# Expertise and Effective Office Warning Strategies

Advanced Warning Operations Course

IC Core 3

Lesson 3: Learning From Post-Mortems

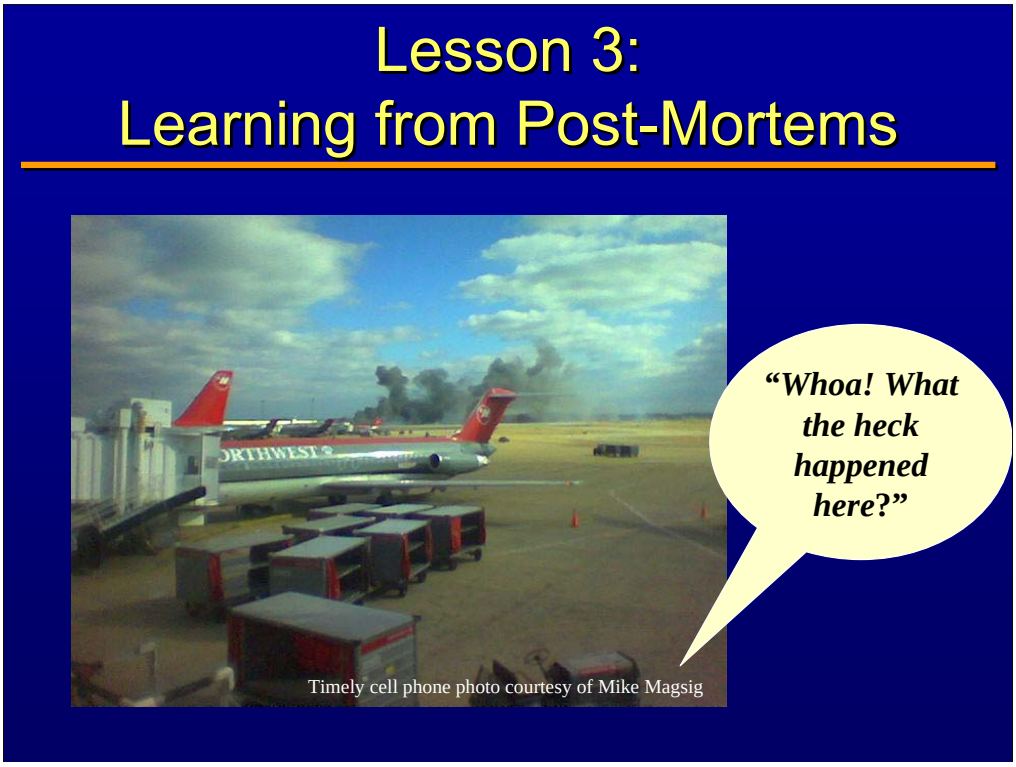
Warning Decision Training Branch

Lesson 3 of IC Core 3 deals with the use of post-mortems as a means to gain expertise as well as a means of gaining insight into to warning operations and decision-making, both for the individual and for the agency.

## Overview of Expertise and Effective Office Warning Strategies

- Lesson 1: Expertise
- Lesson 2: Cognitive Task Analysis of expert warning forecasters
- Lesson 3: Learning from post-mortems
- Lesson 4: Significant event management: Planning, Strategy, Expertise, and Innovation

This is the 3rd lesson in the Expertise and Effective Office Warning Strategies instructional component.




Most often when you work an event which has a bad outcome, you have a desire not to go through that again. By the same token, an event which flows smoothly can offer just as much insight as to effective strategies. Post-mortems should be considered for both situations. The Fed-Ex plane which caught fire on approach to Memphis is an example of an event one would not like to see repeated.

# Brought to you by…

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## Learning Objectives

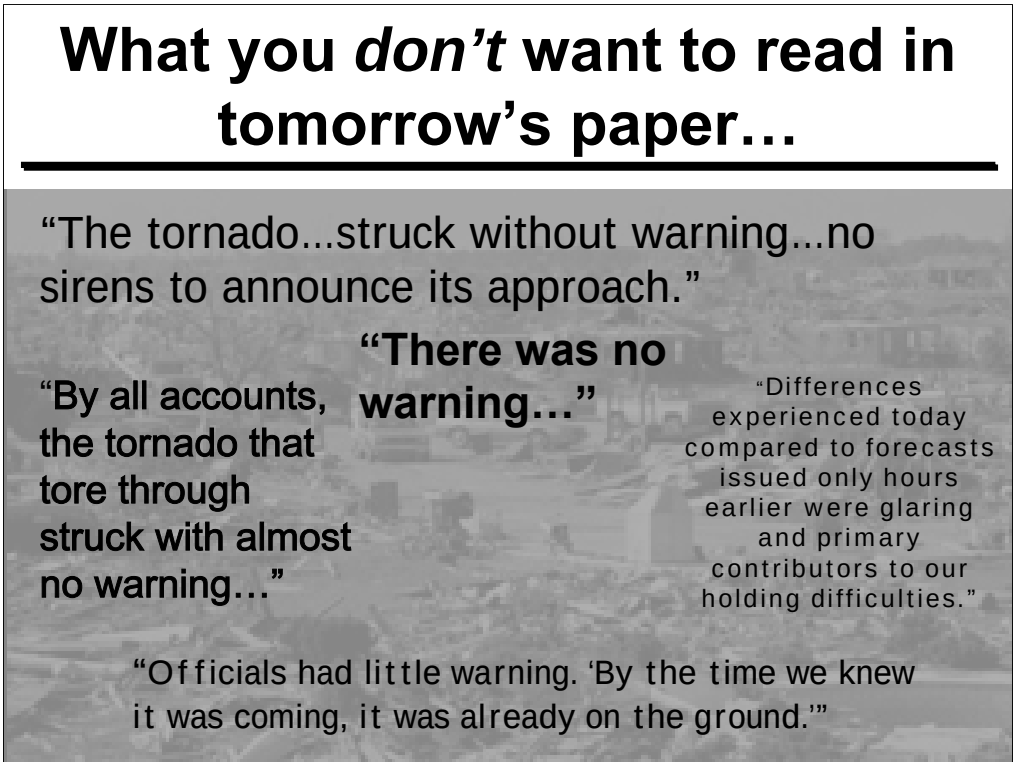
1. Identify the potential benefits of a post-mortem analysis
2. Identify characteristics of ineffective post-mortems
3. Identify the value of having a post-mortem database
4. State what is meant by human error
5. State the impact of the hindsight and outcome biases on performing post-mortems
6. Explain the value and meaning of a root cause analysis

The learning objectives for this lesson are testable and have to do with the benefits of a post-mortem and why you would want to do one in the first place. However, just going through the motions doesn't mean you will reap all the benefits. The post-mortem must avoid certain pitfalls. In addition, having a database constructed of post-mortems from numerous events and offices can reveal systemic issues (both good and bad). We will look at the term "human error" and discuss its meaning and relevance. We will also discuss some of the challenges with assessing decision making in real-time, while already knowing the outcome (outcome and hindsight biases). Finally we'll discuss a means of going in deeper by using a root cause analysis approach.

## Performance Objectives

1. Using the template provided, perform a post-mortem on an event you worked
2. Using root cause structure, perform an analysis on one particular warning decision you made

This lesson will also include two performance objectives in the form of exercises. The first will be to perform a post-mortem using an on-line template based on an event you worked. The second will be to use the root cause method to look at one warning in particular.

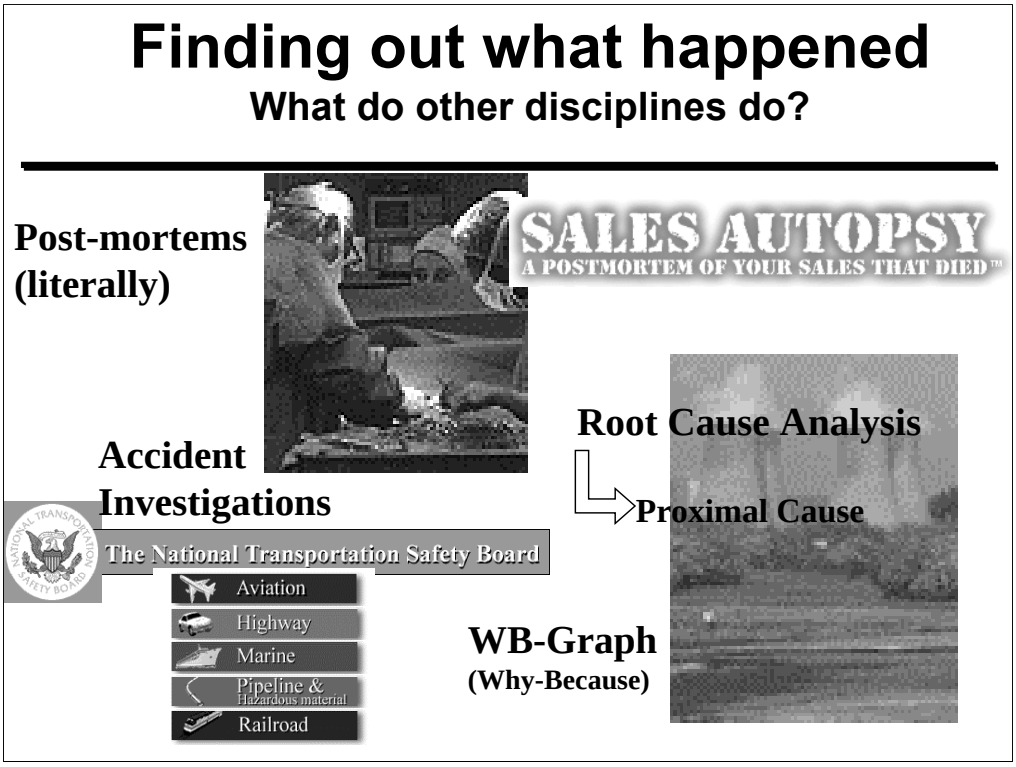



Anyone who's worked a significant weather event has seen headlines the next day which may or may not reflect the service provided, but nonetheless are extremely troublesome. In some cases, the office would have been hard pressed to get a better outcome. In others, actions before and during the event show room for improvement. An honest post-mortem will help us know where improvement can be made, whether it is in understanding the science, better technology, or human factors related issues.

# Overview

1. Value of post-mortems
2. What makes post-mortems ineffective
3. Challenges in performing post-mortems
4. Post-mortem database
5. Methods of performing post-mortems
6. Assignment

We will look at each of these areas with the goal of convincing you post-mortems are a valuable tool to help us assess and learn from both good and bad outcomes, and that it would behoove us to do them much more often than most of us currently do.




As you see here, many domains conduct post-mortems using many different strategies and formats.

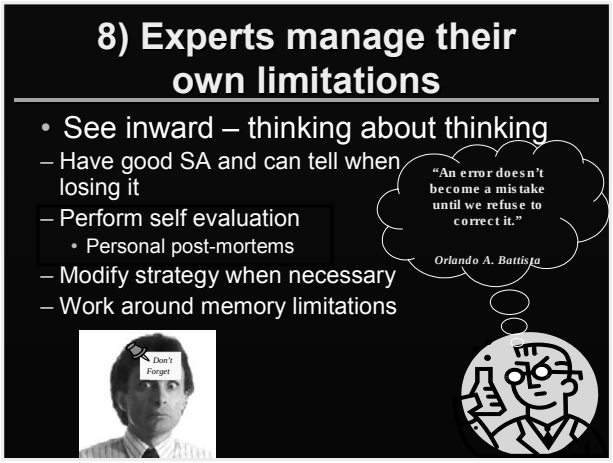
# Post-Mortem - definition

– *n.* 2 short for POST MORTEM EXAMINATION (*AUTOPSY*); a detailed examination or evaluation of some event just ended

**"Post-mortem examinations provide valuable information … and can provide vital information for future treatment and research."** ***(Royal College of Pathologists)***

The official definition of a post-mortem is an examination of an event that has just ended. No mention of whether that event had a good or bad outcome. Post-mortems can not only tell us about the past but can help point us in the direction of needed research, technology, policy, or procedures.

# 1. Value of Post-mortems: a. Tie to expertise

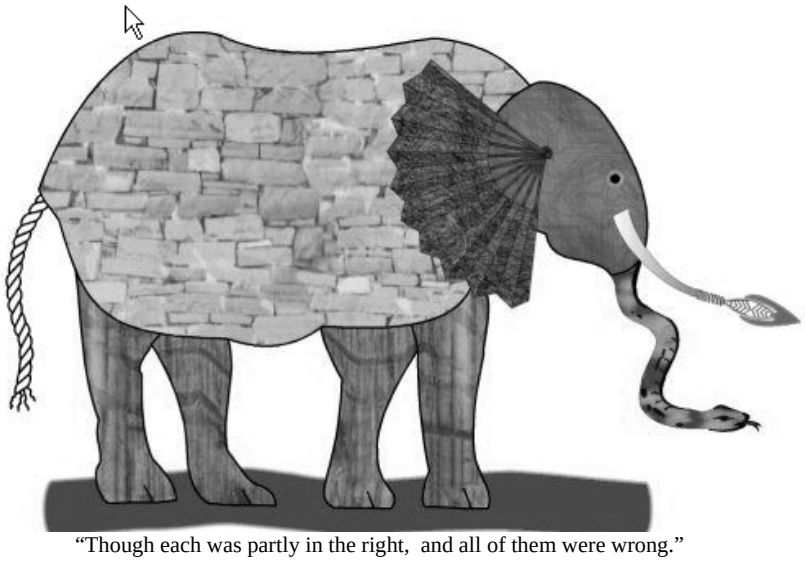



Experts grow in their expertise by doing lots of post-mortems

From IC Core 3 – Part 1: Expertise

One of the most important benefits of a post-mortem is that it ties with the development of expertise. This slide from lesson 1 shows that this is one of the crucial methods that experts use to develop and maintain their expertise. It has not always been a formal look at an event, but enough so that the cause, effect, and actions are understood, and therefore, can provide feedback about current needs or future actions.

