# Causes = Effects?([1])

**Ed Sickafus**
Ntelleck, LLC, Grosse Ile, MI, USA
(734) 676-3594 Ntelleck@u-sit.net, www.u-sit.net

Early in teaching USIT ([2]) to industrial technologists it became clear that finding root causes, in problems brought to class, often was a difficult task. This was the case even though the students had been trained in understanding the importance of knowing root causes and in methods for identifying them. From this teaching experience I developed the plausible root causes method. ([3])

Now I find that students still have difficulty with the exercise. It seems that part of the problem relates to student's inexperience in structured problem solving and to their lack of careful application, or awareness, of the definitions of cause, root cause, and effect. The following discussion is an attempt to clarify use of the fundamental definitions.

**Discriminating Causes, Root Causes and Effects**

The plausible root causes diagram deals with all three concepts: causes, root causes and effects. The diagram, shown in Fig. (1), is a modification of that published earlier in that it has been simplified to the case of a single object, which is not shown. When, in a specific branch of the diagram, a root cause is reached the branch is terminated and the terminal box does not have an associated effect. Instead, it has a list of attributes (also not shown in this figure).

An unwanted effect is placed at the top of the plausible root causes diagram. In the next lower row causes of the effect are listed in separate boxes. Each of these causes is then treated as an effect for the next lower row of causes. Each column of boxes terminates on a plausible root cause. However, this is where most difficulty lies, that is, in finding the termini of the columns. It is a two-step process: in the first step one is analyzing each effect for plausible causes. When no further analysis of causes of effects is evident each cause at the lowest level of each branch of the diagram is taken to be a plausible root cause. In the second step, each plausible root cause is then analyzed in terms of causal attributes. And this is where confusion sets in, three terms have been introduced for almost the same concept; they are, cause, plausible root cause, and causal attribute.

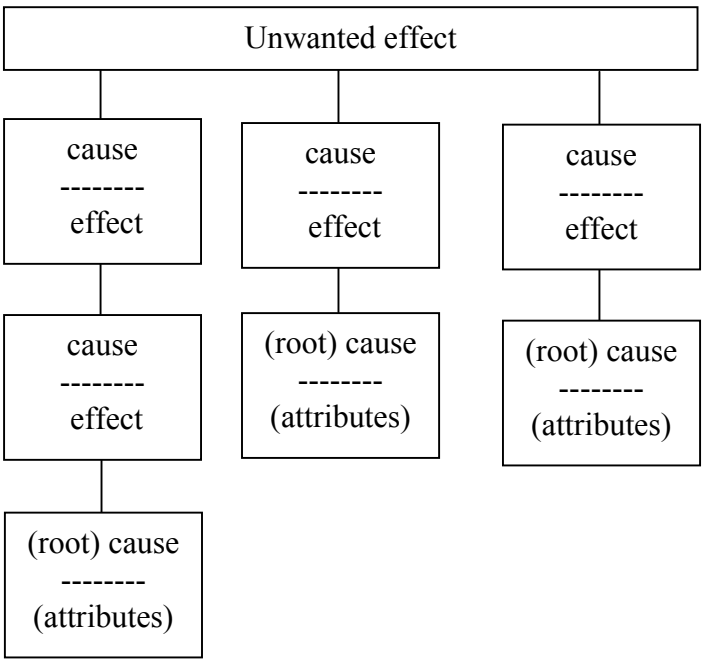


Figure 1. Plausible root causes diagram for a single object (not shown).

The confusion can be put to rest by reviewing several important definitions. Firstly, effects come in two varieties, "wanted effects" and "unwanted effects". Wanted effects are given the special name of "functions". Recall that a function, as well as an effect, modifies or maintains an attribute. Thus, both words, function and effect, carry the connotation of an action; either to modify or to maintain.

The role of causal attribute becomes evident on examining the graphic definition of object-object contact, shown in Fib. (2).

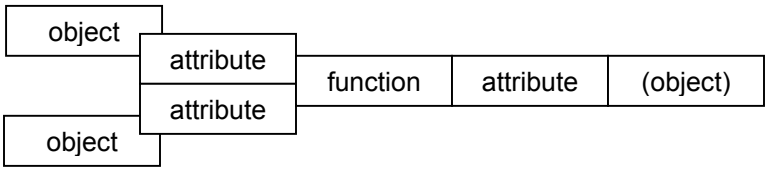


Figure 2. Schematic representing object-object contact via an attribute of each object, which interact to support a function that modifies or maintains a third attribute in one of the contacting objects or in a third object.

