Expertise and Effective Office Warning Strategies

Advanced Warning Operations Course

IC Core 3

Lesson 1: Expertise

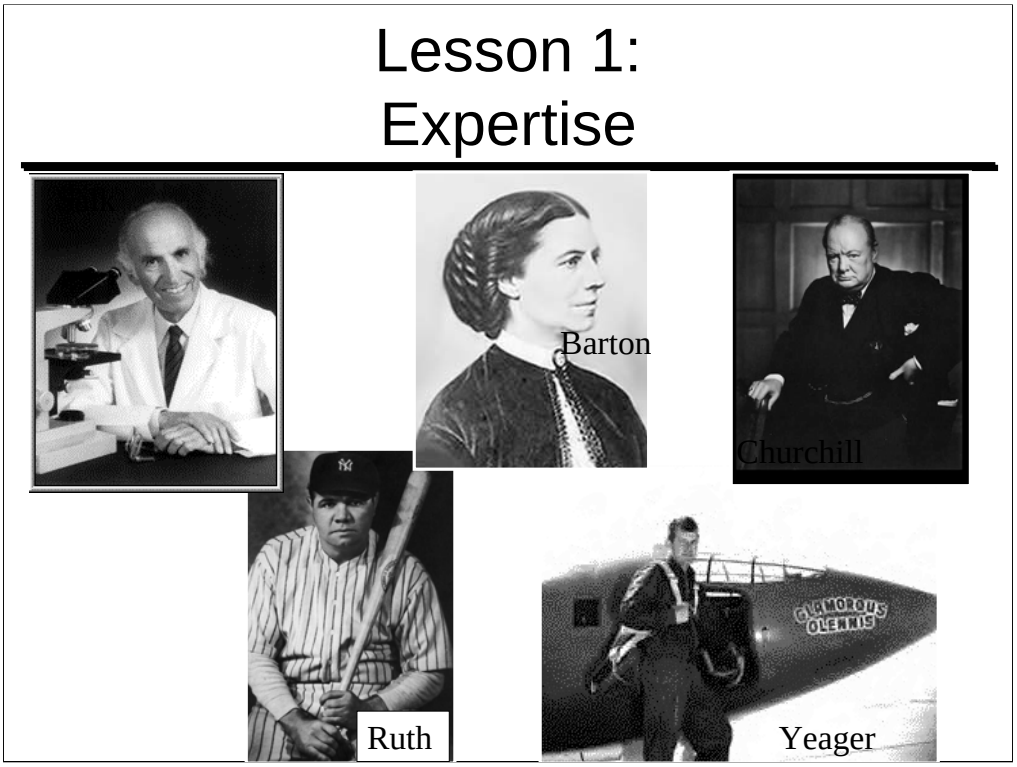
Warning Decision Training Branch

IC Core 3 will begin with a discussion of Expertise. It will be important to understand what we mean by this term in order to appreciate its value throughout the remainder of this IC.

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 lesson will take about 30 minutes to complete. In later lessons we will tie this discussion of expertise into how it looks in the NWS warning environment (Lesson 2), how post-mortems can help us develop expertise (Lesson 3), and some case examples showing where expertise fits in (Lesson 4)



See if you can recognize who these folks are. They all have something in common in that each is associated with a level of expert knowledge or performance in their domain. Whether your area is medicine, baseball, world affairs, pushing the aviation envelope, mitigating human suffering, or issuing warnings, there is a process by which you develop that skill.

Learning Objectives

1. Identify the differences between routine experts, adaptive experts, and novices
2. Identify the characteristics of an adaptive expert
3. Describe how interactions with automation can hinder expertise
4. Identify ways in which expertise is developed

The learning objectives for this lesson are testable. They are: 1) Identify the difference between routine and adaptive experts and novices. 2) Identify the characteristics of an adaptive expert. 3) Describe how interactions with automation can hinder expertise. 4) Identify ways in which expertise is developed.

Expertise
Overview

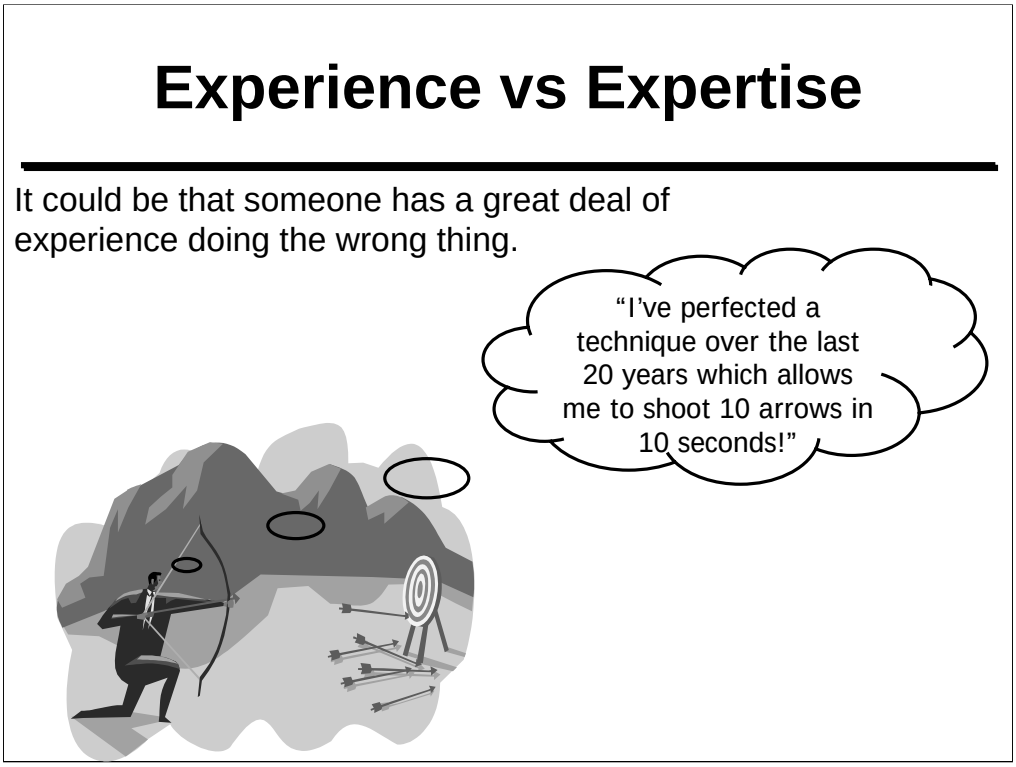
1. What is an expert?
2. What is the value of an expert?
3. What can be the impacts of interactions with automation?
4. What do experts do to acquire and maintain expertise?

During the next 30 minutes, we'll discuss at least some definitions of what constitutes an expert. We'll demonstrate why that expertise is so valuable to an organization. Automation is neither good nor bad. It just is. They way in which it is designed or the way it is applied in operations however can either foster or inhibit the development of expertise. Finally we'll look at what you can do to develop expertise in the area of warning operations. As we go through this talk, think of people you know in your domain, or in other domains with which you interact, and see where you think they fall in these descriptions.

What is an Expert?

- Novice
  - Lives in the moment. Can't recognize complex relationships. Produces limited options.
- Routine Expert
  - Great at everyday stuff, strong procedural knowledge
    - Runs into trouble when problems are ill-structured or novel
- *Adaptive Expert*
  - *Has a deep comprehension of conceptual structure of the problem domain*

We all are novices at many things. I personally am a novice at judging how much air in a tire is too much (since when are tires not suppose to be "round" anymore?). Novices tend to live in the moment. They don't easily make connections and the options they produce for action are limited. Next we have a routine expert. These people are great. They can swoop in and fix what's wrong instantly; they can quote regulations. They only run into trouble when the situation takes on a unique appearance; looks out of the ordinary. Then their very strict processes don't provide unique answers. What we are going to discuss for the remainder of this session is the adaptive expert. Their understanding goes deep. You probably really feel good working a stressful event in the company of this type of expert.

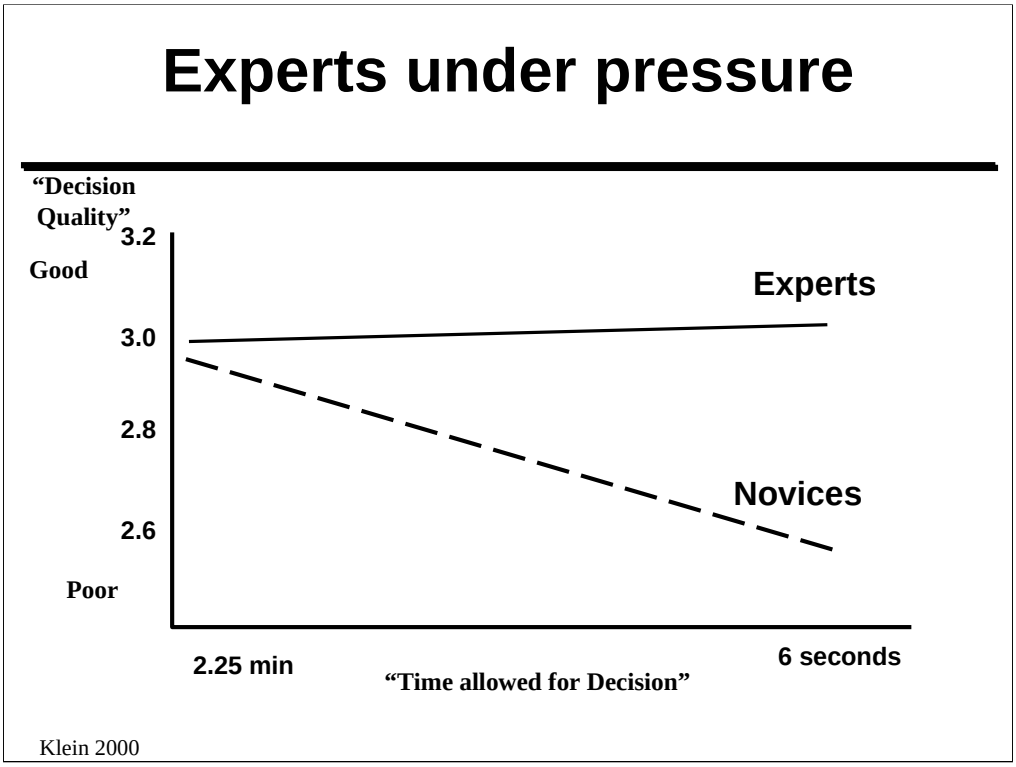


First we should stress that experience alone does not guarantee one develops expertise. This guy is fast but is he really good? Perhaps he’s good at being fast but that’s about it. This person in a forecast office may always get the products out on time but their content leaves something to be desired. What you do with each experience is more important in developing expertise than just having that experience.

Why is expertise so valuable?

- Some disciplines require years to build up expertise
- Person with expertise can be very difficult to replace
  - Many companies protect equipment…overlook the value of an employee with expertise
  - Money can replace the former, only time (maybe) can replace the latter

Why do we care about expertise? One reason is that it often takes time to grow and it can therefore be difficult to replace. Many organizations have made the mistake of saving money (in the short run) but investing in equipment but not in investing in the development of their employees.



Experts really shine when the pressure gets turned up. This study showed that the quality of decisions (as seen on the y axis), tends to remain the same as the time for that decision (on the x axis) is shortened…at least for the experts. The novice on the other hand succumbs to pressure and the quality of their decision making deteriorates.

What do experts do so well that others don't?

1. Recognize patterns
2. Detect anomalies
3. Keep the big picture (SA)
4. Understand the way things work
5. Observe opportunities, able to improvise
6. Relate past, present, and future events
7. Pick up on very subtle differences
8. Address their own limitations

So what do experts do so well that others don't? We'll take a look at each of these characteristics. Keep in mind how you might rate yourself using this criteria.

1) Experts recognize patterns

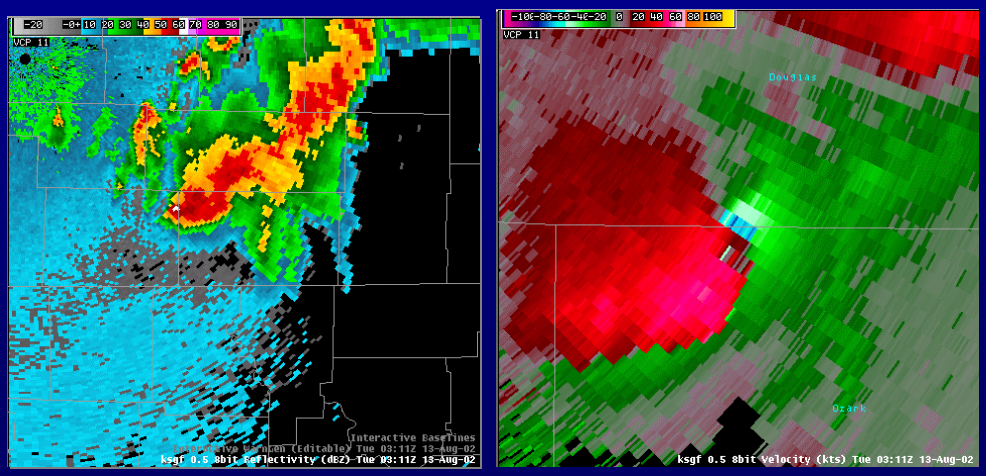
The ability to see patterns gives us SA

- Fireground commanders
  - Look at burning building and can infer what's happening inside. They relate cause and effect by connecting the dots.

Experts recognize patterns. With loads of data dumped on us continually, seeing a pattern, and seeing it quickly, is what can make all the difference. For fireground commanders, it's behavior of smoke in a burning building. It's connecting what looks like unrelated information to form a picture of what's happening. For a warning forecaster it's putting together a spotter report with a radar signature that tells you there's a high likelihood for a tornado. This relating cause and effect helps the development of SA.

Patterns are seen in the raw data

- Look at raw data when possible



DZ – 8 Bit Reflectivity DV – 8 Bit Velocity

Most experts in the warning environment recognize those patterns using base data. That may mean hi-res velocity and reflectivity data, or mesonet observations, or upper air analysis, or live TV video. They get to the data which has gone through the least amount of processing.

2) Experts detect anomalies

Including: Erroneous events and Missing events

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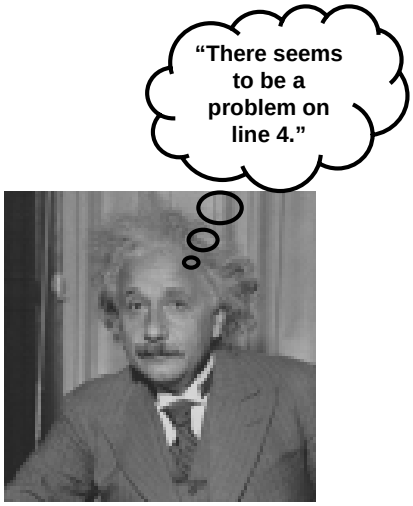


One of the hardest things to do is detect things which are "just not right" or things which are missing. Albert sees the problem here, but I don't. He should, he wrote this equation. For warning operations, it might be a messed up surface observation which is impacting local analysis. Or it might be the lack of acknowledgement from a TV station regarding a warning you just issued (maybe it didn't go out?).

3) Experts keep the big picture

Situation Awareness

- Have an overall sense of what's happening
  - Relevant cues are monitored
  - Plausible goals pursued
  - Actions are weighed

Novices are often confused by all the data elements

Experts often keep good SA. They tend to focus their energy on the important cues and filter out the rest. How do they know what's important? More on that later. They are able to weigh options and judge consequences of each. By contrast, the novice may actually suffer "paralysis by analysis". It's the never ending "one more volume scan" syndrome in which the novice hopes all uncertainty will vanish and the decision will be obvious. Experts are able to make decisions even when the picture is somewhat fuzzy (which it usually is).

4) Experts understand the way things work

- Can see inside events and objects
- Know how tasks are supposed to be done
  - *Also know when to do them differently*

> "General Arnold instructed Col. Marr to 'go ahead and scramble the airplanes, and we'd get permission later.'"
>
> 9/11 Commission report Staff Statement #17 regarding the first notification of hijacking of AA 11.

- Know how teams coordinate
- Know strengths and limitations of equipment

Experts are aware of how and why things and processes are designed. This includes the need for communication and coordination. They have a good sense when to trust equipment and when not. They know when to go with a known practice, and when to deviate. In the 9/11 Commission report, the General violated "protocol" because he believed it was called for in this case.

5) Experts observe opportunities, able to improvise

- Have learned not to rely too heavily on guidance
  - Can generate explanations and predictions which are inconsistent with data

When data sources conflict, experts are often able to resolve the differences. Their deeper level of understanding also allows them see when expectations are not being met before it's too late. This helps them more readily "let go" of a previous expectation when it is clearly no longer valid. While the discussion here is regarding the earlier than expected stratus deck, it may also involve a strong rotational signature developing on a day where "no severe weather" is expected.

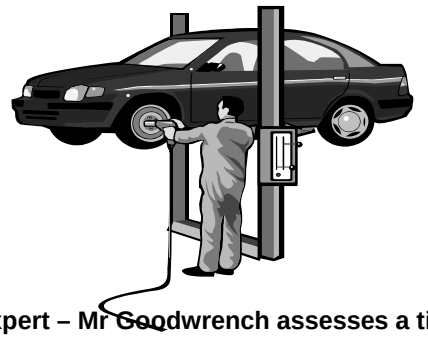
6) Experts relate past, present, and future events

- Connect all events
  - Understand primary causes and can apply them to run mental simulations
  - Generate expectations
- They don't get caught "flying behind the plane"
- Can view from the other's eyes

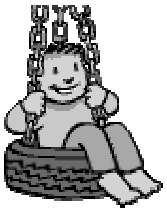
Experts quickly, and usually without being aware of it, make the connections between what has occurred, what is occurring, and therefore what is most likely in the future. They mentally simulate possibilities and outcomes and take action based on the result which gives the first good workable solution. They tend to look at a problem from more than one angle, allowing them to see more than one possible explanation for what is occurring.

