Advanced Incident Troubleshooting Guide

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Basics of RCA Defined

The most common incident investigation theory applied today for an incident or adverse event is called Root Cause Analysis (RCA). These RCA methods are based on a model developed by Sakichi Toyoda, founder of Toyota Industries, called the "Five Whys" in the early 1900s. Innovations and movement in RCA were stagnant until after WWII. From the 1960s on, many behavior-based researchers refined this technique and broadened its appeal. James Reasons "Swiss Cheese Model" opened up new avenues in thinking with RCA methodologies 1980s. There were many other behavior-based safety methodologies introduced during this same span, but we are only interested in a few for this course.

Today, we have many methods in addition to the Five Whys such as Fishbone, Fault Tree, Failure Mode & Effect Analysis, Pareto Charting, Six Sigma, Bow Tie, and Barrier Analysis. An entire industry was birthed from the introduction of OSHA's fourteen elements of process safety. Some companies such as ABS, System Improvements, Apollo, and the Tony Mazzocchi TOP methodology packaged, branded, and sold their programs worldwide.

These RCA programs have had initial success in their deployment and, in some cases, huge successes. This success is based solely on an organization's safety maturity. A company that is a learning organization will not have as much improvement as a company that is safety-immature. However, if you have been at a company that has been using these programs for many years, and they are still experiencing repeat failures, relearning lessons, and having catastrophic events, how can this be a culturally mature, continuous learning Health and Safety minded organization?

There is a flaw in Root Cause. A spider in the web, so to speak. To understand what you are about to learn, let's continue with defining what a root cause is. Most root cause definitions lay the entire burden of why an adverse event happens squarely on the shoulders of management systems. Further, as promoted by Edward Deming, the father of modern QA/QC, Management has a responsibility to identify all the reasonable causes of what can go wrong. With this knowledge, they must build a work environment and train their employees to exist in this reasonably fault-tolerant system.

Therefore, if an employee makes an error or mistake, then management failed to provide an adequate fault-tolerant work environment or knowledge for the worker to be successful in. This flawed model thinking has caused some companies to design themselves out of business or develop work environments in which the hourly workforce must possess a Bachelor's degree in engineering to be successful.

This author has been totally invested in this theory for many years. Then, he was enlightened. What caused this dramatic change? The introduction of learning teams. The basic premise of a learning team is that humans will make mistakes. Further, they will make mistakes that no designer, management system or logic model could ever predict. These errors in the system only

become realized when the utopian design is implemented in the real world, and humans begin to operate within it. There is an inherent disconnect between the designer and the end-user. So, do we throw RCA out the window? The answer is No! We do what all great Professional Engineers do. We learn, improvise, and supplement our findings using alternative methods to make corrections.

The learning team concept opened a new avenue of thought about the root cause. Remember the James Reasons Swiss Cheese model. When a root cause is determined, it is defined on a clear set of facts supported by events and conditions leading to the undesired event. The problem is that a recommendation is drafted based on this defined static model; the world is not static, and the Swiss Cheese is not either. So, the model was further developed into a couple of updated cheese models, and these are processed cheese and hot cheese.

Processed Cheese takes the static cheese slice representing a safety barrier and spins it along with all the other slices of swiss cheese. Depending on the number of holes in that barrier not realized, the odds of the holes aligning can increase or decrease depending on the rotational speed of each barrier. These rotational speeds represent the real world and how humans interact with each barrier. The Hot Cheese model is also based on dynamic change. As new risks or subtle changes arise, they are challenging the barrier's effectiveness until a hole develops that wasn't there before. There are also drips or runny cheese. These represent barriers that deteriorate over time or are slightly changed in some manner.

Still, these models rely on management systems and perfect design as the primary barriers to prevent an adverse outcome. This is the flaw. What is the common thread in all these methods? Humans... People... Teams. Humans are a variable, not a constant.

The general premise of all RCA methods is that if you rip off the band-aide of all the symptomatic causes, it will lead to a Root Cause. If this Root Cause is corrected, then the issue will go away or be significantly reduced in its impacts.

Try this simple experiment. How many times can you take a rubber ball about the size of a baseball and toss it at least three feet in the air and catch it without dropping it? Now, have someone ask you questions while you are doing this. Now, turn on a fan and continue having someone ask you questions. Now, add in someone hitting the table and making a loud noise every two or three seconds.

