

Abstract

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The Need For Root Cause Failure Analysis

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Introduction.

While the definition of “root cause” is often a topic of heated debate, especially when lawyers become involved, there should be no disagreement that root cause analysis is critically important to the ongoing success of a company engaged in the manufacture of electronics. Agreements between suppliers, manufacturers, distributors and retailers often contain warranties which shift the risk of product failure and customer returns “up stream” if a common product defect exists. Early detection of such defects yields numerous benefits, including continuous product improvement, as well as increased product reliability and performance. Conversely, delayed detection can cost a company enormous amounts of revenue, reputation, client satisfaction and, ultimately, market share.

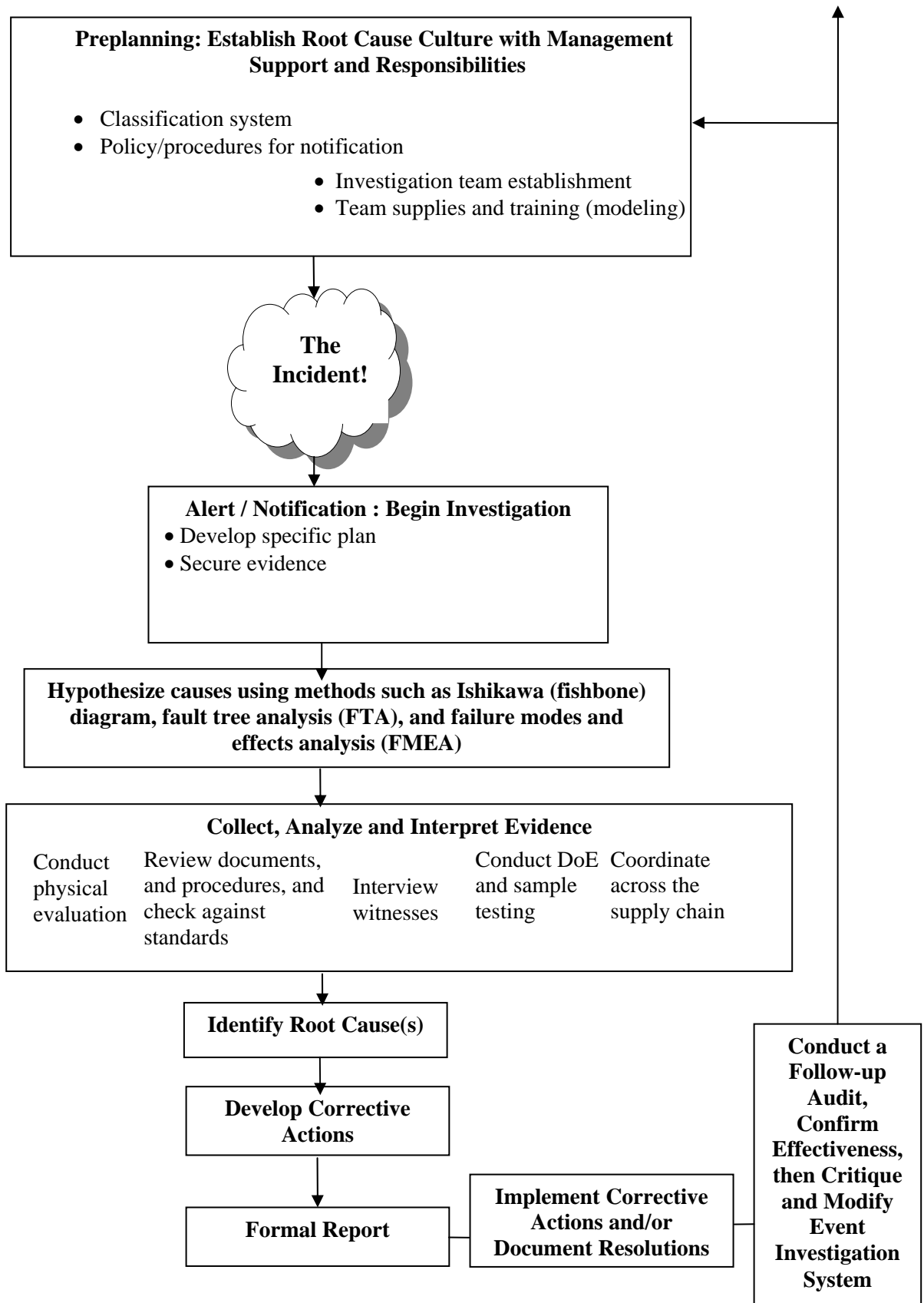
What is Root Cause?