7) Experts pick up on very subtle differences

- Detect nuances that novices can't even force themselves to see
  - i.e., they get it
    - novice's don't because "it" is NOT a fact or insight but rather the sum of varied experiences

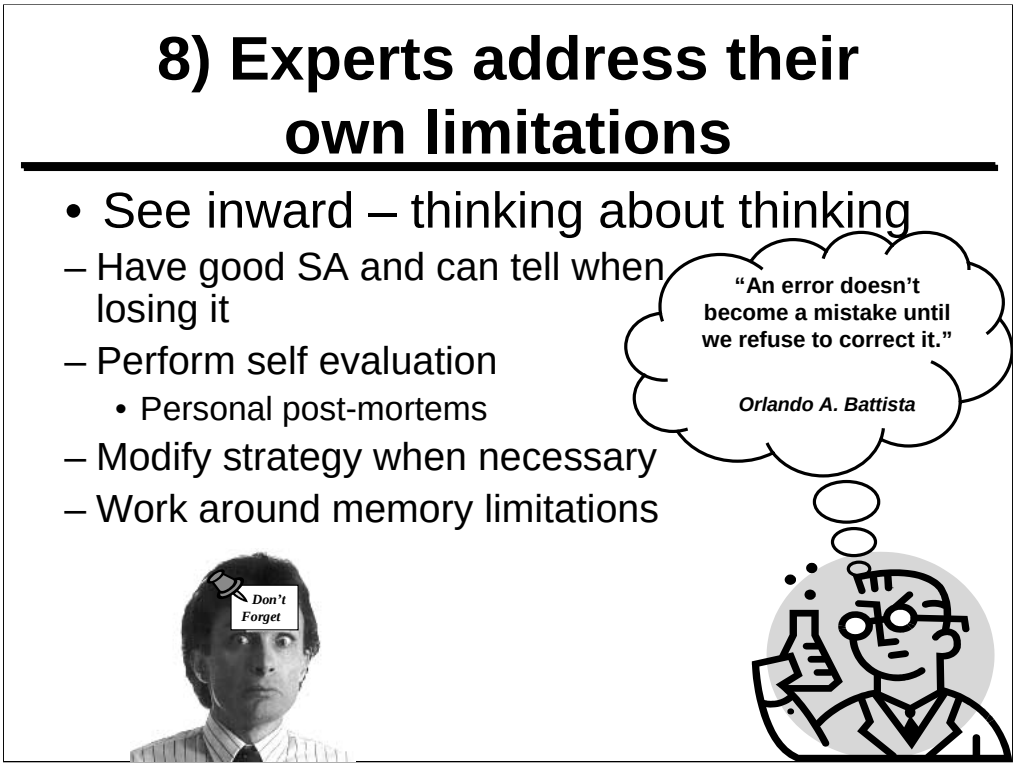


Expert – Mr Goodwrench assesses a tire.



No Expert – I assess a tire

Experts can pick up on subtle differences. The sum of their experiences has come together in a way to make this easier. Novices have not been assessing the same things and have not developed the same sensitivity.



Nobody's perfect, including experts. What allows someone to gain expertise is knowing this fact and constantly making an effort fill in the knowledge gaps. We all make mistakes. We grow in our expertise if we understand why and how a mistake was made. Experts will accept their limitations and work around them. They will be uncomfortable with a situation that doesn't work out as expected and will look at the reasons why. This knowledge will then be available to them the next time they are faced with a complex decision. This is how they get the most out of every experience.

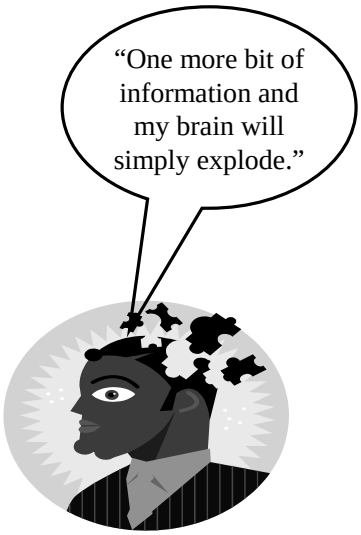
When and why you want experts

- Plane ascending through 24Kft
- Alarm triggered: “ovht eng pressure”
- Additional alarm: “eng 1 oil pressure”
- Alarms continue – a total of 54 alarm messages will be received
    - Many conflicting
    - Crew lead to suspect #1 engine is the problem
- Pilot enlists help of 2 additional off-duty pilots
- Starts emergency descent back to airport
    - All continue to go thru over 20 emergency checklists
- Upon approach, tower informs crew of wing/pylon fire (#1 engine is fine)

Experts are especially beneficial when a crisis erupts and, as is often the case, resolving it means dealing with fast paced decisions in an environment where data is not necessarily all pointing at the same answer. In this case from an NTSB file, one of the most important things this expert pilot did was ask for help when the workload became overwhelming. The group never did resolve the cause of the crisis, but still managed to work through the uncertainty and overcome the consequences of the initial problem before a catastrophe resulted.

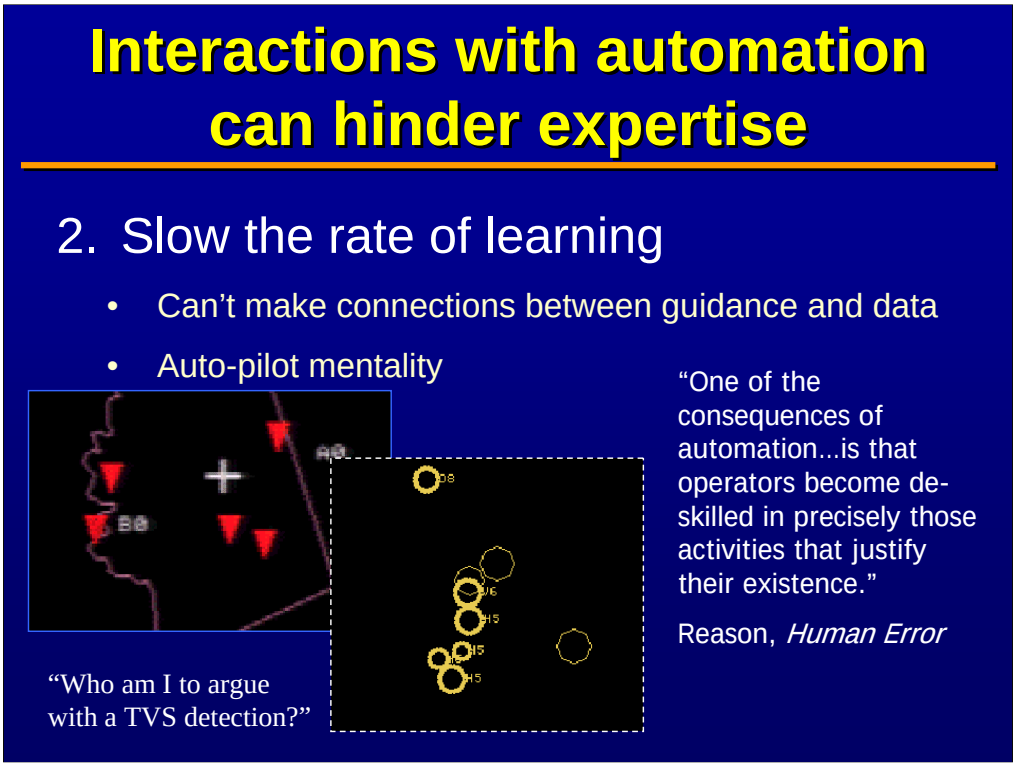
Interactions with automation can hinder expertise

1. Disable learning
   - Information overload
   - Increase uncertainty
   - Reduce confidence
   - Disengage decision maker



So we have looked at the characteristics of an expert, let's look at what can keep them from using that expertise, or what can hinder the novice from attaining it. When automation is inserted into the process without considering the user, it has the potential to "disable learning". If the automation has the characteristics listed here, it can have an affect on learning and application in real time. No doubt you have felt the impact of all these things at one time or another. Simply adding more and more information is not always the answer. Is it better to have 2 sources which suggest 2 possibilities or 10 sources which suggest 10 possibilities? Neither!

On the other hand, more and better information which helps us reduce uncertainty and increase confidence in our understanding of the threats is another story.



When the automation does not provide a means for the user to evaluate its validity, it can actually reduce the decision makers confidence it what they believe is happening, and may even cause them to disengage. This quote from James Reason is pretty telling. When we get to the point of saying we can't argue with the automation, we are implying we are no longer needed in this process. And with perfect automation that may be true. Until then, we need to be able to add value to the decision by using our expertise and incorporating the automation properly.

Interactions with automation can hinder expertise

3. Teach dysfunctional skills

- Attention management – focus on method not mission
- Inefficient strategies
- Promote procedural mentality
- Incomplete feedback from simplistic measures

"My first priority was data entry rather than situation awareness."

Aircraft Safety Reporting System

Sometimes automation can be so labor and attention intensive that we lose track of the process we are trying to accomplish. We don't get to tap into our expertise. The pilot quoted here is lost in the process of working the automation, so much so that he's losing SA. Another problem can arise if the feedback you get indicating whether you succeeded or not is not really representative of your skill, or one's idea of what success really means. Remember our guy who could shoot 10 arrows in 10 seconds? That was easy to measure but did it really measure what was important? Unfortunately, that simplistic measurement can get fed back into the system and ultimately be what we end up training for…not accuracy but speed.

How to Retain/Develop Expertise

- Support efforts to develop
  - Perceptual skills and pattern recognition
  - Construct conceptual models
  - Sense of typicality, ability to spot anomalies
  - Routines and workarounds
  - Form expectations, and learn why they did or did not pan out

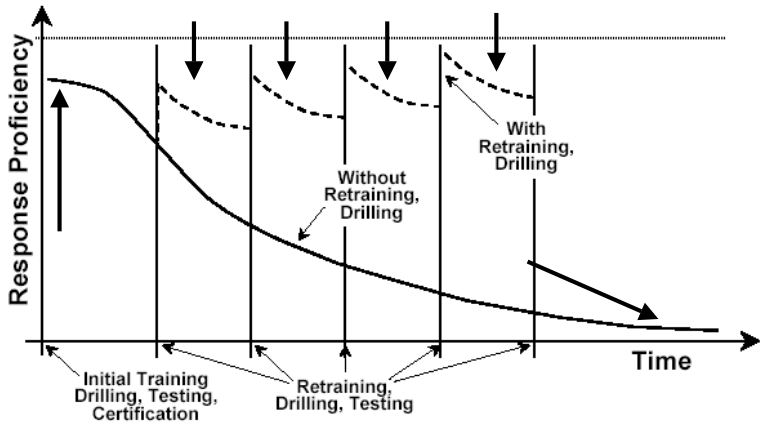
So what do we do? The process by which we assess, understand, and evaluate our decisions is very important. Automation, operations, and training which support the efforts to develop skills in pattern recognition and aid in constructing conceptual models are important. These efforts should also focus on making unusual and rare occurrences more recognizable. Routines are important…they save time. New routines need to be developed when skills or software or mission change. The routine you may have had 15 years ago (not you youngin's) has had to change considerably, as will the one you likely use 5 years from now. One of the best practices you can do is challenge your expectations, both during and after an event. Look at why they are not working out, or did not come to pass.

How to Retain/Develop Expertise

- Simulations
  - 25 hours of *well done* simulations can achieve the same effect as 2 years of experience (or much more)
  - Simulate as many of the "real" parts as possible
    - Including personnel interactions, time, stress, resource allocations, "bogus" data
  - Interject problems
  - Critique reasoning, not just outcomes

One of the best ways to develop expertise is in simulations. Just as having experience doesn't guarantee you have expertise, going through a simulation won't either. It has to be pointed toward some goal which can be rather simple (get very comfortable with WARNGEN) or more complex (recognize MARC signatures). One thing that is common to all simulations is the process of evaluating reasoning, not just outcomes.

Simulations…once is not enough



*Based on: "Human Error Evaluation and Human Reliability Analysis"; B. J. Bell; American Institute of Chemical Engineers

This study revealed how proficiency was impacted by initial training (red arrow) and how it went to pot with time. Like watering a seed when you plant it, and then neglecting it and expecting it to grow without any further nourishment. However, with continued refresher training (blue arrows), proficiency remains at a much higher level and can even improve. This is especially important when the event for which you're training is relatively rare (nature doesn't routinely offer chances to keep up skills otherwise).

How to Retain/Develop Expertise…cont

- Post-mortems
  - Ask Why? Why? Why? and Why not?
- Look at raw data when possible
  - Stay as close to the “truth” when possible
  - Form opinions with this first then look to automated input (avoid automation bias)

Asking “why?’ is a great practice. It’s how most of us learned at a very young age (hopefully, the answer you get when asking that question after a warning event is still not “because I said so.”). Post-mortems are key to advancing knowledge and critical thinking. Looking at the raw data, something the Air Force refers to as “owning the data” also helps cement understanding and assists in solidifying conceptual models. Forming opinions based on objective analysis, and then looking at automated guidance helps avoid what researchers call the “automation bias”. Studies have shown that decision makers are more likely to come to the “automated” solution if they look at the automated solution BEFORE forming their own opinion. In that case, they are less likely to resolve differences in what the automation says versus what their original opinion might have been.

Summary

1. Experts are those that have a deep comprehension of the situation
2. They are extremely valuable to an organization, especially when problems are unique and constrained by time.
3. Automation, if not developed or integrated correctly, can hamper one's ability to gain or apply expertise.
4. Experiencing simulations, doing personal post-mortems, and resolving "why", are ways in which you can gain expertise.

A summary of the meaning and value of expertise.

Questions?

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

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

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Expertise and Effective Office Warning Strategies

Advanced Warning Operations Course

IC Core 3

Lesson 2: Cognitive Task Analysis

Warning Decision Training Branch

Continuing through the Expertise and Effective Office Warning Strategies instructional component, we will now look at a Cognitive Task Analysis of the warning process.

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

In lesson 2, we will see the results of a Cognitive Task Analysis which was conducted using expert warning forecasters. Recall in Lesson 1, we discussed what we mean by experts and the value they bring to an organization. In any domain it is important to see how experts accomplish the task. By doing this, we glean important information which can help us design tools, training, and procedures to support that expertise in places where it is critical.

Lesson 2:

Cognitive Task Analysis of expert warning forecasters

What does expertise look like in NWS warning operations?

COGNITIVE TASK ANALYSIS OF THE WARNING FORECASTER TASK

Final Report

Order No. RA1330-02-SE-0280

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The National Weather Service
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Norman, OK 73071
December 31, 2002

This lesson will share result of a CTA which was recently conducted using NWS expert warning forecasters.

Overview

1. What is a CTA
   - Process
2. CTA of NWS warning forecaster task: Findings
   - General approach to the weather
   - Use of technology
   - Developing mental models
   - Use of unusual cases
   - Working in teams
   - Relating with the public
   - Expert decisions

We'll discuss what we mean by the term Cognitive Task Analysis, or CTA, and the process by which it was conducted. We will also look at the findings from this study. These findings help us get a good picture of what an expert does and thinks as he or she encounters a severe weather event.

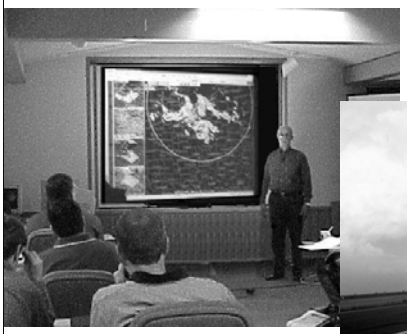
Learning Objectives

1. Define a cognitive task analysis
2. Identify the results of the NWS CTA on expert warning forecasters

The learning objectives, which are testable, involve defining a CTA, and identifying the results of this particular CTA.

What is a CTA?

Definition: Cognitive Task Analysis is a study of the mental processes needed to perform a task proficiently



Can assist in the design of research and training to develop expertise

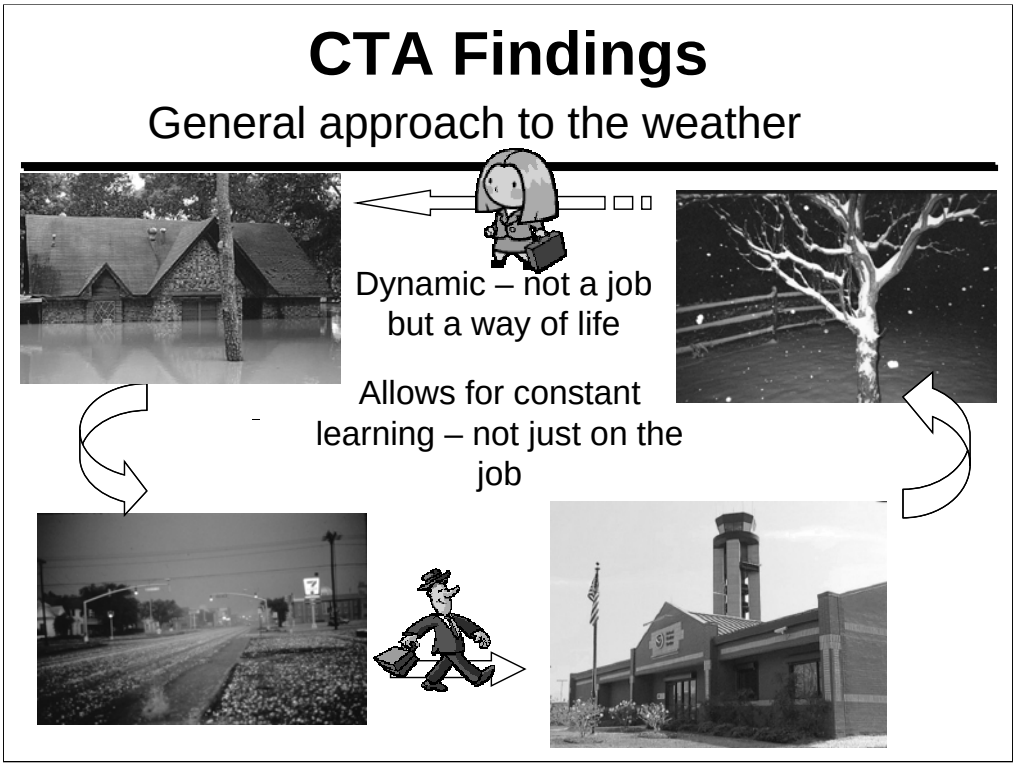
Can assist in the direction and design of hardware and software to foster use of expertise

Did you ever work with someone who was about to retire and think, “Man we need to clone him before he leaves!”. Well a CTA tries to see what the characteristics of that “clone” might involve, at least in the area of interest. In this context, a CTA is defined as a study of the mental processes needed to perform a task proficiently. While a “task analysis” looks at the job tasks which are done to accomplish a goal, the CTA focuses on the thinking processes and reasoning of the person doing the task. Not just what they do, but how they come to the decisions they come to. A CTA can be done on anyone, but if you are attempting to capture and grow expertise, it is important to do this with those who are considered experts. Findings from a CTA can help design research needs and guide training efforts in the direction of fostering, in our case, warning expertise. The results can also be used to direct hardware and software design to assist the expert in using their expertise, instead of working against them.

