Root Cause Failure Analysis – An Integrated Approach

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Introduction

This article is a compilation of the work of numerous researchers who have developed various approaches to the science of **Problem Solving / Decision Making**. It is an attempt to combine and integrate proven techniques into one GENERIC methodology that can be applied to *ANY* problem. Contrary to other, current, (very good) methodologies, this approach does not require a dedicated team, nor do they have to be experts in the subject matter of the problem. Indeed, it is our experience with hundreds of problem analysis sessions based on this model that the solutions generated during public programs attended by a cross-section of participants from different industries and cultures, significantly outperform those of private in-house courses.

A Successful Generic RCFA Problem Solving Methodology must:

1. **Be standardized on a uniform baseline throughout the organisation**
2. **Ensure continuity of effort and promote strong leadership**
3. **Progressively achieve the objectives set at the outset of the session**
4. **Be both effective and efficient, and provide a basis for capital expenditure**
5. **Be generic enough for company-wide as well as high level / low level application, and have potential for a "snow-ball" effect**
6. **Produce fast results, and have a track record of success**
7. **Require minimal data sets, and minimal data accuracy at the outset**
8. **Be relatively cheap (cost effective) to implement**
9. **Allow for both "Logical" as well as "Creative" thought processes**
10. **Be flexible enough to allow for Continuous Improvement**
11. **Be "Open Ended" – have no limitations**
12. **Be non-computerized, but allow scope for expert systems and statistical analysis**
13. **Have no cultural / demographic barriers**
14. **Be suitable for individual as well as group application**
15. **Lead to improved communication, motivation and task focus**
16. **Elevate the Problem and place it into its correct context**
17. **Be rapidly transferable, as well as downwardly cascade-able**
18. **Be supported by ongoing research and training, world wide**
19. **Identify the Root Cause(s) of any Problem**
20. **Result in coordinated Action**

QMS Problem Solving Methodology

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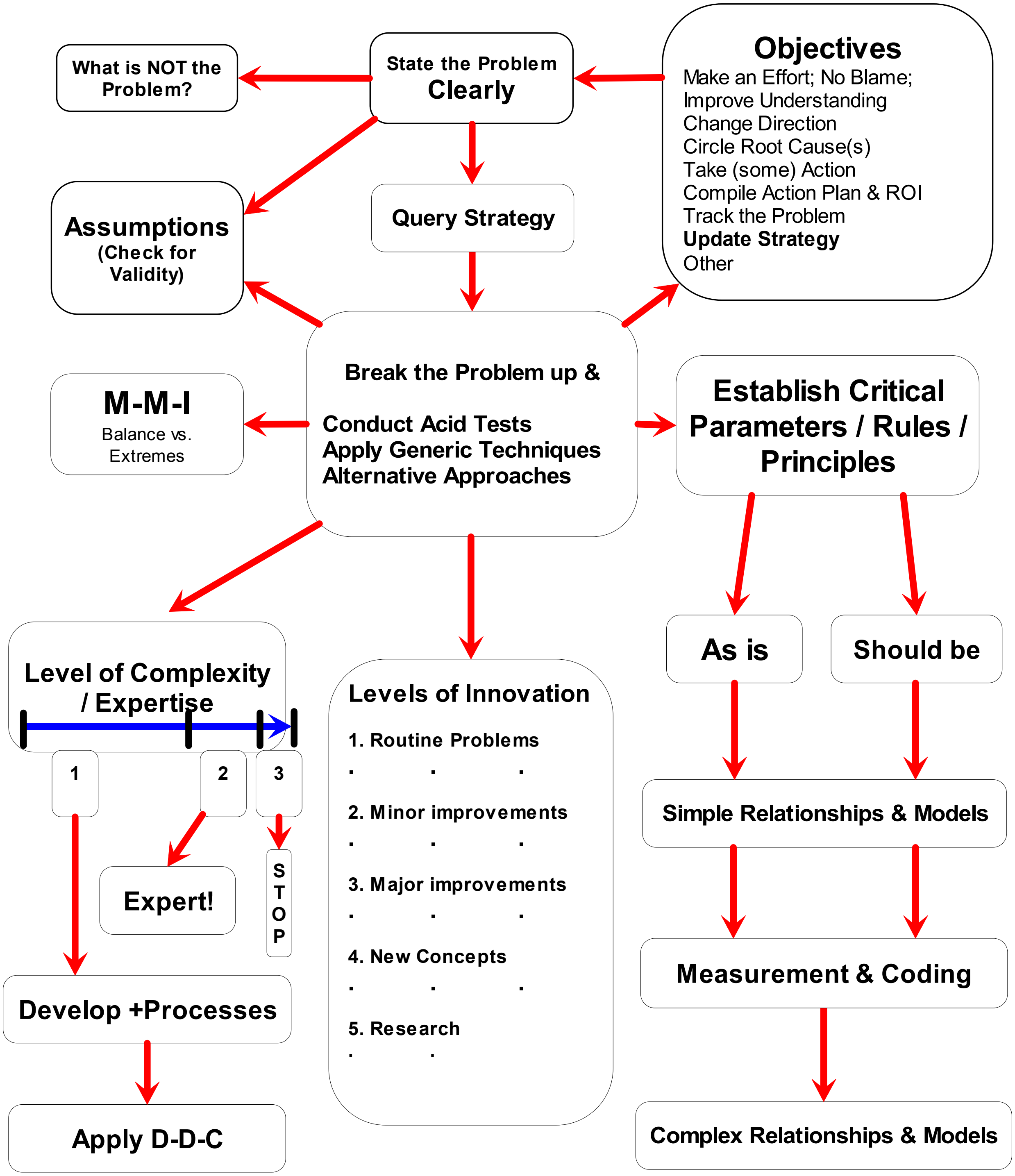

