The Impact of Effective Quality Control and Appraisal on Manufacturing Costs

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What is the Total Cost of Quality?

From the dawn of mass production, poor quality products have been an ever present issue. The methods of measuring quality, drawing conclusions and making corrective actions may have changed and advanced over the years but the goal has always been the same – To manufacture a product with no quality issues every single time.

Quality Improvements Through Automation

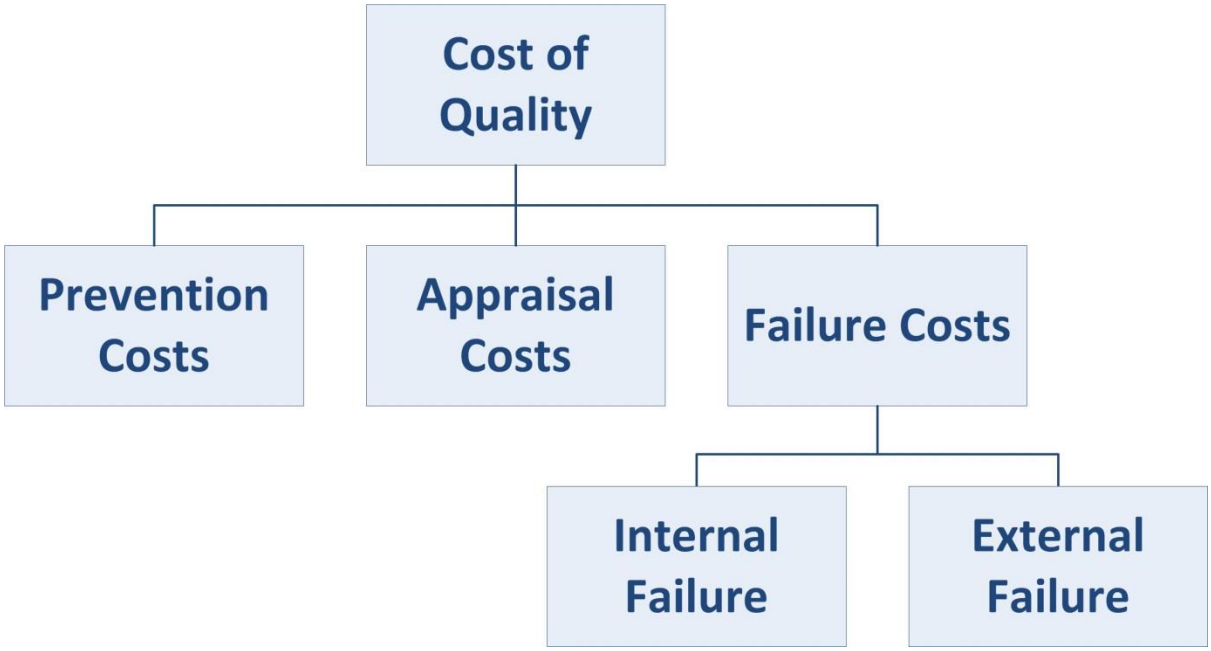
The adoption of automated process equipment leads to more uniform production and a decline in quality issues. Many firms saw a five to tenfold reduction in waste, scrap and rework when manual operations were replaced with automated equipment. This lead to significant reductions in expenditure related to product quality issues (Chase and Aquilano 1995). However, in many industries quality costs can still be equivalent to 5 to 25% of a company's annual sales turnover (Dale and Plunkett 1995). How these costs are handled can therefore make or break a company.

Quality Cost Sub-divisions

At this point it would be useful to see where that money is spent when preventing and paying for quality issues. The American Society for Quality (ASQ) defines 'quality costs' as a measure of the costs specifically associated with the achievement or non-achievement of product or service quality.

The total of the quality costs includes prevention costs of non-conformance to requirements, appraisal costs of product or service for conformance to requirements, and failure costs of products not meeting requirements (Campanella 2003).

To simplify, the costs can be divided as shown below.



These can be defined as follows:

- *Prevention Costs*: Quality planning, designing, implementing and managing the quality system.
- *Appraisal costs*: Measuring, evaluating or auditing products and product materials.
- *Internal failure costs*: Failures and defects of processes, equipment, products and product materials.
- *External failure costs*: Defective products, services and processes during customer use, including warranties, replacements, repairs and poor packaging.