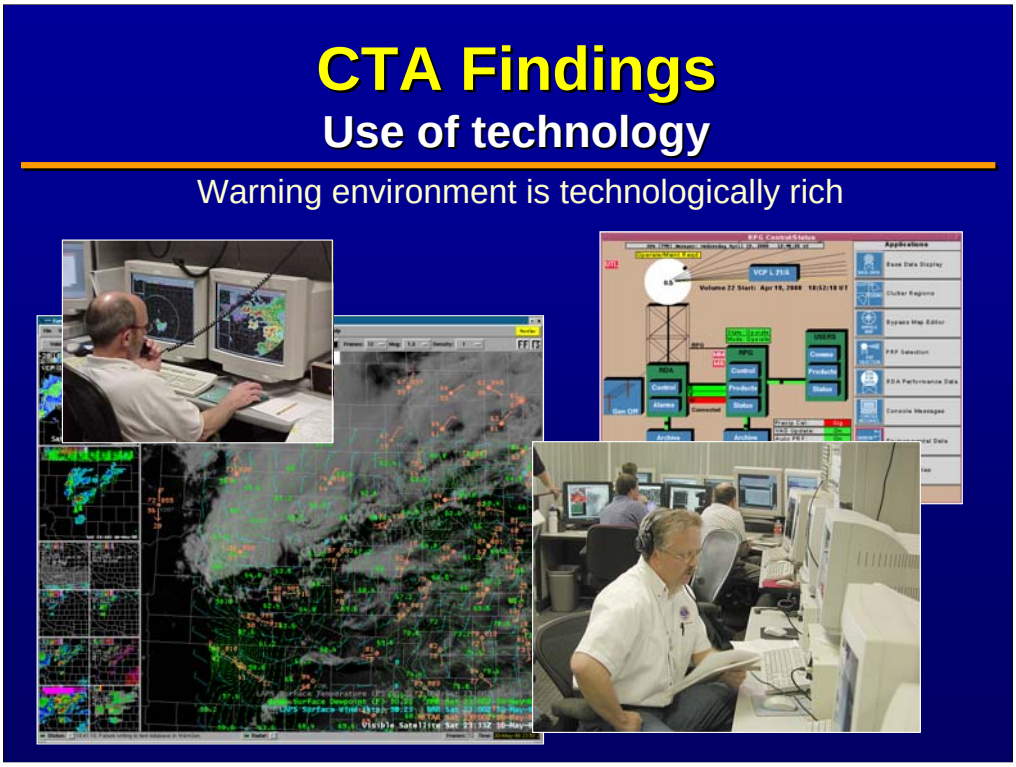
CTA Process

- Klein Associates performed CTA on expert NWS warning forecasters
  - Six recognized experts interviewed
  - Between 12 and 20 years experience
  - Work experience covered most US climatological regimes
- Goal was to capture expertise via the Critical Design Method
  - CDM uses layers of interviews to capture past events
    - Documents actual past actions versus hypothetical future actions
- One novice interviewed

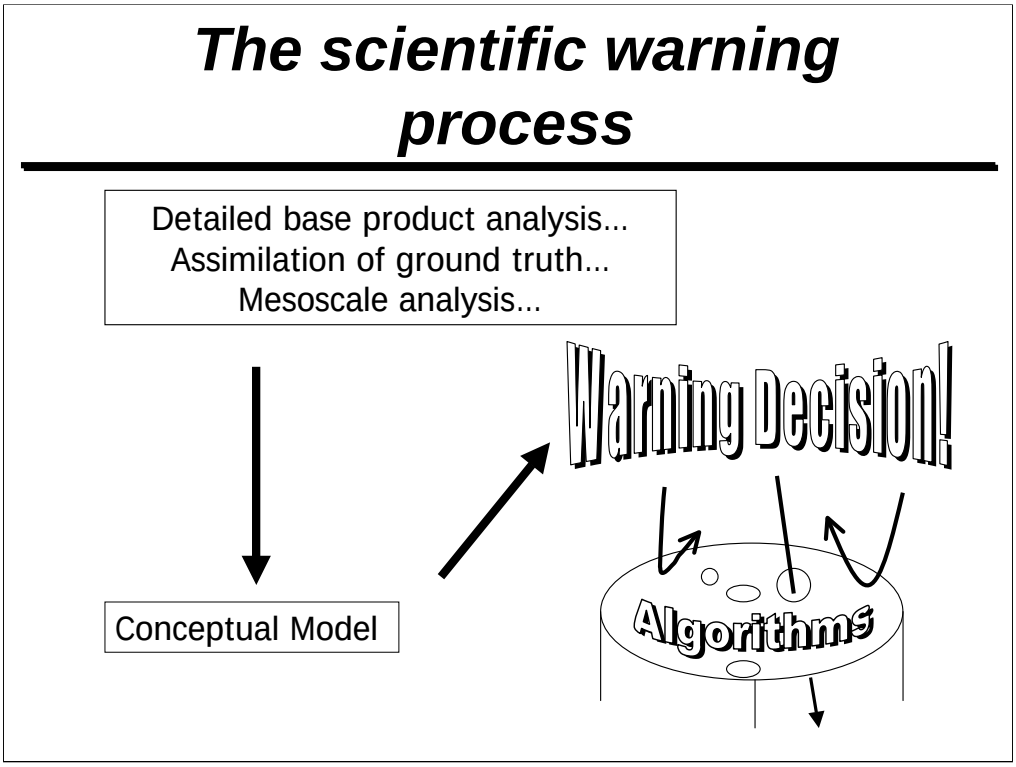
For the NWS CTA, Klein Associates, an organization which does human factors research with other high-stress, pressured domains (Army command and control, Aircraft carrier flight control) was commissioned to conduct a CTA on NWS warning forecasters. They interviewed 6 recognized warning forecast experts, each of which had between 12 and 20 years of experience in offices which covered all aspects of weather across the U.S. In addition, one novice was interviewed, the results of which were used as a control. The process involved interviews of actual events worked by each of the experts, rather than hypothetical situations. In other words, the CTA was focused around what these experts did, not what they might do. Many of you looking at this are probably considered experts, or know someone who is. The findings here will likely NOT be any surprise to you and in fact may describe you!



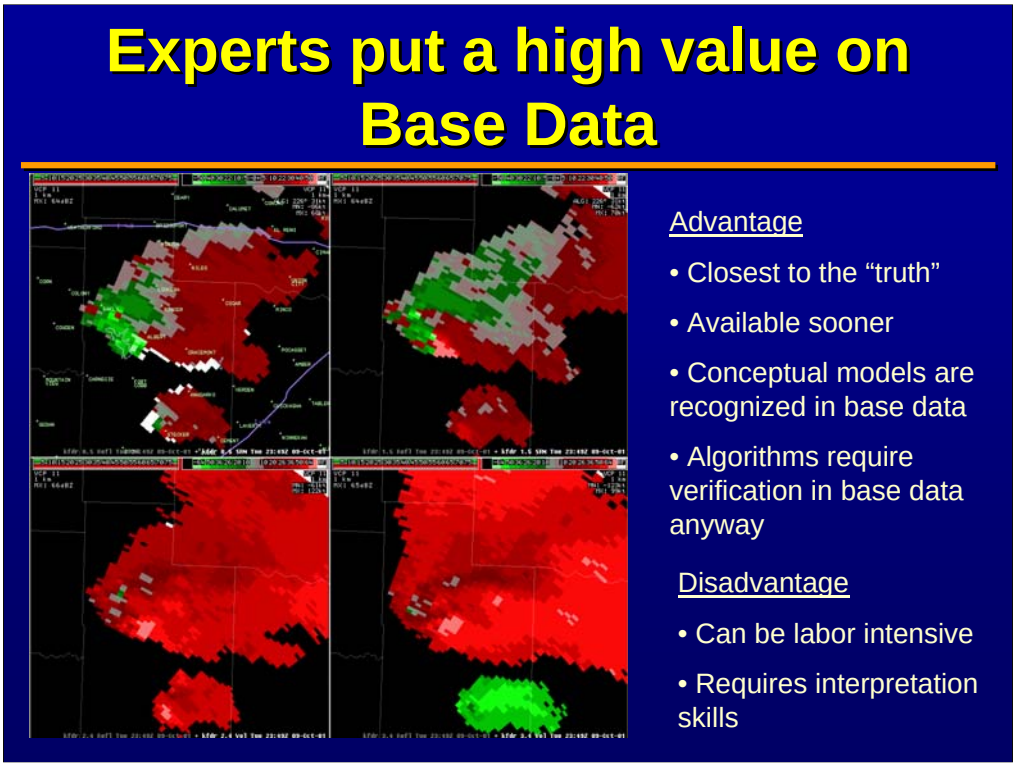
The CTA produced several findings. First was the way that the experts approached weather in general. None considered weather an “8 to 5” job. They were on a lower level of “watch” when off duty but on watch nonetheless. What this means is that they are constantly in a learning, observing mode. The field of weather affords that opportunity more so than other domains. Experts will take advantage of this. By the time they go on duty, they’ve already formulated some expectations about what is in store for them that day. However, experts will frequently reassess expectations which helps prevent them from locking in on their initial assessment.



The second finding involved the use of technology. As you all know, the warning environment is technologically rich, and getting richer every day! This requires experts to have a strong understanding of the domain in which they are immersed and a constant effort to properly use the technology to the best outcome.

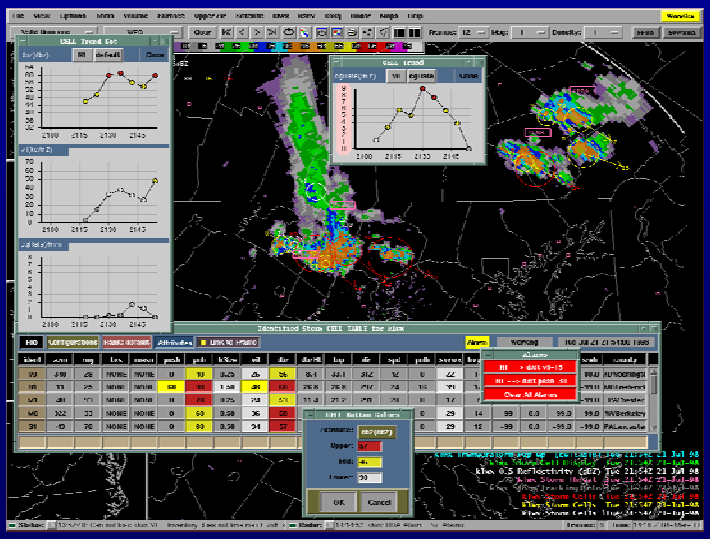


One of the ways experts do this is with a grounded warning process. This process is built around detailed and frequent base data analysis, the assimilation of ground truth, and considerations for the impacts of a representative mesoscale analysis. These things help illuminate conceptual models which help bring order and expectation out of the mountains of available data. The warning decision comes from this process, with the use of algorithms as a safety net to help catch things that slip through the cracks. The experts were aware however that this safety net has “holes” and therefore to rely on algorithms as a “first line of defense” is dangerous.



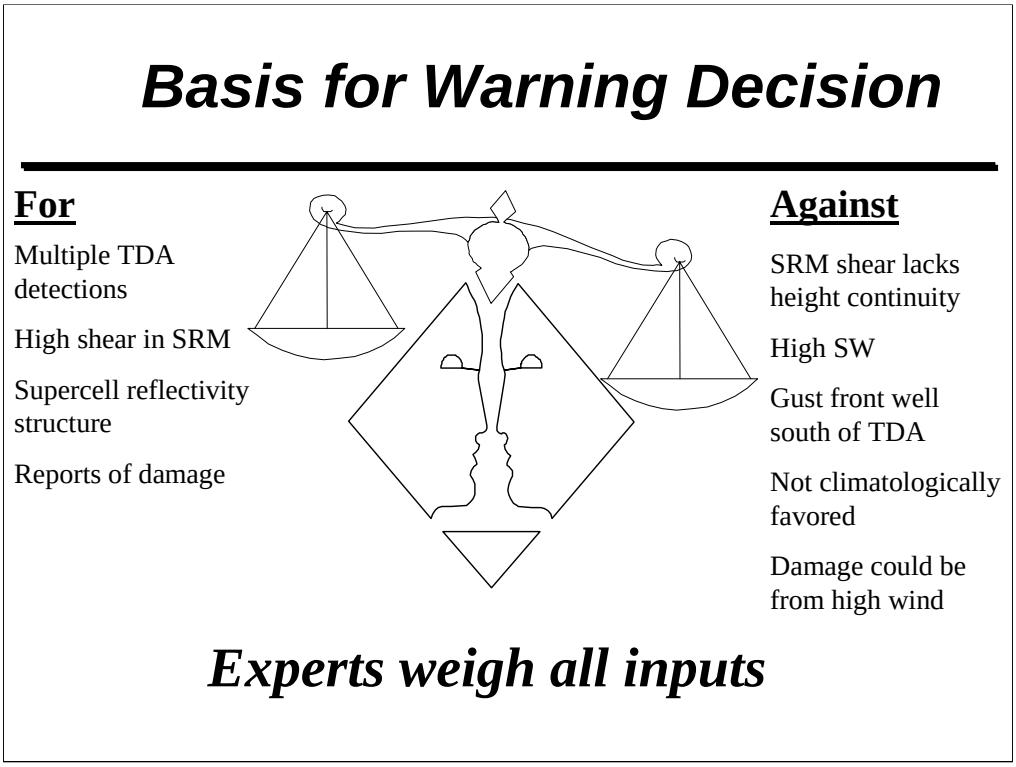
All the experts interviewed here put a high value on base data analysis. They have developed numerous procedures and methodologies to make this analysis as quick and easy as possible. Their reasoning primarily comes from the base data being the closest data one has to the "truth", with each step of processing thereafter having the potential of introducing additional levels of uncertainty. Since these experts are very aware of conceptual models, they are able to use the base data to recognize and validate those models. The challenges of base data analysis for these experts is the workload it places on individuals. However, most placed a high priority of ensuring staffing to support this effort.

Use of Decision Aides

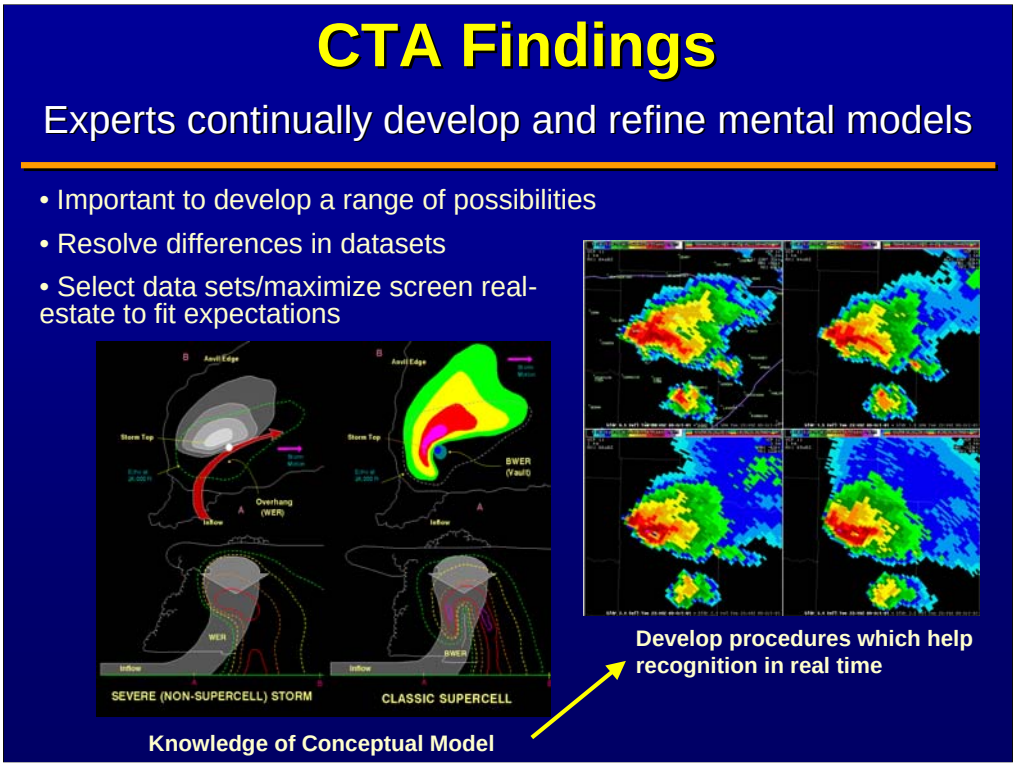


- Used as a "safety net"
- Reliability and applicability are important
- Value related to forecaster's ability to trace output back to its base data input (confidence)

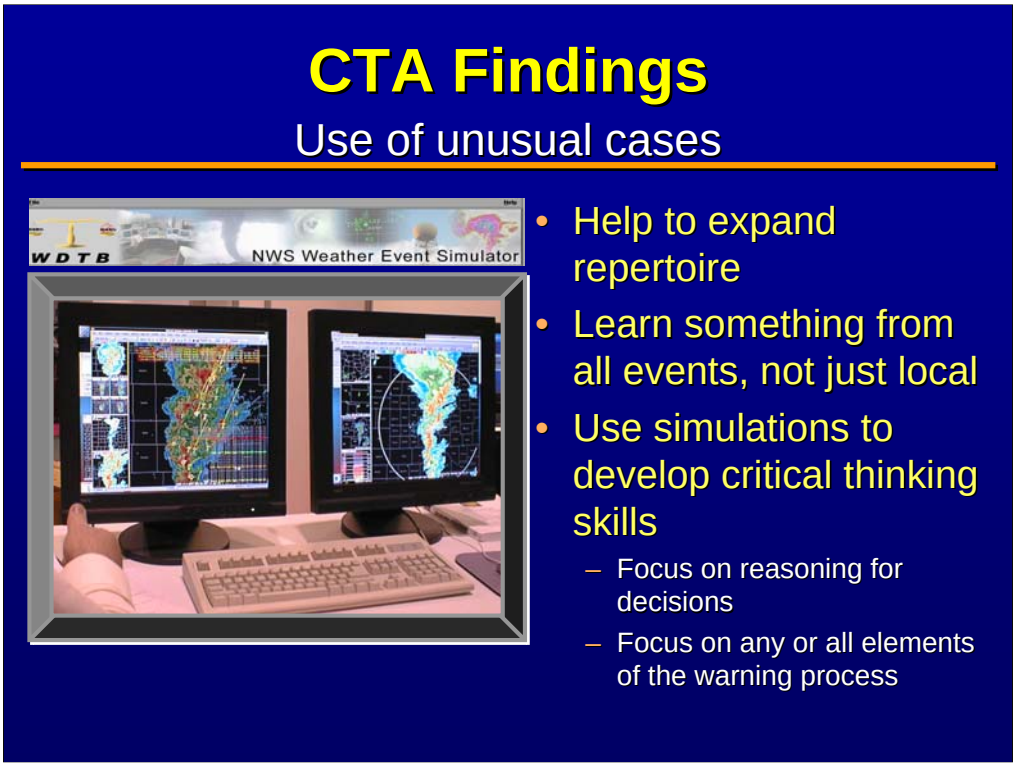
Decision aides, which may or may not use the output of algorithms, were also used to support expert warning forecasters. The experts found value in those outputs which were easily traceable to their base data inputs. This ability allowed them to develop confidence and reduce uncertainty. Outputs which added value above and beyond what was readily detectable in the base data were used more often. However, outputs which were difficult to verify or validate were considerably less likely to be used. On the other hand, novices are more likely to use decision aids without questioning their validity.