# 1. Value of Post-mortems:
## b. include any perspectives



"Though each was partly in the right, and all of them were wrong."
John Godfrey Saxe's (1816-1887) version of the legend

A good post-mortem will include many perspectives. In the old legend depicted here, each person had a hold of a different part of the elephant, and each then described an elephant based on the part they had in their hand. "An elephant is like a rope", said the guy holding the tail. "An elephant is like a snake", said the guy with the trunk. In reality, the elephant was like none of these individually, but all of these collectively. Your perspective of what happened in an event may be totally different than that of the gal working the other desk. Together, your perspectives give a more complete picture of what really happened.

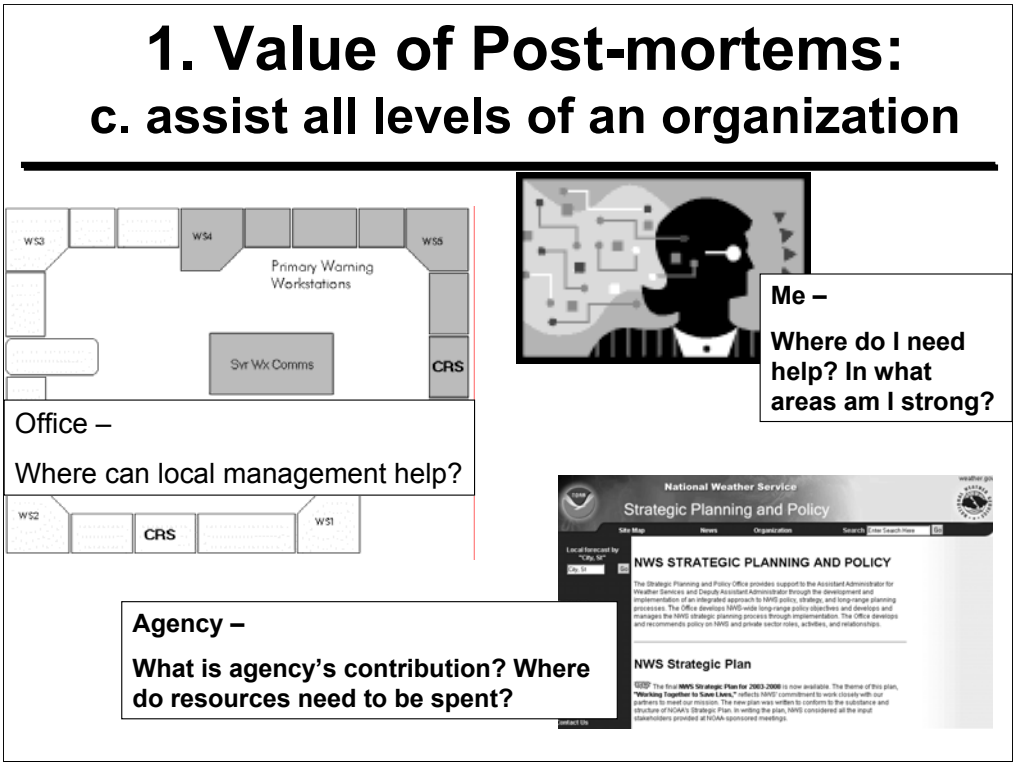
# Traditional post-mortems have not been multi-disciplinary

***"Given an identical problem, an engineer will find an engineering solution, a programmer will find a programming solution, and a sociologist will find a societal solution. A best solution will often involve all three."***

***Dr. Dennis Mileti***

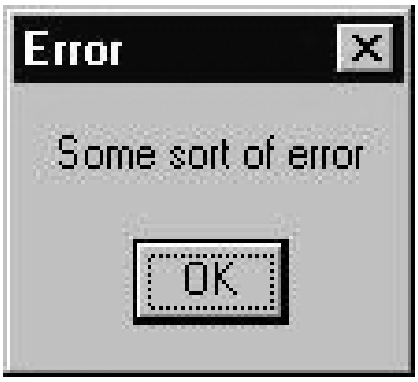
***Director, Natural Hazards Research and Applications Center***

Unfortunately, traditional post-mortems have usually only included the perspective of one domain, which results in a solution originating in that domain. A post-mortem which involves research, operations, and something representing the users will take more effort but may be the key to solving outstanding issues. This quote from Dr. Mileti represents a desire to expand the problem solvers.




A post-mortem can offer insight for any level of an organization. For the individual, he or she can see in what areas they are strong and in what areas they need help, whether it be practice with a new software tool, additional understanding in the science, or a better comprehension of how the operational strategies employed by the office are meant to be. Local management can see what is working and what is actually impinging on forecasters ability to do the job, including office policies (official and unofficial), roles and responsibilities or way in which workload is distributed. The agency can see if the same issues are occurring at several sites and look at policies and procedures which are contributing to these issues.

# 1. Value of Post-mortems:
## d. Help pinpoint what's wrong…




There is nothing worse than having a negative experience and then going on to the next event without knowing why it was so negative. If you can't figure out what went wrong, how will you be able do learn and perhaps prevent it in the future? "Tornado struck without warning" is not enough information, just like "some sort of error" is not enough information.

## 1. Value of Post-mortems:
## …and leave alone what's right.

**Implementing a fix without understanding the problem**

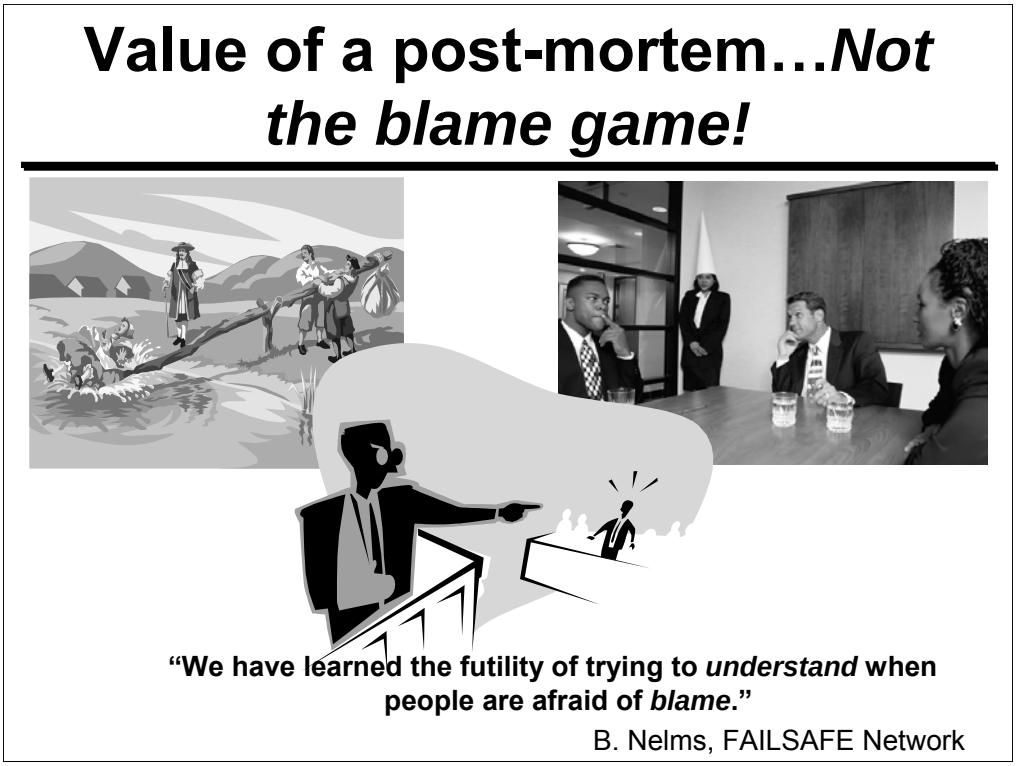
**Problem: FAA records showed runway incursions on the increase.**

**Solution: Paint wider stripes at intersections so pilots can see them.**

**Results: Runway incursions continued to increase.**

**Upon further review: Turns out most incursions were *not* caused by pilots failing to see intersection lines.**

A consequence of not understanding the problem is an increased likelihood of repeating it. A consequence of misunderstanding the problem can be implementing solutions which are irrelevant. In this case, an increasing number of runway incursions was attributed to pilots not being able to see the markings on the runway. So the solution was to paint wider markings. When the mishaps continued to occur, a second and more thorough look found out that runway markings weren't the issue at all. Implementing a solution before understanding the problem in this case was a waste of time and money, and more importantly, didn't help prevent future mishaps.




One of the BIG obstacles to doing post-mortems is the perception that the effort is designed to place blame. If that is true, then most of those involved will expend their energies to ensure the amount of blame they take on is minimal. And who could "blame" them? Research has shown, and your experience probably tells you, that once people suspect the process is all about punishing the "guilty", then the process is hosed. Part of that may stem from historic efforts which only look at cases where the outcome was bad. It's a compelling reason to look at all cases. Another problem has been in the failure to recognize that there are numerous contributors to outcomes, good and bad, at all levels. To affect real change, we must consider all levels, and consider how the entire process came together during the event.

# 2. What makes post-mortems ineffective?

- Categorical thinking
  - *Deciding on the cause before investigating*

"The history of the field is littered with brilliant scholars who completely missed the boat because of the power of their preconceptions."

**Mark Davis, *Into the Fray* (PBS)**

Apollo Root Cause Analysis, 2002

When we go into an event with a strong perception as to the cause, it can result in missing important information. Sort of like when you decide that tornadoes aren't going to happen today and you therefore never check for velocity couplets. It's like having blinders on. The more open minded you can be when reviewing an event, the more likely you are to discover things you hadn't anticipated. As Mr. Davis says, the power of one's preconceptions can cause us to totally miss the boat.

# 2. What makes post-mortems ineffective

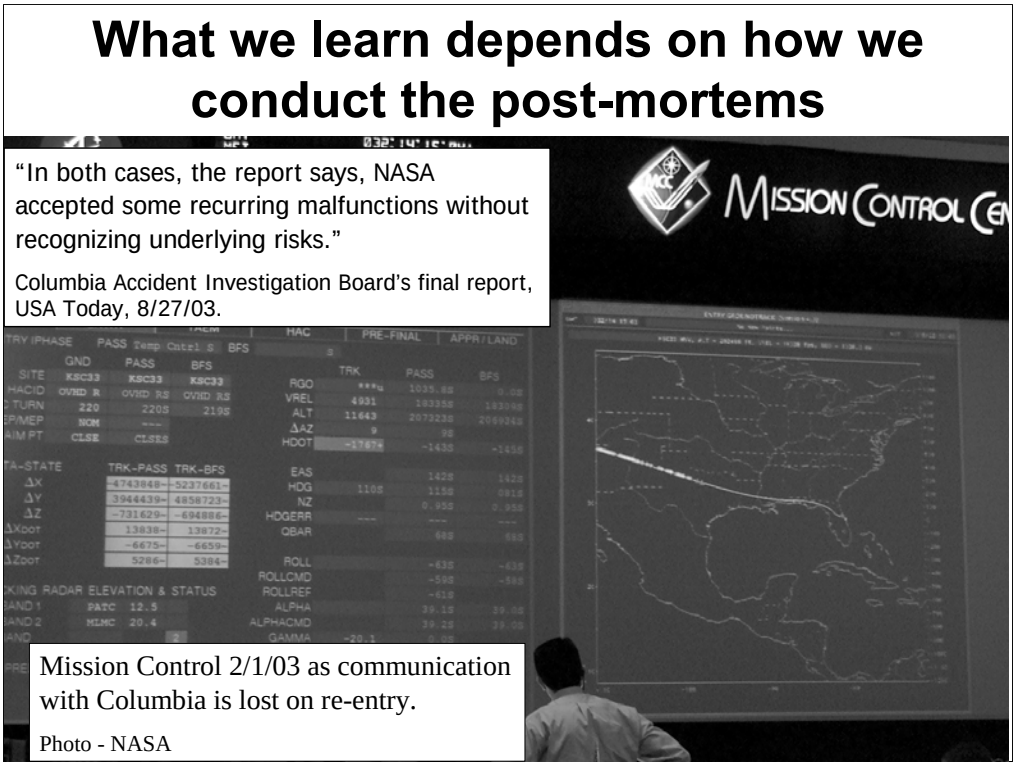
- Causal relationships are unknown
  - Fact finding can omit conditional causes
    - *includes who,what, and when but not <u>why</u>*
- Solution oriented
  - "Favorite solution" mindset
    - *More important to work in "preferred" solution than to understand the cause*

"The leaders had a preferred solution and engaged in behaviors designed to promote it rather than critically appraise alternatives."

