# Effective Solutions Versus The Root Cause Myth

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ROOT CAUSE ANALYSIS

# Abstract

The purpose of this paper is to explain why conventional Root Cause Analysis (RCA) methods work by chance, not by design. In the process, we will examine three causation models commonly used in incident investigations and problem solving schemes. The three models are Cause and Effect, Linear Inferred Cause, and Cause Categorization.

This paper will also discuss why conventional incident reports do not effectively communicate their findings. At the heart of this paper, we will examine the cause and effect principle and develop some simple tools based on this principle. The cause and effect method discussed herein, which NASA calls it's *Stable Reference Point* for problem solving, is simple enough to fit on a credit card and can be used on any event-based problem. In understanding the cause and effect principle, we will also expose the root cause myth, which mistakenly focuses on finding the root cause(s) prior to finding solutions. Conventional wisdom holds that causes are linear and at some point in their linear progression (A caused B and B caused C, etc.) we will find a root cause, probably the fifth cause, that if removed, changed or otherwise controlled, will prevent recurrence. This common but misguided belief fails to understand the cause and effect principle that dictates a non-linear branched set of conditional and action causes that branch and expand until we reach our collective point of ignorance. In variance to the cause and effect principle, most RCA methodologies use some kind of categorization scheme or checklist format to help us find the root causes. But it is not the root cause we seek, it is effective solutions and we can only know the root causes after we know which solutions will prevent recurrence. We will explore this misunderstanding as well as many others that cause the ongoing parade of repeat events we see each year.

## *Learning and Behavior*

In her landmark book *Mapping the Mind*, Rita Carter shares the latest scientific knowledge on how the human mind works. Perhaps the most fascinating insight Ms. Carter shares is the knowledge that the brain is a programmable organ. We take in information through our senses and store it according to our own categorical system. Once stored, we manipulate this information into knowledge based on many strategies — strategies that are developed by trial and error interaction with our environment.

Strategies are our causal understanding of the world. Strategies are the basis for our decisions and we have hundreds of them to get us through each day. We may use the strategy of always staying in the left lane to avoid buses from slowing our drive to work. We may believe that honesty is always the best policy or we may believe that stealing is an acceptable means of survival. Each person is unique and each strategy helps us make a decision based on the input we receive from our senses. Once we learn a strategy we preserve it as a prototypical truth until it fails and then we modify it to fit the new data (Churchland, 1996). Each time a strategy works for us, it is validated. Validation at the neurological level can be observed by physically larger neural connections. Similar to building muscles, our strategies and hence our behaviors are programmed by repeated use.

Because every mind has a nearly infinite set of possible neural connections, each one of us has a unique mind of our own. Of course similarities exist because our culture has a major influence on programming our strategies, but we are unique nonetheless. Regardless of which strategies regulate our behavior, the more we use them the more we perceive them as "right." Once established, neurological connections are very hard to break. This helps explain why we resist change so much – the brain is designed to find the "right answer" or prototypical truth, and stick with it. In fact, it seems that breaking old habits or changing our mind is caused by first replacing an existing idea with a new one. As we continue to use the new idea or strategy it becomes the preferred neural pathway. With disuse the old neural connections (old habits) are disconnected by neurotransmitters in the brain. They actually clean away unused synaptic connections – kind of like scrubbing bubbles. (Restak, 1995)

Behavior is caused by sensed input to our nervous system, interpreted by our operating strategies resulting in a decision to act or not act. When we choose to act, the decision is caused by the strategies we hold within our belief system. Our success in meeting our goals is directly dependent on the problem solving strategies we learn early in life (Goleman, 1995). At the core of our problem solving strategies is a causation model that allows us to understand causal relationships. Knowing the causes of an event allows us to know which causes we can control. Knowing these causal relationships allows us to change or modify a cause such that our goals are realized. The more accurate the causation model, the higher the success rate.

If my causation model is based on the belief that everything is random and stuff just happens, then it is unlikely that I will develop other strategies for planning and preventing accidents. If my causation model is based on the belief that everything is predetermined, then I can just ride the wave and enjoy the view. Both models discourage responsibility and thus behavior is difficult to influence, yet these causal models are very common in our culture.

According to Ludwig Benner, Jr. safety professionals have developed no less than 14 different accident models and 17 investigation methods (Benner, 1985). Each one of these models is a documented problem solving process. His conclusion in “Rating Accident Models and Investigation Methodologies” was that there is unnecessary diversity and that only a few models are worthwhile. I have been studying the various causation and investigation models for the past 14 years and found none of these models to be very effective.

A primary reason for our ineffective causation models lies within the structure of the brain and our language. To better understand this issue, let’s take a closer look at the three most common causation models used in incident investigations.

1. Cause & Effect Model
2. Linear Inferred Cause Model
3. Cause Categorization Model

## Background

Before we discuss these three causation models, it helps to understand the two problem types we normally deal with. As we interact with our world, we deal with two types of problems; event-based and rule-based.

Rule-based problems follow rules that we have created to help us understand repeatable events, such as a company procedure or established laws. In rule-based problems, we agree to a convention, and thus a single right answer or pre-defined solution is always available. For example 2 + 2 = 4 or if we run a red stop light we may be fined. The rule-based approach to problem solving is often more concerned with conformity than with accomplishing our goals and it is based on our fundamental need for security through predictability. For example, the most significant cause of the Three Mile Island nuclear power plant incident was an operator mindset to blindly follow procedures (rule-based thinking) for High Pressure Injection even when the need was not there. Trained to follow the procedures without question rather than think causally, the operators set in motion a sequence of events that led to a loss of the primary coolant pressure boundary and resultant reactor fuel failure.

