From the Book; *Apollo Root Cause Analysis – A New Way of Thinking*, Third Edition by Dean L. Gano Copyright 2007

Comparison of Common Root Cause Analysis Tools and Methods

Having studied and worked with most of the Root Cause Analysis (RCA) tools and methods in use today, I am often asked to compare them with RealityCharting®. To satisfy this request, I will compare the various RCA tools and methods to what we have learned about effective problem solving in this book.

This Appendix provides a short description and evaluation of the current and most common RCA tools and methods used in businesses throughout the world. If you want a more in-depth discussion of them, Reference 1 provides one of the better comparisons, but it was written before Apollo RCA was created. Tools are included along with methods because the tools are often touted and used as a full blown root cause analysis, when in fact there is a clear distinction between them and methods.

Comparison Criteria

If we are to evaluate the many so-called root cause analysis methods and tools, we need a standard to which they can be compared. It is generally agreed that the purpose of root cause analysis is to find effective solutions to our problems such that they do not recur. Accordingly, an effective root cause analysis process should provide a clear understanding of exactly how the proposed solutions meet this goal.

To provide this assurance, an effective process should meet the following six criteria.[1]

1. Clearly defines the problem and its significance to the problem owners.

[1]. It should be noted that there is value in all of the tools discussed herein, as they all help us better understand our world. The question in this discussion is which should you use to be the most effective problem-solver in your world.

2. Clearly delineates the known causal relationships that combined to cause the problem.[2]
3. Clearly establishes causal relationships between the root cause(s) and the defined problem.
4. Clearly presents the evidence used to support the existence of identified causes.
5. Clearly explains how the solutions will prevent recurrence of the defined problem.
6. Clearly documents criteria 1 through 5 in a final RCA report so others can easily follow the logic of the analysis.[2]

Various RCA Methods and Tools in Use Today

As you will discover in this analysis, there is a clear distinction between an RCA method and a tool. A tool is distinguished by its limited use, while a method may involve many steps and processes and has wide usage.

Events and Causal Factors Charting: (Method) A complicated process that first identifies a sequence of events and aligns them with the conditions that caused them. These events and respective conditions are aligned in a time-line. Events and conditions that have evidence are shown in solid lines but evidence is not listed; all others are shown in dashed lines. After this representation of the problem is complete, an assessment is made by "walking" the chart and asking if the problem would be different if the events or conditions were changed. This leads to causal factors that would then be evaluated using a tree diagram (discussed below).

Change Analysis: (Tool) A six-step process that describes the event or problem; then describes the same situation without the problem, compares the two situations and writes down all the differences; analyzes the differences and identifies the consequences of the differences. The results of the change analysis is the cause of the change and will frequently be tied to the passage of time and, therefore, easily fit into an Events and Causal Factors Chart, showing when and what existed before, during and after the change. Change analysis is nearly always used in conjunction with an RCA method to provide a specific cause, not necessarily a root cause.

[2] It is important to understand the difference between connecting causes based on similar attributes such as a taxonomy of causal factors and connecting them based on how nature actually works. More on this later.

Barrier Analysis: (Tool) An incident analysis that identifies barriers used to protect a target from harm and analyzes the event to see if the barriers held, failed, or were compromised in some way by tracing the path of the threat from the harmful action to the target. A simple example is a knife in a sheath. The knife is the threat, the sheath is the barrier, and the target is a human. If the sheath somehow fails and a human is injured, the barrier analysis would seek to find out why the barrier failed. The cause of this failure is then identified as the root cause.

Tree Diagrams: (Method) This type of root cause analysis is very common and goes by many names[1] such as Ishikawa Fishbone Diagram, Management Oversight and Risk Tree Analysis (MORT), Human Performance Evaluations System (HPES), and many other commercial brands. These methods use a predefined list of causal factors arranged like a fault tree. (See Figure A.1.)