This diagram defines a major concept of USIT, namely, the concept of object-object contact to support a function. *Two objects make contact through one attribute from each*

*object interacting to support a function that modifies or maintains another attribute in one of the contacting objects or in a third object*. The word function can be replaced in the diagram with effect, unwanted effect, cause, or root cause. The same object-attribute-function relationship exists for each.

The word *cause* is used in analyzing an unwanted effect. Analysis of an unwanted effect refers to breaking it down into other underlying effects, which we call "causes". The initial concern is to determine if the unwanted effect is a single unwanted effect – a major issue in problem definition for USIT application. Hence, by analyzing a particular unwanted effect in terms of its causes, other, convoluted effects may become apparent. If the initial unwanted effect is a singular effect the first level of causes, in the plausible root causes diagram, becomes a list of attributes.

With these similar terms in mind, I'll redraw part of the defining diagram, Fig. (2), as shown in Fig. (3).

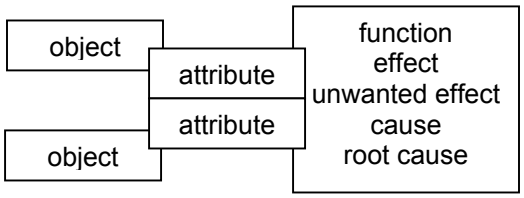


Figure 3. A schematic of object-object interaction illustrating the equivalence of function, effect, unwanted effect, cause, and root cause.

The purpose of this drawing is to emphasize that function, effect, unwanted effect, cause, and root cause are terms having equivalent relationships and that all of them have associated attributes. The associated attributes are referred to as causal attributes when referring to causes of unwanted effects and as supportive attributes when referring to functions. Listing the causal attributes to be associated with each root cause completes a plausible root causes diagram.

Suppose, for example, that dulling of a pencil point is an unwanted effect. Are there underlying causes of the pencil point becoming dull? The answers to this question should draw us closer to the fundamentals of the problem. Since dulling of a pencil point occurs when the pencil is used for writing, we have two objects to consider as being in contact, paper and pencil lead. Each is a source of basic effects. The paper can be seen as abrading the pencil lead. The pencil lead can be seen as fracturing during contact with paper. Both of these are causes of pencil lead dulling. Paper abrading and lead fracturing are illustrated in the next figure.

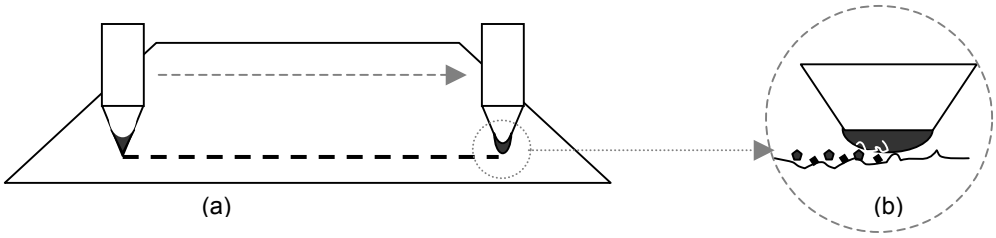


Figure 4. (a) Illustration of a pencil marking a line on paper by abrading the pencil lead in order to leave a mark on the paper. (b) Illustration of lead fracturing and shedding abraded particles.

One can stop at the level of terminal causes (Fig. 1) and define these as root causes. The next step would be to look for causal attributes of each object that support abrading by paper and fracturing of pencil lead. Other analysts may try to take abrading and fracturing to lower levels of cause and effect. Such efforts can lead to microscopic and molecular effects with their attendant causes. An example plausible-root-causes analysis is shown in Fig. (5).