Event-based problems on the other hand do not have a right answer. These are the day-to-day problems like how do you get to grandma's house? Or, how do we prevent accidents? There is no predefined "right answer" for event-based problems, only good, better, and best as a function of our personal or collective goals. To find effective solutions to event-based problems we must understand the causes of the event, not which rules failed.

With this basic understanding, we can now examine the three causation models.

# Cause and Effect Models

## Background

According to tradition, causal relationships are understood by asking why several times. In fact, one investigation model claims that the root cause is generally found after asking why five times. This overly simplistic notion has probably been with us for the last two thousand years and can be seen by a simple linear progression: Problem A was caused by B, which was caused by C, and so on until we reach cause F. By removing the root cause F, problem A will not happen again. It is this overly simplistic linear understanding of cause that most people know as causal analysis and it doesn't represent reality. As we will see later, our language and storytelling cause this linear thinking.

There are many other incident investigation methods that claim to be causal relationship methods, but they are actually categorical methods and we will discuss them in the next two sections.

A much more effective causal relationship model based on the cause and effect principle is known in industry as Apollo Root Cause Analysis. It has been in use for the past ten years and is slowly becoming mainstream. It's continued success and effectiveness lies in its simplicity. More importantly because it is based on the cause and effect principle, it exposes the non-linear aspect of event-based problems. To better understand this, let's take a quick look at the cause and effect principle.

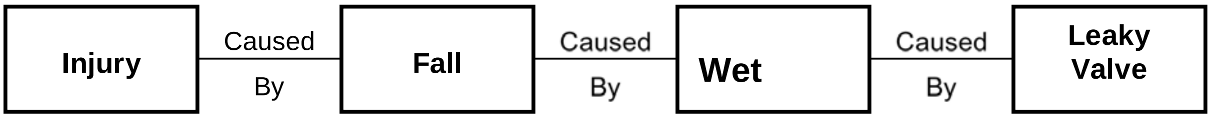
## Cause and Effect Principle

For at least 4,500 years, mankind has used the notion of causation to express happenings (Van Doren, 1991). Unfortunately, we have failed to differentiate the immense power of the Cause and Effect Principle from the simple notion of causation. Causation tells us that everything that happens has a cause, while the Cause and Effect Principle provides four basic characteristics that allow us to better understand reality. These four characteristics are as follows:

1. Causes and effects are the same thing.
2. Causes and effects are part of an infinite continuum of causes.
3. Each effect has at least two causes in the form of actions and conditions.
4. An effect exists only if its causes exist at the same point in time and space.
5. **Cause and effect are the same**

Knowing that cause and effect are the same thing only viewed from a different perspective in time helps us understand why people can look at the same situation and see different problems. They are actually perceiving different time segments of the same event. If we treat each perspective as a different piece of a jigsaw puzzle, we can stop the usual arguing and work on putting the different pieces together. For example, in Figure 1 below, we see that the primary effect is the "Injury" and the first cause is a "Fall." If we ask why "Fall," this cause has to be seen as an effect. That is, we can not ask why of a cause, only of an effect. In a given event, we may each see the causes differently. You might see the

"Fall" as the problem effect, while the next person sees the "Leaky Valve" as the problem effect. The reality is that cause and effect are the same thing, only viewed from a different point in time.



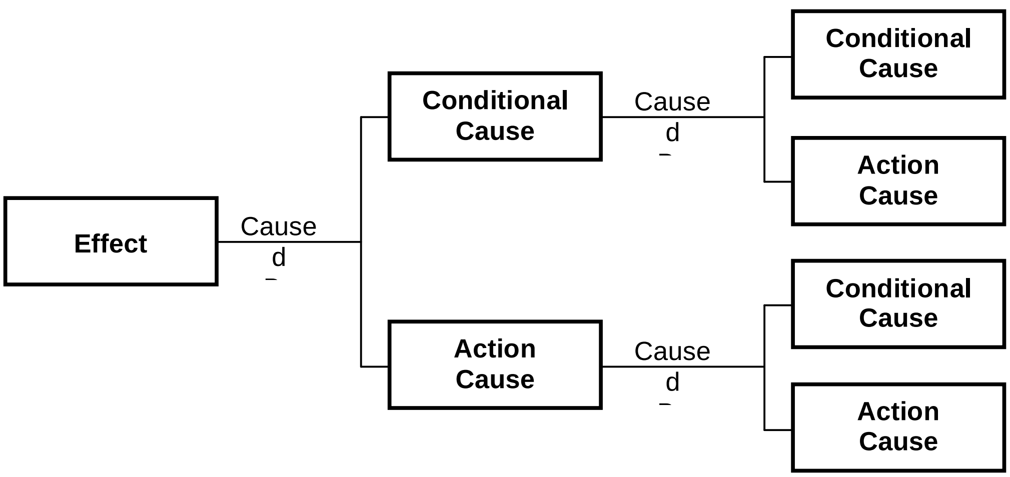

## Figure 1. A Simple Cause Chain

### Infinite continuum

Knowing that causes and effects are part of an infinite continuum of causes helps us understand that no matter where we start our problem analysis, we are always in the middle of a chain of causes. This helps us understand that there is no right place to start. Again, just like the jigsaw puzzle, we can start the problem solving process anywhere and still end up with a complete picture. This avoids the usual arguments over who is right thus allowing agreement based on common goals. Again, in Figure 1, someone may be focused on the injury while another is focused on the leaky valve. Instead of arguing over what the problem is, like we normally do, we can see that all causes are connected somehow in time and we just need to figure out those connections.

