

# Practical Uses of Failure Analysis and Analytical Tools

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## Contents

- [Time Lines](#)
- [Fault Trees](#)
- [Failure Mode and Effects Analysis \(FMEA\)](#)
- [Software](#)
- [Practical Uses](#)

Fire investigators are advised to read and be familiar with all aspects of NFPA 921. So, when a new edition comes out I do just that, read it from cover to cover. Of course, it might take awhile, but I do it.

However, when the 2001 edition came out I skipped chapter 17 "Failure Analysis and Analytical Tools". But the second time I picked it up... okay, the third, I finally read it. What I discovered was information that was understandable and usable, mixed in with the other stuff that I couldn't decipher.

This article will examine the practical uses for portions of Chapter 17 Failure Analysis and Analytical Tools, namely time lines, fault trees and failure mode and effect analysis (FMEA).

## Time Lines

Time lines are a systematic charting of events related to the fire in question. Most of us have used them, formally or informally, hard copy or mentally, to arrange the sequence of events leading to and subsequent the origin of a fire. A more advanced time line, as described in 17.2 and Figure 17.2 will include soft and hard time events.

Hard time events are based on reliable and accurate occurrences, such as dispatch logs and alarm company reports. Hard time events are the backbone of time lines because they establish irrefutable data related to events during the progression of the fire and can be used to place less accurate and subjective events, known as soft time events.

Benchmarks are those hard time events that are key elements to determining the issue in question. The only variables in hard time events involves the possibility that set

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times at the alarm company may not be exactly aligned with set times at the fire dispatch center, much the way as one person's watch may be a few minutes different than another's. In most cases these discrepancies are able to be identified and adjusted.

Soft time events are less accurate than hard time events and are further divided into relative and estimated time. Relative time events are subjective, the result of witness observations, which are corresponded to hard time events. For example, a witness may have information on an event that occurred in the minutes after the monitored alarm sounded and before the fire department arrived on scene. The event is estimated between the two hard time events. Estimated time events are those that can't be associated with a hard time event. Because of this, estimated time events are less valuable than relative time events, but may still assist in the reconstruction of events.

### **Fault Trees**

A fault tree is a diagram that specifies the conditions and events necessary for a failure, in this case a fire, to occur. The chart looks similar to an organizational chart, with the failure at the top, the triggering events at the bottom, and all of the events necessary for the fire to occur in between.

Similar to testing the hypothesis, a properly configured fault tree will identify a chain of events that ultimately resulted in a failure. Along with the correct chain are other potential causes and effects. Ideally, if the proper sequence of events is identified, then the other potentials are able to be systematically eliminated.

Fault trees are comprised of events or conditions tied together with "and" or "or" decisions. A very simple fault tree may have a single "and" or "or" decision, or be more complex with a combination of both decisions and multiple chains of events possible. The "and" or "or" decisions are known as gates.

Fault trees can be further broken down into different geometric shapes that offer a quick reference to the events, failures and results. For example, in NFPA 921, Figure 17.3.1.(a), circles are events, diamonds are failures and rectangles are results.

### **Failure Mode and Effects Analysis (FMEA)**

FMEA is a little less complicated than a fault tree, probably because it is more linear. The FMEA chart identifies an individual component, such as a coffee maker in the NFPA 921 example, Table 17.3.2, and charts the potential failure, how it would present, necessary conditions and end result. A

properly arranged FMEA chart should show a sequential progression where all necessary events occur.

One limiting factor of FMEA charts is that knowledge of all system components of the component item is needed. Then, the human actions necessary and failure mode indicators for each system must be examined, eliminated or confirmed. A very good source for a majority of this information is operations and maintenance manuals. If a failure is obvious, than a FMEA chart can be made without the other system components included, but use caution when excluding potential system failures in the chart.

## **Software**

Software products exist that simplify the process of making time lines, fault trees and FMEA. The following websites and software companies were located on the internet using a Google search. To conduct your own Google search, go to [www.google.com](http://www.google.com), then type in a keyword or series of words on the search line and click "Google Search." The search will display a number of results, which can be clicked and explored. There are many search engines out there, but Google seems to be one of the better ones.

A San Diego based company is offering [SmartDraw 6](#), which allows the user to produce quick and professional time lines, as well as organizational and other graphic charts. A free trial version can be downloaded and sampled.

[Relex Software Corporation](#) offers a demo version of Relex 7.5, a program that will produce fault trees and FMEA charts.

Failure mode and effect analysis (FMEA) software can be obtained from [Dyadem International Limited](#), makers of risk analysis software. A full version of FMEA-Pro 5 can be downloaded free of charge.

There are other companies and software packages available to produce time lines, fault trees and FMEA; these are the ones that presented at the top of the [Google](#) search.

## **Practical Uses**

Similar to photograph logs and diagrams (as opposed to sketches), the municipal fire investigator may find using fault trees and FMEA charts too cumbersome and time consuming to use on a regular basis. The private investigator may find more support for this type of undertaking.

However, it seems that a more suitable use, for both types of investigators, would be backtracking the investigative results when a case or file progresses to the legal forum, the same way diagrams and photograph logs can be produced after-

the-fact. The only requirement for all of these tasks is that sufficient information was collected and documented at the time of the fire or investigation, which should be routine for all fire investigators.

While time lines, fault trees and FMEA are supposed to be used to identify potential events or failures, by backtracking from a completed investigation, the investigator has the benefit of all available data and the known cause of the fire. The use of these tools affords the opportunity to introduce a graphic depiction of the event responsible for the fire as well as the elimination of other causes. Completing a time line, fault tree or FMEA after the investigation does not make the results any less valid if the initial investigation was conducted using the scientific method / systematic approach.

By using these tools when a case or file enters the legal arena, the investigator can take comfort knowing that the expenditure of time will go to good use, namely transforming what otherwise might be a confusing sequence of times or events into an understandable and believable chart or tree that can be traced and examined visually. The jury will be able to follow along with the questioning and the investigator can refer to the time line, fault tree or failure mode and effect analysis chart to good effect.

This is not to suggest that these tools are not useful in identifying cause and event potentials; that is their intended use. But realistically, these are time consuming, labor intensive undertakings that will not often be utilized in that context.

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