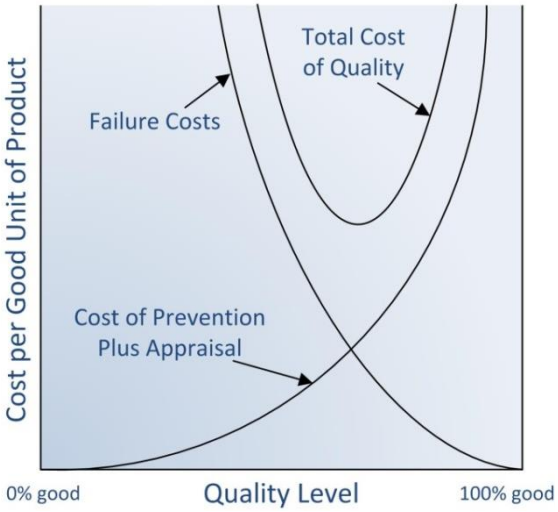
It's important to note where the majority of the money is going. A study of 46 manufacturing companies found that *Failure* costs made up about 70 to 80% of total quality costs (Rodchua 2005). Although this doesn't necessarily tell us how good the quality control is in those companies it does highlight an important issue which is that the cost of a quality issue rises the later it is found during the production process.

Prevention is obviously the best solution but, if this is not possible, then finding the quality issue during the appraisal process is acceptable. In-process containment means reducing the possibility of having a customer discover the quality issue. Otherwise, this leads not only to an immediate financial cost for resolving the issue, but to the equally important problem of a dissatisfied customer who can communicate his/her dissatisfaction to a dozen other potential customers.

Where should money be invested?

The ideal amount that needs to be spent on quality control will vary greatly between companies, although it's fair to say that the more that is spent on *Prevention* and *Appraisal*, the less that is spent on *Failures*.

The chart on the right demonstrates how total costs initially come down as more is spent on *Prevention* and *Appraisal*. However, at a certain point the total amount being spent on *Prevention* and *Appraisal* begins to exceed the amount being saved in *Failure* costs.



This is where the balance needs to be struck and at this point the maths becomes very simple. There are two facts to bear in mind:

- *Failure* costs cannot be controlled but *Prevention* and *Appraisal* costs can.
- It is vastly cheaper to repair a quality issue found during the production process than one found by the customer.

Put simply, the total cost of *Prevention* and *Appraisal* should be raised to a point at which it matches *Failure* costs. Given the relative cost benefits of spending more on *Prevention* and *Appraisal* it's worth pushing spending as close to that mark as possible.

It should also be noted that once a quality control system is in place, the costs of *Prevention* and *Appraisal* will drop further through time as best practices are built upon and personnel become more familiar with the new way of working.

The Value of Appraisal

The value of *Appraisal* can often be undervalued. The problem is that the tests and checks required to make sure a product is defect-free are not a requirement of the customer. In fact, these inspection activities do not add value to the product in Lean philosophy.

Another problem is that performing *Appraisal* won't prevent quality issues from happening again – it merely identifies the issue there and then. For this reason, it may appear a costly approach to quality control.

Managers in different departments are often tasked with handling the quality control themselves and if they aren't fully informed of the *Failure* costs that can be accrued, then they may not invest enough time or money into the right tools and training required for adequate *Appraisal*.

Appraisal and Total Quality Management

To achieve real value for money, a system of Total Quality Management (TQM) is required. This involves a company-wide effort to continuously improve the quality of the products being sent to the customer. It involves every department working together and sharing information relevant to the common goal.

This can be aided by implementing systems and tools that work across departments and combine the efforts of both *Prevention* and *Appraisal*. *Appraisal* shouldn't just involve the detection of non-conformances; it should involve the analysis and reporting of all the recorded issues. Without the guidance of quality cost information obtained during the *Appraisal* stage, efforts to improve quality may be misdirected (Morse 1993).