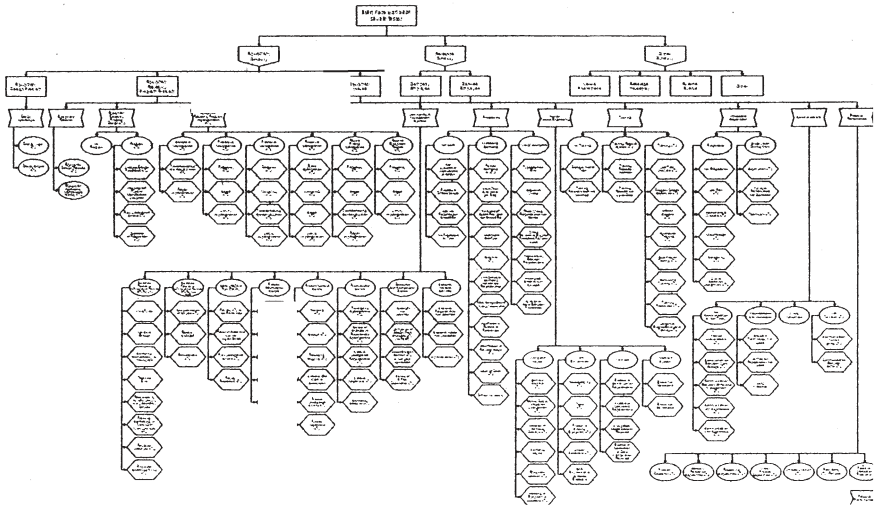

Figure A.1. One Branch of a Tree Diagram

They are sometimes called "Pre-Defined Fault Trees." The American Society for Quality (ASQ) and others often call these categorical methods "Cause-and-Effect Diagrams." All categorization methods use the same basic logic. The premise is that every problem has causes that lie within a pre-defined set of categories. Ishikawa uses Manpower, Methods, Machinery' and Environment as the top-level categories. Each of these categories has sub-categories and sub-sub-categories. For example, within the category of Manpower, we may find Management Systems; within Management Systems we may find Training; and within Training we may find Training Less Than Adequate; and so on. These methods ask you to focus on one of the categories such as People and in reviewing what you know of your event choose some causal factors from the pre-defined list provided. Each categorical method has its own list of causal factors.

After reviewing the list for each category, you are asked to vote on which causal factors most likely caused your problem. After some discussion, the most likely ones are voted on and called root causes. Solutions are then applied to these "root causes" to prevent recurrence. Each commercial brand has a different definition of root cause, but it is generally a cause that you are going to attach a solution to that prevents recurrence. Some of these methods refer to themselves as "Expert Systems" and also provide pre-defined solutions for your problems.

Why-Why Chart: (Method) One of many brainstorming methods also known as the "Five-Whys" method. This is the most simplistic root cause analysis process and involves repeatedly asking "why" at least five times or until you can no longer answer the question. Five is an arbitrary figure. The theory is that after asking "why" five times you will probably arrive at the root cause. The root cause has been identified when asking "why" doesn't provide any more useful information. This method produces a linear set of causal relationships and uses the experience of the problem owner to determine the root cause and corresponding solutions.

Pareto Analysis: (Tool) A statistical approach to problem solving that uses a database of problems to identify the number of pre-defined causal factors that have occurred in your business or system. It is based on the Pareto principle, also known as the 80-20 rule, which presumes that 80% of your problems are caused by 20% of the causes. It is intended to direct resources towards the most common causes. Often misused as an RCA method, Pareto analysis is best used as a tool for determining where you should start your analysis.

Storytelling Method: (Method) This is not really a root cause analysis *method* but is often passed off as one, so it is included for completeness. It is the single most common incident investigation method and is used by nearly every business and government entity. It typically uses predefined forms that include problem definition, a description of the event, who made a mistake, and what is going to be done to prevent recurrence. There is often a short list of root causes to choose from so a Pareto chart can be created to show where most problems come from.

Fault Tree Analysis: (Method) Fault Tree Analysis (FTA) is a quantitative causal diagram used to identify possible failures in a system. It is a common engineering tool used in the design stages of a project and works well to identify possible causal relationships. It requires the use of specific data regarding known failure rates of components. Causal relationships can be identified with "and" and "or" relationships or various combinations thereof. FTA does not function well as a root cause analysis method, but is often used to support an RCA. More later.