### Each effect has two causes

Probably the most profound characteristic of the Cause and Effect Principle is that each effect has at least two causes in the form of actions and conditions. This teaches us that every time we ask "why," we should find at least two causes and for each of these causes we should find at least two more causes resulting in four causes, and from each of these four causes we should find two causes resulting in at least 8, and on to 16, 32, etc. See Figure 2.




## Figure 2. The Infinite Set of Causes

With this understanding, we see that there is an infinite set of causes for each effect, limited primarily by our lack of knowledge. Presented with a reality that has a never-ending set of causes it is now easy to understand why we stop asking why at an early age and pursue simpler strategies like categorization, and storytelling (more on this later). Designed to find the right answer, the human mind simply can not deal with not knowing (Carter, 1999) so we create answers when there are none. This is particularly true in group settings.

With this notion of the infinite set, it seems ridiculous to think we could just keep asking why forever. In practice however, the causal sets are rather short because we are not smart enough to know all the answers. Other natural limits come into play and the process is very manageable as long as we are humble and analyze the problem commensurate with its value.

**Effects exist at the same point in time & space**

Cause and effect relationships exist with or without the human mind, but we perceive them relative to time and space. From observation, we see that an effect exists only if its causes exist at the same point in time and space. In Figure 3, an open fire exists because conditional causes came together with an action cause at a particular point in time and space. As we can see, three conditional causes: oxygen, oily rags, a match, AND one action cause, a Match Strike, occurred at the same point. If these four causes did not exist at the same time and space, the fire would not exist. For example, if the oily rags where stored in a closed can, or if the match was struck at a different time, a fire could not exist. Understanding this characteristic helps us determine the validity of causal relationships.

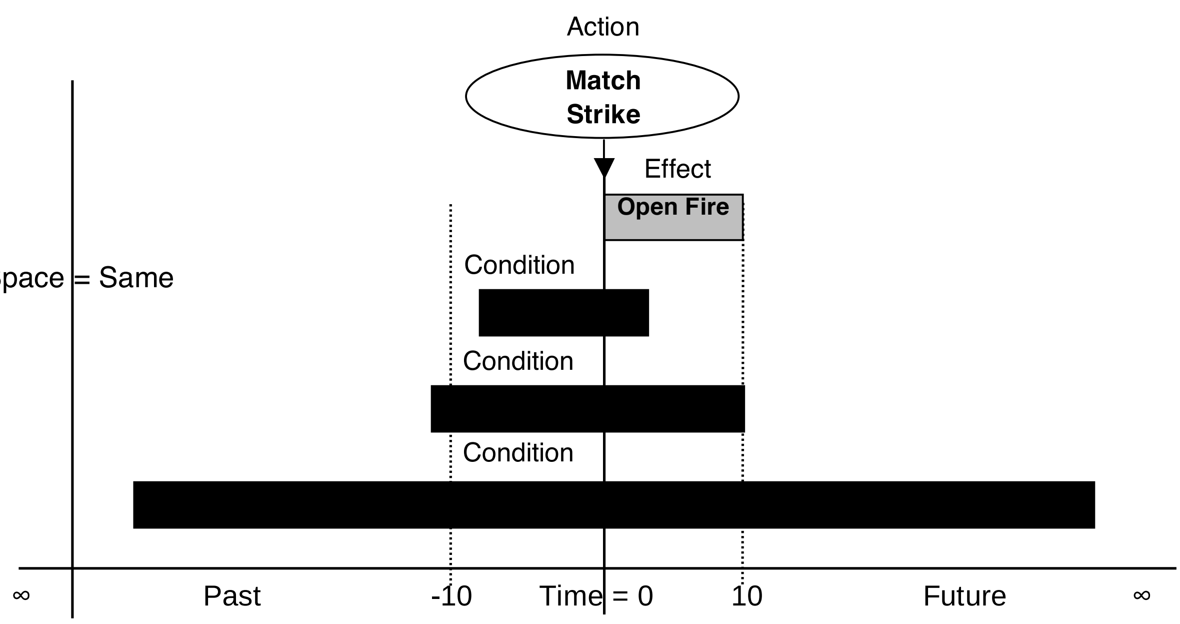



***FIGURE 3. EXAMPLE OF TIME AND SPACE RELATIONSHIPS***

By understanding these four characteristics, we can devise some simple tools that will enable us to tap the awesome power of the Cause and Effect Principle.

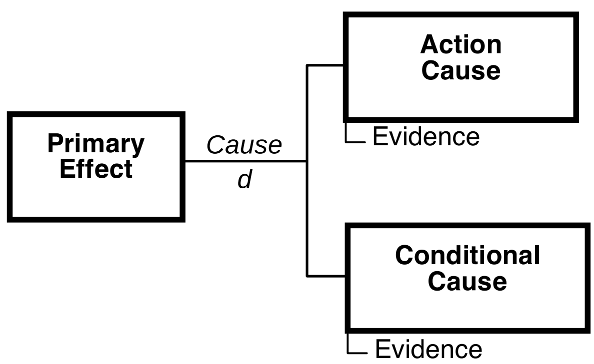
Effective Problem Solving Tools

Using the cause and effect principle rather than some poorly conceived causation model, we can develop a simple problem solving method that can be used on any event-based problem. This new method is called the Apollo Root Cause Analysis (ARCA) method.