For this to work effectively, an electronic system is required that allows every person involved with quality control in the manufacturing process to enter data and extract information from the same database of information in real-time. With the right system in place, the collation and dissemination of this information can become an immensely beneficial and economical sideline of the *Appraisal* process. Some of the benefits are as follows:

- *Managers*: Can view overall trends in the number and type of quality issues being found. These numbers can be easily transformed into cost evaluations

to see what has been saved by not allowing a non-conforming product to be released to the customer. This becomes an invaluable tool for deciding on where future investments in quality control should be made.

- *Line Leaders*: Can view live statistical analysis on the shop floor alerting them to recurring quality issues. This can help them in spotting issues such as measurements going out of tolerance, which allows them to carry out preventative measures before the issue becomes critical.
- *Operators*: Can record quality issues directly into the system with no middleman. This reduces potential human error that can occur when information is recorded onto paper and then entered into the system by a second person. Any piece of information necessary to correct the issue is included, as the system becomes the communication mechanism between inspection and rework personnel.

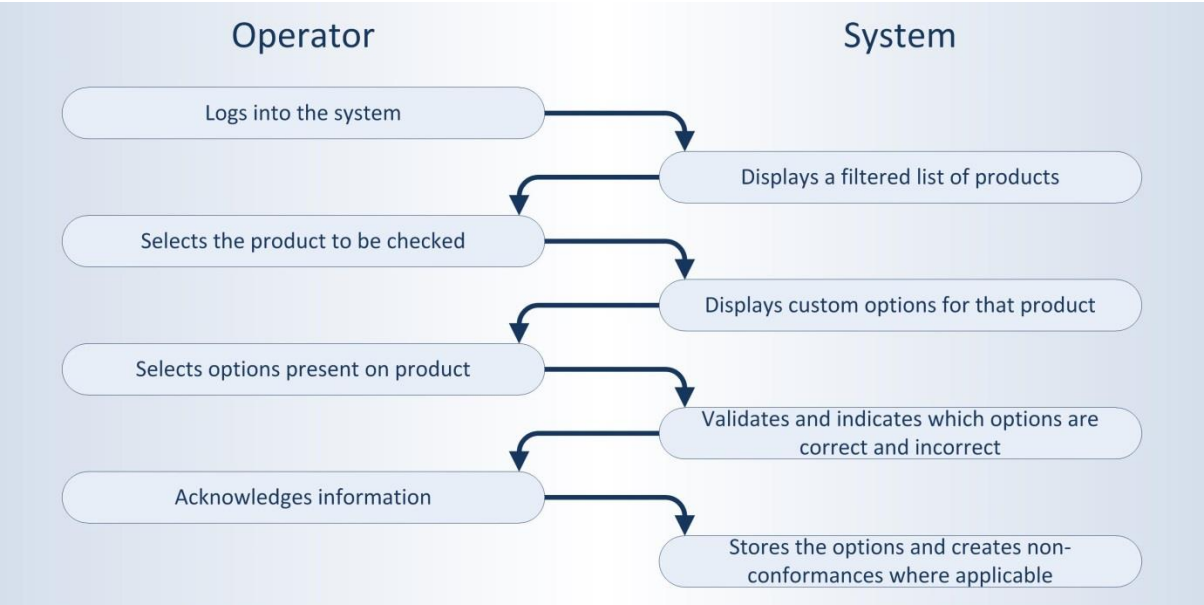
A Solution for an Appraisal System

Attribute and Variable Data

A complete system would need to deal with both attribute and variable data. Attribute data is data which specifies whether a component or feature is correct or incorrect, or present or not present. Variable data, on the other hand, is measurement information, such as lengths, pressures and weights.

Collecting Attribute Data

A simplified non-conformance (quality issue) recording system would work as follows:



This was a very basic description but it highlights the simplicity of the method. The operator is presented only with the relevant information applicable to the product in

front of them. This is a very effective poka-yoke since the options displayed are taken from the Bill of Materials for the product.

The system must also allow the operator to enter cosmetic issues for the product. For example, if the product were a car, the operator could select the location of a scratch on a door or the size of a bubble on the paint.

Once the data has been entered it would be automatically stored and analysed. The line leader who may be in a different department should be made aware if an issue has been found that originated in the department under their control. The manager must be able to instantly view the collated information of all quality issues entered in all areas of the plant to give informed quality control decisions.

