Effective problem solving in quality and reliability

Take - Aways

- Effective problem solving is less about tools and more about the right strategy.
- Solving tough, chronic problems with starting a brainstorm on possible causes is mostly not effective, because the possible causes are unknown.
- Biases and faulty reasoning can doom solving tough, chronic problems to failure.
- Lack of structure is a common pitfall to effectiveness in problem solving.
- Contrasting extremely good and extremely bad products (studying 'What's different?') turns out to be an effective strategy for tough, chronic Q&R problems.
- Defining the logical ‘Families of variation’ and the family with the largest contrast between extremely good and extremely bad products is an effective starting point.

Relevance

The booklet is intended for engineers and other practitioners working in the field of quality and reliability and who have already some experience in solving problems in industry (such as Green and Black Belts). The author explains in the book why it is not enough to just apply a fancy tool, but it focuses on the conditions under which these tools should be used and other strategy- and even psychology-related aspects.

About the author

Jo Mooren has a background in physics, industrial engineering, business management, and is certified DFSS Black Belt. He has more than 30 years of experience in the area of quality and reliability and in applying process improvement and problem solving methodologies within high-tech manufacturing industries. Within Philips he develops and runs Q&R problem solving trainings and he is involved in the Philips Design for Reliability program.
Summary

Objective

The intention of the publication is to provide background information for quality and reliability problem solvers: improving production processes, increasing yield, reducing cost of non-quality, stabilizing manufacturing processes, tackle field failures, and so on. Textbooks on this topic (e.g. by Keki Bhote and Gregg Young) give an overview of effective tools, but hardly explain why those tools work; they neither describe the pre-conditions to make the tools work effectively! The strength of the propounded methodology is not so much in the tools, but in the underlying strategy and structure! The booklet explains this underlying strategy and as such it can be used as an addition to the textbooks and the hand-out material used in problem solving classes. However, just reading this booklet will not make you an expert problem solver. Only by applying the techniques in real life situations one can become an effective problem solver.

General concepts and pitfalls in problem solving

Real-life problems, just like people, are simultaneously different and the same. It is impossible to get a tough problem solved by just applying a pre-defined ‘cook book recipe’. Every problem is to a certain extent different from what one has seen in the past. Copy & paste of a solution from the past is usually not an option. On the other hand, recognizing commonalities among problems is essential if experience from similar instances in the past is to be applied to a current situation. Recognizing the differences among problems, their distinctive characteristics, is also critical, since the devil can lie in the detail.

Effective problem solving is about applying the right analysis tools and techniques in the right context. Too often, quality problem solving practice has focused excessively on tools and techniques alone: rather than thinking carefully about a problem, engineers mindlessly apply techniques that they have learned at trainings and from books. The tools become substitutes for thought, driving out what they were supposed to support. Applying a tool is usually easy, the thinking is hard! Techniques are relatively easy to teach; effective thinking about real-world problems is not. The booklet is about this hard task: it tries to support the reader in how to think effectively about quality and reliability problems. The use of proper tools and techniques is part of that thinking, but there is much more. In the book this is called the strategy development aspect of problem solving.

Problem solving is very much a human activity, for which perception, reasoning, technical knowledge of the application area, and creativity are needed. Reasoning has a prominent role in problem solving. Just recall any of your discussions during a problem solving project meeting: participants make claims about the problem’s nature, the causes, and solutions, supporting their claims with more or less reasoned arguments. Erroneous beliefs and faulty reasoning can doom problem solving to failure. Many people turn out to be fundamentally irrationally, by using quick-and-dirty methods. Besides the psychological pitfall related to our way of reasoning there is another hurdle that could complicate problem solving activities: and that’s lack of structure. The circumstances in which tough problems or high impact incidents have to be analyzed and solved is often not clear from the start: the team has to work under stressful conditions. The situation is very likely rather fuzzy and complex. The problem solver has to be able to clear up the fuzzy situation and give structure to the approach. He should focus on what is really important, prevent the team from being biased or defensive by making sure there will be no blame for their department, company, or for the person,
prevent the team from spending time and energy on irrelevant discussions, and be able to structure the team’s way of reasoning.

