. In contrast, while mainstream customers have raised the bar on quality expectations, the industry has typically met the challenge not with higher quality but with improved performance. Few commercial customers receive perfect quality -- at least not always. Field failures happen every day in the electronic world.

CUSTOMERS DEMAND PERFECT QUALITY BUT WILL NOT PAY EXTRA.

Quality expectations continue to rise in the electronic world. Forget medical applications or even cars. Let's just focus on the "gadgets" we use everyday. We all have grown tremendously dependent on cell phones, computers and other electronic equipment, both personally and professionally. Consider cell phones, alone. The hurricanes, fires and earthquakes of 2005 led many of us to imagine our own plight if, for instance, were we to be trapped in a fallen building with a cell phone that didn't work because an IC component failed. Like most cell phone users, we each demand perfect quality from cell phone manufacturers and service providers. Naturally these companies want perfect quality from their suppliers, and many already demand it. This doesn't mean that cell phone users have been willing to pay extra for this level of quality. Most view it as a given. It's that simple.

Perfect quality becomes an expectation.

It is now very clear that a paradigm shift needs to occur in order for suppliers to meet quality expectations while staying profitable. The old approaches, which primarily involve applying extra testing and inspection, no longer suffice.

PROBLEM-PREVENTION IS KEY TO PERFECT QUALITY.

Do we have the answer to this challenge? Yes, we do. A problem-prevention quality approach is the answer. We simply cannot allow defects to occur. Instead, we must design-in quality and reliability, together with performance, cost, testability, etc., from the very beginning. We need to do everything right the first time. Many have payed lip service to this concept, but few have actually demanded and implemented what can often be drastic process changes in order to realize these goals.

Tools exist to attain perfect quality; however the goal cannot be achieved without a cultural change. Top management must lead this cultural change. The mandate to eliminate field failures must be ingrained in every employee and become part of the company's institutional fabric. It's not hard to deploy tools such as failure mode and effect analysis (FMEA). By applying this tool we can anticipate potential issues and keep them from occurring. Other problems require the investment in more fundamental changes. If top management doesn't support such actions, perfect quality becomes another passing fad.

It's always easier for companies to make investments when they see a clear return in terms of higher revenue or improved gross margins. It is significantly more difficult to make an investment whose purpose is strictly to improve quality, especially when that investment adversely impacts cycle time, revenue or product cost. These are not easy decisions. Employees will not commit to these types of investments unless they feel confident that the company fosters an environment that supports such decisions. Top management must create this environment. An outspoken quality department, alone, will not make it happen.

The company culture must support the journey to perfect quality.

SKYWORKS STARTS ITS JOURNEY TO PERFECT QUALITY.

Our experience at Skyworks offers an excellent example of how companies can start on their path to perfect quality. The first step was a commitment to making perfect quality both a promise to our customers and our advantage over competitors. Next we implemented several measures that were based on a set of well-defined principles.

#1: We asserted that "Quality is money."

This statement can be interpreted in several ways. Poor quality results in lost business. With customers now demanding perfect quality, whoever gets there first shall be rewarded with more business. There is a direct relationship between revenue/profit and quality.

In order to promote our perfect quality plan and ensure that employees equate quality with money, we created a quality metric in our annual incentive plan. It directly measures product quality as seen by customers. We have defined perfect performance as far more than perfect quality (i.e. no field failures), and the quality-program incentive metric covers all elements in our perfect quality plan. Twenty percent of the total incentive payout is associated with this metric. It is worth noting that participants in the annual incentive plan include (but are not limited to) our CEO, CFO and all other executives.

The carrot motivates people more effectively than the stick.

#2: We launched a companywide "customer satisfaction" campaign.

With the help of our creative PR experts, we rolled out an invigorating multimedia campaign across the company that educated employees about customer satisfaction, the perfect quality demand, our action plan, and, most importantly, how every employee in every department can contribute. The program included case histories, customer satisfaction and quality tutorials, quizzes, and a reward program for innovative ideas that were successfully implemented. Customer satisfaction and perfect quality became a rallying call.

#3: We established that top management is the driver of quality.

Quality improvement and customer satisfaction are not the sole responsibility of the quality department. In order for all employees to work together toward a common perfect-quality goal, top management must be clearly identified as the driver. In addition to various leaders talking about quality in communications meetings, we formed the Skyworks' Quality Council, which consisted of each business line's general managers plus the vice president of operations and the vice president of quality. The council meets twice a month to track progress towards perfect quality. Tough decisions, such as spending outside approved budget, are made here. While this council does not have a budget to support extra spending, it does, however, have the ability to authorize changes in the fixed budget to help execute the perfect quality plan.

#4: We took steps to ensure that quality/reliability is designed into the product.

We revamped the product development gate review process. Among the many changes that were made, we added more gates, and clarified accountability and gate exit criteria. We adopted an automotive standard called product part approval process (PPAP) in new product development. A critical element of PPAP is Design FMEA. It is simple yet powerful and enlightening, and has resulted in a ranked list of risks to be addressed. The challenge lies in supporting the subsequent actions. Some quality-focused requirements may have adverse impact on, for example, the die footprint or component costs, etc. Smart engineers can design high-quality products and enjoy doing so. Management needs to support the necessary trade-offs.