Failure Modes and Effect Analysis: (Tool) Failure Modes and Effects Analysis (FMEA) is similar to fault tree analysis in that it is primarily used in the design of engineered systems rather than root cause analysis. Like the name implies, it identifies a component, subjectively lists all the possible failures (modes) that could happen, and then makes an assessment of the consequences (effect) of each failure. Sometimes a relative score is given to how critical the failure mode is to the operability of the system or component. This is called FMECA, where C stands for Criticality.

Realitycharting*: (Method) A simple causal process whereby one asks why of a defined problem, answers with at least two causes in the form of an action and condition, then asks why of each answer and continues asking why of each stated cause until there are no more answers. At that time, a search for the unknown is launched and the process is repeated several times until a complete cause and effect chart, called a Realitychart, is created showing all the known causes and their inter-relationships. Every cause on the chart has evidence to support its existence or a "?" is used to reflect an unknown and thus a risk. All causes are then examined to find a way to change them with a solution that is within your control, prevents recurrence, and meets your goals and objectives. The result is clear causal connections between your solutions and the defined problem. Because all stakeholders can see these causal relationships in the Realitychart, buy-in of the solutions is readily attained.

RCA Methods and Tools Compared

Many purveyors of Root Cause Analysis state the process is so complicated that you should use several of them for each problem or select them based on which type of problem you are experiencing. In researching the various proponents of this approach I find that the reason some people think root cause analysis is so complicated is they don't understand the cause and effect principle. To quote Albert Einstein, "If you can't say it simply, you probably don't understand it."

Method/Tool	Type	Defines problem	Defines all causal relationships	Provides a causal path to root causes	Delineates evidence	Explains how solutions prevent recurrence	Easy to follow report	Score
Events & Causal Factors	Method	yes	Limited	no	no	no	no	1.5
Change Analysis	Tool	yes	no	no	no	no	no	1
Barrier Analysis	Tool	yes	no	no	no	no	no	1
Tree Diagrams	Method	yes	no	no	no	no	no	1
Why-Why Chart	Method	yes	no	yes	no	no	no	2
Pareto	Tool	yes	no	no	no	no	no	1
Storytelling	Method	Limited	no	no	no	no	no	0.5
Fault Tree	Method	yes	yes	yes	no	yes	no	4
FMEA	Tool	yes	no	Limited	no	Limited	no	2
RealityCharting®	**Method**	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**	**6**

Figure A.2. Comparison of Selected RCA Methods and Tools

Using the comparison criteria we established earlier, Figure A.2. provides a summary of how each method or tool meets the criteria. One point is scored for each criteria that is met. “Limited” is scored as 0.5 points.

While the comparison in Figure A.2 serves to show how poorly these conventional

tools and methods provide effective solutions, it does not tell the whole story, as explained below.

Events and Causal Factor Charting can provide the time-line to help discover the action causes, but is generally inefficient and ineffective because it mixes storytelling with conditional causes, thus it produces complicated relationships rather than clarity.

Change Analysis is a very good tool to help determine specific causes or causal elements, but it does not provide a clear understanding of the causal relationships of a given event. Unfortunately, many people who use this method simply ask why the change occurred and fail to complete a comprehensive analysis.

Barrier Analysis can provide an excellent tool for determining where to start your root cause analysis, but it is not a method for finding effective solutions because it does not identify why a barrier failed or was missing. This is beyond the scope of the analysis. To determine root causes, the findings of the barrier analysis must be fed into another process to discover why the barrier failed.

Tree Diagrams, a.k.a. Categorization Schemes, are steadily being replaced with RealityCharting® but continue to retain a few followers because they appeal to our sense of order and "push button" type thinking (as discussed in Chapter 1). Based on what you have learned in this book, you can now understand why this is a failed strategy. There are at least 7 major weaknesses in the Tree Diagram model:

1. A Tree Diagram is clearly not a "Cause and Effect Chart" as the proponents of these methods would have us believe. It simply does not show all the causal relationships between the primary effect and the root causes. Consider the following example: Given a simple event, I have arranged the causes according to the rules of a Fishbone Diagram in Figure A.3.