The root cause is the most basic causal factor or factors that, if corrected or removed, will prevent the recurrence of the situation.² The purpose of determining the root cause(s) is to fix the problem at its most basic source so that it does not occur again, even in other products, as opposed to merely fixing a failure symptom. Identifying root causes is the key to preventing similar occurrences in the future and improving the company’s products.

What is Root Cause Failure Analysis?

Root cause analysis is a methodology designed to help: (1) describe *what* happened during a particular occurrence; (2) determine *how* it happened; and (3) understand *why* it happened. What differentiates root cause analysis from, for example, trouble shooting, are its long and wide-ranging goals. Whereas troubleshooting emphasizes the elimination of a symptom or particular problem in a single unit or product, root cause analysis seeks to determine why a particular event or failure took place so as to correct the problem from ever occurring again in that or any other product. In this way, root cause analysis is a tool that can be used to constantly improve all aspects of product development and production.

Graphically, a root cause analysis program might well have the appearance set forth below:



Root Cause Analysis: The Essentials.

There must be specific protocols established regarding the type of reliability and performance data that is to be gathered. Whoever controls the data and its collection controls the analysis. In drafting reliability and performance agreements, one must understand the nuances of established standards so that all data necessary to apply those standards are gathered. Generally, a party's ability to prevent and/or resolve reliability or performance disputes increases with the amount of data available. It is, therefore, important for the manufacturer of a product to gather as much data as possible.

There must be a mechanism established whereby all gathered data is promptly distributed to the organizations participating in the development, manufacture and distribution of the product. Data which is never reviewed is useless. A purpose of gathering reliability and performance data is to identify and address promptly and objectively trends suggesting substandard quality. Because poor reliability and performance may be associated with one or more aspects of development, manufacture an/or distribution, every party associated with these processes should receive the data. It is difficult to hold a party responsible for substandard quality without providing that party an opportunity promptly to understand the nature of the problem. It is, of course, in every party's interest to resolve quality issues as quickly as possible to minimize financial liability, and also to minimize damage to the party's reputation in the marketplace.

There must be a process established for engineering professionals involved in the development, manufacture and distribution of the data to meet and confer, regularly, to discuss the collected data. Just as it is important for collected data to be analyzed, so too is it important for those analyzing the data to share their thoughts with other parties involved in the products development, manufacture and distribution. What may be an insignificant statistical "blip" in the data to one party may well be a significant trend to another. Requiring "meet and confer" sessions among those reliability engineers and other professionals who review the collected data will enhance everyone's understanding of the product's performance characteristics, and also prevent one or more party from developing and concealing conclusions regarding the product, which conclusions might later prove difficult to dislodge.

There must be an agreed upon methodology for product testing and analysis, should the data suggest a trend warranting investigation of reliability and performance problems. Just as the party who selects the data to collect and analyze controls the results of the analysis, the party who structures or conducts the product testing, or design of experiments, can have great influence on the test results. It is, therefore, important that the parties' agreement address these issues. The parties may wish to agree, at the outset, that the results of any testing or analysis will be presumed invalid in any subsequent dispute concerning a product's performance or reliability unless the testing regimen is agreed upon by the party(ies) against whom the results are sought to be used.

There must be a dispute resolution mechanism established to enable the parties to overcome differences of opinion concerning investigative techniques, observations and proper interpretation of test results. Any two persons, reviewing the same data, document, product, and the like can draw differing conclusions. It goes without saying that differences of opinion are magnified as the amount at stake (money, reputation, future business opportunities) increases. Therefore, it may be worthwhile to agree that scientific protocols, observations and similar non-business / non-legal issues will be resolved by a referee of sorts. The selection of a referee may, of course, prove to be unmanageable in some situations because of the need to act promptly. To avoid these types of

delays, it may also be advisable to work within the dispute resolution framework of industry organizations, which ought to be able to respond relatively quickly to requests for referees.

Why Is Root Cause Failure Analysis Important?

Inevitably, a recurring product defect will lead to claims by the “buyer” that the “seller” has failed to deliver goods of the quality and character agreed. Such claims will lead to often costly repair or replacement claims, or sometimes even more costly litigation. The goal of an effective root cause analysis program is to reduce and/or eliminate those types of claims so that the value of the product increases.