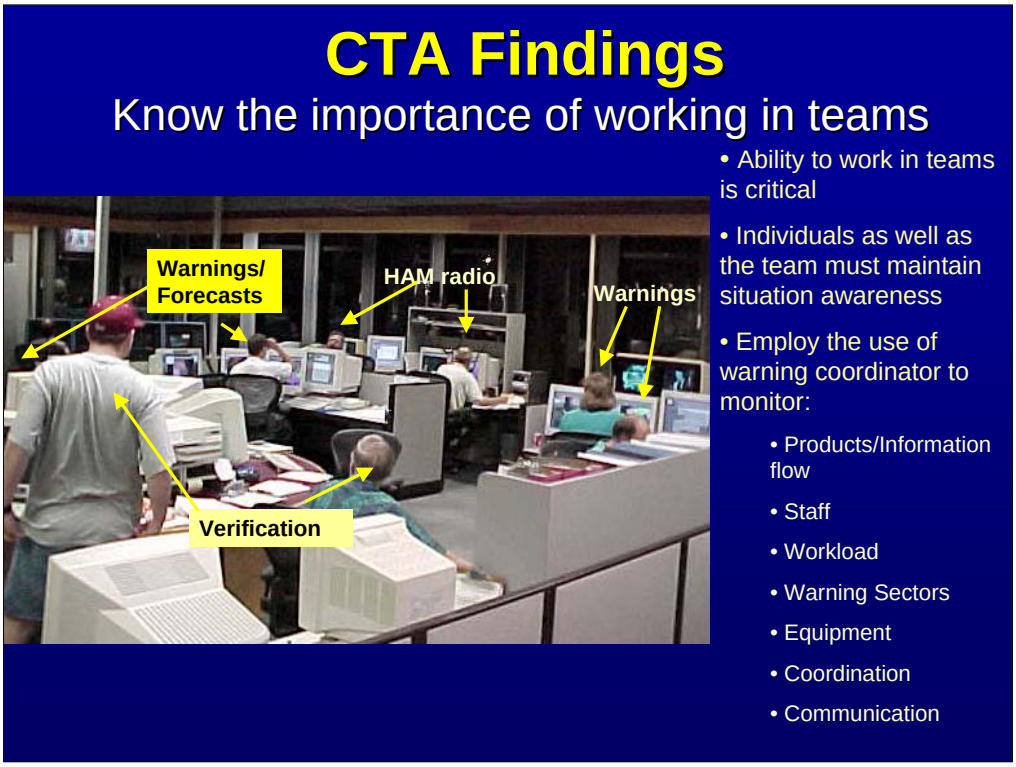
For the expert warning forecasters, all data gets weighed against all other data, and in the context in which it is received. All data sources rarely point to an “obvious” answer. In addition, no one piece of data (except on extremely rare occasions) is ever enough to base a decision upon. The expertise comes in deciding on which side of the scale inputs reside and how much weight each carries with it. The context in which the event is occurring is always being considered.



The CTA found that expert warning forecasters are very familiar with mental and conceptual models. This begins taking shape during the expectation phase before echoes appear on the radar screen. It was important for these forecasters to not get locked in on any particular threat, but rather consider a range of threat possibilities, each with an associated likelihood. This helps focus effort on the biggest threats and ensure resources are arranged to support that effort. At the same time, it was necessary to prevent tunnel vision ("flash flooding is not a threat today") which can contribute to the likelihood of low probability or rare events going undiagnosed. In addition, the experts were aware that oftentimes the signatures will not fit the "textbook" classics, but that they can still be good enough.



The experts were very prone to looking at numerous events in hindsight. This included events from other areas, even other countries, and events which, even though they were not common to their particular locale, were in the realm of possibilities. The benefit of doing this was to expand exposure and possibilities, as well as develop critical thinking skills. They viewed simulations as a challenge and sought to get the most out of any event they experienced.



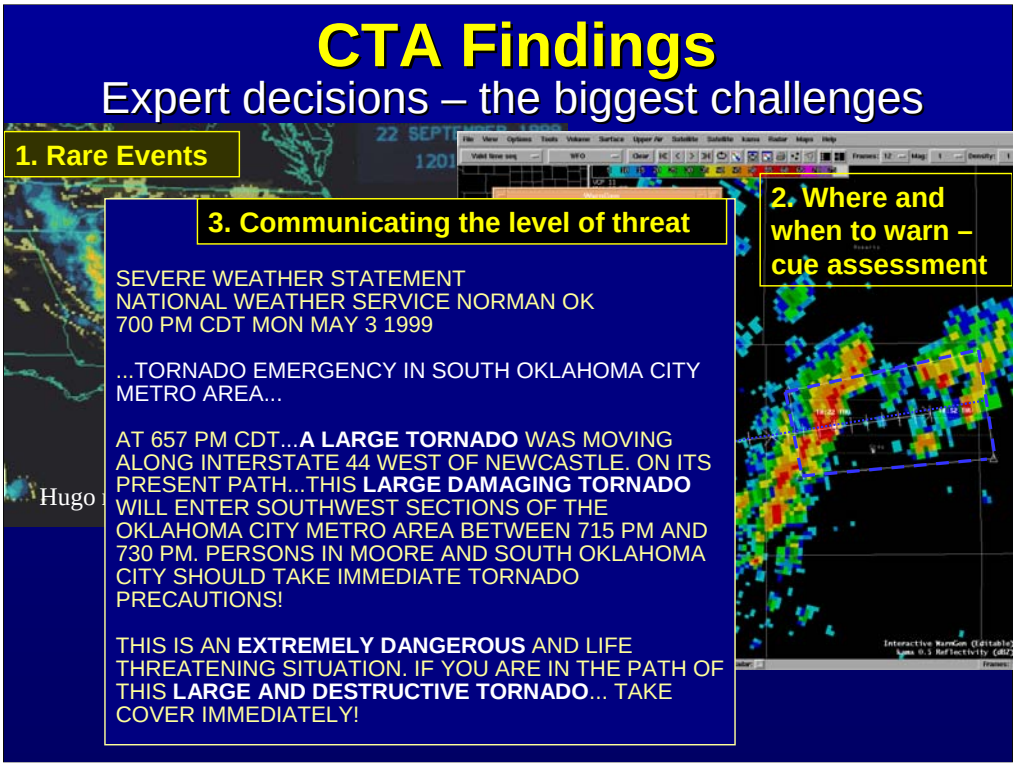
The teamwork focus of the experts interviewed was a common theme. They considered success and failures as belonging to the office and the NWS, not just the person composing the warning. Each team member has a responsibility for communication and coordination as well as situation awareness. They valued the role of each member of the team, regardless of their experience level. The experts endorsed the use of a warning coordinator to help ensure nothing gets overlooked and that the message the office is sending is understood be each team member.

CTA Findings

Relating with the public

- Sensitive to role in protecting public
- Attempt to keep tuned with public vulnerability
- Focus is on communicating level of threat
- There is effort to get the public to react correctly

The experts viewed issuing warnings as a social action which was based on a scientific decision. They were very focused on their relationship with the public and public vulnerabilities at any point in time. They did not view their job as just issuing a warning, but rather making attempts to elicit the best public response to ensure safety. A focus on a constant and consistent communication of the threat, both from sources within the office and with outside partners, was a critical piece of the job.



The biggest and most important challenge that the forecasters interviewed found in their jobs was the ability to rise to the occasion when the "big event" presented itself. It was believed that this was where the NWS needed to meet and even exceed all expectations. They tended to look at all events as having that potential, knowing that it is often not known ahead of time which event will be the one that defines your reputation or that of your office or the agency. Their belief was that seeing and properly reacting to these catastrophic events as they are unfolding (correctly assessing the relevant cues) is the biggest challenge one is faced with in the forecast and warning environment. The importance of categorizing the threat once it is realized in words which convey not only its magnitude but its certainty was thought to be imperative.

Summary

1. What is a CTA
   - Process
2. CTA of NWS warning forecaster task: Findings
   - General approach to the weather
   - Use of technology
   - Developing mental models
   - Use of unusual cases
   - Working in teams
   - Relating with the public
   - Expert decisions

Questions?

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

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

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Expertise and Effective Office Warning Strategies

Advanced Warning Operations Course

IC Core 3

Lesson 3: Learning From Post-Mortems

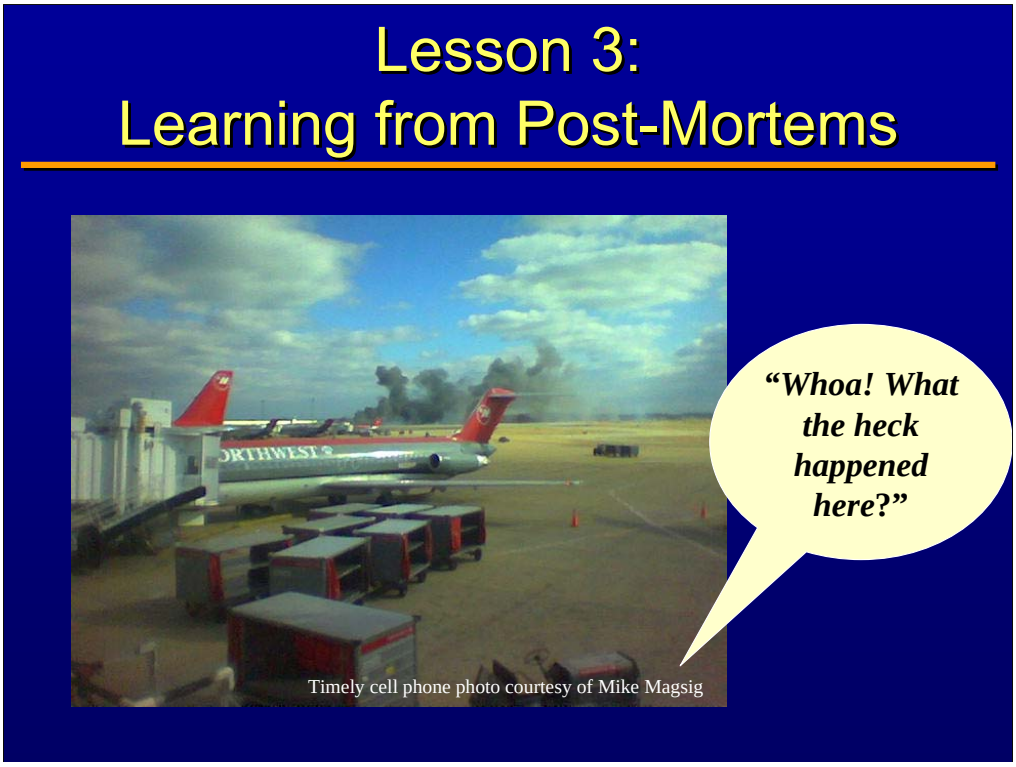
Warning Decision Training Branch

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…

Liz
Quoetone

Joe
Baalke

Don
Rinderknecht

Jami
Boettcher

Learning Objectives

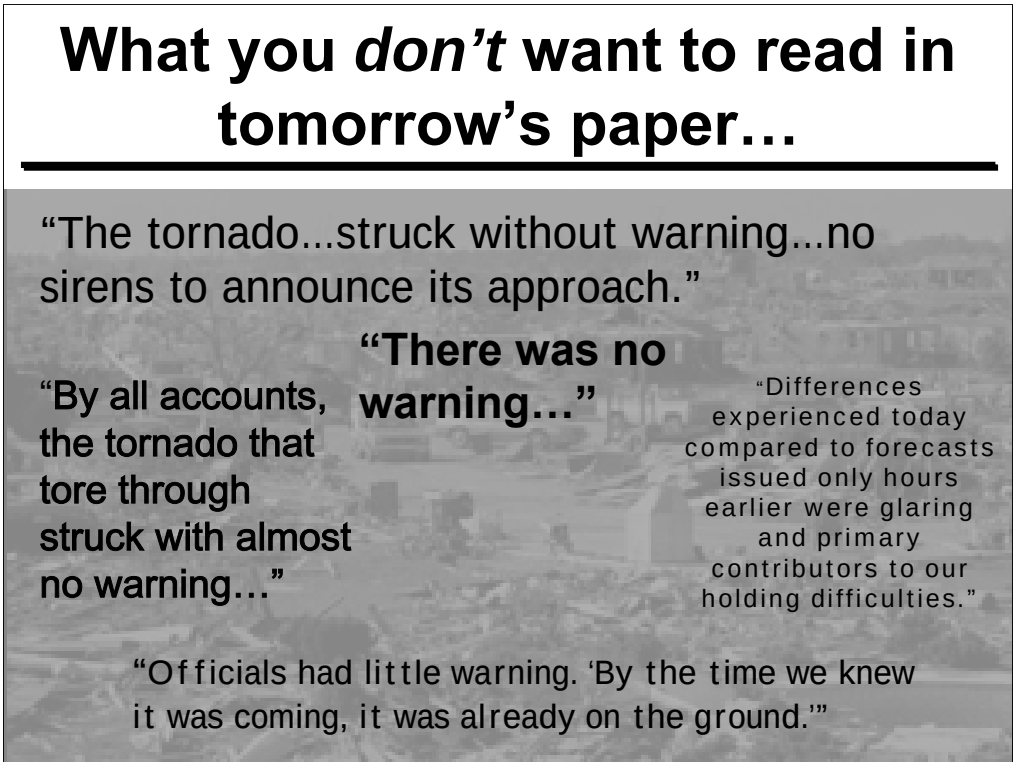
1. Identify the potential benefits of a post-mortem analysis
2. Identify characteristics of ineffective post-mortems
3. Identify the value of having a post-mortem database
4. State what is meant by human error
5. State the impact of the hindsight and outcome biases on performing post-mortems
6. Explain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

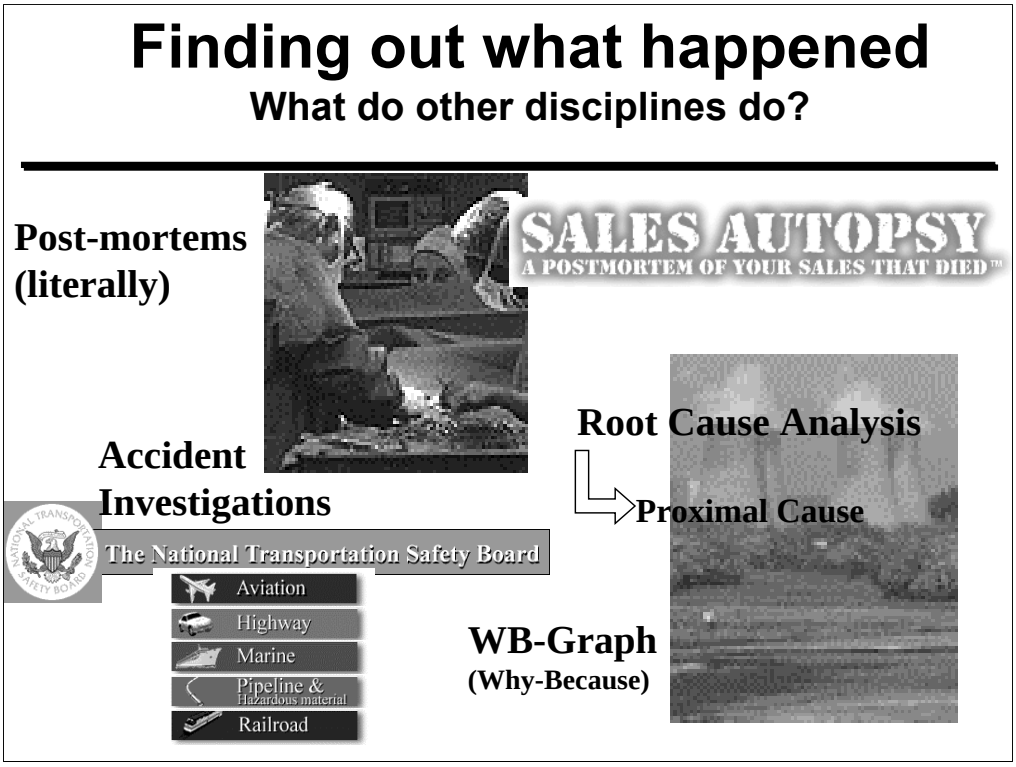


Anyone who's worked a significant weather event has seen headlines the next day which may or may not reflect the service provided, but nonetheless are extremely troublesome. In some cases, the office would have been hard pressed to get a better outcome. In others, actions before and during the event 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.

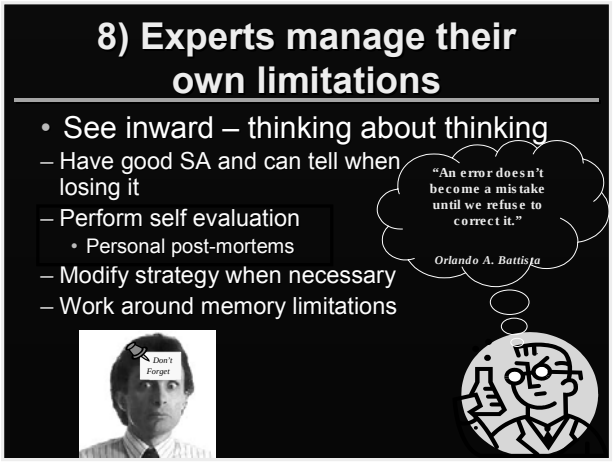
Post-Mortem - definition

– *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

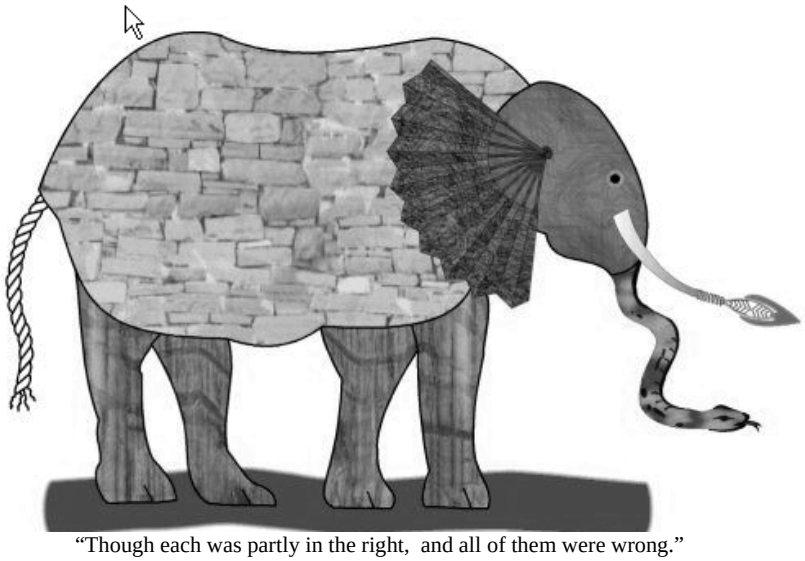


Experts grow in their expertise by doing lots of post-mortems

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.