   As we can see, the causal relationships are not clear at all. Could it be "Car Struck" was caused by "Foot on Accelerator" and "Truck Swerved" and "Truck Existed" and "Moving Truck?" Certainly these are some causes, but their relationships are not apparent. The diagram was created by looking at the event as I understand it, asking what causes could be classified as Manpower, Methods, Materials, and Machines and then placing those causes on the fishbone according to the categories they belong in—not how they are connected causally. The theory behind these Tree Diagrams is that because all events have certain causal factors

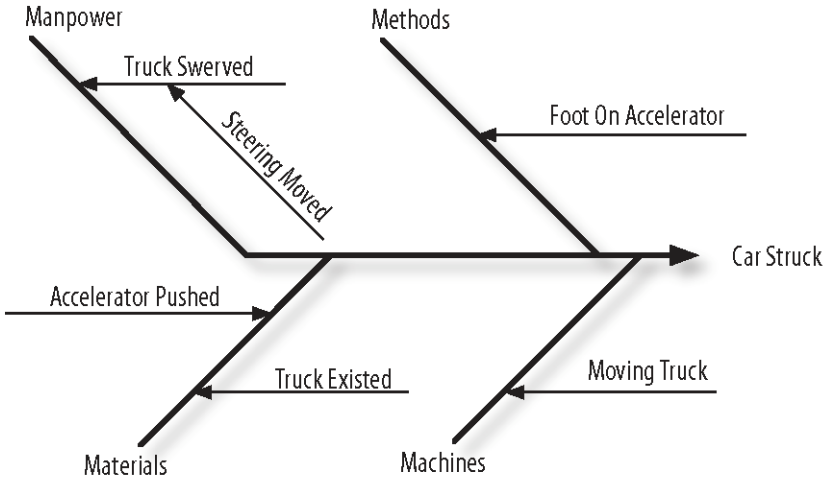

Figure A.3. Fishbone Diagram

we can find the root causes by looking for them in the pre-defined set provided. And while it can help jog the mind into certain lines of thinking, it fails to provide a causal understanding of the event.

If we use this same event and create a Realitychart (Figure A.4.) we can clearly see the causal relationships. I have added the categories to the top of each cause to emphasize how knowing the category provides no value whatsoever.

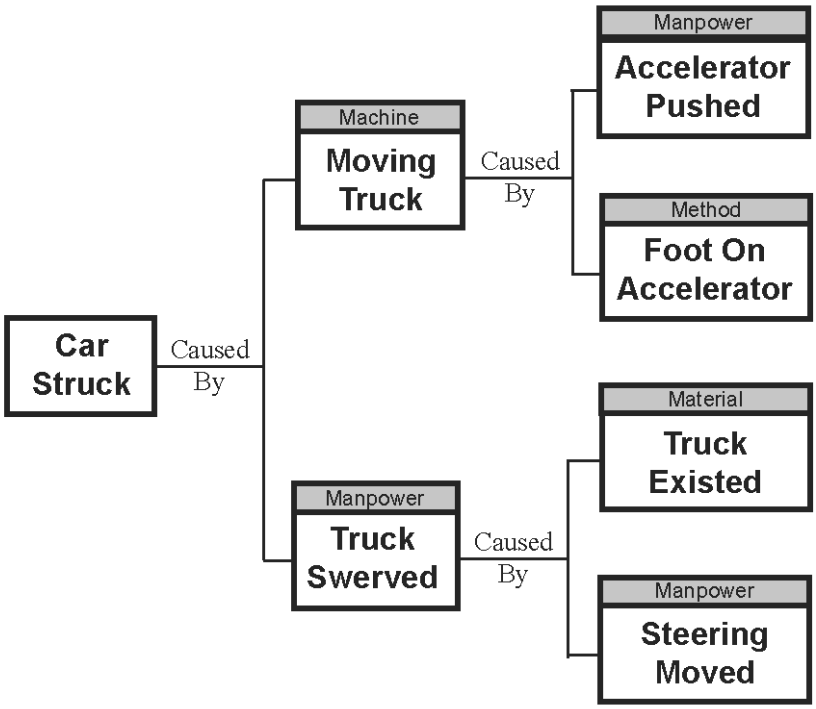

Figure A.4. Realitychart vs. Categorization

2. No two categorization schemes are the same, nor can they be, because as discussed in Chapter 1, we each have a different way of perceiving the world.[2]

Therefore, we have different categorical schemes and hence the reason there are so many different schemes being sold. When asked to categorize a given set of causes it is very difficult to find a consensus in any group. For example, what category does “Pushed Button” fall into? Some will see this as hardware; some will see it as people; and some will see it as procedure. If you have ever used any of these categorization methods to find a root cause, I suspect you have incurred many a wasted hour debating which is the correct category.