A claim that a product is defective generally arises in the context of a warranty claim. Warranties of product reliability and performance are, and generally should be, customized by the product’s buyer and seller. In the context of this discussion, both “buyer” and “seller” are commercial enterprises engaged in the manufacture, distribution and/or sale of the product, not end users, or “consumers.”³ Consumer warranties and guarantees are highly regulated, in the United States for example, by state and federal statutes. Such consumer warranties do not generally involve the risk shifting considerations that are the give and take of business-to-business manufacturing and product development agreements.⁴

Commercial warranties, even when established by statute or convention, are generally modified and customized to meet the needs of the merchants involved in the transaction. Statutory and conventional warranties simply provide the framework on which merchants and business persons negotiate risk shifting. Such risk shifting warranties are often very intensely negotiated because of their enormous potential downside.

International Commercial Warranties.

The United Nations Convention On Contracts For The International Sale Of Goods (1980) (“CISG”) provides a structure which its drafters believed would “contribute to the removal of legal barriers in international trade and promote the development of international trade,” by taking “into account the different social, economic and legal systems” of differing States.⁵ The CISG is specifically not applicable to consumer transactions;⁶ rather, it applies to contracts for the sale of goods, which are “to be manufactured or produced,”⁷ as opposed to contracts contemplating the provision of “labour or other services.”⁸ Perhaps most importantly, Article 6 of the CISG permits the contracting parties to entirely waive its application or, with only a slight limitation imposed by Article 12, to “derogate from or vary the effect of any of its provisions.” Rarely, if ever, should a merchant ignore the opportunity to customize and tailor warranties to fit the precise circumstances involved in the transaction at hand.

Express & Implied Warranties.

Section II of the CISG contains the articles which should be of most interest, and concern, to those engaged internationally in the purchase and sale of goods and products. Article 35(1) of the CISG provides, in part, that: “[t]he seller must deliver goods which are of the quantity, quality and description required by the contract . . .” - the *express warranty*. Subpart 2 of Article 35 thereafter describes the *implied warranty*, providing that “goods do not conform with the contract [for purchase and sale] unless they:”

- Are fit for the purpose for which the goods are ordinarily used;
- Are fit for the purpose specifically or impliedly known to the seller;⁹ and/or
- Are consistent with samples or models of the goods shown to the buyer.¹⁰

In manufacturing complex products, especially electronic products, it may be tempting to produce samples for design and engineering validation studies using the finest craftsmanship, techniques and materials possible. However, if a manufacturer succumbs to this temptation, not only is it likely to be a violation of the buyer's expectation that the samples will be "off the line" and not custom, but it will establish a benchmark against which all future goods will be judged. That is, while it may be possible to manufacture a handful of products to exceptional standards, during actual production the manufacturer will soon realize that it cannot manufacture, for the contract price, thousands and thousands of products of the same quality. The options then become rather stark for the manufacturer: (1) Manufacture to the standards established by the samples presented to the buyer – and lose money; or (2) Manufacture to industry standards and face mounting warranty claims for having failed to deliver conforming goods. Either option will, eventually, cost the manufacturer substantial amounts of money, reputation and market share.

Customized Warranties: Competing Interests.

Warranties of product reliability and performance are risk shifting devices. Critical issues to address in the negotiation of such warranties include: duration, triggering event, cost to remedy and anticipated rate of participation. The interrelation of these factors must be understood to manage the economic risk associated with the warranty. Clearly, the longer the warranty period, the more likely the product is to fail, unless greater resources are expended to design and manufacture a product with a longer useful life. The buyer of "high-end" products will push strongly for longer warranty periods to match the perceived reliability of the product. Conversely, with lower-end products, the perceived useful life will be shorter so that reduced warranty periods are more easily negotiated.

The "middle market" product, where price competition is often most severe, can result in prolonged negotiations concerning warranties. In these negotiations, the tension between the business person's desire to manufacture and sell the product at a lower cost, and the engineer's need to design and manufacture the product to minimize warranty claims, is most evident.

Warranties: The Lawyer's Role.

The world of lawyers is divided into two realms: the transactional lawyer, who helps create the contractual relationship, and the litigation lawyer, who finds fault and exploits ambiguities in the language used by the transactional lawyer.

In the context of reliability and performance warranties, the transactional lawyer's role is that of mediator among scientists, engineers, business people and other lawyers. The business lawyer must be able to identify and eliminate language that could otherwise permit the creative litigator to exploit loose language to either enforce an invalid warranty claim, or nullify an otherwise valid claim.

For example, creating a warranty whose trigger point is a percentage of product failures over some period of time resulting from "a single root cause" may well be interpreted in many different ways.