Paradigms in quality problem solving
A major reason why certain problems are ultimately not solved is related to the fact that the approach most engineers use (let’s call this the “conventional approach”) is not effective in all cases. This conventional approach is based on a set of tools and techniques that is less effective for solving tough, chronic problems. By definition, chronic problems are those kinds of problems for which it is difficult, if not almost impossible, to conceptualize or brainstorm the possible causes.

Some problem solvers (the ‘mechanics’) address problems by figuring out “What’s wrong?” These problem solvers study symptoms until they can conceive (hypothetically) the cause. They then propose a design change to either the product or the process that they believe will fix the problem. Since they can usually envision (by brainstorming) a number of potential causes, they often propose several changes. Their fundamental perspective is that the presence of problems must mean there is a flaw in the system. This is a dangerous approach when the engineers start changing the process or the design while neglecting the fact that the majority of the products performed well and just a certain percentage of the products failed.

It would be better to find the cause of the problem in the existing design first, and then decide what to do to fix the problem. The alternative approach (or paradigm) is by focusing on “what is different?” It’s about combining statistical thinking with engineering insights to converge on the cause-effect relationship that is driving most of the difference between the extremes of a population of products.

This means that there are two fundamentally different approaches or paradigms: either you will work according to a “Cause to Effect” (1) strategy or to the “Effect to Cause” (2) strategy!

Quality versus reliability
In the engineering world it is common to make a clear distinction between quality and reliability. Quality refers to the ability to perform according to specification during manufacturing or at the end of manufacturing. Quality problems will become manifest at the different inspection gates and test stations in a manufacturing process. Reliability, on the other hand, is about the performance of the products once these are in the field (customers). Reliability problems refer to failures ‘in the time domain’. Quality is the ability to perform according to spec at t=0; the customer is normally not aware of quality problems; information regarding quality comes from manufacturing. It is an aspect of design, parts (material) or manufacturing process and can be measured and ‘calculated’ from the information from in-line and end-of-line test stations. As such it is quite ‘deterministic’: it is simply a matter of aggregating the existing data. Reliability failures (i.e. failures at the customers) have a high customer visibility and impact. Info comes from field service and reliability performance is not only related to the design, manufacturing process and parts quality, but also the environment in which
the product is used and the length of time that a product has been used for. Finally, reliability information comes from field feedback.

**Developing an investigation strategy**

First one needs to understand the concept of “families of variation”, because understanding the variation within each family will lead the problem solver to the best inroad to find the root cause. A family of variation can be defined as a collection of variation sources having common elements. It is a logical way of stratifying or grouping all possible influencing causes (Xs). The Xs can be grouped in logical entities, having specific characteristics in common. Some of the causes (Xs) will be related to the incoming material; other causes will be related to the behavior of different batches or to the equipment behavior, and so on. At the beginning of an investigation one doesn’t know the influence of all these Xs on the effect one needs to optimize (Y). In fact, we do not even know if a specific X has any influence at all! We do not know whether we have to focus on incoming material, differences between lots or machine performance. This is why one will use a more general stratification and definition of the various families of variation, such as:

- Families related to within-product variation
- Families related to product-to-product variation
- Families related to variation over time

It depends on the specific definition of the effect (the “Y”) and the manufacturing process how those families can be characterized. During the early stages of the project one has to list all the relevant families of variation and determine what is already known about the contrast in each of them. It is very likely that there is already knowledge about the variation in specific families (from historical data). For instance it is known that problems come from certain material batches or from one specific machine. The further investigation will focus on explaining this contrast.

The booklet explains what tools and techniques can be used to work from here.

**Use of investigation roadmaps**

As already stated before, it is impossible to formulate a cook book recipe for problem solving: there is no silver bullet! Every problem is unique and therefore duplicating an effective solution from the past is usually not an option. On the other hand recognizing commonalities among problems, such as using the concept of families of variation as a starting point, is essential. These commonalities are the basis for the general problems solving roadmaps (one for quality and one for reliability problems). The booklet gives a high-level explanation of the background and use of these roadmaps.

**Effective problem solving tools**

Although the objective of the booklet is not to explain all details of effective problem solving tools, it gives a comprehensive overview of most commonly used quality and reliability tools. The book gives a short description of the main tools and ends with a glossary of terms and a reference for further reading.