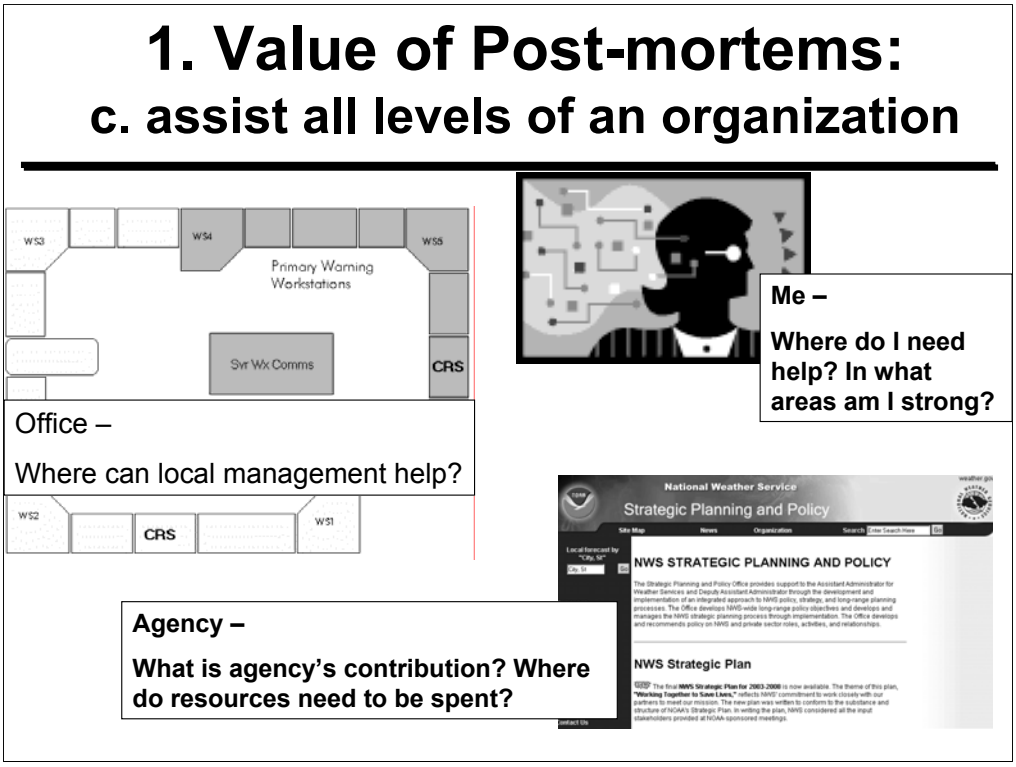
Traditional post-mortems have not been multi-disciplinary

"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

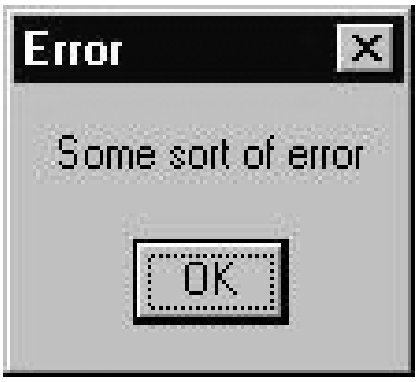
Director, Natural Hazards Research and Applications Center

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

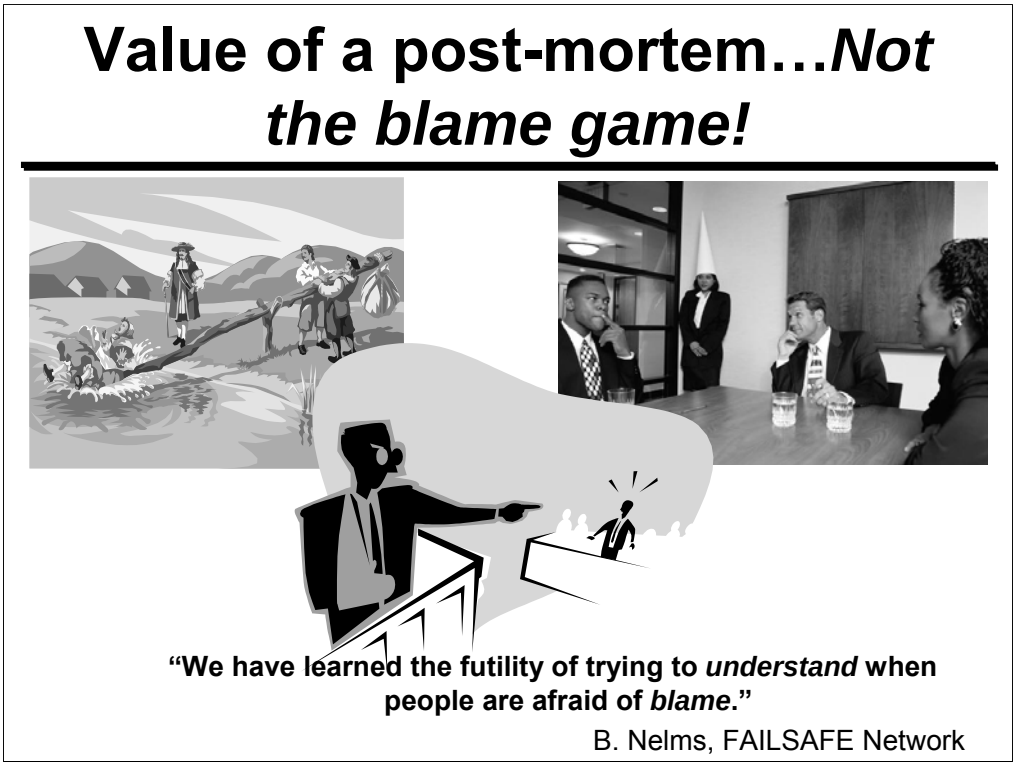
Problem: FAA records showed runway incursions on the increase.

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

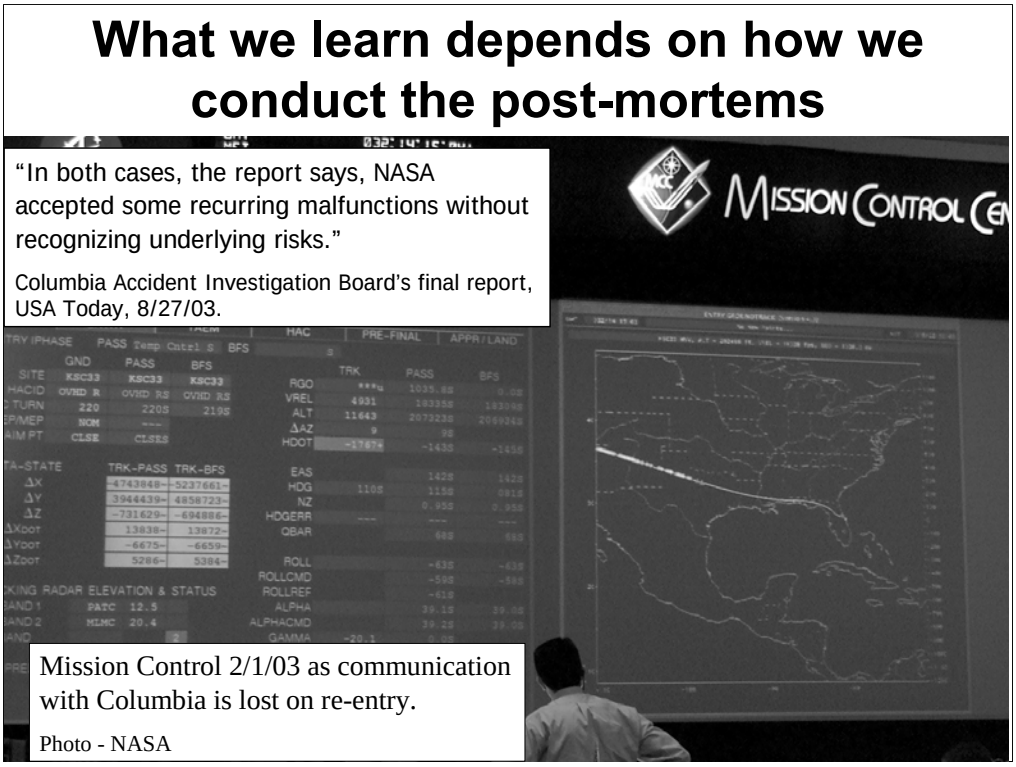
- Causal relationships are unknown
  - Fact finding can omit conditional causes
    - *includes who,what, and when but not <u>why</u>*
- Solution oriented
  - "Favorite solution" mindset
    - *More important to work in "preferred" solution than to understand the cause*

"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

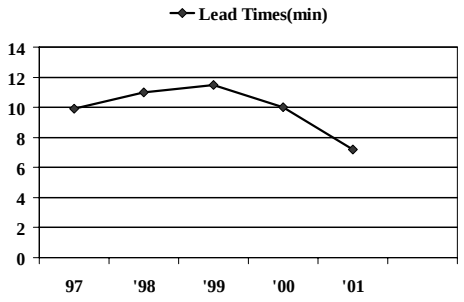
	Office A	Office B
POD	80	70
FAR	70	80
Ave. Lead Time	10	10
Total Fatalities	2	2

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?



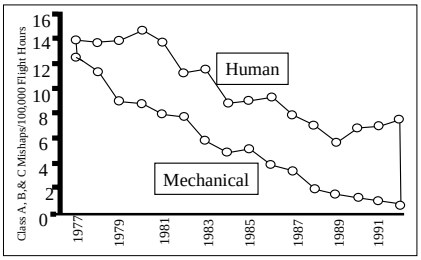
- What was F-scale of each?
- What was time of day?
- What was range of each?
  - How did radar(s) sample?
  - How well did other sensors sample?
- How well was event anticipated?
  - Were there environmental clues?
- How well did staff work together?
- What was experience level of staff?
- What was 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.**

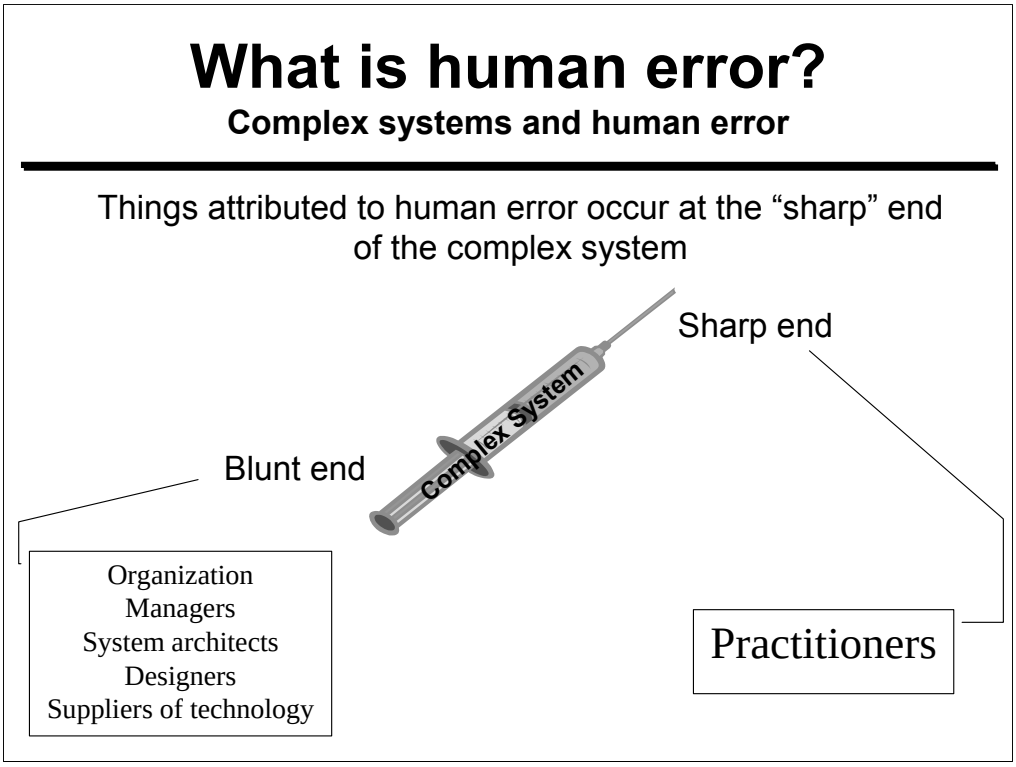
Shappell & Wiegmann, 2000

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

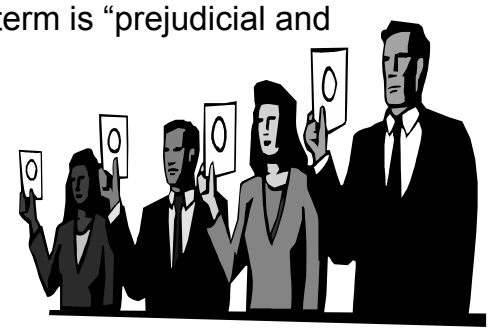
However, it is likely not that simple. As technology continues to expand in scope and coverage, the need to include the human user in the design is not always (often) considered. Technology which does not consider how a human operates, especially an expert, is not going to have good results when fielded. 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”?

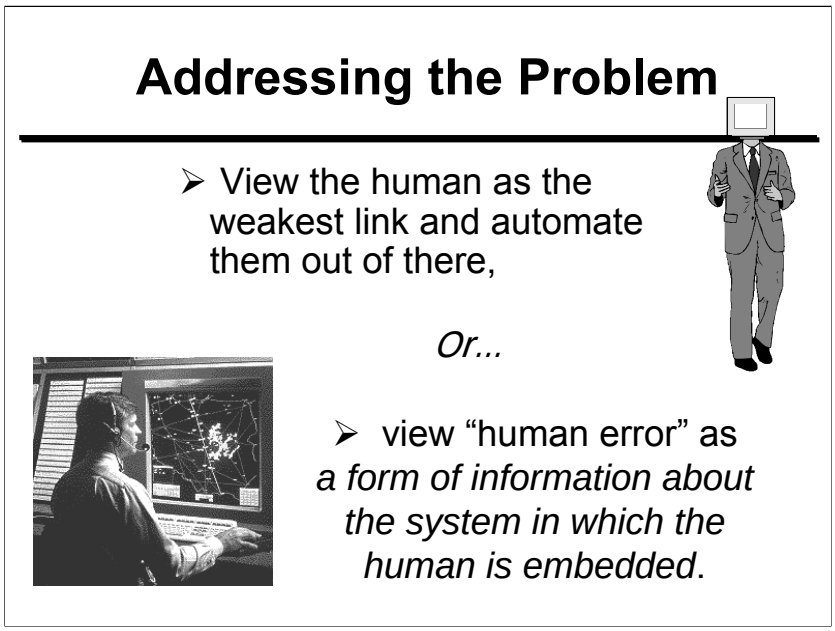
- Attribution of human error after the fact is social judgment, not objective conclusion
- Studies show the use of the term is “prejudicial and unspecific”
- Holds back, rather than advances, understanding of how complex systems fail



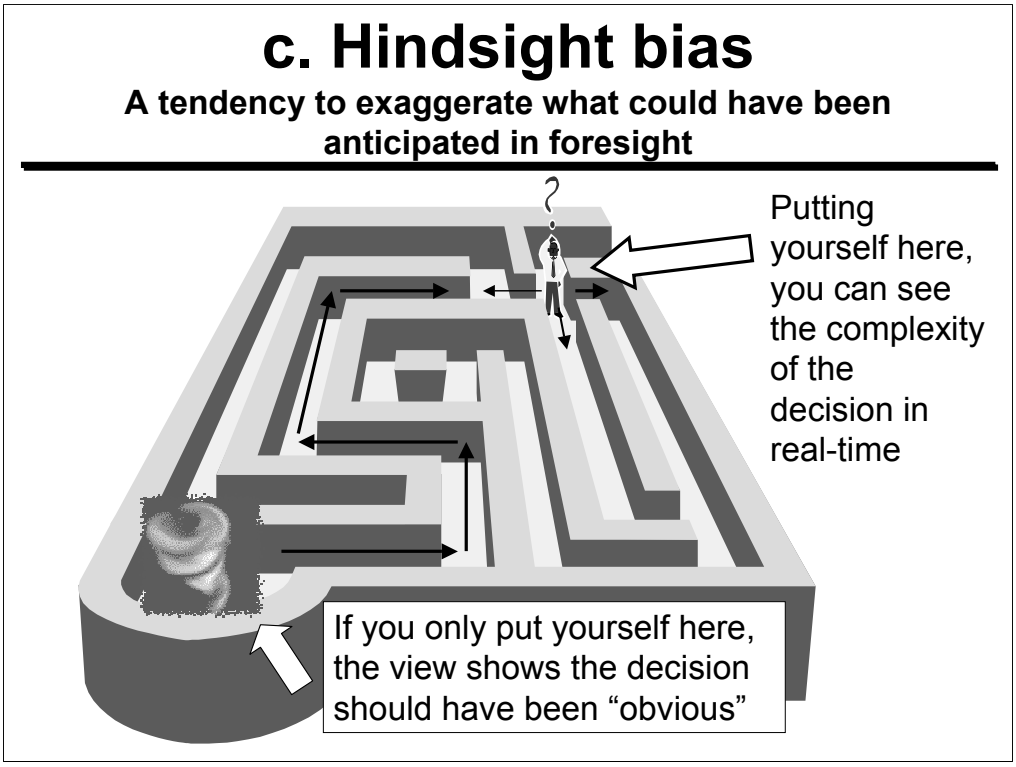
(upon hearing that a twin engine plane had crashed into the World Trade Center), “The President’s reaction was that the incident must have been caused by pilot error.”