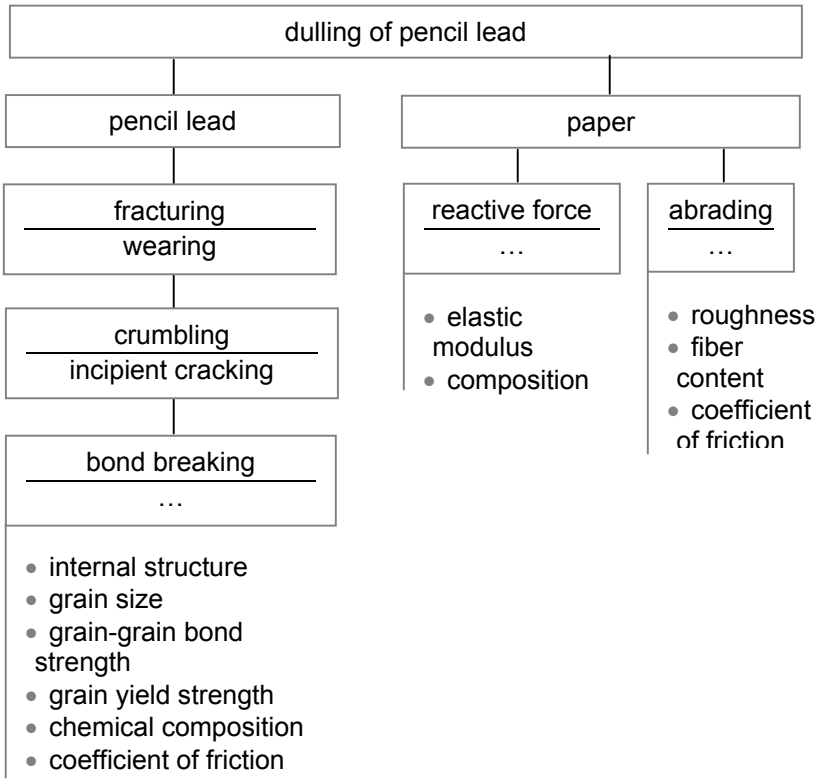


Figure 5. Plausible root causes diagram for the unwanted effect, “dulling of pencil lead”.

The diagram in Fig. (5) represents notes made as one thinks about the underlying phenomenology of an effect. It is not an independently confirmed technical analysis. Different technologists will produce variations of the diagram. For example, in the first column "wearing" has been shown as a cause of the effect "fracturing". It could have headed a separate column as a cause of "dulling". This is logical in that fracturing is a internal phenomenon while wearing is a surface phenomenon. Hence, the word "plausible" in the title of the diagram is intended to buffer concerns of variability and lack of independent confirmation. Variability is promising. Confirmation is an issue of filtering final concepts after USIT analysis has been terminated.

**Summary**

In summary, discriminating the words cause, root cause, and effect is as follows: An effect maintains or modifies an attribute. Its USIT model consists of a pair of interacting attributes, one each from two objects in contact. Thus the cause of an effect can be described in three different ways: in terms of another effect (or function), in terms of two interacting attributes, or in terms of two contacting objects. An example of using a specific pair of supporting attributes for a function is shown in Fig. (6).

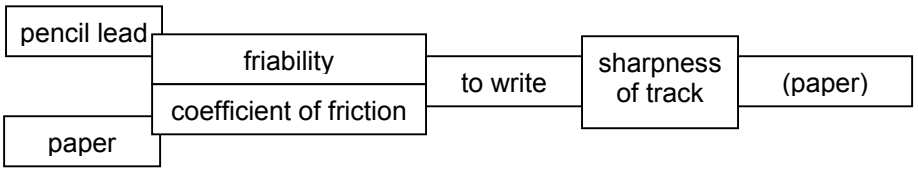


Figure 6. An illustration of an object-object contact diagram having two interacting attributes supporting the function "to write".

The plausible root causes tool of USIT was developed to address cause-equal-effect confusion and to define root causes. When searching root causes of an effect a plausible root causes tree can be constructed. The effect is placed at the top of the tree. Causes of this effect are listed in the next lower level, using any of the three possible expressions. Each cause is then treated as an effect and its causes are entered in the next lower level. Through iteration of this process the problem solver strives to discover causal attributes for which no further analysis is obvious. These lowest levels of causes are termed root causes.

In this process the mind first considers actions and then gradually transitions to physical properties: transitions such as, effects → causes → attributes, aid our mental modeling of, phenomena → fundamental causes → physical properties. Solution concepts can arise at any level, but are especially effective when couched in terms of physical properties.

**Acknowledgements**
Juan Carlos Nishiyama and Carlos Eduardo Requena of Argentina recently pointed out to me that students easily confuse causes, root causes and effects. I am grateful to them for this insight, which led to the current discussion. I am also grateful to Dr. Ellen Domb for the invitation to submit this paper for publication in The TRIZ Journal, and for her constructive suggestions.

**References**:

1. This discussion was first published as U-SIT and Think Newsletter NL-19. These free newsletters contain mini-lectures on USIT and related topics. You may register to receive them at www.u-sit.net.

2. USIT, an acronym for unified structured inventive thinking, is a structured problem solving methodology developed while the author was a manager of the Physics Department in the Ford Motor Company Research Laboratory. USIT is based on the original systematic inventive thinking methodology (SIT) of Dr. Roni Horowitz and colleagues, now called ASIT. That work was based on TRIZ. USIT is now being taught in companies worldwide.

3. See "Unified Structured Inventive Thinking – An Overview" – an ebook available free at www.u-sit.net. A textbook containing detailed problem examples has been published titled, "Unified Structured Inventive Thinking – How to Invent", ISBN 0-965-94350-X. Details are available at the same website.