Moorhead, et al., **Group decision fiascoes continue: Space shuttle Challenger and a revised groupthink framework**. *Human Relations,*44

Apollo Root Cause Analysis, 2002

It's important to not just get facts but get "stories". Some of the most important information can be gleaned when people recount events. One of the things that gets left out with just the facts is how pieces of information fit together…their causal relationships. Finally, the one who goes into an event with a "favored solution" in mind will no doubt find what they are looking for…somehow. There can be all kinds of reasons for this approach, most of which are left for your imagination, but the end result can be that real and meaningful cause and effect are left out, and therefore not addressed in the solution. The article from Moorhead et al in *Human Relations* points to the dangers.




The bottom line is that what you get out of a post-mortem depends on your attitude going in and the process by which you conduct it. In the final report regarding the Columbia Accident, it was noted that with both the Challenger and Columbia, problems were accepted without a full understanding of the risks associated with those problems.

# 3. Challenges in performing post-mortems

a. Measuring success

b. Human error

c. Hindsight bias

d. Outcome bias

*"What you see depends on where you sit."*

Col. Alan Scott (ret) First Air Force, regarding the events as they unfolded on 9/11

So let's look at some of the challenges we face when doing a post-mortem. They involve how we measure success in the first place, how we define and account for human error, and the effect of biases. Col Scott probably said it best when he said, "What you see depends on where you sit." This is certainly the case as an event unfolds (whether 9/11 or a significant weather event), as well as in looking at an event after the fact.

## a. Measuring success

**Which Office Performed Better?**

| | Office A | Office B |
|---|---|---|
| POD | 80 | 70 |
| FAR | 70 | 80 |
| Ave. Lead Time | 10 | 10 |
| Total Fatalities | 2 | 2 |

Let's look at how success may have been measured for these offices. The statistics are fairly close with Office A showing slightly better numbers. Based on these measures of success, which office did a better job? Which office would you rather be? If in trying to answer these questions, you have more questions of your own, then you probably feel that there is more that should be included in this assessment.

# To learn, you must go deeper

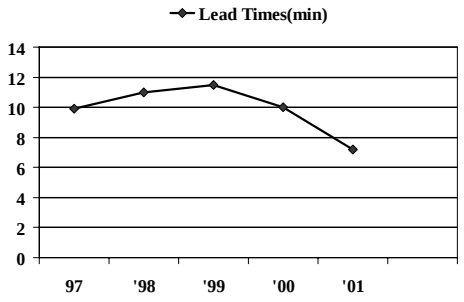
| | Office A | Office B |
|---|---|---|
| POD | 80 | 70 |
| FAR | 70 | 80 |
| Ave. Lead Time | 10 | 10 |
| Total Fatalities | 2 | 2 |

In the eyes of the customer….Office B was a hero. Office A got nothing but grief. Why?

There was more to the story than just these statistics (there usually is).

And you are right. These numbers tell some of the story but not the whole story. Other issues were involved. What are some of the questions you'd like to have answered?

# What doesn't this graph tell us about individual events?



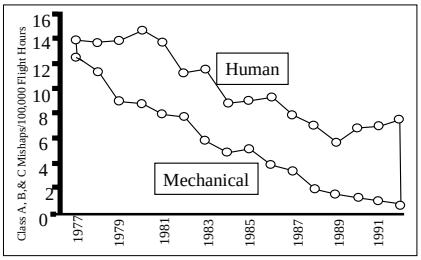

- What was F-scale of each?
- What was time of day?
- What was range of each?
  - How did radar(s) sample?
  - How well did other sensors sample?
- How well was event anticipated?
  - Were there environmental clues?
- How well did staff work together?
- What was experience level of staff?
- What was maximum expected lead time in "best case scenario"?
- ... the
- ...y?
- What was public response?

If we can't answer these questions, how do we know what to leave alone and what to fix?

Here are just some of the details which might be useful when trying to decide what performance was really like. Answering these questions may help us know if the event was handled well or if there is room for improvement, and if so where? These and other questions you and your co-workers might have should be included a a routine part of a post-mortem.

# b. The human aspect

- **Human error has been implicated in 60-80% of accidents in aviation and other complex systems.**




- **Accidents attributable to mechanical factors have been greatly reduced, those attributable to human error continue to plague organizations.**

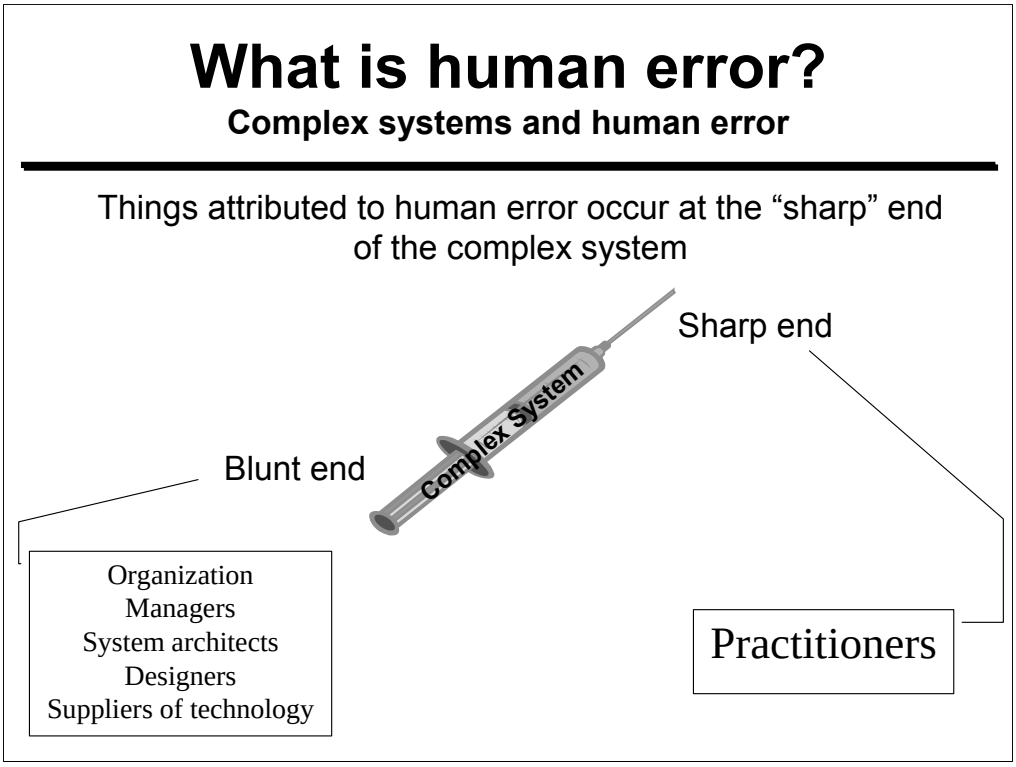
**Shappell & Wiegmann, 2000**

Human error has been implicated in 60-80% of accidents in complex, high technology systems. These systems include aviation, nuclear power, oil, medical, rail, and marine transport industries. Although the overall rate of many industrial and transportation accidents has declined steadily during the past 20 years, reductions in human error-related accidents have not paralleled those related to mechanical/environmental factors. The tendency after seeing this is to think that humans are becoming more and more of the problem.

## Some possible explanations

- Systems induce human error
  - Often don't account for human need to understand the state
- Implementing "fail safe" measures can lead to higher risk behavior
  - Ground proximity warnings systems
  - Stop lights
  - The "unsinkable" Titanic
  - Algorithms/ decision aid tools
    - Easy to forget that the safety net has holes!
- Not getting good feedback on human-system interactions

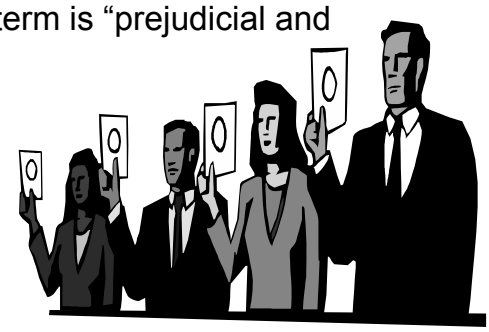
However, it is likely not that simple. As technology continues to expand in scope and coverage, the need to include the human user in the design is not always (often) considered. Technology which does not consider how a human operates, especially an expert, is not going to have good results when fielded. It is also a possibility that the person using the technology will have an overconfidence in its ability to perform a function. This may result from never having seen the technology "fail" (perhaps too few cases), or from not having much expertise in the area (must rely on technology as I don't know any better). Finally, it is likely that we are not getting routine feedback on the human-system interactions. That feedback is not only necessary during design but after implementation.




There are lots of definitions of “human error” all of which seem to point to the action taking place at the “sharp end of the stick”. This is where the practitioner takes everything which has gone into the process up to this point and makes a yes/no, warn/no warn, shoot/don’t shoot etc., decision. While that may be the easiest thing to do, it is extremely simplistic and does not account for all the components present in a complex system.

## What is the danger when using the term “human error”?

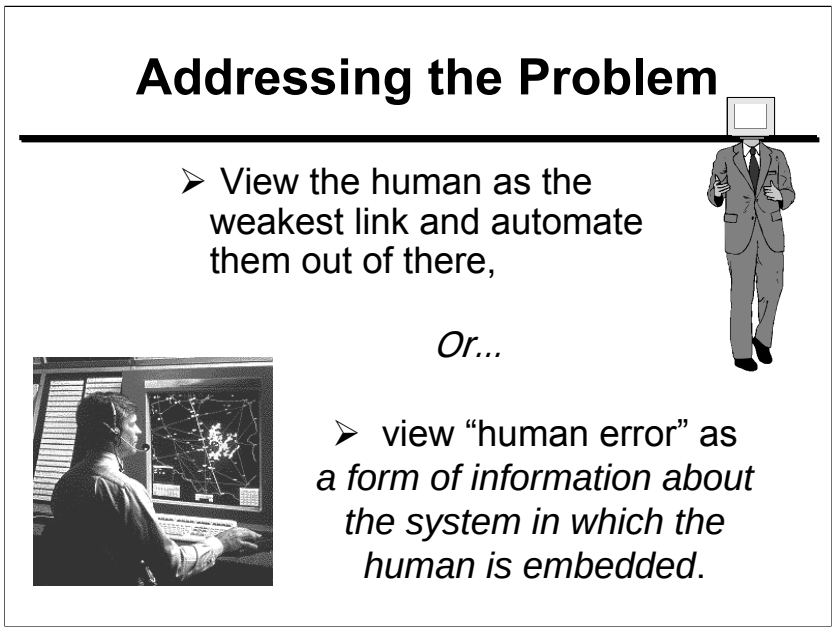
- Attribution of human error after the fact is social judgment, not objective conclusion
- Studies show the use of the term is “prejudicial and unspecific”
- Holds back, rather than advances, understanding of how complex systems fail



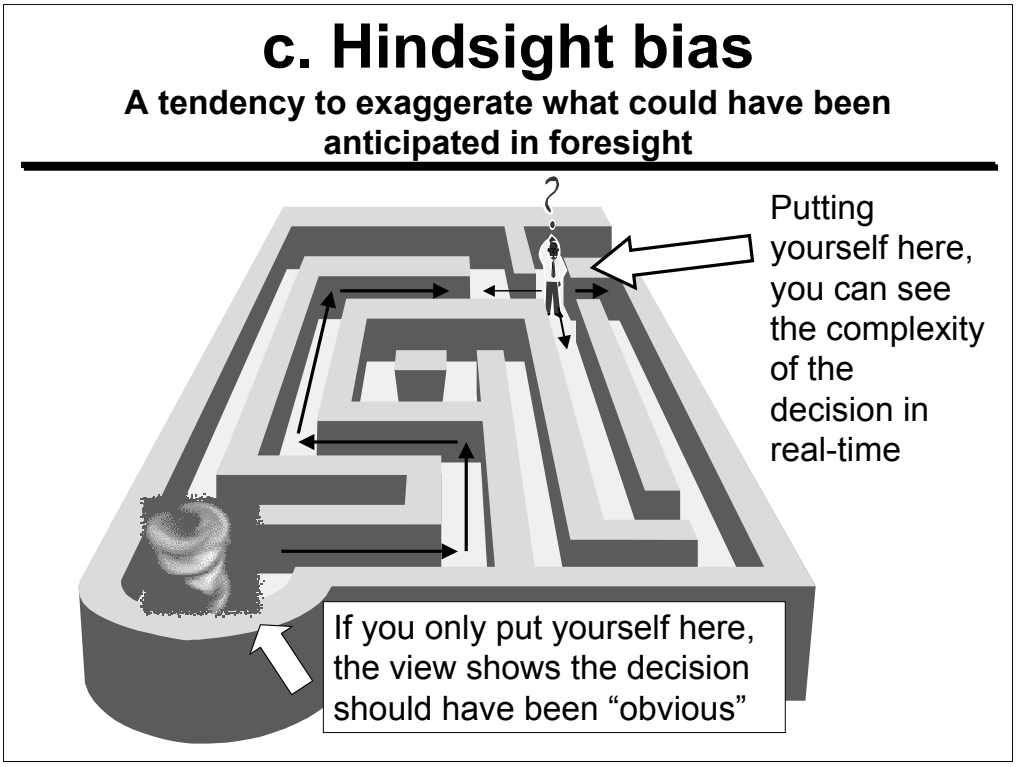
(upon hearing that a twin engine plane had crashed into the World Trade Center), “The President’s reaction was that the incident must have been caused by pilot error.”

