

THE COST OF QUALITY IN ENGINEERING

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Abstract— It's a term that's widely used – and widely misunderstood. The "cost of quality" isn't the price of creating a quality product or service. It's the cost of NOT creating a quality product or service. Every time work is redone, the cost of quality increases. Obvious examples include:

- The reworking of a manufactured item.
- The retesting of an assembly.
- The rebuilding of a tool.
- The correction of a bank statement.
- The reworking of a service, such as the reprocessing of a loan operation or the replacement of a food order in a restaurant.

In short, any cost that would not have been expended if quality were perfect contributes to the cost of quality.

Index Terms— Quality, Product Design, Efficiency Losses

I. WHY STUDY COST OF QUALITY?

- To identify opportunities for cost reduction
- To investigate individual aspects of the quality effort so that the total cost of quality will be minimized and still insure a product that meets its design intent

II. COST OF QUALITY OBJECTIVES

- Identify problems on a dollar basis
- Establish a means for evaluating the need for changes
- Establish a means for evaluating the benefits to be derived from changes

(Reduced costs, improved quality levels, less scrap and rework, increased business, etc.)

III. COST OF QUALITY CLASSIFICATION

1. Prevention Costs

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Prevention costs are the costs associated with designing, implementing and maintaining the quality system. These are costs incurred to reduce all other quality costs. Prevention costs include quality planning and training. Prevention costs are the values of effort associated with the planning, implementing, maintaining and monitoring of a quality system that will prevent the occurrence of failures.

- **Quality and process control** - The value of time spent by QC engineers and others planning and implementing quality systems. Quality survey activities may be included in this element.

- **Reliability** - The value of time spent by engineers and others planning and designing for product reliability.

- **Product Analysis** - The value of time spent by product engineers and others planning and implementing quality or yield improvements. Included are specifying and installing inspection and testing equipment, and attending QC team meetings.

- **Quality Improvement Programs** - The value of time spent by employees participating in group activities that relate to quality.

- **Product Design** - The value of time spent by managers, engineers and others in coordination with the designer, in resolving quality problems in design and start-up activities.

- **Test Equipment** - The value of time spent by test equipment engineers and others planning and designing new or improved test equipment or instructions.

- **Tools and Gauges**

- **Training** - The value of time spent preparing for, conducting, and or attending training sessions to enhance skills. This includes quality and product training. The costs associated with most training that a company provides will fall under prevention costs. - The value of time spent by engineers and others planning and designing new or improved tools and gauges.

2. Appraisal Costs

Appraisal costs are costs associated with measuring, evaluating and checking products or materials to assure conformance to quality requirements or standards. These costs include process inspection, final inspection, incoming inspection and testing. Appraisal costs are the value of that

effort associated with determining the degree of conformance to quality specifications the first time through.

- **Testing Activities** - The value of time and material spent testing product for conformance to various characteristics. The tests may be electrical or mechanical. The time to enter data is included. Re-test is excluded because it is a failure cost.
- **Inspection Activities** - The distinction between what is considered inspection and what is considered testing is not always clear. Inspection usually involves checking for visual characteristics and testing involves using a test set. In some cases the inspectors will use test sets. Testers will usually (but not always) test 100% of the products where the inspector will select a sample. Inspection includes the value of time spent by employees inspecting incoming materials, work-in-process, completed product and data-entry. The activities include inspection at outside supplier sites. Re-inspection is excluded because it is a failure cost.
- **Chemical and Metallurgical Laboratory Analyses** - The value of time spent by laboratory personnel analyzing chemical and physical properties of materials in order to determine conformance to specifications.
- **In-Process Checking Activities** - The value of time spent by employees reporting to production in performing in-process checking functions related to quality or the measurement of characteristics or recording quality statistics and other data.
- **Test Set and Gauge Maintenance** - The value of time spent in maintaining and calibrating shop and inspection organizations' testing and gauging equipment.
- **Customer Appraisal** - The value of time spent by employees related to customer appraisal of our products and services.
- **Efficiency Losses** - The value of employee idle time caused by the results of in-process checks, inspection and testing.

Failure Costs

Failure costs are the costs associated with labor, scrap, materials, components, and other parts that fail to meet quality standards and cause a manufacturing loss. Failure costs are also the value of products or services found defective on and after the first time through. They include the value of effort associated with correcting or disposing of the failures. Failures may be sub-divided between internal and external. Internal failures are those discovered in-house and external failures are those discovered by the customer.

3. Internal Failure Costs

- **Rejected Lot Review** - The value of time spent by employees conducting reviews and providing instructions for disposition of rejected materials.
- **Rework and Repairs** - The value of time spent by employees reworking and repairing non-conforming (your own and incoming) materials.
- **Detailing and Sorting** - The value of time spent detailing and sorting rejected product or parts including return of defective materials from customers.
- **FMA Activities** - The value of time spent conducting Failure Mode Analyses.
- **Re-inspection and Re-testing** - The value of time spent inspecting and testing resubmitted product or parts including time spent preparing the materials, recording the data, and any special handling that may be required.
- **Complaint Reconciliation** - The value of time spent investigating any complaints related to quality and developing methods for correction.
- **Material Scrap** - The value of all material that cannot be reused.

4. External failure costs

- **Complaint reconciliation** - The value of time spent by in the investigation and resolution of customer complaints.
- **Product returned for replacement** - The value of time spent with the return and replacement of customer goods plus the value of goods scrapped.
- **Material repair** - The value of time spent in the return and repair of customer goods including analyses, re-testing, re-inspection, packaging and shipping.

IV. COST OF QUALITY DIRECTION AND GOALS

A reduction in certain costs of quality usually mean better products. In many cases, extra handling or the screening out of defective parts creates more problems than originally existed. The less steps that a product goes through, the less chance of damage or newly created defects.

Inspection and testing add no value to the product and may also create problems of their own. If there is assurance that the product has little inherent variability and consistently meets all quality requirements, then inspection and testing may be reduced and in some cases eliminated.

Additional expenditures in the prevention category such as quality planning and training will significantly reduce appraisal and failure costs. It is estimated that each additional dollar increase in prevention costs will reduce failure costs by five dollars. For a cost of quality program to be effective, it must be integrated into the total quality system. The overall goal is to improve quality and reduce its associated costs.

V. BASIC APPROACHES TO COST OF QUALITY

• **Keep Track of all Incurred Quality Costs :-** Keeping track of quality costs may be difficult to do in some cases. Many reports that show total quality costs are broad based and do not include all effort associated with specific defects. If a cost of quality report is published on a periodic basis, and no specific projects to reduce the actual costs are undertaken, then the report may be of little value. In many cases a published cost of quality report is not a stimulus for action.

• **Keep Track of Cost of Quality Reductions :-** After an overall cost of quality base is established, cost reductions may be subtracted from this base. The base may be established on a monthly or yearly basis. This approach measures the results of specific efforts or projects and the effect on the overall costs of quality.

Cost of quality reduction projects include changes into design and processes that make it difficult for errors or defects to be created. The projects should also stress the elimination of manual operations and the implementation of mechanized and computerized facilities where appropriate.

A reduction in the defect rate for a specific product is an example of a quality cost reduction. If the product is to be assembled into another product, then less rework, handling and scrap will occur, thus reducing the cost of quality.

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