The four steps of the Apollo method are as follows:

Step 1: Define the problem by writing the
- What: Primary Effect (Noun Verb)
- When: Relative Time of the Primary Effect
- Where: Location in System, Facility, or Component
- Significance: Why you are working on this problem?
  - Cost
  - Frequency

Step 2: Create an Apollo Cause & Effect Chart
- For each Primary Effect ask why
- Look for causes in Actions and Conditions
- Connect causes with “Caused By”
- Support causes with evidence or use a “?”
  - The basic chart elements look like this:




Step 3: Identify effective solutions
- Challenge the causes and offer solutions
- Identify the best solutions — they must:
  - Prevent recurrence
  - Be within your control
  - Meet your goals and objectives

Step 4: Implement the best solutions

The product of steps 1 and 2 is an Apollo Cause and Effect Chart like Figure 4. The iterative process of step 3 identifies effective solutions. And while obvious, step 4 is often not performed, so it is included as a reminder.

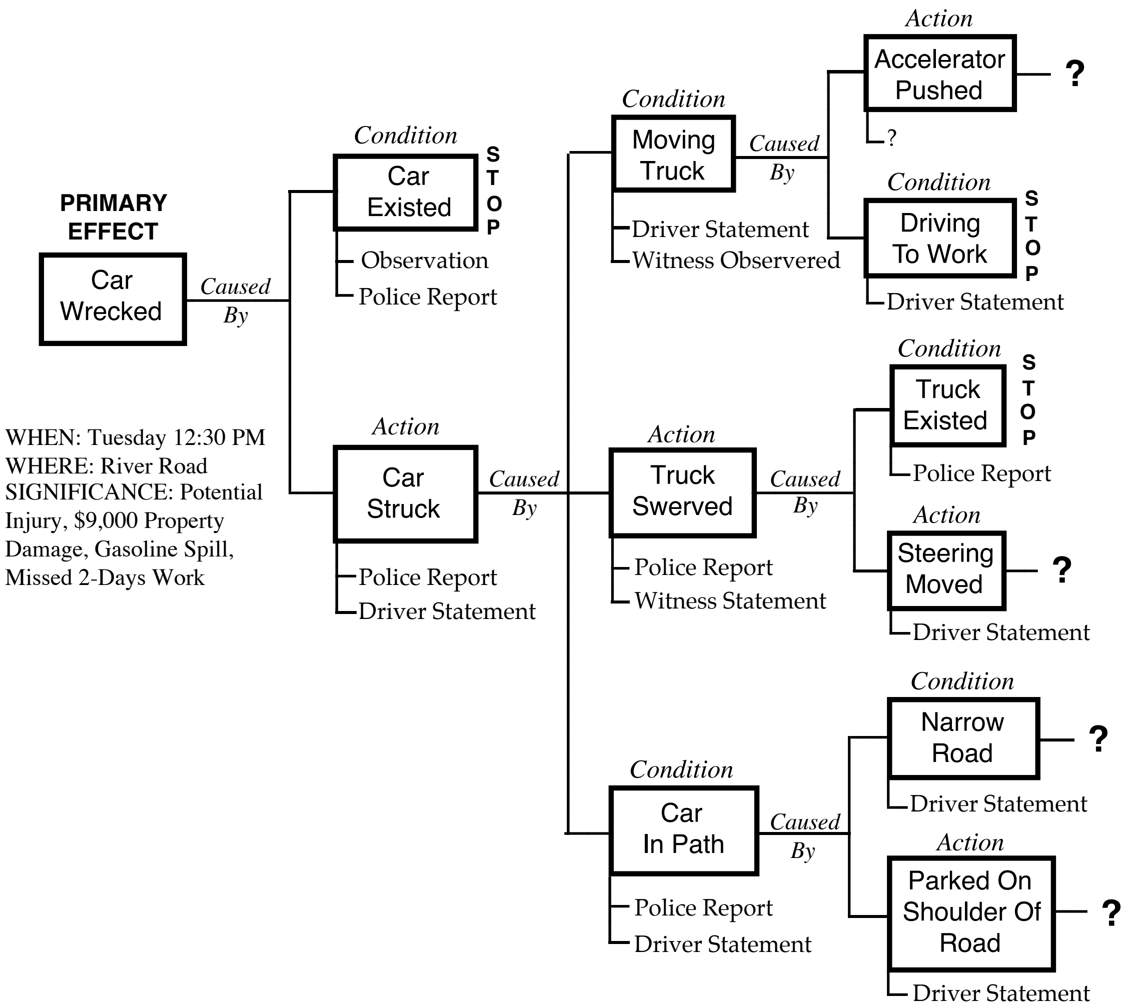



**Figure 4. Example of the Apollo Cause & Effect Chart**

An added feature unique to the Apollo method is the inclusion of evidenced–based causes. When you can't find evidence, or can't find the next cause, embrace your ignorance and use a question mark. Evidence should be data we know from using our senses, not supposition. It supports the existence of the various causes. Without sensed evidence, we are subject to our own prejudices and preconceived ideas. It helps to be humble when pursuing causes and evidence. When you don't know, admit it and use a question mark to signify this on the chart. If there is value in pursuing the unknown, then do so. If no value is perceived, you can make a conscious decision to stop, like we did after "Car Existed," or leave the uncertainty on the chart, like we did after "Narrow Road." If evidence is uncertain, use a question mark to express your doubts. Look closely at Figure 4 to see how the question marks have been used. Finding answers to these unknowns becomes your first action-item list to better understanding the causes.