Summarized Description of the Methodology

The model is not a flowchart in the strict sense although it does exhibit some flowchart characteristics and looks like one. A random approach to the sequence of analysis may well be just as successful as a strict linear "block-by-block" procedure. In fact, when the process is fully understood, it may even be faster and will certainly generate more excitement. It is however critical that the entire problem analysis be visible to all participants at every stage of the process.

Each section of the methodology has its own unique set of "Rules" which can unfortunately not be comprehensively explained here due to space constraints and other limitations.

The process starts by setting objectives. These should be carefully phrased so that the first few are easily achieved.

The second step is to "State the Problem Clearly". Its rules are as follows:

1. Take time to examine and explore the problem thoroughly before setting out in search of a solution. Often, to understand the problem is to solve it.
2. The formulation of a problem determines the range of choices: the questions you ask determine the answers you receive.
3. Be careful not to look for a solution until you understand the problem, and be careful not to select a particular solution (Root Cause) until you have a whole range of choices.
4. The initial statement of a problem often reflects a preconceived solution.
5. A wide range of choices (ideas, possible solutions) allows you to choose the best from among many. A choice of one is not a choice.
6. People work to implement their own ideas and solutions much more energetically than they work to implement others' ideas and solutions.
7. Remember the critical importance of acceptance in solving problems. A solution that is technologically brilliant but sociologically stupid is not a good solution.
8. When the goal state is clear but the present state is ambiguous, try working backwards.
9. Denying a problem perpetuates it.
10. Solve the problem that really exists, not just the symptoms of a problem, not the problem you already have a solution for, not the problem you wish existed, and not the problem someone else thinks exists.
11. Honestly face defeat; never fake success.
12. Exploit the failure; don't waste it. Learn all you can from it.
13. Never use failure as an excuse for not trying again.
14. Fail towards your goals

The next three blocks can be done in quick succession by simply following the arrows. If the group seems to be dumbfounded by any element of the process, they can do either of two things: briefly study the rules of the block, or move on to the next element of the process. Re-grouping and classification of problem elements is a common occurrence. No random insight must be allowed to go uncaptured, and participants are encouraged to voice these as soon as they occur. The trained facilitator should have the presence of mind, awareness of each situation as it develops and the necessary skills to guide the group through the process without being dominant.