9/11 Commission Report Staff Statement #17

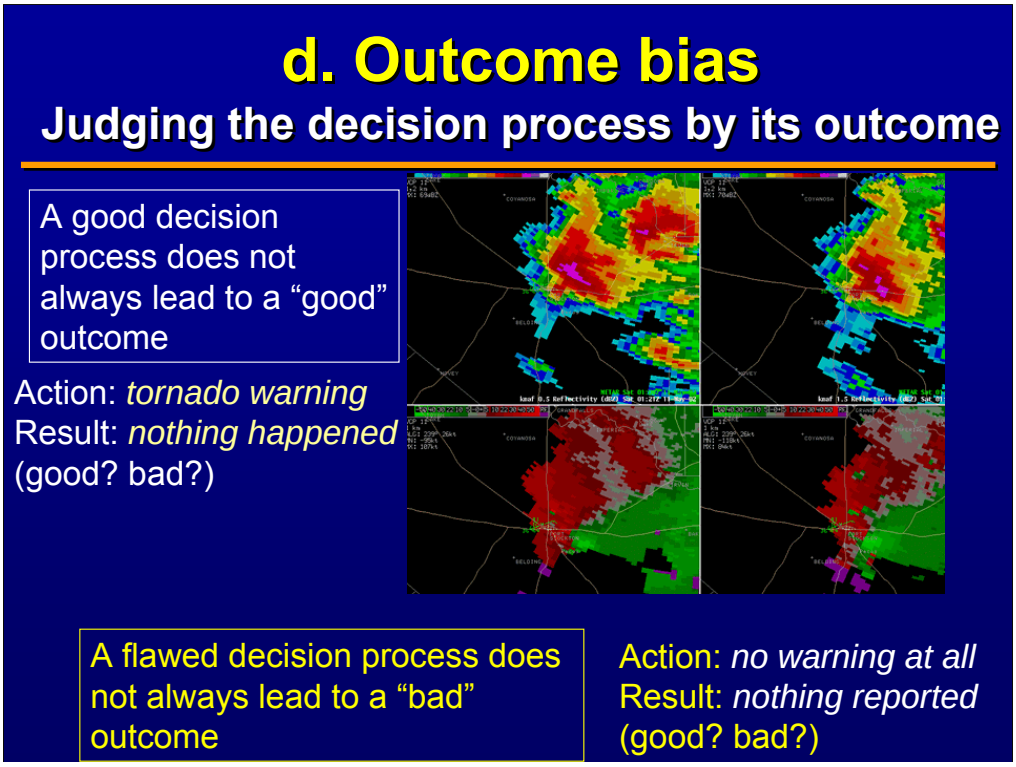
Far from being a compelling diagnosis, citing human error has often been used to direct blame. In reality, it is not an objective assessment and may actually keep an investigation from going any further. A “Heads will roll!” mentality. There is something in assigning “human error” which implies that 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

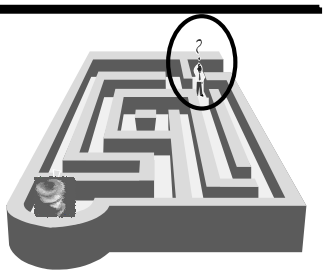
To affect outcomes, evaluate the process

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

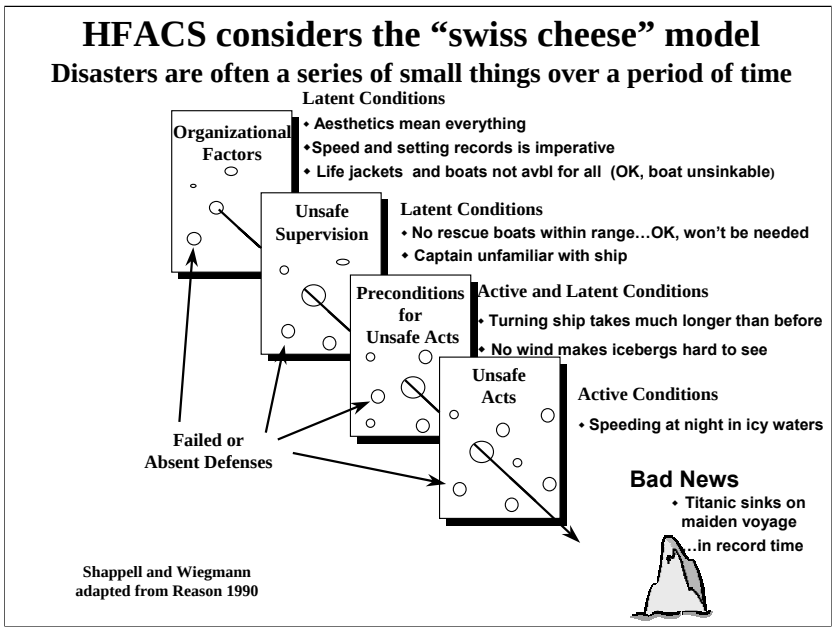
The aviation industry is looking at better ways to capture the "human factors" aspects of incidents. They've developed system called HFACS. This system assumes the following principles regarding all complex productive systems, many of which we've eluded to here today:

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.

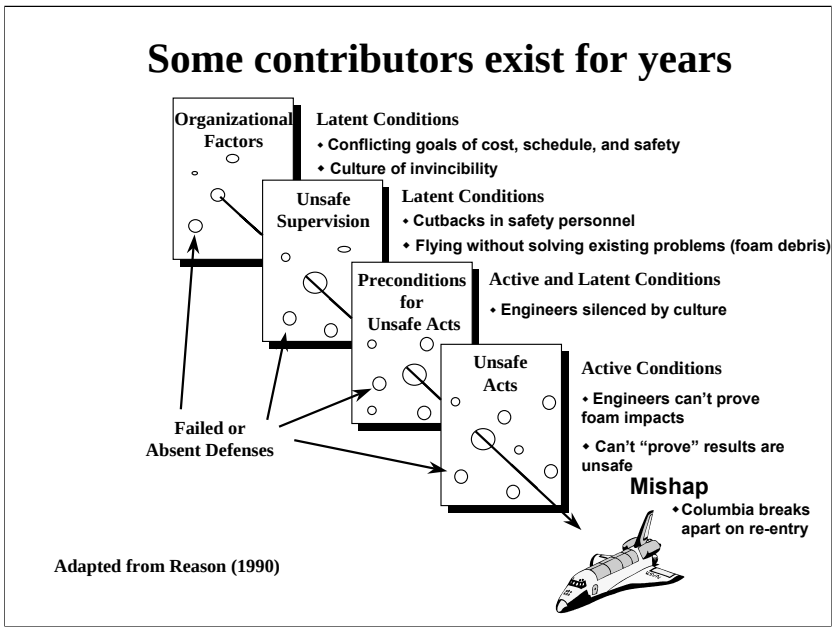
2) *Blaming an error on the decision maker is like blaming a mechanical failure on the hardware.* Decision makers often serve as the last barrier that stops a sequence of events from causing an accident. When errors do occur, they are often only a symptom of the system's underlying problem.

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.

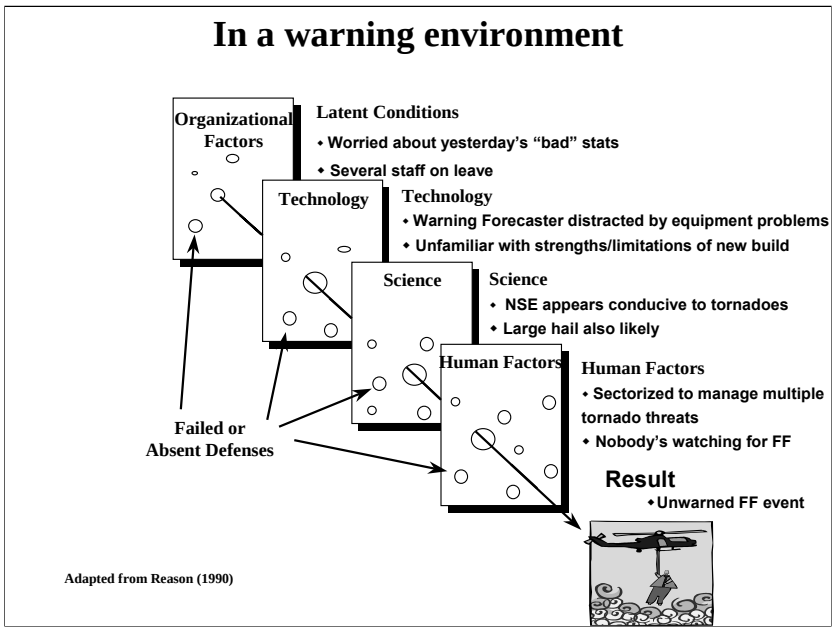
4) *Accident investigation and error prevention go hand-in-hand.* Searching for "why" an error occurred is not to reassign blame or liability, nor even to excuse the error, but to identify the underlying system deficiencies that might cause an accident to occur again. Prevention, not punishment, should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



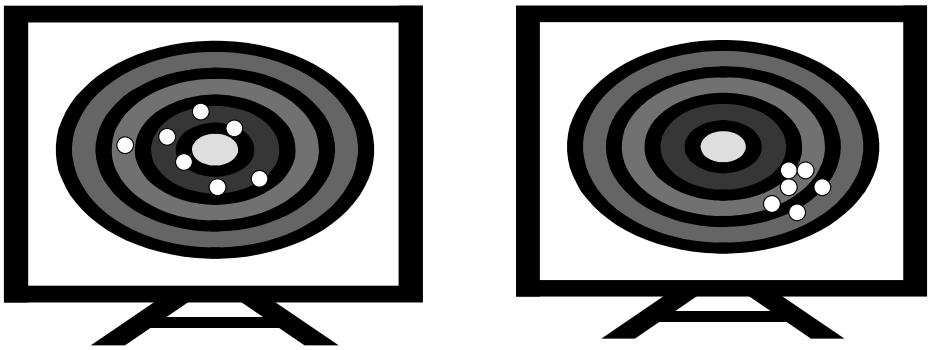
Another example can be gleaned from the final report on the Columbia mishap. Numerous latent conditions, many still in place after the Challenger investigation, were cited as contributors.



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



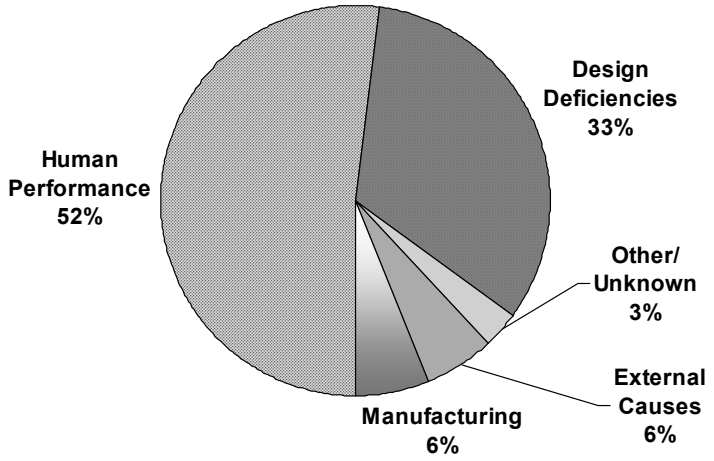
- When we miss the target, is the reason varied, or are we continually missing in the same direction?
- Identify trends
- Find relationships

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.

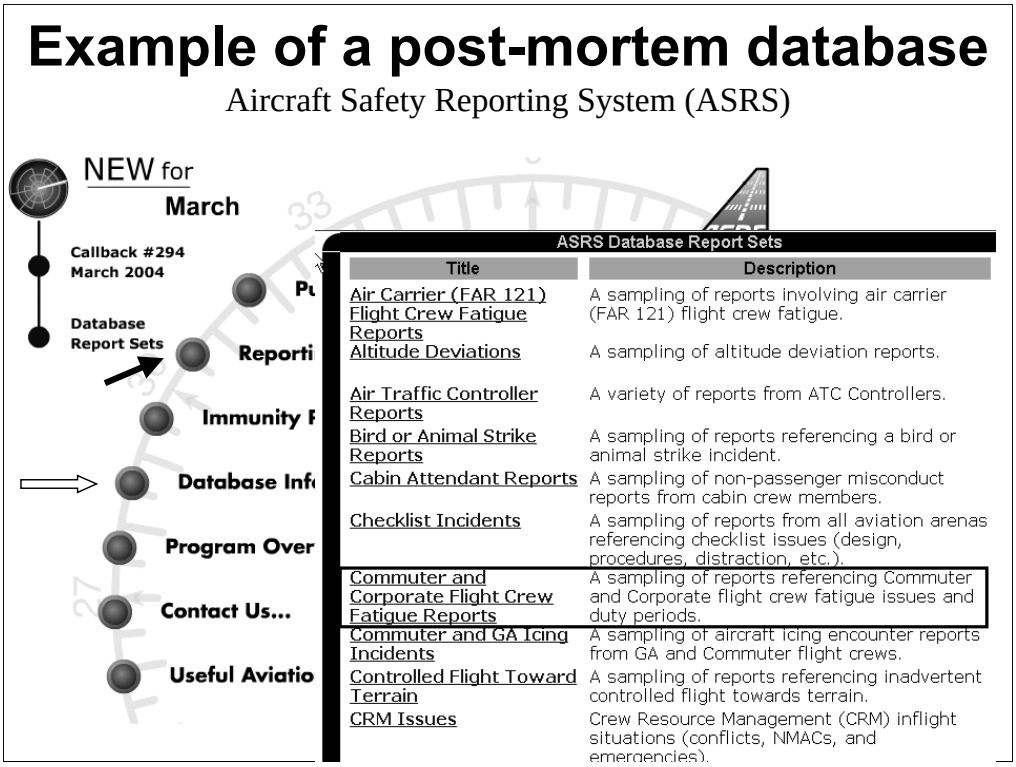
Insight from a post-mortem database

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

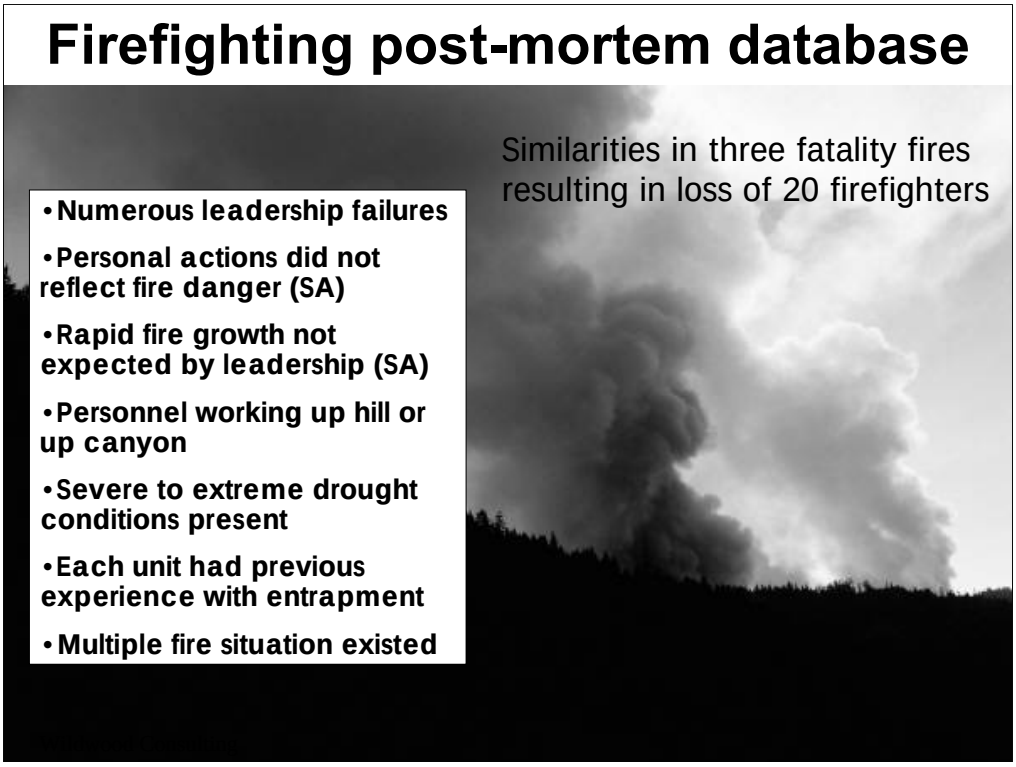
Narrative :

" 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.



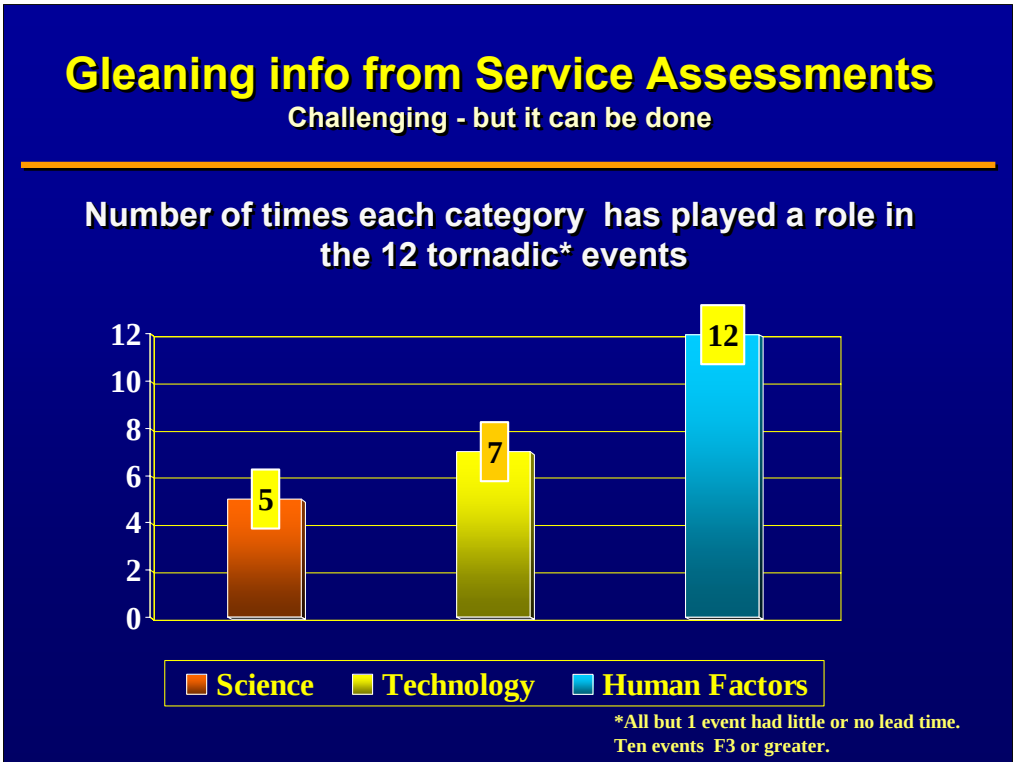
Here is a look at a limited number of wildfires, in particular those which resulted in fatalities amongst firefighters. In this case, we see what all the events had in common. All revealed because a database of incidents were looked at. By the way, your experiences in the warning environment may have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

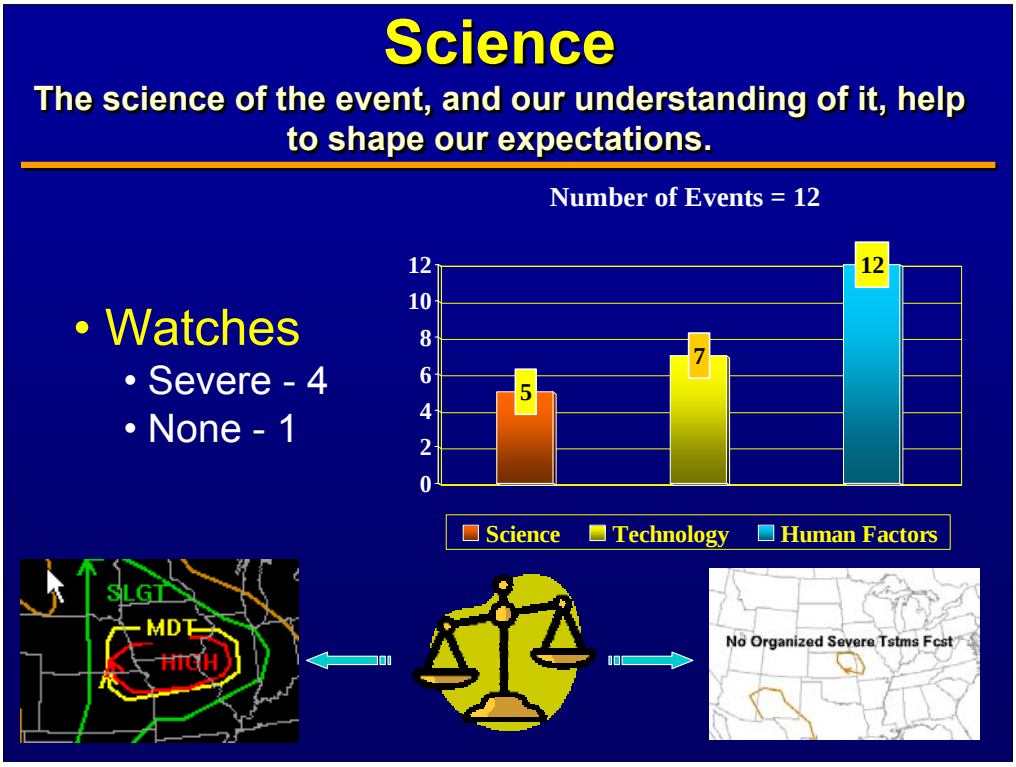
5. Methods of performing effective post-mortems