With a clear understanding of the cause and effect principle, we can see that these simple tools allow us to pursue our ignorance. Indeed, embracing ignorance is the pursuit of knowledge. By taking every cause path to the point where we honestly don't know, we can document everything we do know and hence find the best causes to act upon to prevent recurrence. It is important at this juncture to understand that it is not the perfect or "right" cause and effect chart we are looking for. The purpose of problem solving is to find solutions that will meet our goals and prevent the problem from recurring. By documenting everything we know about the causes we can be assured of effective solutions.

While simple, the Apollo methodology takes practice to become proficient because it represents a new way of thinking. It also requires an understanding that there is no such thing as common sense or a "right answer" for event-based problems. Both of these illusions are fully entrenched in our culture and must be purged to facilitate effective problem solving. For more detailed information read *Apollo Root Cause Analysis – A New Way Of Thinking* (Gano, 1999).

## *LINEAR INFERRED CAUSE MODEL*

Most attempts at incident investigations include an event description, causes, and recommended corrective actions. This unsophisticated model, common to most incident reports, is nothing more than a story of what happened, some educated guessing about the causes and someone's best guess at how to fix the problem. The causation model used here can best be described as an intuitive linear progression of inferred causes. To illustrate what I mean, consider the following "real-life" example and how inadequate it is at communicating a causal understanding of this event.

> *A technician entered building 288 to get Methyl Ethyl Ketone Peroxide (MEKP) for a job to be performed in the Laboratory later in the day. He opened the flammable chemical storage cabinet to get the MEKP. A strong odor was noticed and liquid had collected on the floor of the cabinet. The technician notified his supervisor Ed Kaminski that MEKP had leaked in the cabinet. Upon notification, Ed notified security. When security officer Scott Edwards and John Piscole of the fire department arrived, the chemicals in the cabinet were reviewed along with the MSDS for MEKP. A fireman in full protective equipment entered the building and removed the one gallon bottle of MEKP that had pressured up and was presumed to be leaking. A one gallon can of Styrene monomer was also in the bottom of the cabinet and inspection revealed that it had been leaking, not the can of MEKP. When Industrial Health arrived, they provided information on the type of PPE to be used and cleanup commenced. The PPE was obtained and all the chemicals in the cabinet were placed in a fiber pack containing Cell-Sorb. Plant personnel completed waste characterization and all materials were taken to the incinerator and disposed. The root cause of this incident was procedures less than adequate. The corrective action is to move all MEKP to refrigerated chemical storage and review the procedures.*

Does this sound familiar? The overwhelming majority of event reports I have read throughout the world have the same elements as the one above. It doesn't matter what language, industry, or company we look at, this linear storytelling is commonplace. Storytelling, whether it is ancient history or a recent event description is a linear understanding of an event in a time sequence from past to present, and it significantly violates the cause and effect principle. Because we do not understand the branched causes of the infinite set, we use our own understanding of cause, which is generally to follow the action causes. (See Manuele Ch 8, 1997, for an extensive review of this effect.) Because we typically fail to see conditions as causes, we ignore them and primarily focus on a linear set of action causes, which are often initiated by people. If you look closely at the event report above, you will notice that nearly every sentence describes a human action. The misguided notion that 97% of all accidents are caused by human error comes from a failure to understand the nonlinear aspect of causation. Specifically, that every effect has at least one conditional cause and one action cause.

While stories are our primary form of communications, they conflict with the cause and effect principle in three ways:

1. Stories start in the past, while causal relationships start with the present.
2. Stories are linear, while causal relationships follow the branches of the infinite cause set.
3. Stories use inference to communicate, while problems are known by causal relationships.

Let's examine a simple little story to see how detrimental these conflicts are.

> *The little crippled boy lost control of the run-down wagon and it took off down the hill on a wild ride until it hit the little blind girl next to the drinking fountain by Mrs. Goodwin. The little boy was in the wagon the whole way, but was not injured. The boy's mother should never have left him unsupervised. The root cause of the girl's injury was human error.*

### Stories Start in the Past

As you can see, the story starts in the past at the top of the hill and progresses through time from the past to the present, from the beginning of the ride to the end; from the safe condition to the stated problem of injury. The conflict this creates is that by going from past to present, we do not see the branched causal relationships of actions and conditions. Our language and the rules of storytelling simply do not allow for this. We can not express 16 causes and then tell what they caused and so on.

### Stories Are Linear

As we look at this simple story (or any story), we find our language and our mind restricts us to a linear path through time and space. Stories go from A to B to C, without regard for the order of causal relationships. We are told of the little boy losing control of the wagon as it goes down the hill and strikes the little blind girl. There is no ever-expanding set of branched causes expressed like those in Figure 4.

We have the ability to escape this linearity and express branches if we use the words "and" and "or," but the rules of grammar tell us not to use these connecting words excessively. The best we can accomplish is one or two branches for each sentence. The conflict arises because the cause and effect principle dictates an infinite set of causes for everything that happens while stories are created and expressed linearly.