9/11 Commission Report Staff Statement #17

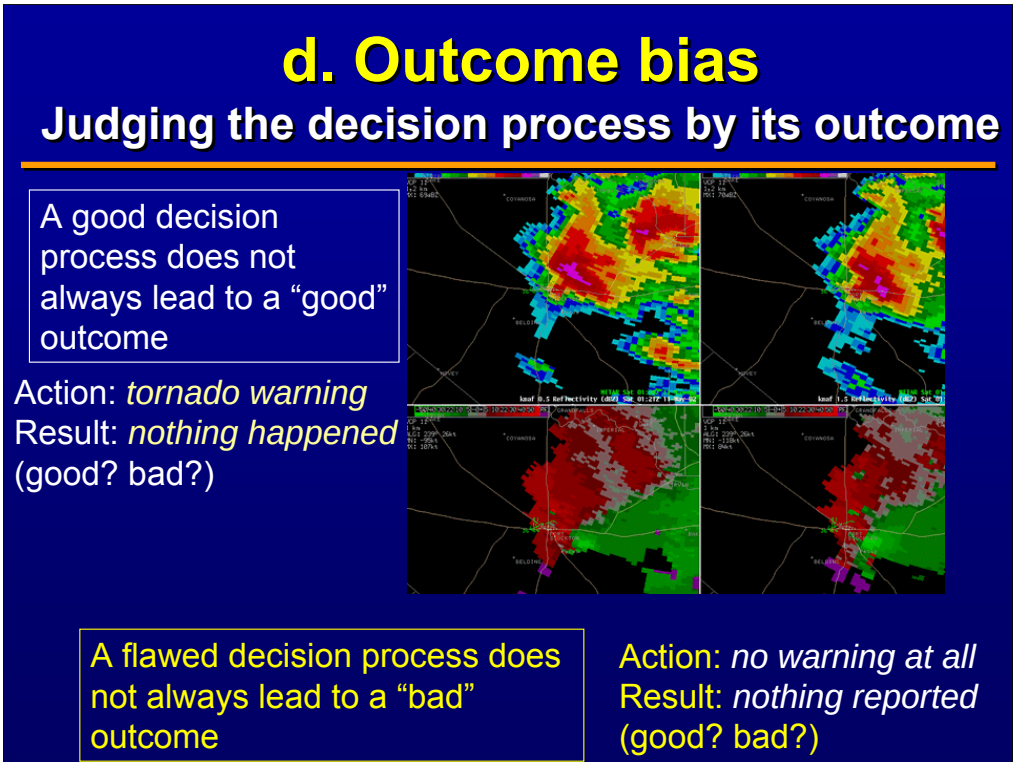
Far from being a compelling diagnosis, citing human error has often been used to direct blame. In reality, it is not an objective assessment and may actually keep an investigation from going any further. A “Heads will roll!” mentality. There is something in assigning “human error” which implies that nothing is really wrong, except the person making the decision.




So to address the problem one can take a couple of stances. Decide the human is really the problem and ramp up the automation to replace them. This might have one set of implications when the task is wrapping bon-bons in candy wrappers, but an entirely different implication when the human in the loop is there to add expertise and employ critical thinking. Another solution might be to look at the way the human and automation interact and view "errors" as a form of information about that interaction.




What are some other dangers when doing post-mortems? Have you ever seen a bad outcome and wonder "just what was the guy thinking?" or thought "Anybody should have been able to see that!" Well that may be how you feel, and it may even be true, but apparently it didn't happen in this case and the question is "why"? To really understand how we got from a to b, it is important to leave behind what you know happened, and put yourself in the position of the office or decision maker and see what they saw *at that time*. This helps avoid the "hindsight bias" which is a tendency to exaggerate what could have been anticipated in foresight. We see lots of issues regarding this in the 9/11 discussions. Look at the options which were available to the decision maker at the time and see how they got to where they went. That's where the real understanding of the process and the potential solutions lie. If you only set yourself at the end of the event and look backwards, you won't have the same view. The best way to work a maze is by starting at the end and going back to the beginning…there is only one way to go and it is obvious. But that tells you nothing about how it was possible for the events to unfold as they did.




Another bias to be aware of is the "outcome bias". In this instance we tend to judge the process by the outcome. Good outcome…must have been good process. Bad outcome…must have been bad process. Not necessarily. In the first example, a tornado warning was issued and no verification was received. Was it a good or bad decision process based on what you see here? Although verification stats show a check in the FAR column, do you feel the warning justified based. Strong rotation at more than one slice at a location with a pendant and inflow notch are certainly in the tornado potential category. Maybe no one was there to witness it, or maybe it just didn't happen. Knowing the limitations of the science and technology as well a need for adequate lead time, perhaps this was the best decision. In the second example, no warning was issued and nothing was reported. Was it a good or bad decision process based on what you see here? True it went down in the books as a good non-warning decision but that could have been attributable to other things, not to mention one of which was nobody in the vicinity. While you might could argue the tornado potential with this, the substantial TBSS would point to a high certainty of very large hail, whether or not someone was underneath it.

## Getting past the outcome bias

### How about evaluating the process?

A good decision-making process accounts for:

- the current state of the science
- strengths and limitations of the technology
- human factors

Uncertainties in all areas means outcomes will not always be perfect

"Irreducible uncertainty is accompanied by inevitable error which results in unavoidable injustice." Kenneth Hammond

So it is important to do the best we can with what we have and what we understand. Ultimately when assessing the process, you want it to be sound and based in a good understanding of the science and technology with consideration to the context of the event itself including the public you serve. You'd want the action repeatable. The process is in our control, but the outcome is not. Dr. Hammond captures the dilemma when he discusses the effects of irreducible uncertainty. At any moment in time there is some degree of uncertainty and if you are not able to reduce it by adding data or adding understanding, you must make decisions based on the information available at the time, imperfect as it can be.

# Overcoming biases

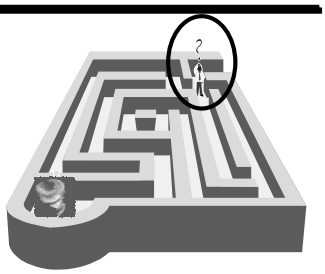
To affect outcomes, evaluate the process

Ask,

"What would you do next time given the same set of circumstances?"

"What would your co-workers do?"

"What would an expert do?"



If the answer is "the same thing", solution probably doesn't lie with the decision process.

If the answer is "something different", investigate the reasoning for alternate courses of action.

One set of questions you might ask of yourself after an event is whether or not you would do the same thing next time? Maybe ask some co-workers or someone you'd consider an expert. If all agree, then you probably have a good process and the issues may have resided in the uncertainties of the data sets or technology we have. Or it could have been a conscious decision to err on the side of caution due to an unacceptable risk you perceived for those in the path. If others might have done something else, look at their reasoning and discuss. Maybe you haven't thought of all aspects, or maybe they haven't thought of yours. Regardless, it's an opportunity to grow in knowledge and advance your critical thinking skills.

## Another way to look at the human factors contributions

### Human Factors Analysis Classification System

HFACS Guiding Principles

1. **In complex productive systems, human errors are inevitable.**
2. **Blaming an error on the decision maker is like blaming a mechanical failure on the hardware.**
3. **An accident, no matter how minor, is a failure of the system.**
4. **Accident investigation and error prevention go hand-in-hand.**

Shappell and Wiegmann 2000

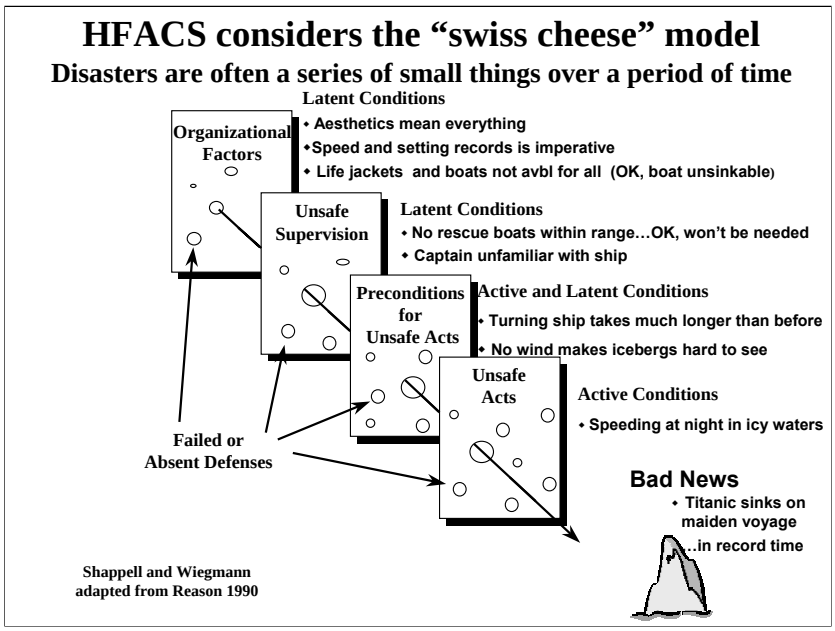
The aviation industry is looking at better ways to capture the "human factors" aspects of incidents. They've developed system called HFACS. This system assumes the following principles regarding all complex productive systems, many of which we've eluded to here today:

**1)** *Human errors are inevitable within productive systems.* To err is human, and therefore we should strive to reduce the consequences of human errors rather than preventing them.

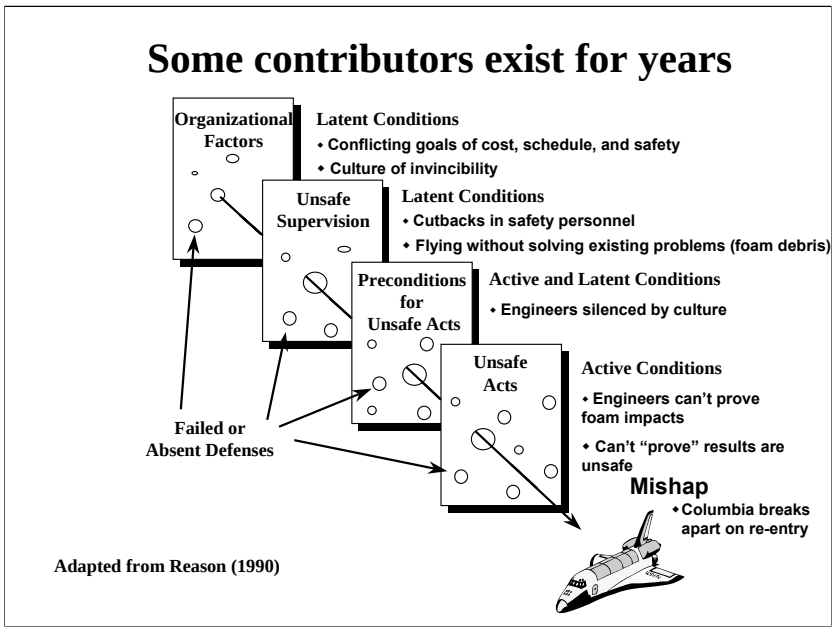
**2)** *Blaming an error on the decision maker is like blaming a mechanical failure on the hardware.* Decision makers often serve as the last barrier that stops a sequence of events from causing an accident. When errors do occur, they are often only a symptom of the system's underlying problem.

**3)** *An accident, no matter how minor, is a failure of the system.* Systemic problems are often the cause of errors and we must search the system to determine "why" the errors occurred. We need to look at the entire sequence of events and the multiple factors that contributed to the accident.

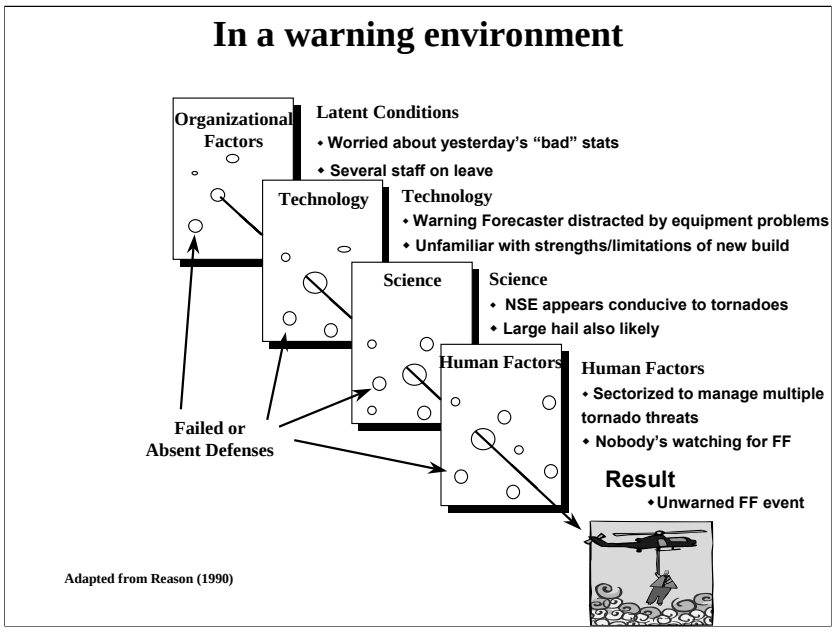
**4)** *Accident investigation and error prevention go hand-in-hand.* Searching for "why" an error occurred is not to reassign blame or liability, nor even to excuse the error, but to identify the underlying system deficiencies that might cause an accident to occur again. Prevention, not punishment, should be our goal.