Collecting Variable Data

The system would work similarly for variable data. The operator needs to be able to quickly and easily enter variables directly into the system. Using the car again as an example, this could include tire pressure or the torque on wheel nuts. If these values start to vary erratically or develop a trend taking them out of conformance, then the appropriate person needs to be warned immediately.

In a fast moving production environment this can only be achieved quickly enough using an electronic system which is tied in to all of the key manufacturing departments.

Alarms

An electronic system would also have the benefit of being able to spot subtle patterns and trends over time that may not be spotted by an operator or line leader working on the shop floor. This could include, for example, finding 3 loose wheel nuts in the last hour, or the first occurrence of a safety issue that endangers the lives of the product users.

Automated Data Entry

Many product validations can be performed automatically, with no operator intervention. Examples of this are electrical or mechanical tests that evaluate the presence of expected parts, the conformance of product or process variables within specification and the fulfilment of customer requirements. An appraisal system should have the capability of receiving input from automated test equipment to reduce capture time and elimination of human error in data entry.

Training

The system must be accompanied by adequate user training as incorrect *Appraisal* can lead to unrequired expenditure. Initial training will help to reduce the time taken for each inspection and after the initial investment it will become a saving in a short amount of time.

System Confidence

Obviously the reports and analysis obtained from the *Appraisal* process are only as good as the information that has been entered. If the data entered is incorrect then the reports and analysis are of little value. For this reason the system of *Appraisal* must have a standard nomenclature for the quality issues, avoid the capture of wrong information and guide the operator through the data capture in a user-friendly manner.

A Lean Six Sigma Approach

The examples and descriptions above could well be attributed to a single process or machine but it should be remembered that any quality improvement initiative usually encompasses improvements across the entire plant.

It should be hoped that the plant will be utilising *Lean* manufacturing techniques to reduce waste and unnecessary costs as well as *Six Sigma* to reduce manufacturing variation. Within each of these approaches there are already processes that will help reveal the true cost of quality within production processes and identify and manage any required improvements.

The ATS Inspect Solution

ATS is well established in the world of manufacturing as a leading exponent of lean manufacturing techniques. Its leadership of MESA (Manufacturing Enterprise Solutions Association) International gives ATS access to the latest advances and best practices across a broad spectrum of industries.

With this background ATS is perfectly placed to offer ATS Inspect as a solution for attribute and variable quality data during the *Appraisal* stage of the quality control process.

ATS Inspect is designed to reduce the costs associated with scrap, rework, warranty claims and production bottlenecks in many different fields of manufacturing. Working in unison with existing systems it raises the quality of the manufacturing process and the final product.

Data Collection

Attribute data collection is provided with fully customised screens that guide the operator through the inspection process. When recording quality issue data ATS Inspect displays images of the part or assembly to be inspected and uses simple touch screen tools to identify and evaluate quality issues. Quality issues can be found, flagged and automatically routed to rework.

Electronic checklists can be used to record issues and to make sure all required visual and option content checks have been completed. Checklists can be added and modified in real-time without the need to reprint and redistribute to the operators.

This eliminates the difficulty of preserving, retrieving and using paper checklist data for later review and analysis.

Instant Event Notification

ATS Inspect can instantly inform personnel of the current state of quality throughout the production facility. It utilizes a messaging service that conveys information via e-mail and static display devices, such as message boards and overhead monitors.

It can also be configured to send out information-based or exception-based messages. Criteria for event messaging are user defined and may include:

- Quality thresholds
- Production thresholds
- Critical quality issues
- Quality statuses
- Production statuses

Data Analysis and Reporting

ATS Inspect allows real-time quality data to be viewed in various charts and tables. You can even export reports to spreadsheets and PDFs.

The web-based reports can be viewed anywhere in the world using Microsoft Internet Explorer® running on secure connections. This allows management to monitor performance even while on the road.