### Stories Use Inference to Communicate Causes

Since good stories seem to provide us with a valid perception of what happened, we need to question how this can occur in light of the above two conflicts. The key word here is perception. When we read or hear a story our mind provides most of the information (Carter, 1999; p149). As we read or hear the words, we are busy creating images in our mind's eye. These images are created from past experience and assembled into a sequence of events. We don't necessarily need causal information to create the image; our mind fills in with it's own causes. Because stories or the pictures we create do not express the branched causes of the infinite set, we must makeup for it some how and we do this by inference. We infer causes within the story that are not stated. For example, we read that the little crippled boy lost control of the wagon. Since no cause is stated for why he lost control we can infer anything our mind will provide, and we do just that if questioned about it.

Furthermore, stories imply cause by the use of prepositions like in, on, with, etc.  Prepositions and conjunctions by definition imply a relationship between words, and the relationship is left to the reader. The word "and" is often used to mean "caused." In this story we read that the boy lost control of the wagon **and** it took off down the hill, meaning the loss of control caused the wagon to take off down the hill. Within this "and," is the potential for many causal relationships and they are left for the reader to interpret. For me, the "and" between *lost control* and *took-off down the hill* is obviously a broken steering mechanism. You may have inferred that crippled means a paraplegic and this condition was the cause. The next person's mind sees the wagon wheel strike a rock, which causes the wagon to veer sharply, while another person is so shocked by the politically incorrect usage of "crippled" and "blind children," they have lost the ability to think about the problem altogether. Because we do not express what is happening causally, each word in the story provides the reader with the opportunity to think they know more about the event than is stated. We interpret the situation from our own biased mind, which is not necessarily what happened or what the storyteller meant.

In the end, each one of us thinks we know what happened but we really don't because stories can not express the full set of causal relationships. Our linear language, and the linear thinking behind it, prevents us from knowing and expressing what actually happened in any given situation. And when we get together to discuss our problems, we usually end up arguing and making presumptuous statements like: "It's obvious why this happened," or "the solution is clear." By breaking away from storytelling and creating an Apollo Cause & Effect Chart, we are able to include all possible causes without the usual arguing and politics.

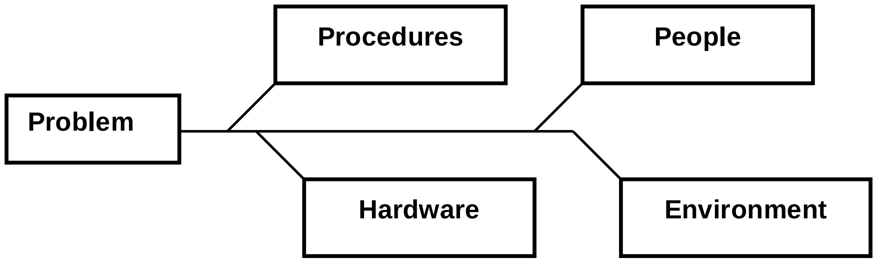
The linear inferred cause model also includes cause categorization as a strategy for reducing complicated issues to simplistic notions. For example, in the Styrene story presented earlier, it was concluded that the root cause was procedures less than adequate. This is not a cause that will allow a specific solution. Instead, it is a broad category that results in the wimpy solution to review the procedures. Categories are useful in an argument because they allow the listener to provide their own inference and thus do not have to be discussed. Each person thinks they understand what is meant by the category and thus the illusion of knowledge transfer is presumed effective and complete. It is anything but complete and is the cause of many communication errors that occur everyday of our lives.

Categorical thinking is a natural progression for the human mind because we have never fully understood the cause and effect principle. As children we ask why until we realize the answers are infinite in scope and to pursue them requires more energy than we are willing to expend. We also have a natural tendency to simplify things by putting common patterns in a box called a category or classification. We even have colloquial expressions for this strategy: By putting things together, "we can kill two birds with one stone," or "we can get the biggest bang for the buck." Presented with the option to keep asking why and look for causes or to simplify and use categories, the intellectual laziness inherent in the human species will normally chose the path of least resistance. This common practice of categorization has found its way into the problem solving methods used around the world, and they are discussed in the next section.

## Cause Categorization Models

Cause categorization schemes include Management Oversight and Risk Tree Analysis (MORT), the Ishikawa Fishbone diagram, and many so called "cause tree" methods (Wilson, 1993). The causation model for these methods is not based on causes, but on cause categories. To demonstrate the difference, let's take a look at the Ishikawa Fishbone Diagram in

Figure 5. All other categorization methods use the same logic. The premise is that every problem has causes that lie within a small number of categories. Ishikawa uses People, Procedures, Hardware and Environment. Each of these categories has sub-categories and sub-sub-categories. For example, within the category of People 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.




## Figure 5. Example of the Fishbone Diagram

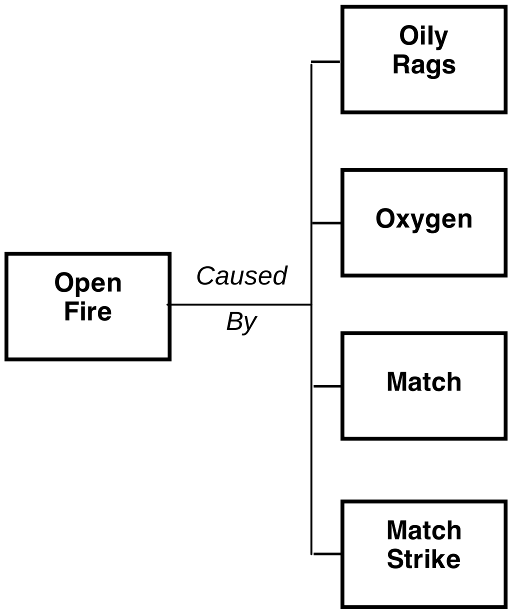
There are two major problems with this model. First, it has nothing to do with causal relationships. It is simply a list of possible cause categories used for the stated purpose of finding the root cause. This is supposed to happen by cross-correlating the categorical scheme with the investigator's knowledge of the event. The primary focus being on identifying the root cause rather than establishing causal relationships. Its usefulness lies in providing a mind tickler, nothing more.