HFACS incorporates Reason's (1990) so called "swiss cheese" model of how contributors from numerous sources contribute to the breakdown of a system. In this model, system failures are classified as either active or latent conditions. What is important to note is that many of the "latent holes" are present all the time. It's only when they line up with "active holes" that a problem occurs. In this case, the latent errors may not have been thought of as errors at all, since no harm had come from them. In fact none of these things by themselves seems to be the "thing" that happened. In order to alter the course of this event, someone would have had to put the pieces together ahead of time, or even more challenging, during the event itself and take steps to "plug up" the holes.



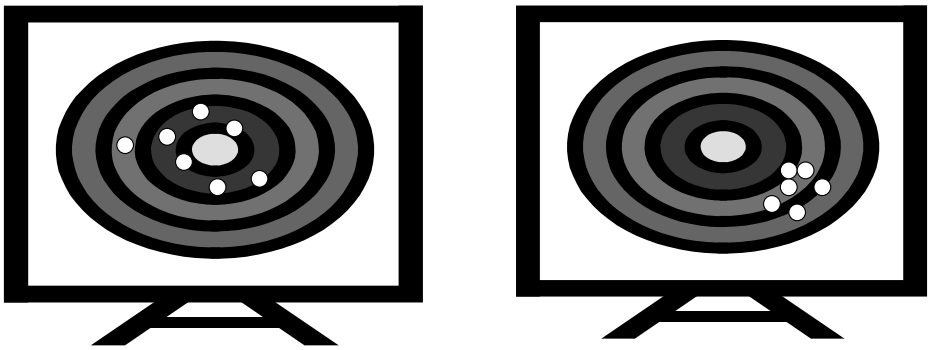

Another example can be gleaned from the final report on the Columbia mishap. Numerous latent conditions, many still in place after the Challenger investigation, were cited as contributors.




How about in warning operations? There may be organizational issues in place either nationally or locally every day which are not in and of themselves bad. However when put with other contributors can facilitate a bad outcome. In this example, the "slices of swiss cheese" are organizational factors, technology, science, and human factors with the "holes" in each representing factors or in some cases contributors to the outcome.

# 4. A post-mortem database

## A database can tell us several things



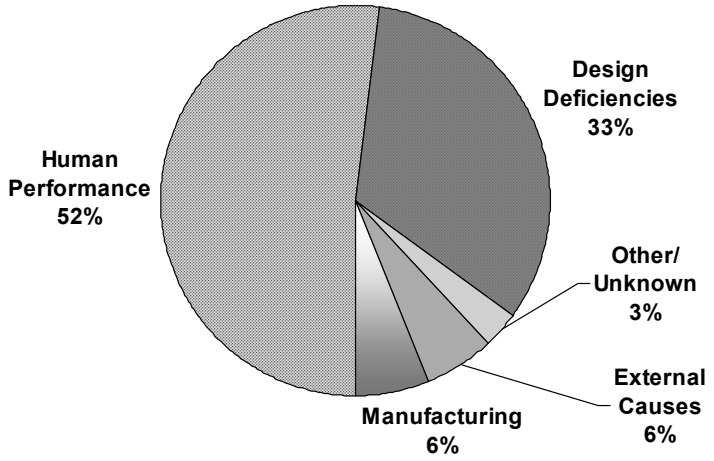
- When we miss the target, is the reason varied, or are we continually missing in the same direction?
- Identify trends
- Find relationships

Reason 1990

Next we want to look at another motivation for doing post-mortems which is producing a database. When we no longer have just a few in depth assessments, but rather a large population of events, much can be revealed. We can see if most contributors to bad outcomes all fall in the same area, or if they vary by office or region or time of year. We can compare meaningful statistics over time to see if more or less outcomes are being affected by technology-based contributors, or if workload for instance, is becoming more and more of a factor. We can answer those questions about sampling issues or time of day and see if there is a relationship between these occurrences and our ability to get lead time.

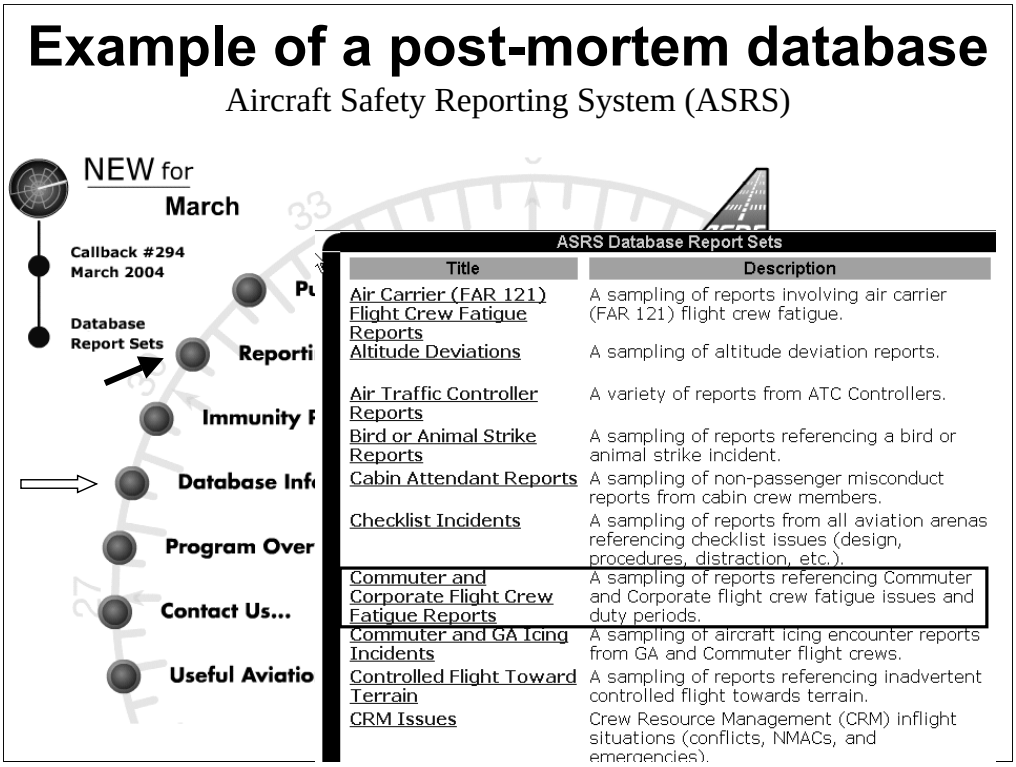
# Insight from a post-mortem database

Analysis of 87 significant events (182 identified root causes) reported to Institute of Nuclear Power Plant Operations in 1983.




Reason 1990

Here is an example of a database of Nuclear Power Plant operations in 1983. By having a database, it was readily apparent what categories were showing up in what numbers. Human performance (and hopefully we now have a better understanding what we mean by that) was the leading category. Design deficiencies followed that. This can be helpful (after digging a little deeper of course) when trying to adjust problem solving resources.




Another example of the use and construction of a database can be seen in the Aircraft Safety Reporting System (ASRS). This came about when it was felt that valuable information and critical lessons were being lost because flight crews had no avenue to express concerns (below the NTSB investigation level) without fear of retribution. This website is used for flight crews who want to anonymously report safety issues which occur during the course of a flight. None of these would be under the guise of a full-blown NTSB investigation, but most have resulted in a near miss of some disaster. The information flow via this vehicle is two-way. The arrows indicate both where a report can be generated, and where database information can be extracted. In this example we see a list of categories under which the issues reported fall into. In particular we will look at the “Commuter and Corporate Flight Crew Fatigue Report”, or incidents in which fatigue played a part.

# ASRS Sample Entry

ACN: 540959

- **Time**
  Date : 200203
  Day : Fri
  Local Time Of Day : 1801 To 2400
  **Place**
  Locale Reference.Airport : TYS.Airport
  State Reference : TN
  **Environment**
  Flight Conditions : VMC
  **Aircraft / 1**
  Operator.Common Carrier : Air Carrier
  Make Model : DC-8 70
  Mission : Freight
  **Aircraft / 2**
  Controlling Facilities.Tower : TYS.Tower
  Make Model : DC-9 Undifferentiated or Other Model
  **Person / 1**
  Function.Flight Crew : First Officer
  Experience.Flight Time.Total : 6600
  Experience.Flight Time.Last 90 Days : 75
  Experience.Flight Time.Type : 2000
  ASRS Report : 540959
  **Person / 2**
  Function.Oversight : PIC
  Function.Flight Crew : Captain
  **Person / 3**
  Function.Flight Crew : Second Officer
  **Person / 4**
  Function.Oversight : PIC
  Function.Flight Crew : Captain
  **Person / 5**
  Function.Controller : Ground
  **Events**
  Anomaly.Non Adherence : Clearance
  Anomaly.Non Adherence : Company Policies
  Anomaly.Non Adherence : FAR

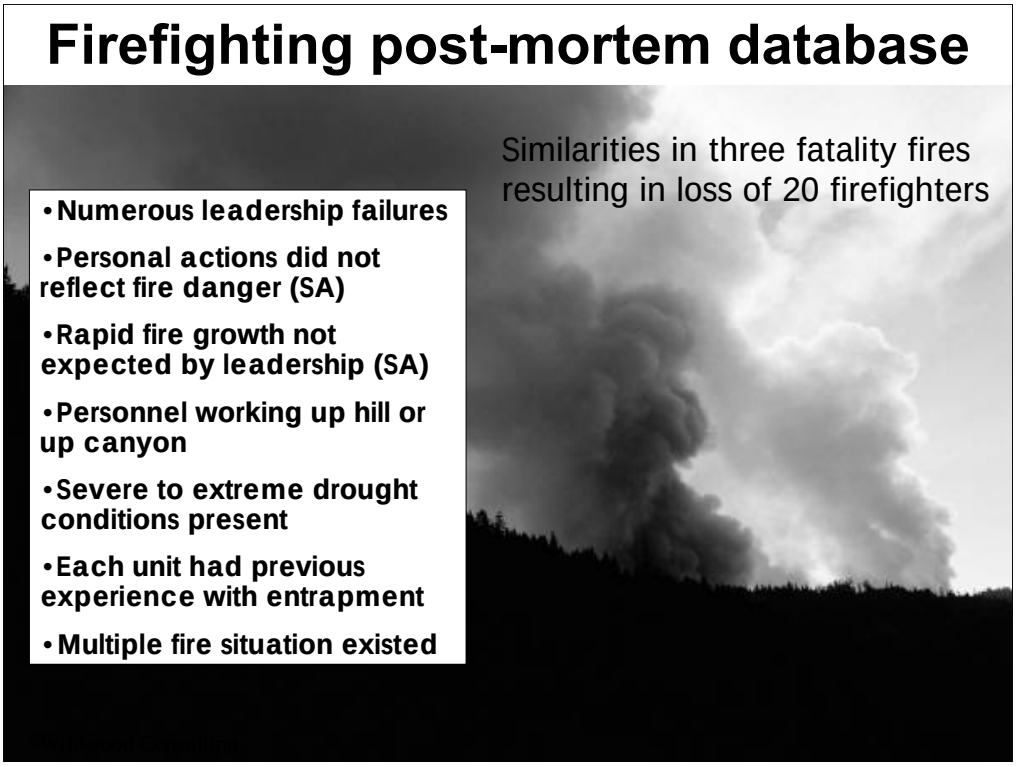
Narrative :

" WE WERE GIVEN A VISUAL APCH TO RWY 23R AT TYS…. WE EXPECTED TO GET THE CLRNC TO CROSS AND IN MY MIND I THOUGHT WE WERE CLRED. FATIGUE PLAYED A LARGE ROLE IN THIS INCIDENT… **EVEN THOSE WHO FLY THIS ALL THE TIME** OR BELIEVE THEY ARE USED TO THIS 'BACK-SIDE-OF-THE-CLOCK' SCHEDULE, **ARE NOT IMMUNE TO THE CUMULATIVE EFFECTS OF FATIGUE**. BEING CONDITIONED FOR CERTAIN EVENTS, OR CLRNCS IN THIS CASE, TO OCCUR WAS ALSO A FACTOR. I REMEMBER HEARING ABOUT THIS DURING CRM TRAINING…**THIS IS A CASE OF WHERE FATIGUE COMBINED WITH ACTING UPON AN EXPECTED RESPONSE FROM ATC COULD HAVE RESULTED IN DISASTER."**

Synopsis :

RWY INCURSION IN A CARGO DC8 DURING A NIGHT OP AT TYS, TN.