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

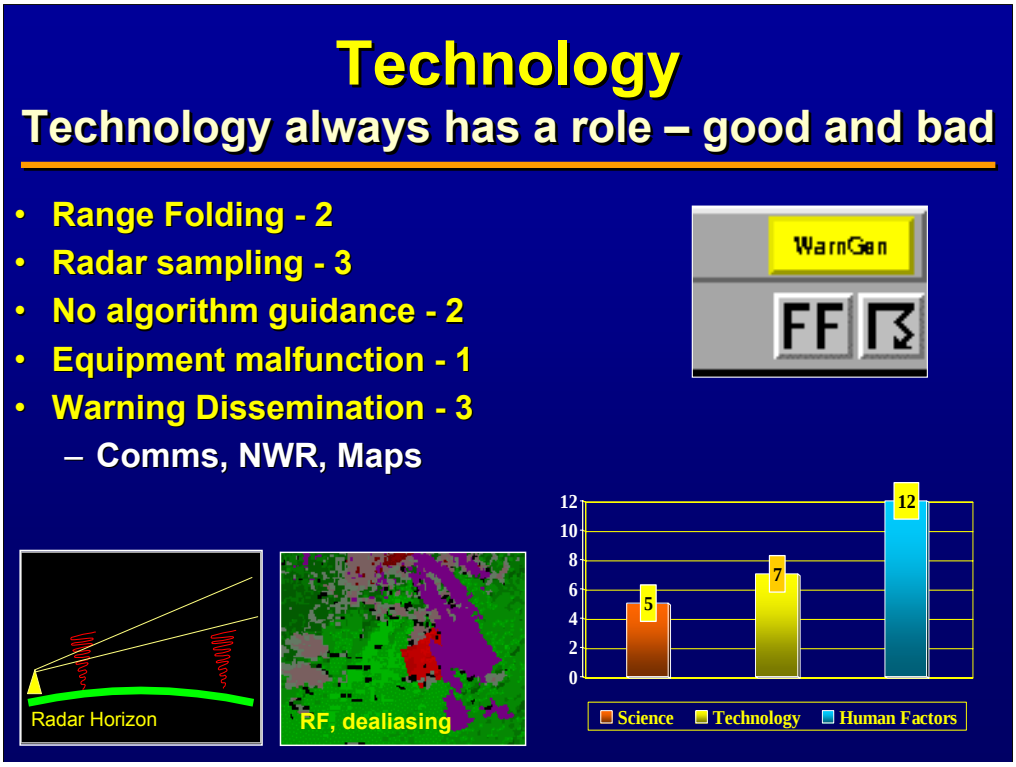
In this last section we'll look at post-mortems which are done in the NWS and suggest some additional possibilities. There currently is a variety of ways in which we examine events, varying considerably by region and by office.



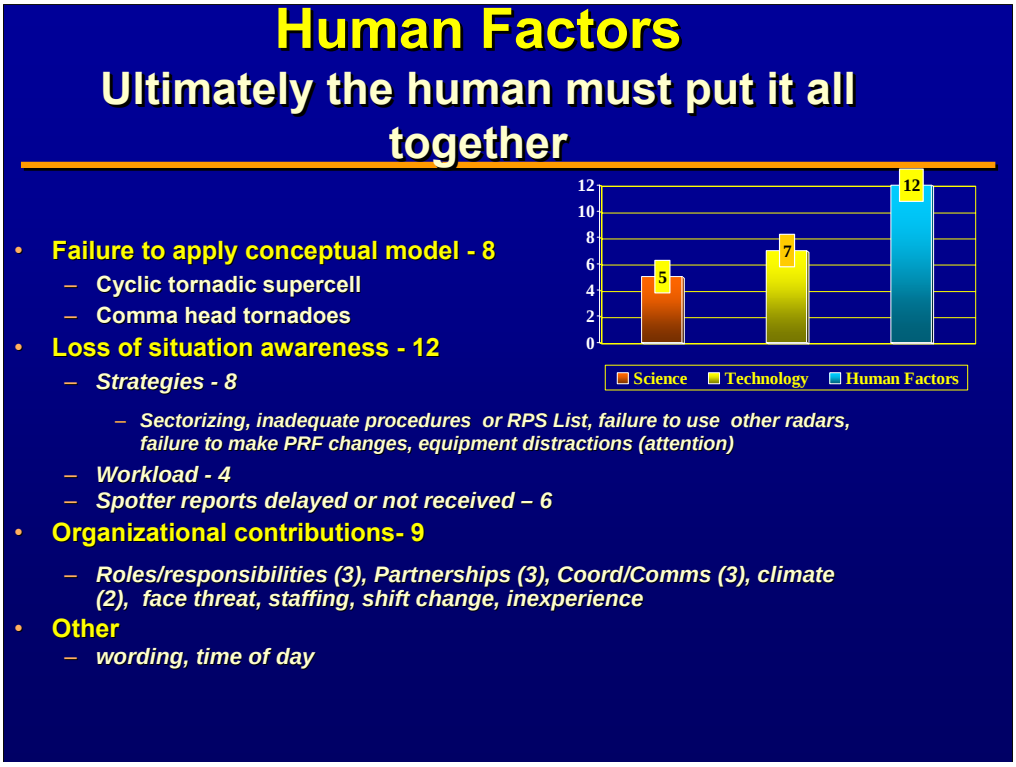
We can sort of glean database type of information from service assessments but it takes some doing. In this example, which many of you have seen before, the categories of contributors were analyzed by doing detailed studies of service assessments or interviews with those involved. From that effort, we 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.



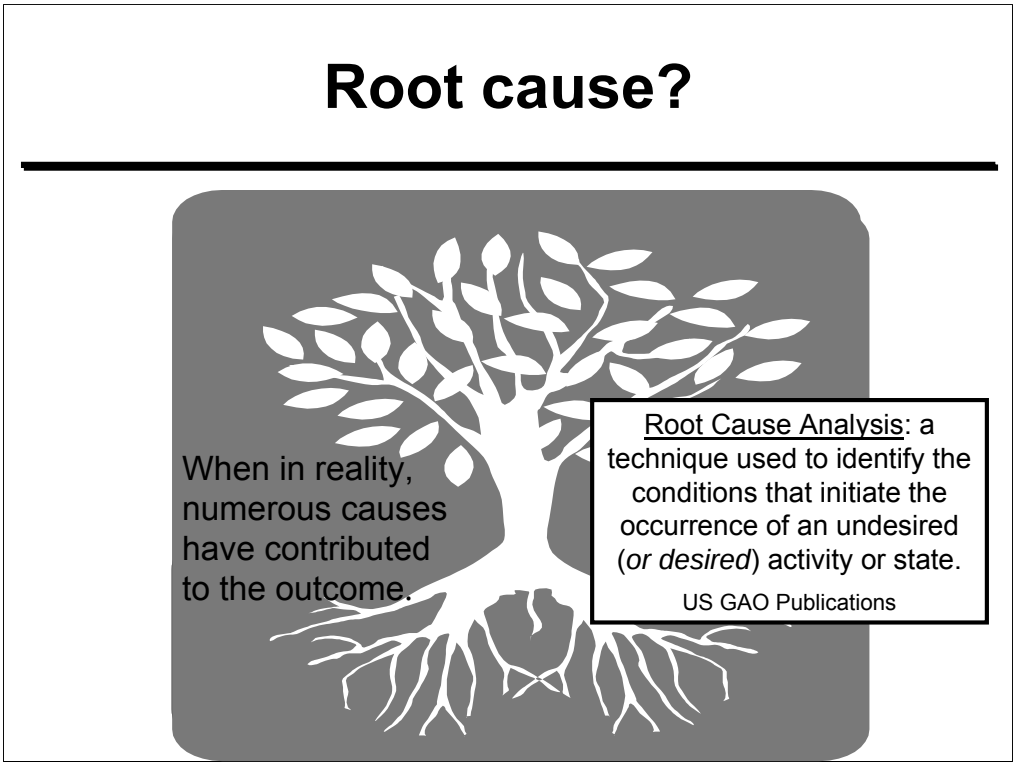
Specifically, the science contribution was reflected in the expectation of the day, with that ranging from no thunder to a high risk.



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?

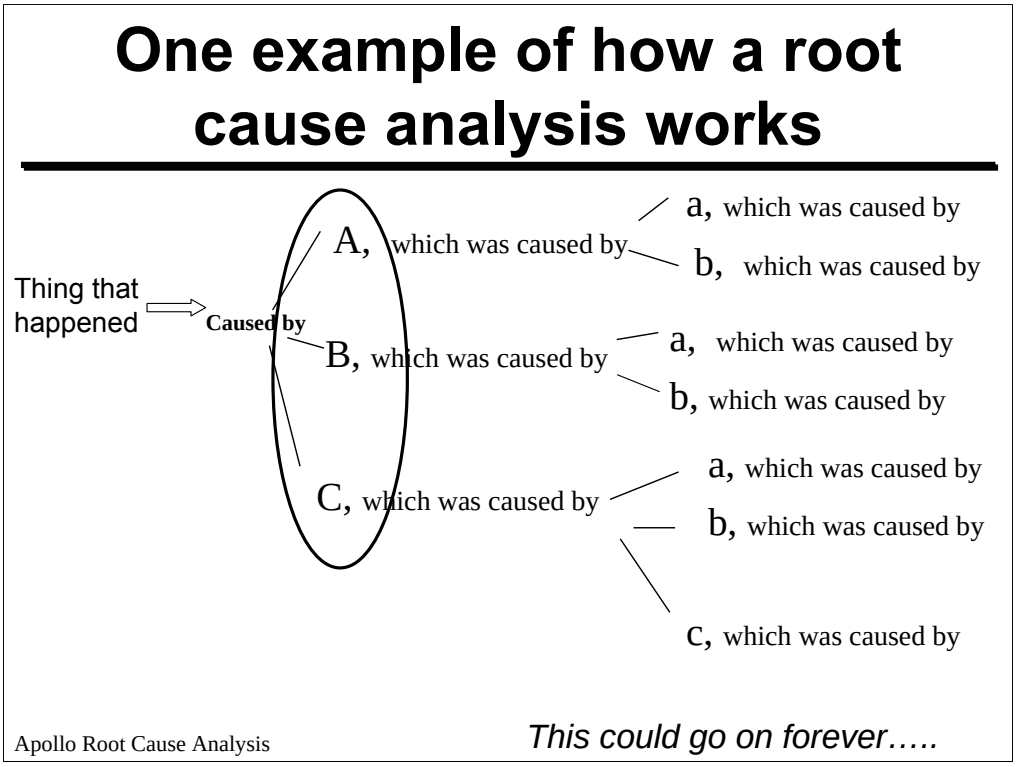
"...most of the root causes of a serious accident in complex technologies are present within the system long before the obvious accident ..."

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

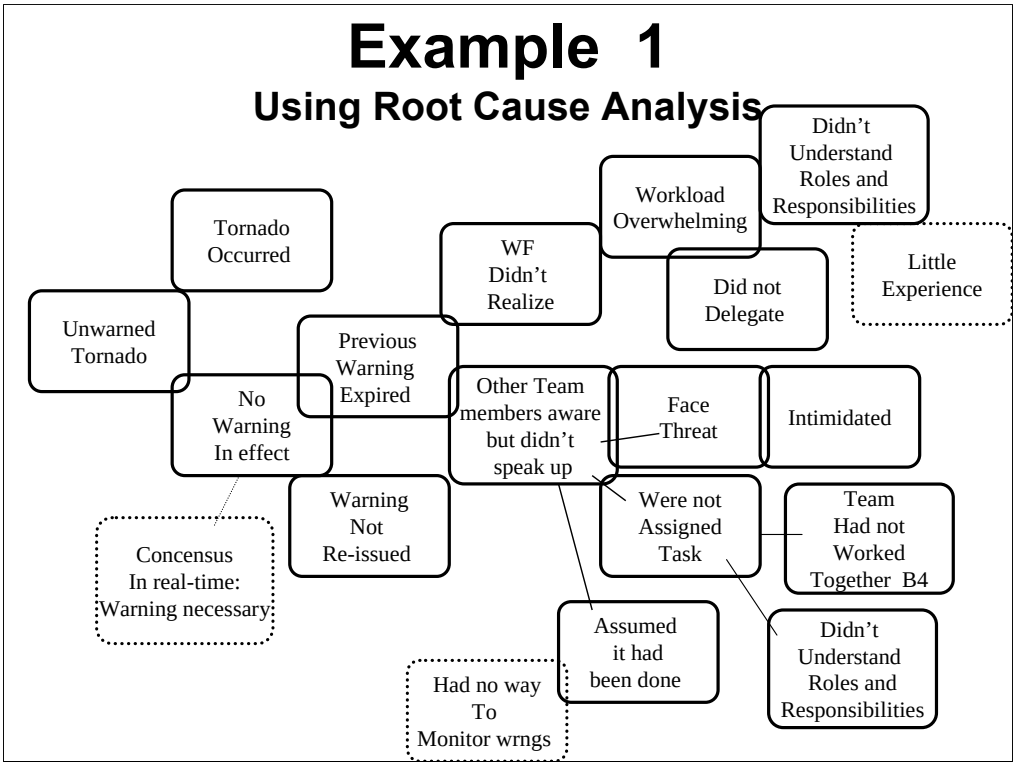
Warnings: 5 tornado, 25 severe, 2 flash flood. Average lead time 8 min. on tornadoes, 15 min. for severe, 45 minutes on flash flood. No lead time for county in which deaths occurred.

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

Systems: Functioning properly

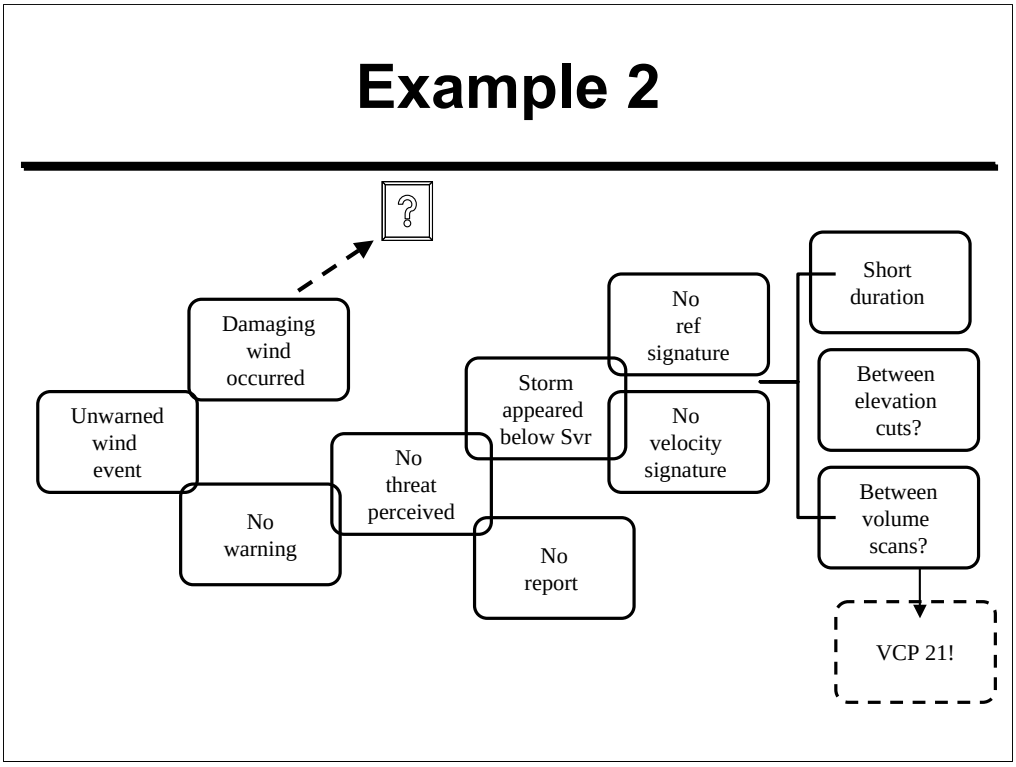
Response: Covered initially by local media. Damage survey team sent.

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.

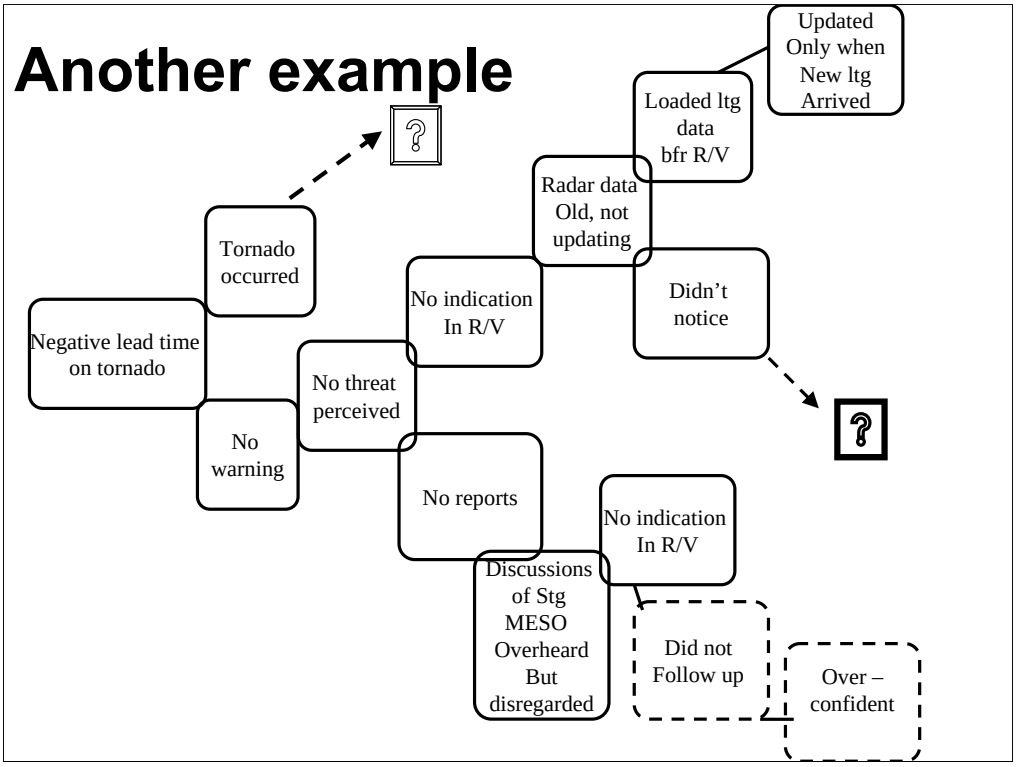


So we start with the "unwarned tornado". The two things which had to occur together for this to be an issue are: Tornado occurred AND no warning in effect. Change either of those and your outcome is different. As some information on the side, we see that there was an expectation by the team in this event 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.