The second problem with this model is that no two categorization schemes are the same, nor can they be, because each human has a different categorization scheme. 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 the root cause, I suspect you have incurred many a wasted hour debating which is the correct category for your root cause.

Perhaps the greatest misunderstanding perpetuated by categorization methods is the inappropriate pursuit of the root cause. Remember that our linear thinking provides the illusion of a root cause. By virtue of this linear model, we presume there is an end cause or root cause that if removed will prevent the problem from occurring. Notice that during the categorization process, there are no causal relationships established or written down like those in Figure 4, just a subjective search for the root cause. Once the root cause is found, corrective actions are decided upon and implemented. In light of what we have discovered so far, let's examine why categorization models find effective solutions by chance not by design.

Let's use the simple example of an unwanted open-air fire so we can see the process. If we use the linear thinking and categorization models to examine an open-air fire, we might find that the root cause is human error in that someone struck a match next to some combustible material. Since they have been told never to do this, we will punish them for not following the rules.

Now, let's look at the same problem using the Apollo cause and effect chart. This is represented in Figure 6. If we try to identify the root cause, it soon becomes obvious that any of these causes can be a root cause. (A *Root Cause* being the cause that is removed, changed, or modified by a solution to prevent the problem from occurring.)




## Figure 6. Find the Root Cause

If we remove the oily rags, the problem will not recur, so that must be the root cause. If we remove the match, the problem will not recur. In fact, in this example, we can remove any one of the four causes and the fire will not occur. As we can see, the root cause is dependant upon which solution we choose, not on the root cause we choose, as the categorical methods would have us do.

The purpose of problem solving is to find effective solutions, not the root cause. Contrary to nearly every incident investigation method in use today, the Apollo problem solving methodology focuses first on the cause and effect relationships and then on effective solutions and root causes are only identified after these solutions are committed to. With this understanding, it can now be stated that the only value categorization methods provide is a mental reminder of the possible cause categories in which we may find causes. It is this memory jogging **and** the specific knowledge of the investigators that chances an effective solution, not any design of the categorization scheme.

A sad consequence of categorical methodologies is that they lend themselves to being computerized. Once a categorical set is established it can easily be put on a computer that allows the user to turn off their brain and just follow the bouncing ball. Cause-tree software looks something like the following:

To identify the root cause answer the following questions:
Failed Component Is?: Pump? Motor? Compressor?
Answer: Pump
Component Failure?: Bearing? Seal? Rotor?
Answer: Seal
Failure Mode?: Wear? Abrasion? Tear?
Answer: Tear
Cause of Failure?: Burr on shaft? Debris? Exterior Force?
Answer: Debris
Root Cause: Debris in fluid
Solution: Install a strainer on the flushing line.

By virtue of a documented logical set as shown above, a great illusion is created by the fact that it makes sense to the reader—it has been observed before and familiarity makes it "right." (Please recall how the human brain is designed to create a "right answer.") Being solution oriented and highly biased, we reason that it would be a waste of time to consider other possibilities when a favorite solution is at hand. Because this logic takes us to a favorite and seemingly successful solution, the illusion is compelling. I say "seemingly successful solution" because we erroneously believe that past success will always guarantee future success. And it will, if we know all the cause and effect relationships. But when we only identify a few of the categorical causes, we delude ourselves into thinking we know what really happened. By fixing the causal chain together like the example above, the infinite set of possibilities such as how the pump was maintained, operated or designed is ignored.

In short, cause categorization trees and computer software based on them create the illusion of finding solutions, but these solutions will not provide the same assurance of effectiveness since they do not provide the branched causal relationships required by the cause and effect principle.

Categorization methods are popular with rule-based people because they validate existing perceptions in a written format. If it is on a computer, it becomes even more trustworthy for them. In our search for an effective solution, we are often misguided by our existing strategies and when solutions are presented as easy and painless we tend to just accept them. Success dictates that there is no substitute for causal thinking.

## *OTHER MODELS*

A brief note on other models: There are many other problem-solving methods with sound bases and helpful tools. For example, change analysis, barrier analysis, energy flow analysis, systems analysis, constraint analysis are all good tools for understanding an event from different perspectives, but they always end without asking why and if we don't ask why we can't know reality.

## Conclusion

If you were given a choice between the styrene investigation report provided earlier and the Apollo Cause and Effect Chart of the same event provided in Figure 7, which do you think would yield the best corrective actions?