The susceptibility of the warranty language to myriad interpretations by lawyers, judges and others renders it impossible to manage warranty risk.

Warranties: The Scientist's Role.

A warranty of product reliability and performance, as well as product price, which is established without the guidance of a scientist/engineer presents unnecessary and avoidable risks. Before a manageable warranty can be created, the inherent mechanical and electrical limitations of the product must be understood. It may be that for the price the client is willing to pay for the product, it is simply impossible to manufacture it to the client's expectations. This cost/price tension must be understood and addressed.

Reliability and performance requirements must be based upon specific scientific qualitative and quantitative standards. Without such widely-recognized standards against which to analyze and/or characterize product failures, a warranty based upon "same root cause" or similar undefined term can be the recipe for disaster. Unless the parties are able to specify in their agreement a set of objective standards against which a product is to be judged, subjective interpretations will too often lead to disagreements which cannot be resolved short of formal proceedings such as litigation or arbitration. It is not possible at the outset of product development or manufacture to address every potential reliability or performance problem. Therefore, to the extent that specific scientific standards, such as those adopted by the IPC¹¹, cannot be defined in the parties' agreement, it may be useful to describe a method for later determination of applicable standards. It should be a goal of drafting agreements relating to product reliability and performance to eliminate to the greatest extent possible subjectivity.

Warranty Claims & Root Cause Failure Analysis.

Product warranties, including Articles 36 and 39 of Section II of the CISG, reinforce and encourage the concept of openness and shared information between manufacturer (seller) and buyer of the product. Article 36 provides that "even though . . . [a] lack of conformity becomes apparent only after . . ." delivery to the buyer, [t]he seller is liable in accordance with the contract and the . . . CISG for any lack of conformity which exists at the time" of delivery.¹² Article 39 further tempers the rather open-ended liability established by Article 36 by providing that "[t]he buyer loses the right to rely on a lack of conformity of the goods if he does not give notice to the seller specifying the nature of the lack of conformity within a reasonable time after he has discovered it or ought to have discovered it."

Article 36 recognizes, as it should, that not all non-conformities are patent, or discernable from on a reasonable visual inspection. Rather, some non-conformities may be latent, and detectable only through the use sophisticated and destructive testing. If the product has failed after delivery to the buyer, but before the expiration of some warranted or specified "life" of the product, then the CISG places the liability on the manufacturer.

It is at this point in the life of a product (*i.e.*, when it fails) that an open and thorough investigation of the root cause(s) of the failure is crucial. Article 39 of the CISG, as well as most customized warranties, relieve the manufacturer of its liability if it delays unreasonably in identifying and/or reporting a non-conformity. And this is as it should be, for the manufacturer is often at the mercy of the buyer to report problems with a product. At other times, the manufacturer itself will have

established a repair facility for the product, in which case it is essential that thorough and routine reports of failures and follow-up investigations be provided to the buyer. Only then will the buyer be in a position to exercise its remedial rights contained in the warranty.

Need For Open & Cooperative Root Cause Analysis Atmosphere.

The self interests of buyer and seller, when product failures appear, would upon first impression seem in conflict. In reality, they are not. When buyer and seller understand the alignment of their interests, and work together to determine causes and mechanisms of product failure, then will they each obtain full benefit of the open and shared communication which warranties attempt to engender. For the buyer, the need to act reasonably and diligently in the investigation and disclosure of non-conformities can be seen in the following points:

- Early discovery of non-conformity increases manufacturer's opportunity to eliminate defective design, component, manufacturing technique, etc.
- Early discovery of non-conformity decreases volume of products requiring repair and/or replacement.
- Early discovery of non-conformity increases chance that goods remain centralized (warehoused) such that shipping costs incidental to repairs are reduced or eliminated.
- Early discovery of non-conformity will decrease number of non-conforming goods which are sold to consumers, thereby limiting amount of adverse publicity (*i.e.*, adverse publicity; decreased market share).
- Early discovery of non-conformity will increase buyer's ability to hold manufacturer liable for non-conformity.
- Early discovery of non-conformity increases manufacturer's ability to assert warranty claims against its suppliers and/or subcontractors, as appropriate.

Each of these points may also be expressed in the negative, with contrary results. For example, delayed discovery or reporting of a non-conformity will make it difficult, if not impossible, for a manufacturer to assert warranty claims against its suppliers and/or subcontractors. The warranty period(s) may have expired by the time the non-conformity is discerned; the subcontractor may be out of business; documents necessary to assert the claim may have been lost or destroyed; witnesses may now be unavailable, etc. In the end, both manufacturer and seller enjoy increased opportunities to eliminate losses if they work together diligently to identify and investigate potential problems, and then develop and implement a solution. The price of delay is nearly always increased costs, lost reputations, markets and customers - not to mention costly and time consuming warranty and contract litigation.