A very common stumbling block is the "Assumptions", the majority of which we make unconsciously. Its rules are as follows:

1. If you must assume something, assume something that is easy to test for validity.
2. Most assumptions will be hidden and unrecognized until a deliberate effort is made to identify (and capture) them. They are normally made unconsciously.
3. Often it is the unrecognized assumption that prevents a good solution.
4. They set limits to the problem and thus provide a framework within which to work.
5. Assumptions reflect desired values, values that should be maintained throughout the solution.
6. Assumptions simplify the problem and make it more manageable by providing fewer things to consider and solve.
7. A problem with no assumptions is usually too general to handle.
8. Assumptions are **often self-imposed**
9. Is the assumption necessary?
10. If the assumption is not necessary, is it appropriate?
11. Consider any unconscious assumptions you have made about the following constraints: Time; Money; Cooperation; Law; Energy; Cost / Benefit; Information; Culture Binding;
12. Alternatively, consider the assumptions you may have made with regard to the Life Cycle stages: Design; Transport; Installation; Commissioning; Operation and Maintenance; Disposal
13. Focus your assumption identification on the crux or sticking point of the problem.
14. Look over your written statements of the problem and your lists of constraints and write out a list of the assumptions behind each item. Group your assumptions as follows:

    General assumptions;
    Assumptions at the crux of the problem;
    Assumptions determining the constraints;
    Assumptions with regard to support systems and rate of change.

The following five sections of the process are all powerful insight generators in their own right, but each requires the balance (counterviews) provided by the others to enable the process to remain in perspective.

Break the Problem up

"Break the Problem up" into sub-problems is a relatively well known procedure, but for some mysterious reason simply not done regularly. We tend to rather jump to conclusions. The "Acid Test" is simply posing the following question to the group: "If all the sub-problems identified are resolved, will the main problem then be solved?" Likewise, each sub-problem can then be broken up into a next stage of contributory, smaller sub-problems and the "Acid Test" repeated. The 10 "Generic Techniques" and 60 "Alternative Approaches" are left till later in the process, but will not be covered in this article due to space constraints.

M-M-I

Maintenance Maturity Indexing (M-M-I) is likewise well-known. Some models use five stages – this one uses four. The rules for establishing the number of stages were derived from Complexity Theory and the logic thereof is undeniably true. Theoretically we strive to maintain a "Balanced" approach by each maturity stage, because this will result in sustainability and continuity of operation, but there are certain conditions when "Extremes" are unavoidable, and in fact, would be the correct approach.

Levels of Complexity / Expertise

The "Levels of Complexity / Expertise" block establishes a scale with three ranges. The last (number 3) interval corresponds with incredibly high complexity – such as is encountered with "Trends". Nothing can change true trends, such as for example automation or the information explosion. Fashion trends are not true trends, they come and go every year in a manipulative way and change with the seasons. The problem solving team must stop the analysis at the point when true trends are identified. There is nothing that they can do except to recognize and acknowledge the trend, the sooner the better.

The centre level of the scale relates to areas of distinctive expertise which falls outside of the range of skills available in that particular organization. The action to take in that instance is to contact the expert for assistance. This expertise requires being available – usually for sale!

The first interval of the scale is the area where the problem solving team can provide the most inputs. This entails the development of numerous small inter-related processes whose outputs are the positives of the various sub-problems identified previously in this analysis. Every element of each small process is then subjected to a D-D-C procedure. That means the element is rated on a scale of 1 – 9 for "Definition", "Difficulty", and "Commitment", and the products of these ratings are then calculated and compared with reference to the process, and to a standard.

Levels of Innovation

This table is the result of the work of hundreds of current TRIZ researchers. TRIZ is an acronym for "Teoriya Resheniya Izobreatatelskikh Zadatch" , which means "Theory of Inventive Problem Solving". The original theory was developed by Genrich Altschuller (1926 – 1998), a Russian academic who wrote his first paper on the subject in 1947.