3. The notion that anyone can create a list of causal factors that includes all the possible causes or causal factors of every human event should insult our intelligence. Ask yourself if your behavior can be categorized in a simple list and then ask if it is identical to every other human on the planet. The very fact that a method uses the term causal “factor” should be a heads-up that it does not provide a specific actionable cause but, rather, a broader categorical term representing many possible specific causes. At best, it acts as a checklist of possible causes for a given effect, but it does not provide any casual relationships. Since this error in logic is very contentious with those who use these methods, it begs the question why do these methods seem to work for them. What I have discovered after talking with many people who claim success in using these methods, is that it works in spite of itself by providing some structure for the experienced investigator whose mind provides the actual causal relationships. It is not the methodology that works, but the experience of the investigator who is actually thinking causally. And while these methods seem to work for the experienced investigator, they are still incapable of communicating the reality of causal relationships. This inability to effectively communicate prevents the synergy among stakeholders necessary to fully understand the causes of the event, which is required to get buy-in for the solutions.
4. These models do not provide a means of showing how we know that a cause exists. There is no evidence provided to support the causal factors in the list, so it is not uncommon for causal factors to be included that are politically inspired with no basis in fact. With these methods, the best storytellers or the boss often get what they want, and the problem repeats. This may help explain why many managers and self-proclaimed leaders like this method.
5. Categorization schemes restrict thinking by causing the investigator to stop at the categorical cause. Some methods re-enforce this fallacy by providing a “root cause dictionary,” implying that it is a well-defined and recognized cause.
6. Categorization methods perpetuate the root cause myth discussed in Chapter 1, based on the belief it is a root cause we seek and solutions are secondary.

Because these methods do not identify complete causal relationships, it is not obvious which causes can be controlled to prevent recurrence; therefore, you are asked to guess and vote on which causal factors are the root causes. Only after root causes are chosen are you asked to identify solutions and without a clear understanding of all causal relationships between the solution and the primary effect, this method works by chance not by design.

7. As mentioned earlier, some of these methods provide what is called an "expert system" and includes solutions for a given root cause. Expert systems can be quite useful for a very specific system such as a car or production line where 99% of the causal relationships are well known and have a long history of repeatability. To presume that one could provide an expert system applicable to all event-based problems seems to me to be incredibly arrogant. In light of what you now know about the infinite set of causes that governs reality, how could anyone presume to know the causes for all systems, how they interrelate, and what constitutes the best solution for every organization or individual? Beware the salesperson.

The Five-Whys method is inappropriate for any complicated event, but it is actually quite useful when used on minor problems that require nothing more than some basic discussion of the event. Unlike most of the other methods, it identifies causal relationships, but still subscribes to the root cause myth of first finding the root cause and then assigning solutions. It should never be used for formal incident investigations, but is perfectly acceptable for informal discussions of cause. A popular graphical representation of the "Five-Whys" approach is the "Why Staircase," which if used improperly leads to a linear set of causal relationships.

Pareto Analysis uses a failure database to trend the frequency of categorical failures. As discussed in Chapter 5 under Trending Causes, this process is fraught with many landmines, a few of which are discussed below.

1. The accuracy of a Pareto chart is limited by the accuracy of the data used to create it. If you use a failed approach like tree diagrams to determine the causes, the Pareto chart will only reflect causes from the pre-defined list provided.
2. As you learned in this book, the cause and effect principle shows that all causes and effects are part of the same continuum. It many cases, certain causes will be closely linked (i.e. close to each other). For example, the cause "procedures not followed" is frequently caused by "procedures not accurate." In the Pareto analysis, this causal connection is lost. Instead, we see both "procedures not followed" and "procedures not accurate" in those top causes, so we end up working on solving both problems when in reality we may only

need to solve the "procedures not accurate" problem. In this example, the incomplete view of reality provided by a Pareto analysis may have caused you to expend more resources than necessary.