In the beginning, most people can toss and catch the ball about ten times before becoming unstable, moving their feet, leaning, or moving to compensate. When you add more and more exterior stimulus, the number of successful catches and tosses dramatically drops. Some people can't even do it once with all this stimulus going on, and others can continue on as nothing has changed. This is your workforce. These are the people your company hires, trains, and places into your utopian Professionally Engineered and designed work area.

In RCA, if you drop the ball, deviate too often, or even get fatigued tossing the ball, then RCA says to look at the Management System, Design and Knowledge they possess. However, we are not SPOCK from Star Trek. We fatigue, become distracted and often are just plain bored. Moreover, as humans, we improvise or test the limits of a design knowingly or unknowingly.

Think outside the box for just a moment. Imagine that you purchase a brand-new pen and place it in your pocket. The pen is fine for several days, then one day, you feel something on your chest. You look down, and the pen is leaking all over your $200 Lacoste dress shirt. Whose fault is this? Is it anyone's fault? Didn't the manufacturer of your $80 pen think of every scenario in designing and building a pen that won't leak? That is why you use an $80 pen instead of a $0.80 pen.

You log on to the pen manufacturer website, find the model you own, then read the fine details about its design and limitations. The pen is designed to withstand up to 120^F and 33^F without leaking. So, what is the problem? As a professional Mechanical Engineer, you decide to do a Root Cause investigation. As you are building a timeline, you recall inspecting a freezer system for a client. These are huge refrigeration buildings. You were in there at below-freezing temperatures with a parka on for almost an hour. The pen did not and could not freeze as it was mostly covered by the coat and against your body. Only a small portion was exposed. In fact, you signed some paperwork immediately upon leaving the freezer compartment, and you know it was not frozen and was still functioning as designed.

However, you are in Tucson, AZ. When you left the client company about ten minutes later, you went outside. It was a very hot and dry day, about 108°F. As you traversed to your car, you received a phone call. You stood outside halfway between the car and the client's office for over fifteen minutes near noon. The sky was clear, and you remember feeling the sun's rays beating down on you. You finished the phone call and continued to your car. You opened the door, and the car was over 150°F inside. You quickly start it and turn on the AC unit.

This is when you felt it. The ink was coming out of the pen and down your chest. At this point, you realize that even though the pen stayed between the two operating parameters set by the manufacturer, they, nor you, ever considered rapid temperature changes. With rapid changes in temperature expansion, forces were so great it pushed the plug out of the ink cartridge, allowing a loss of containment. In industry expansion, relief is provided on transfer lines that carry hydrocarbons. But this is a pen. There are no expansion relief paths.

You decided to test the pen and run experiments by placing it in the freezer then controlling the warmup rate until you determine the rate at which the pens ink cartridge will catastrophically fail. You complete the analysis, build a report, and mail it along with your recommendations to the pen manufacturer. After you almost had given up on a reply, you finally receive a letter in the mail and a new pen.

The letter thanks you for your kind and thoughtful analysis, but respectfully declines to change the way they design the pen as your case is determined to be an extreme and a one-off. They further recommend that you not have over 10°F temperature swings over a five-minute period. You were successful in utilizing the pen in a manner that no one had ever thought of, and in conditions, the average person would almost never experience.

What was the one common thread besides the pens ink cartridge in this example? You. Human interaction. You were the one dynamic in this scenario. The ink cartridge was a static piece of this puzzle. People make decisions daily that affect outcomes and result in either acceptable or unacceptable consequences. The process by which decisions are made is called a Decision Web. This is a brand-new concept and model introduced in this course.

RCA incident investigations are broken down into four general categories: Organizational, Management System, Mechanical or Equipment Related, and Human Factor Causes. However, many of the most popular Root Cause methods in their desire not to place blame on individuals have lost the ability or watered down the conversation in lieu of blaming a management system. This institutionalized flaw, a.k.a the normalization of deviance, where we cannot discuss the actions and consequences of human response, allows repeat failures.

What is the Decision Web, and how does it work? We will dive deeper into this new model in a later section, but it is important to introduce it now. The Decision Web is the process of how you or I make decisions. It is a process that was developed from the author's education, experience, observation, research, incident investigation, and behavior-based safety application over a twenty-seven-year career.

Here is the process:

1. Options
2. Knowledge
3. Time
4. Emotional State
5. Familiarity
6. Physical State
7. Company Culture

These seven items are decision influencers. When you arrive at root causes from an investigation that falls in the Human Factors area where a decision by someone had an adverse outcome, this test will assist you in developing recommendations and test your cause determination. Let's run this using the pen example.