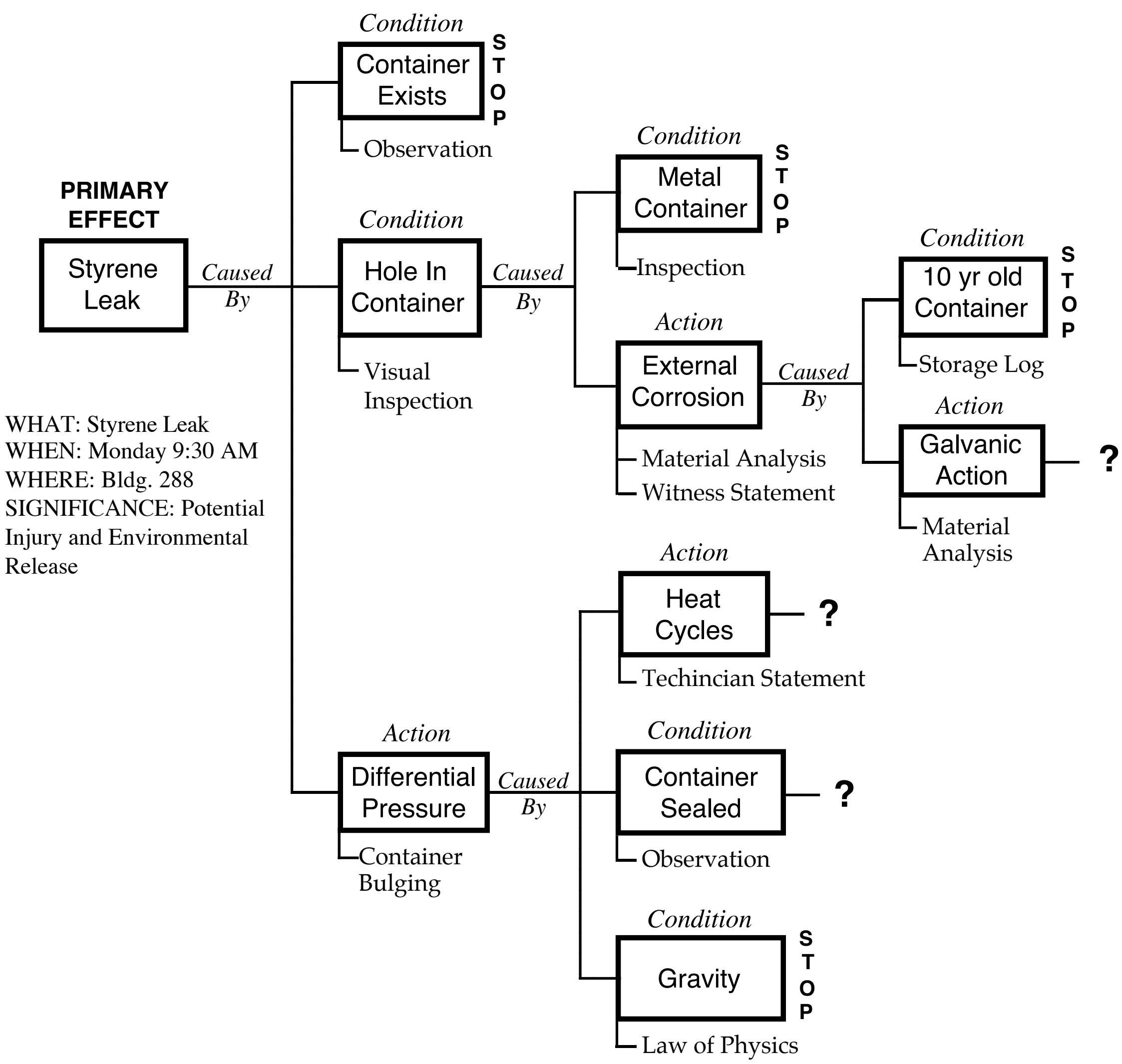



*FIGURE 7. EXAMPLE OF AN APOLLO CAUSE & EFFECT CHART FOR THE STYRENE EVENT*

Surely, the example in Figure 7 could be much more complete, but even in its current stage of completion it provides a better representation of the event than the story provided in "real-life." I trust the argument has been presented well enough for the reader to understand why categorization and story telling work by chance, not by design. Neither one of these methods follows the cause and effect principle and thus have no chance of being effective without an experienced incident investigator. This is not to say we humans are foolish, it is to recognize that we have never fully understood the cause and effect principle as presented herein and therefore have been set up to fail by conventional wisdom. If ever there was a need for change and a dedication to continuous improvement, it is in the area of human problem solving. We simply can not afford to continue solving today's problems with yesterday's thinking.

In reflecting on my journey these past 14 years I keep coming back to a haunting question I am often asked by strangers. What do you do for a living they ask, and I always say: "I teach problem solving to the world." The inquisitor then responds with: "What do you mean by problem-solving?" I find it very difficult to answer this question because conventional wisdom holds that problem solving is unique to the subject matter and no matter what I say, the inquisitor will not understand without a long explanation. Contrary to conventional wisdom, problem solving is not unique to the subject matter, but founded in the cause and effect principle and ready to be taught to the world. Reality itself can be represented with the Apollo Cause and Effect Chart, and as you can see from the brief description provided herein, it can be used on any event-based problem. More importantly, the Apollo method provides a new way of communicating that facilitates every player's perspective and when complete assures buy-in from all stakeholders. With these attributes, many companies and organizations like Boeing, NASA, Dow Chemical, FAA, Capital Group (Financial Organization), Kodak, Ericsson, Sprint, Cargill, and many more Fortune 500 companies are using Apollo Root Cause Analysis as their primary problem solving methodology. What are you using?

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