By selecting on this we see several entries, one of which we have displayed. We see the "just the facts ma'am" type of stuff on the left (all of which has been stripped of pilot/plane identification), and the narrative which accompanied this on the right. You can see why this incident report has fallen into the fatigue category and how big of a near miss this person felt they had. There is a boatload of information in this which if we waited for the actual disaster to occur before studying, we might not have seen before the next time it occurred and did result in disaster. Think of times where you've had near misses, the "right thing for the wrong reason" type of situation and imagine how beneficial it would be to study that type of situation as well.



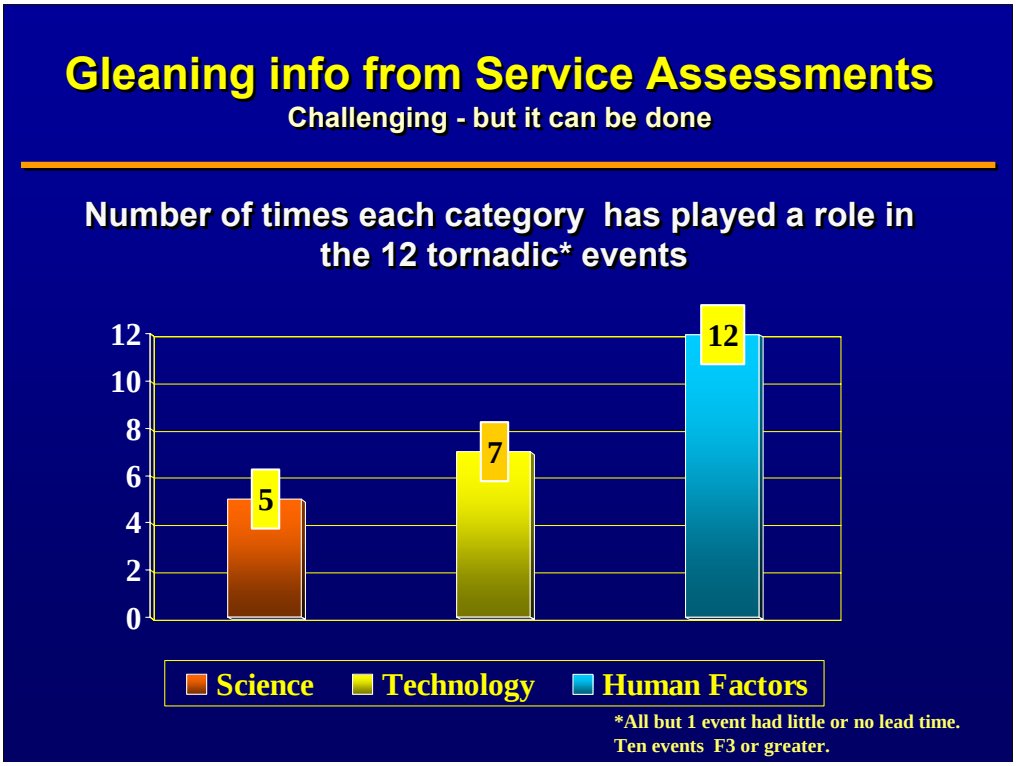

Here is a look at a limited number of wildfires, in particular those which resulted in fatalities amongst firefighters. In this case, we see what all the events had in common. All revealed because a database of incidents were looked at. By the way, your experiences in the warning environment may have something in common with those facing decision makers in the fire fighting world.

Another database, this time the Naval safety Center database. This information must first be illuminated, via a post-mortem type of process, before it can be gathered and used for local and agency purposes. Once again, while many of these entries are domain specific, many could apply to any domain.

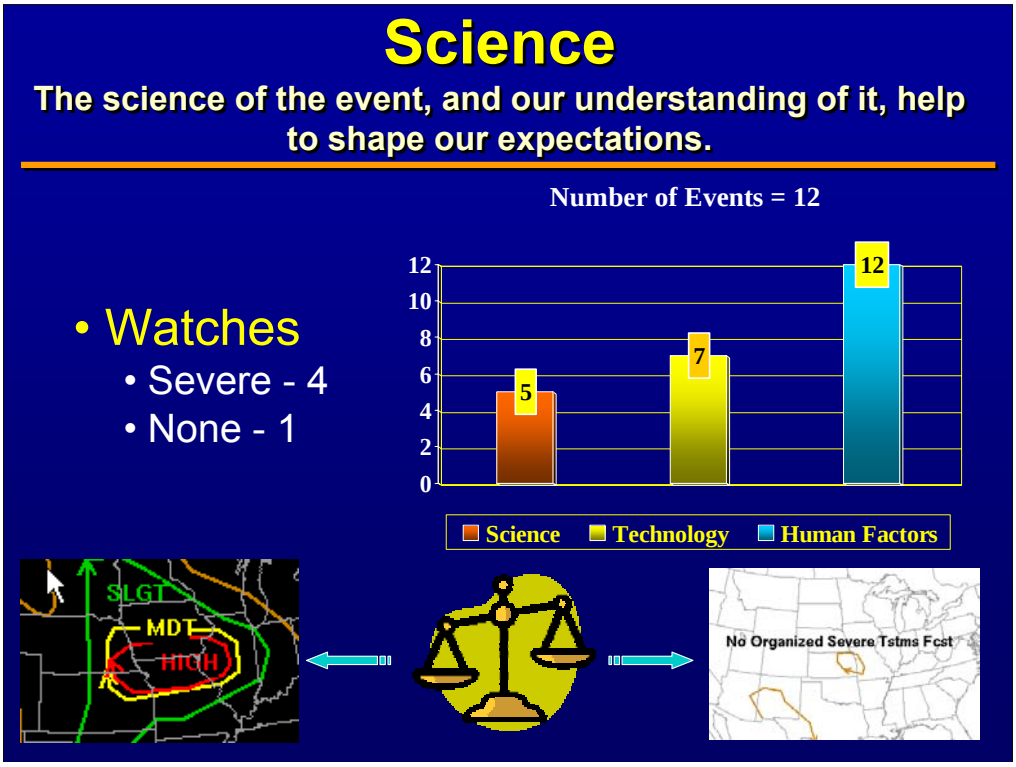
# 5. Methods of performing effective post-mortems

- National
  - Service Assessments
- Regional
  - Sig Ops, For the Record, etc.
- Local
  - Varies
  - Some very detailed, performed regularly
  - Some brief, occasional

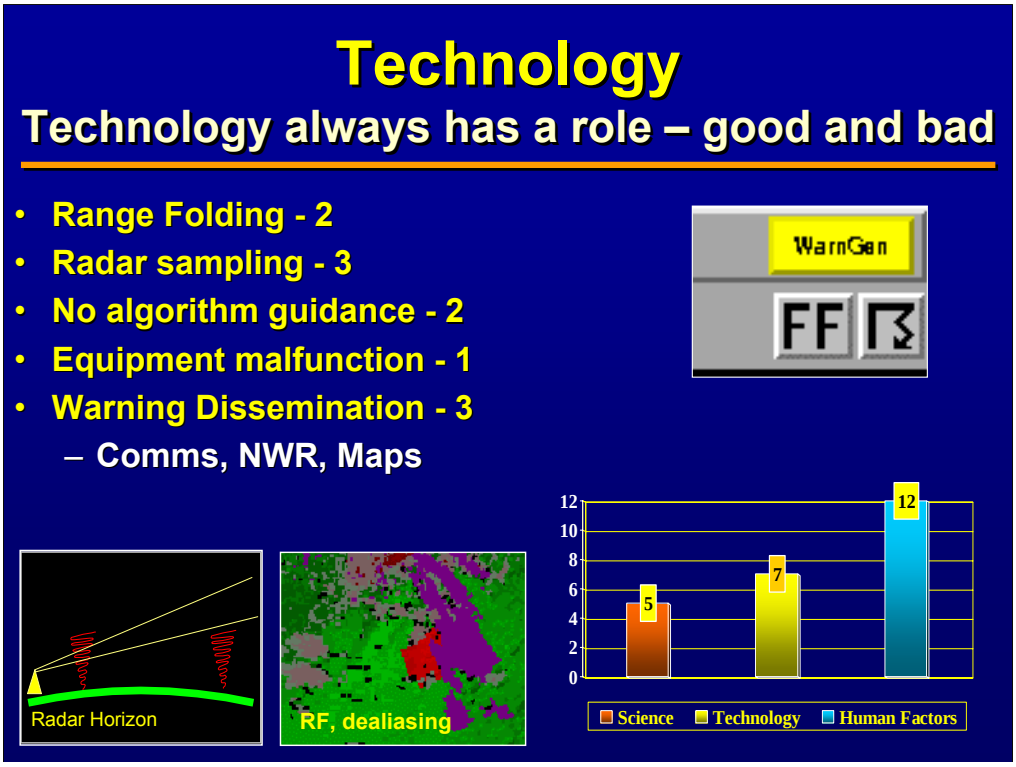
In this last section we'll look at post-mortems which are done in the NWS and suggest some additional possibilities. There currently is a variety of ways in which we examine events, varying considerably by region and by office.



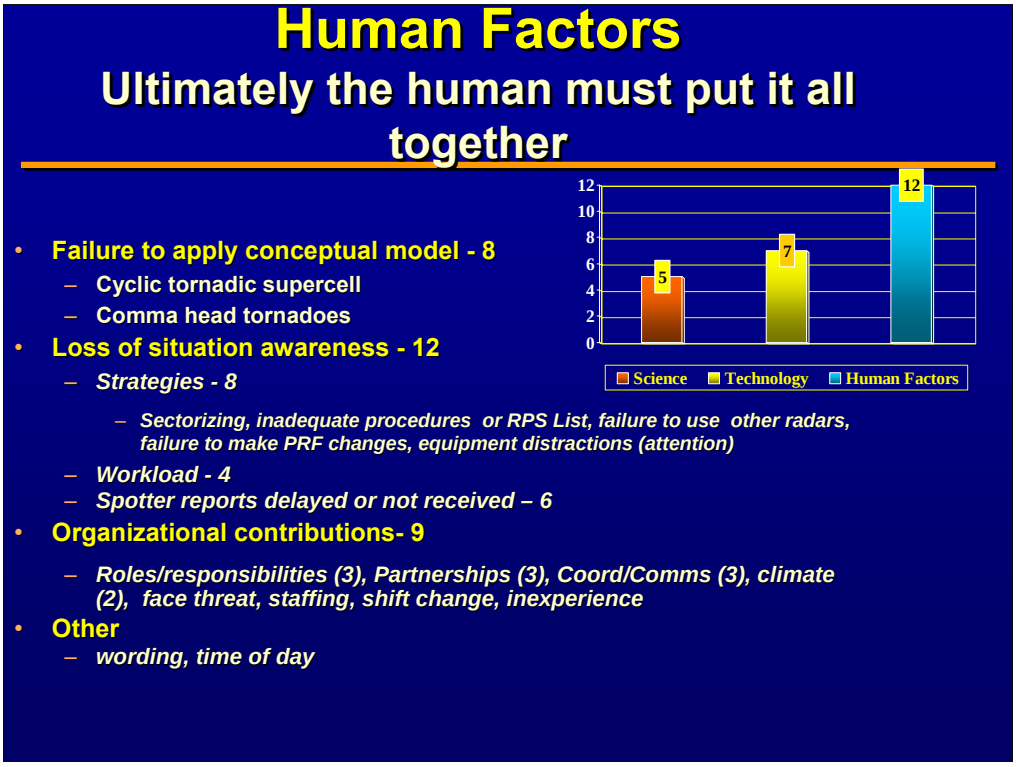

We can sort of glean database type of information from service assessments but it takes some doing. In this example, which many of you have seen before, the categories of contributors were analyzed by doing detailed studies of service assessments or interviews with those involved. From that effort, we see that of the 12 tornadic events studied, 10 of which were F3 or greater, and all but 1 of which had little or no lead time, science limitations played a role in 5, technology in 7, and human factors in all 12.