Endnotes

¹ Mr. Rundle's practice emphasizes a wide variety of both national and international litigation, including arbitration and mediation. Mr. Rundle is a member of the London Court of International Arbitration ("LCIA"), an arbitrator with the American Arbitration Association ("AAA"), as well as a former Settlement Officer with the United States District Court for the Central District of California.

² "Root Cause Analysis Handbook, A Guide to Effective Incident Investigation", ABS Group, Inc., Risk & Reliability Division, Rockville, Maryland, 1999. *See also*, Dew, John R., "In Search of the Root Cause", *Quality Progress*, pp. 97 - 102, March 1991; Gano, Dean L., "Root Cause and How to Find It", *Nuclear News*, pp. 39 - 43, August 1987; Electronic Industries Association, EIA/JEP131, *Process Failure Mode and Effect Analysis (FMEA)*, February 1998; Field, S. W. and K. G. Swift, "Engineering A Quality Change: An Engineering Approach", John Wiley & Sons, New York, 1996; Latino, R. L., K. C. Latino, "Root Cause Analysis: Improving Performance for Bottom Line Results", CRC Press, Florida, 1999; Mobley, R. K., "Root Cause Failure Analysis", Butterworth-Heinemann, Woburn, Massachusetts, 1999; Modarres, M., M. Kaminskiy and V. Krivtsov, "Reliability Engineering and Risk Analysis", Marcel Dekker, New York, 1999; Nelms, Robert, "What You Can Learn From Things That Go Wrong: A Guidebook to the Root Causes of Failure", Failsafe Network, Richmond, Virginia, 1994; United States Government, MIL-STD-1629A, *Procedures for Performing A Failure Mode, Effects and Criticality Analysis*, 1980; Wilson, P. D., L. D. Dell and G. F. Anderson, "Root Cause Analysis: A Tool for Total Quality Management", ASQC Quality Press, Milwaukee, Wisconsin, 1993.

³ As it relates to the manufacture of a given final product, there may be several "buyers" and "sellers". For example, in the manufacture of computer or telecommunications equipment, the last buyer before the consumer is the distributor of the final product. Before the distributor obtains the final product, however, it will generally be manufactured by a different company, called an original equipment manufacturer, or OEM. For example, nearly all personal computers sold by American computer companies are actually manufactured overseas by OEMs. The OEM will have purchased various components (products) with which to assemble the final product (*e.g.*, hard drives, disc drives, CRT's, LCD's, mother boards, modems, etc.). Further, the manufacturer of these sub-assemblies (products) may well have purchased from yet another supplier various components (products) with which to manufacture the sub-assemblies. At each stage of this manufacturing process, there will exist a buyer and seller. The focus of this discussion is the commercial relationship that exists at each of those stages, and how those parties engage in risk shifting efforts by negotiating warranties of product reliability and performance.

⁴ *See, e.g.*, Magnuson-Moss Warranty – Federal Trade Commission Improvement Act (15 U.S.C. §§ 2301, *et seq.*) and Song-Beverly Consumer Warranty Act (*Cal. Civ. Code* §§ 1790, *et seq.*), both of which impose strict requirements on the nature, scope, presentation and negotiability of consumer warranties.

⁵ *CISG, Prefatory Remarks & Art. 1.*

⁶ *CISG, Art. 2.*

⁷ *CISG, Art. 3(1).*

⁸ *CISG, Art. 3(2).*

⁹ If, however, the circumstances make it clear that the buyer did not rely, or it was not reasonable to rely, "on the seller's skill and judgment," then the goods will be deemed conforming.

¹⁰ Additionally, a product will be deemed non-conforming unless it is properly packaged. However, this paper is addressed more to manufacturing-related issues and, therefore, the proper packaging of a product, while a very important consideration in ensuring the delivery of defect-free goods, is omitted from this discussion.

¹¹ The Association of Connecting Electronics Industries, formerly the Institute of Interconnecting and Packaging Electronic Circuits.

¹² This is not to say that the buyer can wait unreasonably to give notice of nonconformity to the seller. Indeed, Article 35(3) of the CISG provides that a buyer cannot assert a valid implied warranty claim under the CISG "if at the time of the conclusion of the contract the buyer knew or could not have been unaware of such lack of conformity."