TRIZ is a problem solving, strategy development, value maximizing tool for new product development professionals. It forces the product development professional (maintenance practitioner) to look outside the box, to look into the future and to look at successful ways of solving a problem using technology that the practitioner does not even know about. TRIZ enhances the productivity of product development professionals and compresses problem solving cycle times.

Researchers have to date analyzed approximately 2 million patents using his theory, and one of the outcomes was the table in the model (The table is not complete – it requires a separate study for full comprehension). It is an extremely powerful approach and has perfect synergy with all the other blocks. You simply move your problem (or sub-problem) through every level, from 1 to 5 until it is resolved or indicates inconsistencies, constituting a different team on each level.

Establish Critical Parameters / Rules / Principles

This series of blocks are in fact derived from the TRIZ research, and it is supported by separate articles, a 2 hour lecture on complexity, as well as an exercise in our program.

Five Important Pillars of TRIZ:

- Contradictions
- Ideality
- Functionality
- Resources
- Trends (not the same trends referred to in the section on "Levels of Complexity"!)

Problem solving maintenance practitioners are particularly interested in the "Trends" of any variables in the maintenance environment that are in "Contradiction" to each other, and that conform to the complexity principle of "Attractors", in other words, they reside in the same domain. An example of this is the simple relationship between "Direct Maintenance Cost" and "Indirect Maintenance Cost". They are inversely proportional, or in "Contradiction" in the sense that if you reduce the one, the other tend to increase. And what follows is the absolute cross to bear of all maintenance departments everywhere in the world, throughout history, but even more so today:

There is a TIME DELAY between reducing your budget (direct maintenance expense), and the consequential downtime / inefficiencies of plant and equipment / losses (increase in Indirect Maintenance Cost).

It does not happen immediately (unfortunately). This time delay can be from three months to as long as ten years depending on the particular situation. Needless to say, there is a high probability that the original decision makers / problem solvers will be long gone after ten years! Moreover, even if the Maintenance Engineer should caution top management and the Financial Director about this "probability", he will find them strangely disinterested, because: "It will not be their problem when it happens!" (And they intend to be long gone as well!)

"Ideality" will be achieved if you can manage to reduce both of these two (and all other) contradictory variables at the same time, and maintain that state of affairs, which is the case in point in World Class Manufacturing organizations. It is achieved by "bending the curve". The attributes of World Class Manufacturing organizations are well known and have been researched extensively. What is less well known is just exactly how they got there, and what they should do to stay there! (They have in fact SOLVED THEIR PROBLEMS and should continue to do so).

Conclusion

This brings us full circle back to the objectives. The comprehensive analysis would have yielded many small indiscrepencies, errors in logic, inconsistencies and sub-standard parameters. Circle all of them and evaluate their impact. The major impact issues are the Root Causes of the sub- and main problem, but all needs to be corrected. Action plans can now be developed and implemented to address the Root Causes. Another advantage of this analysis is that it can be reviewed at a later date by a different team and new insights will be gained. It not uncommon for minor problems to resolved in the very first block of this analysis! Take action as soon as it becomes evident that action is required.

And last but not least: This methodology is not restricted to Technical / Engineering / Maintenance problems. It should be introduced company wide. The Science of Maintenance has evolved to include much more than just the plant and equipment and spares in your organisation. The involvement of other functional disciplines and the integration of all and any available resource into solving problems is no longer a luxury or nice-to-have, it has become essential for survival.

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About the Author: Herman Ellis is an engineer who has worked in a number of organizations in the manufacturing and mining sectors in South Africa. He currently heads up **Qualitech Management Services**, a Maintenance Improvement Consultancy Network that specializes in sustainable maintenance performance improvement initiatives. QMS is currently franchising its operation world wide. During 1995 Herman spent 7 weeks in a WCM organization in Macon, Georgia and has since traveled extensively in Africa and in the Middle East. He can be contacted at: hermane@megadial.com or at +27 (0) 83 267 5331 for more information or assistance with problem solving.