Another change that we have already benefited from is performing early reliability testing. Traditionally, there is a reliability qualification prior to the release of a new product. Some of the industry-standard reliability tests take weeks to complete. With frequent specification changes from customers and shortened time-to-market, it is not uncommon that products must be released to volume production before fully completing all the reliability tests. At times, we discovered reliability risks when we were already in volume production. Worse still, we discovered issues after our customers had made business commitments to their own customers.

We decided not to wait for the finalized product before collecting reliability data. As soon as we have functional parts, we subject them to various stress tests. By doing this, we expose problems early enough to make necessary changes without impacting program schedule. As changes are made, we apply pertinent tests to the revised version of the product, thus establishing a trail of reliability records. Customers applaud this approach. Even if we don't have enough time to complete all tests before the final version is released into production, the existing reliability data builds confidence in the product performance.

The idea is simple but it again needs management support. For example, reliability hardware is quite costly nowadays and must be procured early in the program when there are risks that the product may not ultimately reach the market. Certain product changes may be significant enough as to make the reliability hardware obsolete which necessitates further investment. Without a strong customer-focused orientation, risk spending is unlikely to be authorized.

#5: We determined that quality, after it has been designed into the product, must also be *built* into the product.

Most high-tech companies understand the direct correlation between quality and manufacturing cost. Consequently, they have invested in continuous improvement. Statistical process control (SPC) tools are in wide use and we will not spend time on this commonly adopted process monitoring and control technology. There are two specific programs I'd like to share with you. They are not proactive in the purest sense; however, they help prevent us from shipping questionable products to customers. The first is an ongoing reliability monitor. Parts from finished goods, ready to be shipped to customers, are regularly pulled and subjected to a full set of reliability tests. This monitor enables us to track the "bill of health" for our processes, packages and products. Any shift spurs action. The existence of such a program is yet another example of management's commitment to perfect quality. It requires extra resources and sacrifices revenue-ready material.

We also implemented a "watchdog program" to catch *maverick*, or anomalous, lots. People in the semiconductor world are accustomed to putting low-yielding lots on hold for additional evaluation. This is not sufficient, since we usually only look at final test yields to identify low-yielding lots. Two lots, each exhibiting 90 percent final test yield, may have distinctly different characteristics because of parametric shifts. We apply statistical limits on critical parameters. If a critical parameter shifts outside a pre-specified range, we put the lot on hold, regardless of the cumulative final test yield. If further evaluation determines the lot to be maverick, we scrap it. In the past, a large portion of such material would have been shipped to customers. Some might have caused issues. Today, unless we can prove beyond doubt that the material is reliable and meets specifications, we scrap it. Such painful decisions prompt deeper investigation. In turn, we uncover sources of variation that we were not aware of. Consequently, we were able to take manufacturing to the next level of excellence.

#6: We ensured that changes were tightly controlled. Changes are a way of life. We make process or product changes for various reasons. Cost reduction is a common one. At Skyworks, we evaluate changes very thoroughly via cross-functional change-control boards. Changes bearing possible impact to form, function, fit, or reliability have to go through a qualification process that includes electrical characterization and reliability testing.

#7: We acknowledged that customers are our quality partners, but also adopted an "It's my problem" attitude. Field failures are tricky. These failed parts not only passed our testing and inspection but also our customer's testing and inspection. In order to prevent these issues, we cannot work alone. We must team up with customers to better understand the application environment. At the same time, however, we must maintain a mindset throughout the process that acknowledges all problems are ours. It is easy to blame customers for causing or not catching problems. This attitude would quickly rid one of business opportunities.

#8: We instituted a willingness to say "no." There will be times when we are unable to provide a timely, perfect-quality solution with the desired profit margin. At this point we must say no and walk away from the business, or risk customer dissatisfaction or undesired business results.

Don't release a product before its time. People in the high-tech industry are, in general, optimistic. We always believe that we can resolve product issues before customers see them. This is not always true and we could jeopardize our business, as well as our customer's. Take a good look at the existing data. If the product is not ready, do not push it into production. Explain the facts to the customer. It is a better than creating customer dissatisfaction and adverse business consequences.

ARE WE PERFECT YET?

We are not perfect yet. However, we have a path to achieve perfect quality and we are much closer to it now than before. The company has invested the resources to achieve this end. It is important that we look beyond the short term return on investment (ROI) and view such investment towards perfect quality as a way not only to survive, but to thrive.

WHAT COMES NEXT?

Preventing field failures is our first step towards perfect quality. After we achieve this goal, the new challenge will be preventing all customer-experienced product failures. In other words, we shall prevent any product returns from customers. After that, we shall set a goal for zero defects throughout our processes.

CONCLUSIONS

End users of electronic equipment have formed an expectation of perfect quality. In turn, it becomes a requirement for component suppliers to fulfill. We have taken the first step to prevent field failures and devised a plan to achieve this end. The author outlined critical elements of this plan. The most important step is to create a perfect-quality culture. Top management in the company must make a firm commitment to perfect quality, foster an environment that rewards behaviors aimed at achieving perfect quality, and invest in resources to accomplish this challenging goal.

ACKNOWLEDGEMENTS

The author would like to thank all at Skyworks that contributed to the perfect quality plan. In addition, the editing work done by Pilar Barrigas to finalize this extended abstract was much appreciated.

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ACRONYMS

PPM: Parts per Million
PPAP: Product Part Approval Process
FMEA: Failure Mode and Effect Analysis
SPC: Statistical Process Control
ROI: Return on Investment