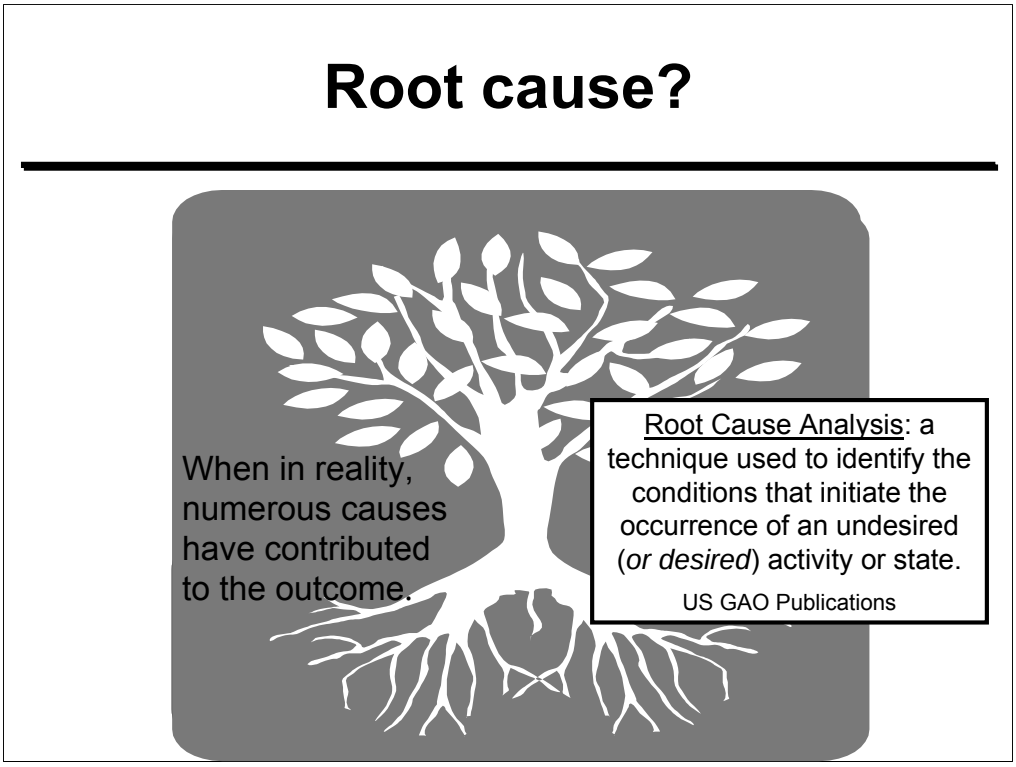

Specifically, the science contribution was reflected in the expectation of the day, with that ranging from no thunder to a high risk.




We glean the impacts of technology limitations. Some of which have work arounds but others which are out of our hands.




Finally, in pouring through the assessments we can see indications of where the human factors come into play. You can see a variety of issues listed here, most all of which contributed to a negative outcome. In some cases we can see casual relationships (loss of SA related to workload), understand why others occurred will take further investigation.




That further investigation might take the form of a root cause analysis. While the term “root cause” implies there’s one thing at the bottom of it all, it really is not the case. In fact, when doing a root cause process, one uncovers numerous “roots” each with numerous “offshoots” which have all contributed to an outcome. While the definition of Root Cause Analysis is wide and varied, depending on where you ask, the one listed here seems to fit our needs.

# What is the value of finding the root causes?

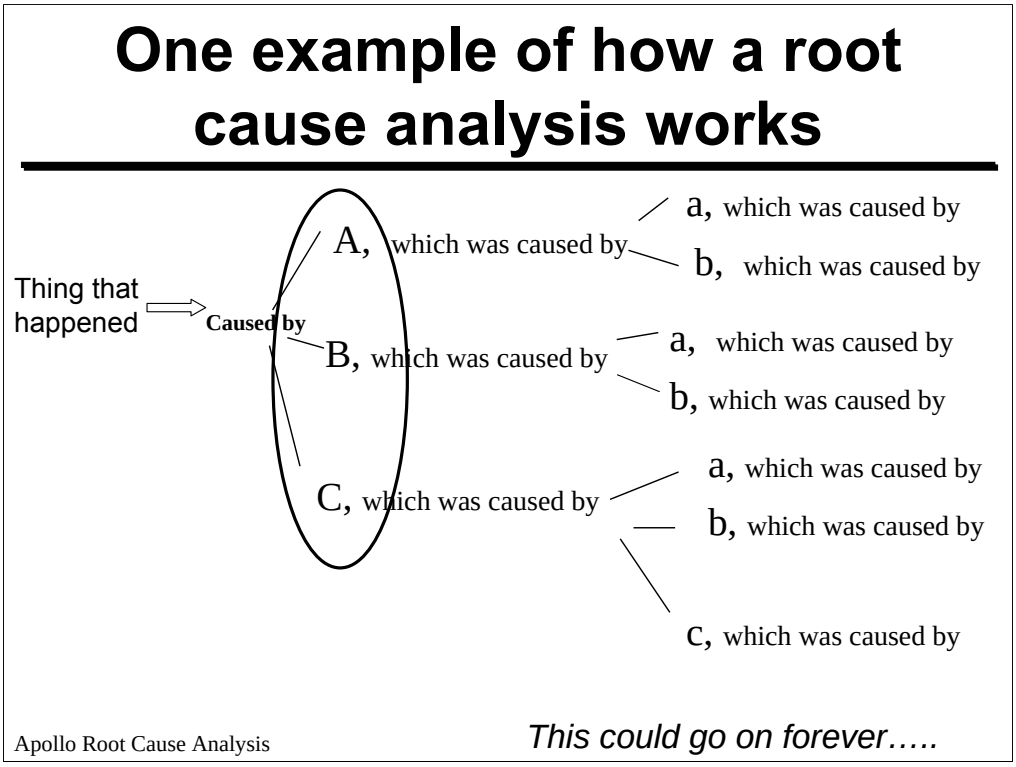
"...most of the root causes of a serious accident in complex technologies are present within the system long before the obvious accident ..."

Reason *Human Error*

**"On 9/11, the existing protocol was unsuited in every respect for what was about to happen."**

**9/11 Commission Staff Statement No. 17**

So why find the root causes? Just as with the "swiss cheese" model of "latent" factors, the root causes of most incidents are present long before the thing happened. From a plane crash in Siberia to the sinking of the Titanic, the root causes are many and varied. One root cause highlighted by the 9/11 commission was the "existing protocol" with dealing with an attack of the type which unfolded. The protocol didn't describe nor account for the type of attack which ultimately occurred. Sort of like not having a conceptual model in place, understood, or accepted before the event occurs.




The ways in which you can do a root cause seem to be numerous. Lots of schools of thought exist on how and when these should come about. There are a host of vendors and sites which offer root cause training. Some require travel, while others can be done on line. If you are interested, some resources which point to further training can be found at the end of this presentation. One example is presented here but this is certainly not the only way, or maybe even the best way to do the process. But it is one we'll use in our simplistic example.

For this analysis, the "thing that happened" (either good or bad) is what you start with. You locate at least 2 contributors to that, listed here as A,B,and C. In this method, A, B, and C must all have occurred together. If you take A away, no problem. If you take C away, no problem. All must have occurred together. Then each of these has a list of contributors, and so on. This process will end when:

1) You get enough information to work solutions
2) You run out of time
3) The "branch" your going down is cost or time prohibitive or out of your control

We'll look at some actual examples shortly.

# Let’s look at one event

**Severe weather outbreak early in the fall season with a considerable number of storms to manage.**

Example 1 Event Summary

Deaths: 3

Injuries: 10

Damage: 400K

Outlook: Slight risk of Svr

Watches: Tornado Watch issued at 1830z

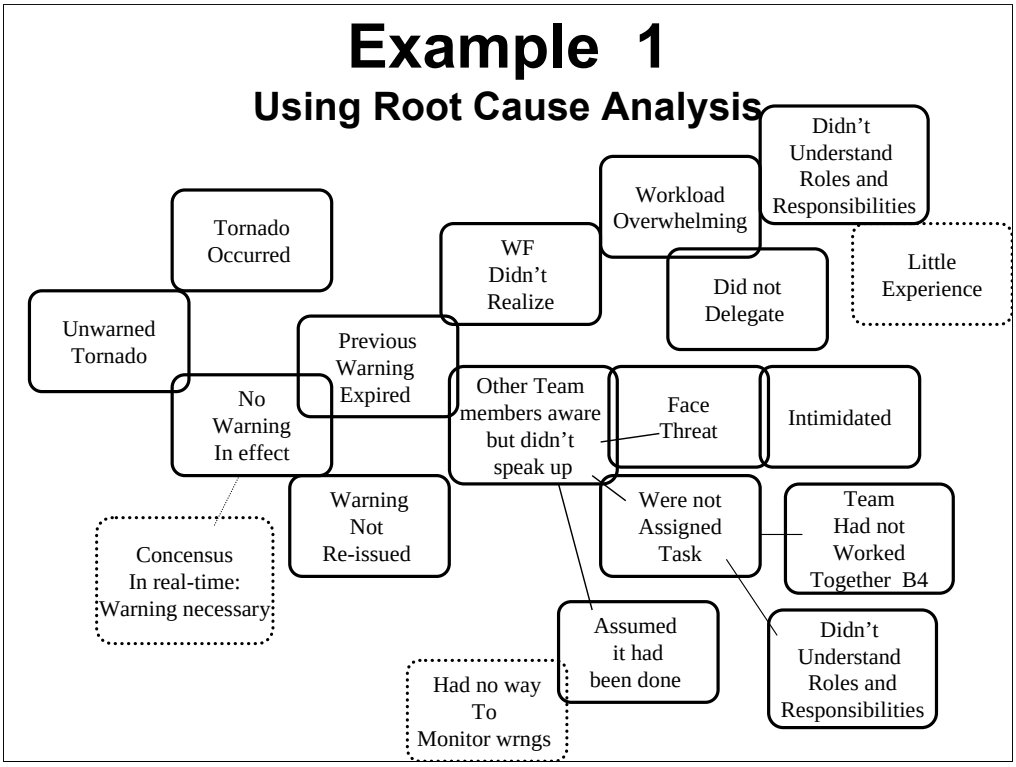
Warnings: 5 tornado, 25 severe, 2 flash flood. Average lead time 8 min. on tornadoes, 15 min. for severe, 45 minutes on flash flood. No lead time for county in which deaths occurred.

Service: Tor warning for storm in upstream county. Warning re-issued when report arrived.

Systems: Functioning properly

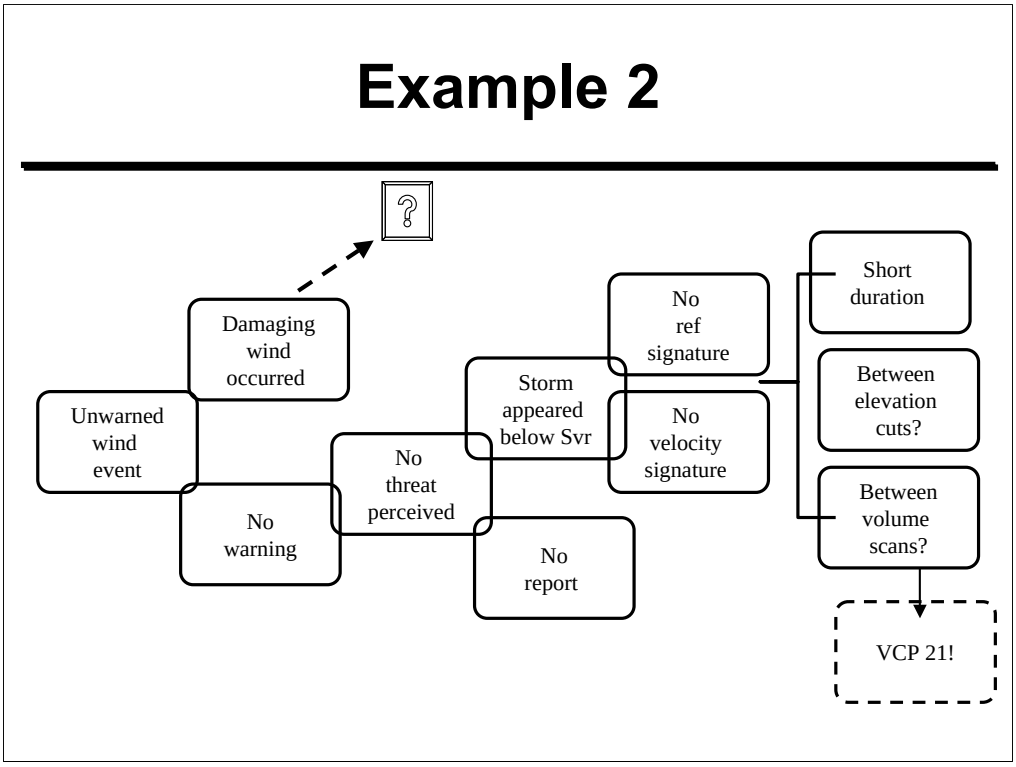
Response: Covered initially by local media. Damage survey team sent.

For comparison’s sake, here’s an event which had a negative outcome. This is how it might look in a write-up which captures the facts of the event. In this case, there was no tornado warning for a county in which deaths occurred. We’ll do a RCA on that particular event.