1. What were the available options at the time it was decided to place an $80 pen in your pocket? Leave it outside the freezer, not even purchase it, keep it insulated better, buy a .80 cent pen.

2. What knowledge did you possess about the pen and its construction? Even if you knew all the manufacturer's information from the internet, would that have made a difference? Did you need more knowledge or skill? After all, it's a pen.

3. How much time did you have to make that decision? In fact, did the pen come to mind at all before entering the freezer? Was this an impromptu tour, or was it the purpose of the trip? The amount of time you had to make the decision can play a huge part in what you decide to do.

4. Emotional State. Travis Bradberry and Jean Greaves wrote a great read about managing emotions. The basic theory is that you must manage your emotional responses in favor of your logical response. For this example, if you had known the pen could reasonably leak with an extreme temperature swing, you probably would not have used it. Further, after the event, you could have gotten angry and threw out the pen and the shirt and chalked it up to bad luck and learned nothing from the adverse event. Both of these are emotional

response questions.

5. Familiarity. Have you been buying this pen for years and never had this happen before? You have never owned an expensive pen like this, and this was a chance to let the client know you are successful right down to the pen you use. If you or someone you know had a bad experience with this pen or you had read customer feedback describing a bad experience, would your actions have changed?

6. Physical state. This explores you. Were you out last night drinking with your entourage all night? Are you out of shape, and was the heat killing you before you got to the client? Was this the last stop on a five-day straight client review, and you were heading home on a four-hour flight after this?

7. Company Culture. Do you work in a very good, culturally mature safety and learning organization? Do you work in a disjointed company where the safety message is dynamic, and as long as the work gets done, it's ok to improvise? Is casual compliance acceptable? Was the knowledge about these pens tribal in nature in which co-workers knew the pen leaks in extreme temperature changes? The learning was not shared with you as either a joke or because that type of sharing and transparency is not promoted?

We will dive much deeper into the Decision Web in the advanced troubleshooting technique for RCA. How is this approach different than traditional RCA root cause tests. Traditional tests say that if you remove or better manage the root cause, then the adverse event will go away, or the impacts will be significantly reduced. However, what if the root cause lies somewhere in the human factor realm, and you did not ask the right questions or research the correct data to discover the human side of the causes.

This technique will allow you to explore causal areas that traditional RCA methods avoid. Further, it may lead you to a different Root Cause.

Even if you have the root cause nailed down, you may still not prevent a repeat due to recommendation reduction. This happens when good recommendations are written to correct the root cause. However, many companies work to reduce the number of recommendations from an investigation, thinking one root cause one recommendation. If you want to learn more about writing good recommendations, see the training course “Writing Effective Recommendations for Incidents, PHAs, LOPAs, MOCs, Reviews, Projects, and Audits,” Course Number: P-2024 by this same author.

Let's go back to the flawed origins of why root cause methods fail. There are several flaws with the root cause:

1. The methodologies are so desirous of not assigning blame that they avoid asking or pursuing human decision making or human actions.

2. They base their root cause finding on a static set of events and conditions. The root cause recommendation addresses that same alignment of events and conditions along with some variations. Further divergence from these events and conditions, as shown in the Process and Hot Cheese models, can allow barriers to be defeated or fail again.

3. The tests for a root cause are based on correcting management system practices and having more knowledge. In no way do they breach testing how human decisions were made, so they don't attempt to correct the behavior or circumstances forced upon the human leading to the outcome. This is why the Decision Web was created.

4. The investigation processes promoted do not prompt the investigator to ask Decision Web-based questions. In the pen example, there were several questions about options, knowledge, time, emotional state, past experience, physical state, and organizational norms.

This leads to the flaw or issue with Decision Web methodology. This method is only applicable to incidents where decision making and choice were a part of the incident. Some examples would be the decisions leading up to shutting down a heater, a pump, or unit remotely. If a pump seal failed prematurely, this might not be a good application of the Decision Web method. The good news is that most incidents have human decisions a f why there was an adverse outcome.

As you noticed, the a ess contributing causes. Why? You still may e ill reinforce that choice. You may end up being ditional finding that, although not a root cau any.

We have defined a Roo causes are basically errors, mistakes, failure this would get you to a Root Cause.

Consequences are the ou ies do not like divisive words, we use a d outcome.

One more observation to human can sing. Every human cannot sing ssing to the people hearing it, even if it is you place that child in a position to sing in public? gative reactions from the child could scar that child for li the parents who were not honest enough to tell their child that they nee another hobby or talent to explore.