3. Pareto analysis can mask larger, more systemic issues. For example, if quality management has transitioned into a state of dysfunction, it can cause symptoms in many different areas, such as poor procedures, inadequate resources, outdated methods, high failure rates, low morale, etc. Pareto analysis has you capturing all these symptoms of a larger problem as causes, and wasting time solving the symptoms.

Storytelling: Perhaps the most common of all methods is storytelling, also known as the fill-out-a-form method. This method was discussed in more detail in Chapter 1 but is summarized here for consistency. The primary difficulty with this approach is that you are relying completely on the experience and judgment of the report authors in assuring that the recommended solutions connect to the causes of the problems. The precise mapping between the problem and the recommended solutions is not provided.

The primary purpose of this method is to document the investigation and corrective actions. These forms usually do a good job of capturing the what, when, and where of the event, but little or no analysis occurs. Consequently, the corrective actions fail to prevent recurrence 70% to 80% of the time.

With such poor results, you might be wondering why organizations continue to use this method. The answer is twofold. First, most organizations do not measure the effectiveness of their corrective actions, so they don't know they are ineffective. Second, there is a false belief that everyone is a good problem-solver, and all they need to do is document it on a form. For those companies that recognized they are having repeat events, a more detailed form is often created that forces the users to follow a specified line of questions with the belief that an effective solution will emerge.

This is a false promise because the human thinking process cannot be reduced to a form. In our attempt to standardize the thinking process, we restrict our thinking to a predefined set of causes and solutions. The form tacitly signals the user to turn off the mind, fill in the blanks, and check the boxes. Because effective problem solving has been short circuited, the reports are incomplete and the problems keep occurring.

Fault Tree Analysis is not normally used as a root cause analysis method[3], primarily because it does not work well when human actions are inserted as a cause. This is because the wide variance of possible human failure rates prevents accurate results. But it works extremely well at defining engineered systems and can be used to supplement an RCA in the following ways:

1. Finding causes by reviewing the assumptions and design decisions made during the system's original design

2. Determining if certain causal scenarios are probable, and
3. Selecting the appropriate solution(s).

Additional insight into the various RCA methods, and how RCA integrates with quantitative methods such as fault tree analysis can be found in Reference 3.

Failure Modes and Effect Analysis: Failure Modes and Effects Analysis (FMEA) is sometimes used to find the cause of a component failure. Like many of these other tools, it can be used to help you find a causal element within a Realitychart. However, it does not work well on systems or complex problems because it cannot show evidence-based causal relationships beyond the specific failure mode being analyzed.

Realitycharting*: Realitycharting is unlike all other RCA tools and methods. It is the only one that actually provides a graphical representation with evidence of all causes and their inter-relationships. With this clear understanding of your reality, it can easily be communicated to anyone with a full appreciation of how the solutions will prevent the problem from recurring.

Summary

While conventional root cause analysis tools provide some structure to the process of human event problem solving, this review shows how they are significantly limited and often work by chance not by design. The common processes of storytelling and categorization are the product of thousands of years of evolution in our thinking, but it is time to move on. RealityCharting® is becoming the standard for all event analysis because it is the only process that understands and follows the cause and effect principle, thus it is the only process that allows all stakeholders to create a clear and common reality to promote effective solutions every time.

*** A note on terminology:** What we used to call "Apollo Root Cause Analysis" is being replaced by the term "Realitycharting." The end result, a Realitychart, is being requested by name. Informed managers require Realitycharts for all major problems and employees ask to be trained because they see how it can help them be more successful. Realitycharting has become a core competency in many companies because the return on investment is overwhelmingly positive.

References

1. Wilson, Paul, et al., 1993, Root Cause Analysis – A Tool for Total Quality Management, Quality Press, Milwaukee, WI

2. Churchland, Paul M., 1996, The Engine of Reason, the Seat of the Soul, MIT Press, Cambridge, MA

3. Reising, Larry; Portwood, Brett, 2007, Root Cause Analysis and Quantitative Methods - Yin and Yang?; 2007 Paper presented at the International System Safety Conference (a copy of this paper can be found at www.realitycharting.com).