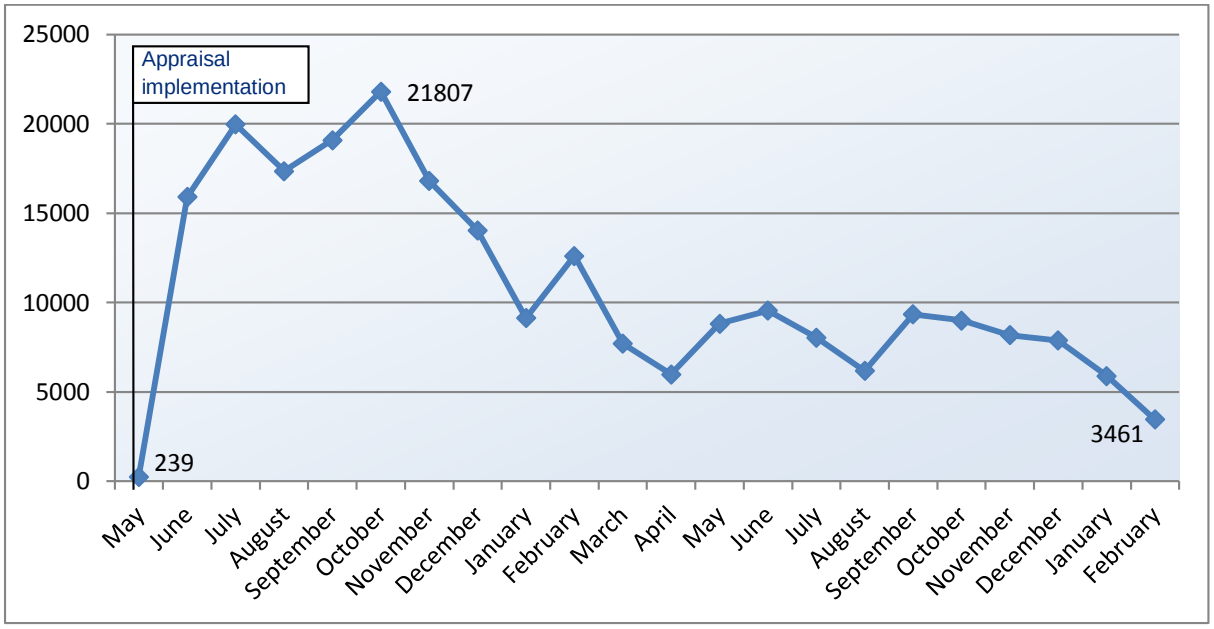
Reports can be generated for each product tracked in the system, and can be based on factors such as serial number, date, time, production area or cell, historical quality data, operator/inspector, quality issue type, severity /rank, repair status and current location. Report settings can be personalized for each user.

Fully customized reports can also be generated. Designing reports in-house means the company can quickly respond to business needs as soon as they arise.

Another useful feature of the reporting in ATS Inspect is the ability to schedule up-to-the-minute reports to be sent to the relevant people at regular intervals automatically. Like many other automated features in ATS Inspect this reduces the chance of human error.

The Results of Effective Appraisal

This example is taken from an automotive customer where there was a growing number of options on each vehicle being manufactured. In order to prevent these added complexities from generating issues they used ATS Inspect to carry out checks at key gating points during the production process. The following chart shows the effect that implementing a thorough visual defect *Appraisal* system had.



The total number of defects discovered on all vehicles inspected (by month)

The dramatic initial growth occurred after the system was implemented. This is due to the fact that the inspections were suddenly a lot more thorough and nothing was missed. The system guided the operator through the inspection process reducing the chance of an inspection step being overlooked. Also, the quick and intuitive method of entering quality issues means that the operator is more likely to enter the smallest issues which can be recorded individually rather than the operator simply drawing attention to an area of the vehicle.

After the initial peak the chart then slowly descends as the issues found are fed back to the *Prevention* side of the quality control systems. This would include actions such as faulty equipment being re-calibrated and extra training being given where required.

Conclusion

A complete picture of the money being spent on quality within a company needs to be attained. Once this has been achieved the amount being spent on *Prevention* and *Appraisal* must be increased (if required) to match the amount being spent on the combined total of *Internal* and *External Failures*. It should be remembered of course that an increase in spending on *Prevention* and *Appraisal* will lead directly to a drop in *Failures* and their costs.

The company must adopt Total Quality Management (TQM) to get the most out of each individual area. In the *Appraisal* stage this involves making the results of any data collected available to all interested parties within the manufacturing process.

An electronic system must be used to allow real-time data analysis and reporting. It will also increase the opportunity for automated and customised data entry, reducing the risk of human error.

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