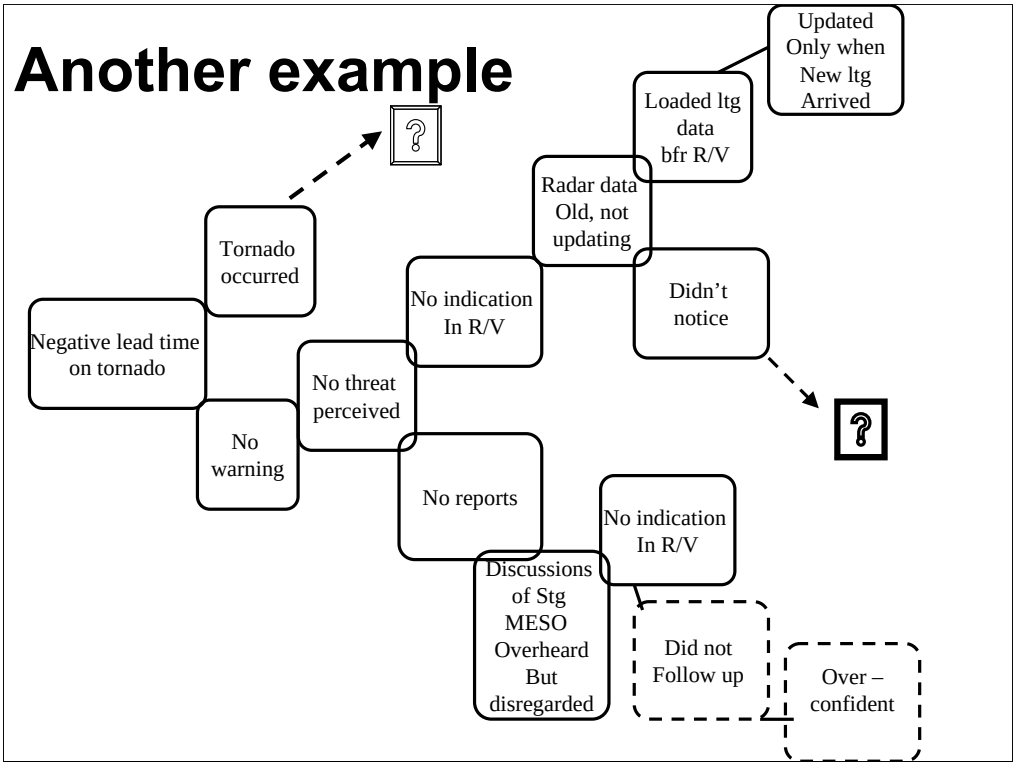



So we start with the "unwarned tornado". The two things which had to occur together for this to be an issue are: Tornado occurred AND no warning in effect. Change either of those and your outcome is different. As some information on the side, we see that there was an expectation by the team in this event that a warning was needed. Hmmm…so why didn't it happen? Of the two causes, "tornado occurred" and "No warning in effect", we will choose to focus on the "no warning in effect branch". If this was a science based focus, we might choose to go down the "tornado occurred" branch and see what clues the science holds (especially useful when there was no expectation of tornado possibility), no doubt leading to some research.

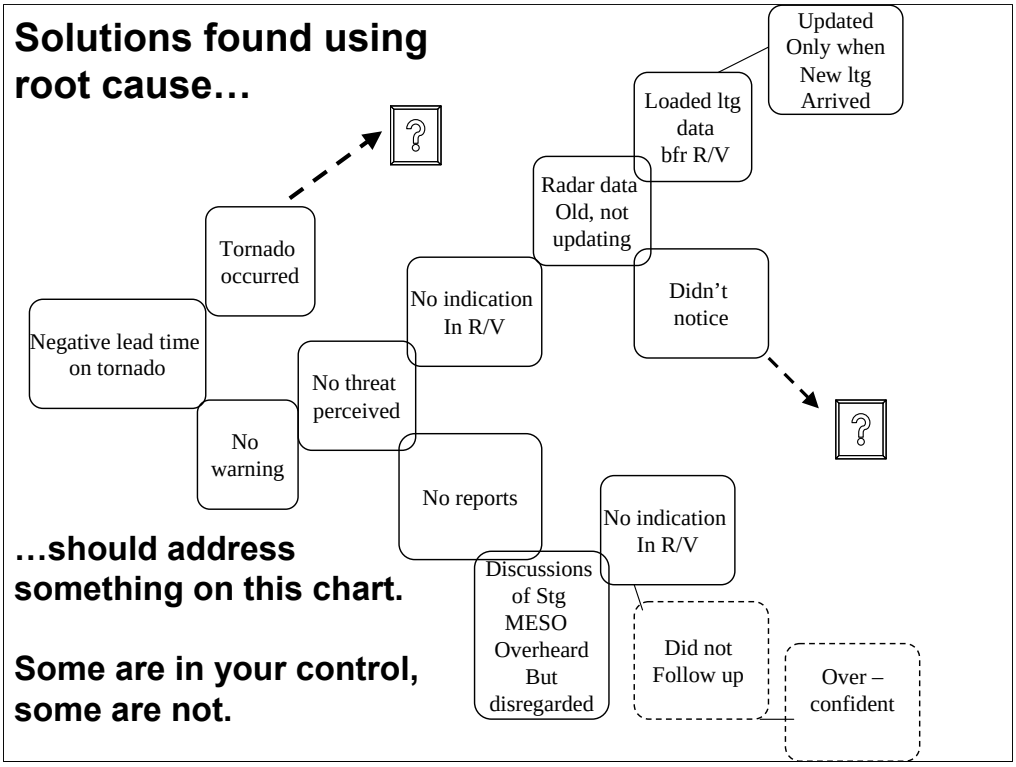
You can see the various contributors to the question as to why no warning was in effect. Included here are inputs from all team members which ultimately point to several factors, some technological, and several involving communication and roles and responsibilities. It is easy to see how this warning fell through the cracks with this in place.




Another example is an unwarned wind event which, unlike the previous example, was an intentional action, that being, no warning. Ultimately the RCA reveals that threats were not apparent in the data, likely because of the short-duration nature of the event coupled with a VCP which is not well suited at sampling such events.




Our final example comes from a trainee who missed an event during a simulation and performed a quick RCA to see what it revealed. Once again, no threat was perceived. The question marks represent avenues one might choose to explore. This person found their problems could be traced to a level of over confidence which kept him from following up inconsistencies with the opinion of others in the room, coupled with a use of the technology which resulted in him making decisions on relatively old data.




The benefit of doing a RCA like this is that solutions fall out of the process. You address the things in the boxes in order to address the outcome. This may point to training, or technology, or process but it will point to something that was relevant for this event.

## When to do an RCA

- May or may not choose to set established “criteria”
- Use when you want to find casual relationships
- Judge impact of event
  - Consider “near misses” as they can provide extremely valuable information
- Consider events which went well
  - May find examples of good processes to model for others, or
  - May find you were making a decision based on the wrong reason (got lucky)

When should you do a root cause analysis? More schools of thought on that, whether it be event driven, or a function of resources, etc. It will take some time. Maybe your office, or you personally, want to develop some guidelines. Generally, use it any time you want to find casual relationships. Not just the facts, but how everything fit together. Pick one warning outcome or decision. Look at events that went well, and also look at “near misses”

## Summary

1. Value of post-mortems
2. What makes post-mortems ineffective
3. Challenges in performing post-mortems
4. Post-mortem database
5. Methods of performing post-mortems
6. Assignment

Hopefully you have a good understanding as to why post-mortems are important. In addition, we've discussed what can make them ineffective and challenges you may face in doing them. Further, we've illustrated the benefits of having a database of post-mortem results. Finally, we've looked at some ways to dig deeper.

## Learning Objectives

1. Identify the potential benefits of a post-mortem analysis
2. Identify characteristics of ineffective post-mortems
3. Identify the value of having a post-mortem database
4. Define what is meant by human error
5. State the impact of the hindsight and outcome biases on performing post-mortems
6. Explain the value and meaning of a root cause analysis

We've restated the objectives here.

## Performance Objectives

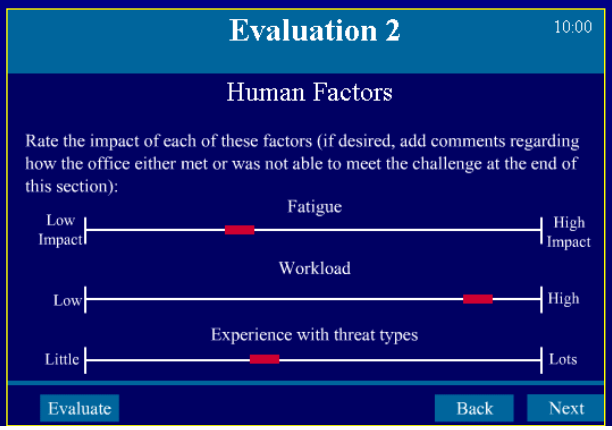
1. Using the template provided, perform a post-mortem on an event you worked
2. Using root cause structure, perform an analysis on one particular warning decision you made

The performance objectives will take the form of exercises which are outlined on the following slides.

# 6. Really Cool Assignments!

1a. Assignment 1: Using on-line template, do a "post-mortem" of some event you worked.

1b. Optional: Share with your SOO or office.




Note: All assignments will be confidential and will not be shared in their individual state.

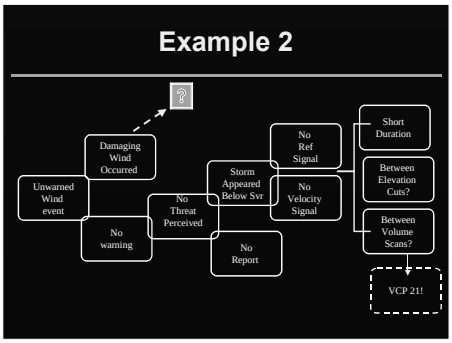
Every NWS office had a representative come to the Warning Decision Making IV workshops. Each contributed and refined the type of information they would want to see in post-mortem. This has been incorporated into a "Template" which you are to use for this exercise. Go to the web site as indicated by your instructor, and fill out the template based on some event you worked. Your event will be submitted to your instructor. You are also welcome to share it with your SOO if you desire. After submitting your case, you'll be able to look at the sum and averages of all those events submitted so far.

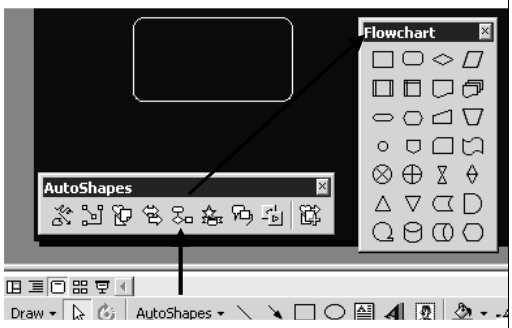
# Assignment 2

2a. Assignment 2: Using root cause, analyze a specific warning decision or outcome in which your were involved.

2b. Optional: Share with your SOO or office.

Note: All assignments will be confidential and will not be shared in their individual state.




In this assignment, you are asked to do a RCA on some warning event or decision. You can do it very simplistically (hook words and lines together by hand), or you can construct one to be like the examples in this presentation. The latter used PowerPoint, selecting the “AutoShapes” feature, and one of the many “Flowchart” shapes. Make one box how you want, copy and past it several times, and then edit the content to say want you want. These are easy to move around on the screen where you want. You can either email to your instructor as a PowerPoint presentation or fax it to him/her.

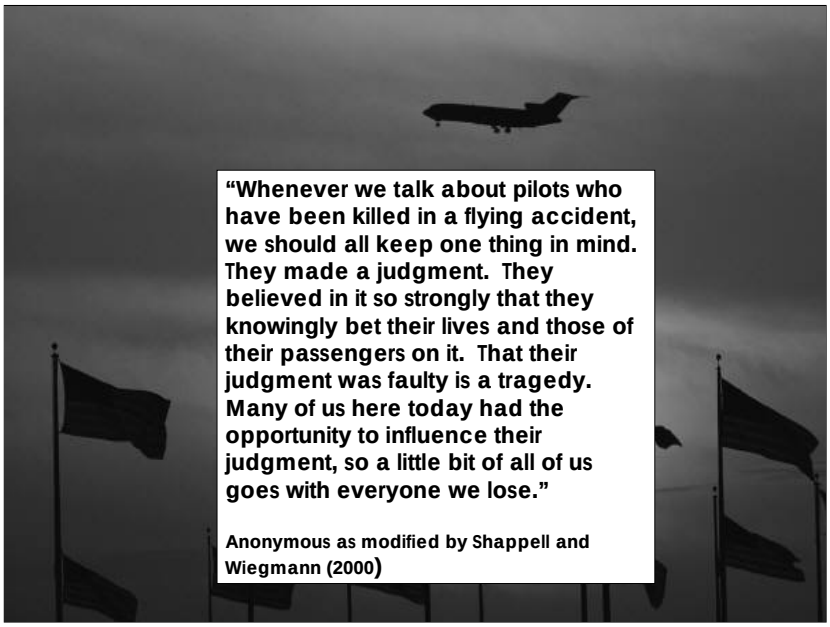
# Assignment 3

3a. Optional: Do either of these based on a simulation using WES.

3b. Really Optional: Share with your SOO or office.

Note: All assignments will be confidential and will not be shared in their individual state.

Assignment 3 suggests you do this with an event you do via simulation.




Finally, when doing post-mortems it's important to keep in mind that most people are doing there best. No one intends to work an event that has a bad outcome. We are all part of the same agency (especially as far as the public sees) and what any office does reflects on me, whether it be a local office or an office at region or headquarters. We are all part of the same team and we can either support each other in that or not. This quote from Shappell and Wiegmann illustrates the belief in an aviation environment.

# Questions?

1. Check with your AWOC facilitator (most often the SOO)

2. Send your questions to iccore3@wdtb.noaa.gov

WDTB Fax:

405-573-3462

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