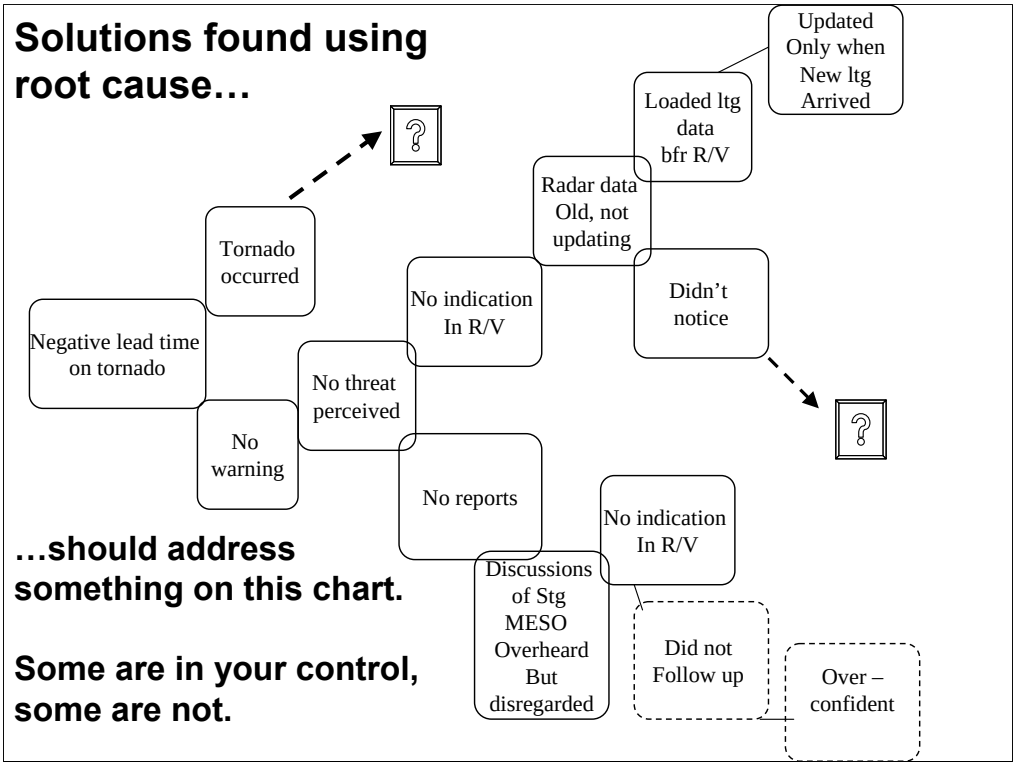
You can see the various contributors to the question as to why no warning was in effect. Included here are inputs from all team members which ultimately point to several factors, some technological, and several involving communication and roles and responsibilities. It is easy to see how this warning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

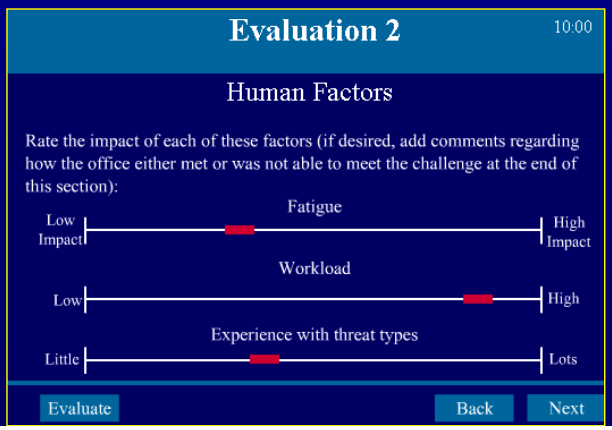
1. Using the template provided, perform a post-mortem on an event you worked
2. Using root cause structure, perform an analysis on one particular warning decision you made

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.

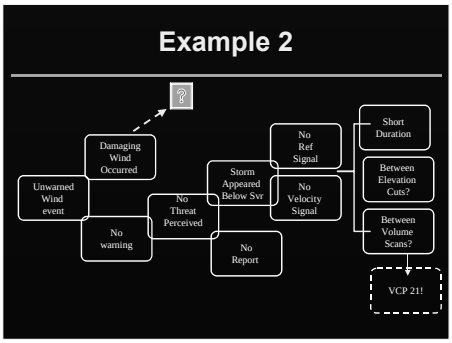
Every NWS office had a representative come to the Warning Decision Making IV workshops. Each contributed and refined the type of information they would want to see in post-mortem. This has been incorporated into a "Template" which you are to use for this exercise. Go to the web site as indicated by your 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.

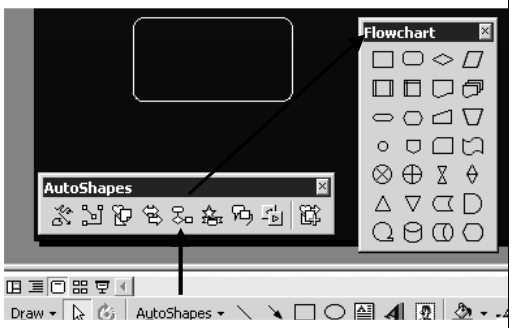
Assignment 2

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.

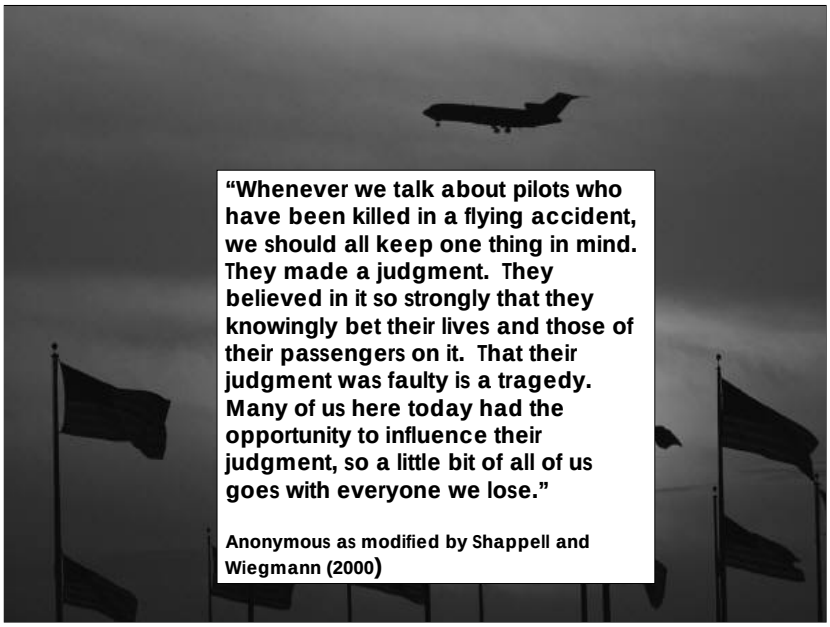
Assignment 3

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

References

Aviation Safety Reporting System, http://asrs.arc.nasa.gov/main.htm

Gano, Dean L. (1999) *Apollo Root Cause Analysis*. Yakima Wa: Apollonian Publications

Hammond, Kenneth (1996) *Human Judgment and Social Policy.* New York: Oxford University Press.

Reason, J. (1990) *Human Error*. New York: Cambridge University Press.

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Shappell, S., D. Wiegmann. (2000a). The Human factors Analysis and Classification System (HFACS). (Report Number DOT/FAA/AM-00/7). Washington DC: Federal Aviation Administration.

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Wood, David D., Johannesen, L., Cook, R., Sarter, N., *Behind Human Error: Cognitive Systems, Computers and Hindsight* (SOAR December 1994, from the Crew Systems Ergonomics Information Analysis Center). Wright-Patterson AFB, Columbus OH.

Expertise and Effective Office Warning Strategies

Advanced Warning Operations Course

IC Core 3

Lesson 4: Significant Event Management

Warning Decision Training Branch

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 4th lesson in the Expertise and Effective Office Warning Strategies instructional component.

Lesson 4:
Significant Event Management

Planning, Strategy, Expertise, and Innovation

Presented by:

William F. Bunting

WFO Fort Worth, TX

David L. Andra, Jr.

WFO Norman, OK

Learning Objectives

1. Understand meaning of the term "Significant Event"
2. Identify four elements important to managing Significant Events

The learning objectives for this lesson are testable and address the meaning of the term "significant event' and the four elements which are important to managing the event.

Performance Objectives

1. Given a hypothetical Significant Event, cite appropriate actions in each of the four elements

Keep this performance objective in mind with regard to an event you worked, or one that unfolds in the future.

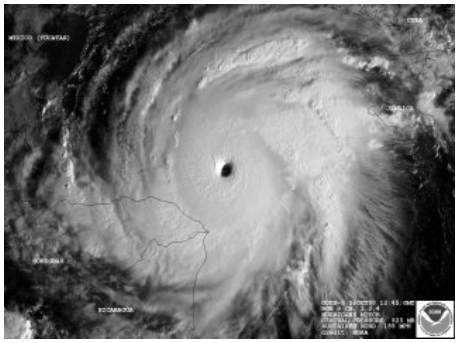
What is a Significant Event?

Significant event: Manmade or natural circumstance, often hazardous, dependent upon or sensitive to weather. Significant events usually affect large numbers of people, generate media interest, and their nature is such that the WFO has, or can quickly develop, meteorological expertise to provide service or mitigate hazard.

While virtually every event can be considered significant in some sense, the term is defined here to encompass more than traditional hydrometeorological events. Also, an increased level of external interest in, and scrutiny of, NWS performance accompanies significant events.

What is a Significant Event?

- Severe convective storms
- Tropical storms
- Winter storms
- Flooding
- Wild fires
- Extreme heat, cold, drought



Typical hydrometeorological causes of significant events.

What is a Significant Event?

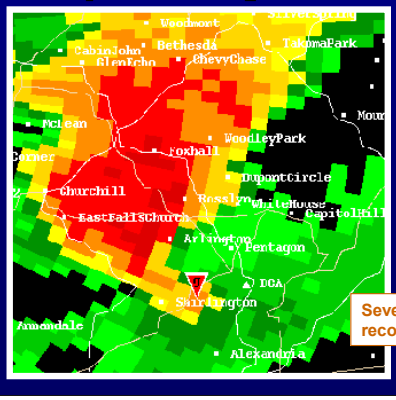
But also…

- Homeland security / terrorist acts
- Hazmat situations
- Accidents / disasters with national impact or mass casualties
  - Rescue and recovery

Though not as common, these non-traditional significant events require additional skill sets and are often unanticipated. Preparing for the possibility of such an event at a local office requires attention to four management elements described shortly.

Significant Event Management

The ability of you and your office to identify and manage a significant event has far-reaching consequences personally and to the agency.



Severe weather threatening Pentagon recovery operations after 9/11

One of the characteristics of a significant event is the scope of its reach. This factor alone will generate interest outside the norm and as a result in increase in workload and stress.

Management Elements

- Planning
  - *Think about and plan for the possibilities.*
- Strategy
  - *What is most important and how do we work efficiently?*
- Expertise
  - *The most important thing humans do!*
- Innovation
  - *Rare or high-impact events have special needs.*

Mount Saint Helens
USGS Photo by Austin Post

Planning sets the vision for an office to respond to a significant event, while strategy provides the details to accomplish that vision. Individual or office expertise defines the decisions and actions that provide valuable information to those at risk, and innovation addresses the ability to respond in often unique ways to unique circumstances.

Significant Event Management

The management elements rely on an ability to develop, maintain, and apply situation awareness.

NORAD Command Center
Courtesy NORAD

In other domains, significant events are expected and come with a higher level of mitigation efforts. The need for SA in these environments has led to technological solutions and operational practices aimed at keeping the big picture.

Significant Event Examples

and

Elements Important to Their Management

We will look at four examples of significant events. Two of these are meteorological in origin while the other two are not.

Example – Homeland Security April 19, 1995

- Unprecedented Terrorist Bombing
  - Destroyed Federal Building in OKC
  - Mass casualties
  - MDT risk of severe storms
  - Weather critical to rescue and recovery
    - Recovery about 1 month

Photo: www.whitehouse.gov

April 19th, 1995 began as a day where the possibility of severe weather was of prime concern to the local WFO. Within minutes, new priorities emerged, and requests for operational weather support for emergency responders were received.

Planning… *what was done*

The Oklahoma Department of Civil Emergency Management
After Action Report
Alfred P. Murrah Federal Building Bombing
19 April 1995 1995 in Oklahoma City, Oklahoma
Detailed Summary of Daily Activity

WEDNESDAY, APRIL 19, 1995

*** 0902 HRS: An explosion occurs in downtown Oklahoma City at the Alfred P. Murrah Federal Building. Oklahoma City Fire Station One responds immediately, reacting to the sound. Fire, emergency medical, and law enforcement personnel, American Red Cross Disaster workers, and civilians, enter the bombed structure without delay as they immediately initiate a massive search and rescue effort.**

*** 0904: The explosion is reported to the Oklahoma Department of Civil Emergency Management (ODCEM) by staff in the field. State agency liaison officers are requested to report to the SEOC immediately.**

*** 0920: The ODCEM Disaster Recovery Manager is dispatched to the scene. State agency liaison officers begin arriving at the SEOC.**

*** 0925: The SEOC is fully operational and State Director Tom Feuerborn orders 24-hour operations until further notice. Selected staff are sent home to report for the second shift beginning at 2400. Agencies initially represented in the SEOC include:**

- **ODCEM**
- **The Oklahoma Department of Public Safety**
- **The Oklahoma Military Department**
- **The Oklahoma Department of Human Services**
- **The Oklahoma Department of Health**
- **The Oklahoma Department of Education**
- ***The National Weather Service***
- **The Civil Air Patrol**

✓ **Well established relationship with state EOC**

NWS offices typically have excellent working relationships with local emergency management officials. Developing those same relationships with state officials is an important aspect of responding to larger-scale or prolonged events. It wasn't long into the events of April 19th, that the NWS was called to be a part of the operations center.

Planning… *what could be done*

- Strengthen relationships will all levels of EM
- Have disaster plan to cooperate with external organizations and agencies

- Planning
- Strategy
- Expertise
- Innovation

4/19/95

U.S. Department of Homeland Security
Washington, D.C. 20472

Federal Emergency Management Agency
Directives Management System

FEMA

FEDERAL PREPAREDNESS CIRCULAR

	Date	Office
FPC 65	June 15, 2004	**Office of National Security Coordination**

TO: HEADS OF FEDERAL DEPARTMENTS AND AGENCIES

SUBJECT: FEDERAL EXECUTIVE BRANCH CONTINUITY OF OPERATIONS (COOP)

1. **PURPOSE:** This Federal Preparedness Circular (FPC) provides guidance to Federal Executive Branch departments and agencies for use in developing contingency plans and programs for continuity of operations (COOP). COOP planning facilitates the performance of department/agency essential functions during any emergency or situation that may disrupt normal operations.

Emergency management organizations are one of several groups with whom offices work during significant events. Attending multi-jurisdictional and regional planning meetings will help promote awareness of NWS services and capabilities, and an understanding of the needs of other agencies and groups in the event of a disaster.

Strategy… *what was done*

- Modified staffing on-the-fly to send senior forecaster to EOC
- Established email link to EOC

- Planning
- Strategy
- Expertise
- Innovation

4/19/95

In some cases, local officials may want an NWS staff member on site to provide briefings and to answer specific questions. In extreme cases, this may last several days or weeks. On April 19th, an NWS forecaster was on-site at the Multi-Agency Command Center around the clock for nearly 2 weeks.

Strategy… *what could be done*

- Have standing team/pool of forecasters ready for disasters
- Staffing policy in place
- Redundant means of communication in place

- Planning
- Strategy
- Expertise
- Innovation

4/19/95

Expertise… *what was done*

- Onsite briefings concerning weather elements important to rescue and recovery
- Personal phone briefings 24 x 7 for FEMA onsite coordinator

- Planning
- Strategy
- Expertise
- Innovation

4/19/95

Expertise… *what could be done*

- Interagency training to integrate forecasters into emergency management command structure
- Training and exercises to improve our understanding of EM needs

- Planning
- Strategy
- Expertise
- Innovation

4/19/95

Innovation… *what was done*

- Establish email link to EOC
- Segment the NOW to contain section in support of rescue recovery efforts
  - On NWR
  - Very specific and quantitative
  - Updated very frequently

- Planning
- Strategy
- Expertise
- Innovation

4/19/95

Innovation… *what could be done*

- Specialized numerical modeling
- Graphical forecasts / warnings
- Deliver information friendly to mobile technologies
- Develop portable workstation and briefing computer

- Planning
- Strategy
- Expertise
- Innovation

4/19/95

Example – Killer Tornadoes May 3, 1999

- Record outbreak of violent tornadoes
  - Most costly in U.S. history
  - 42 fatalities
- Day began with SLGT risk

The May 3rd Outbreak only became an “outbreak” in hindsight. As the day unfolded, it only gradually turned into a significant event.

Planning… *what was done*

- Well established spotter networks and EM contacts
- Extensive preparedness and outreach efforts

An Introduction to Storm Observation and Reporting

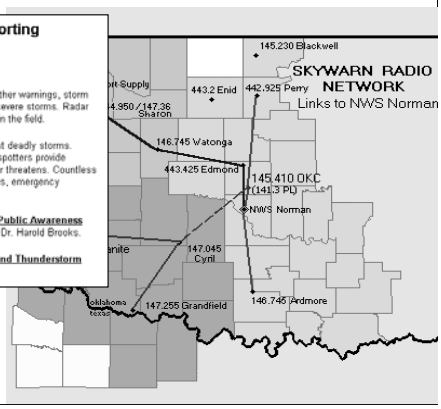
National Weather Service Norman, Oklahoma

Even with all the technology used by the National Weather Service to prepare severe weather warnings, storm spotters still give us the most complete picture of what's really happening in and around severe storms. Radar simply cannot tell us everything we need to know. Storm spotters are the eyes and ears in the field.

For more than 60 years, storm spotters have been the Nation's first line of defense against deadly storms. Working with their local communities and with the local National Weather Service office, spotters provide invaluable assistance and critical information to decision makers when hazardous weather threatens. Countless lives have been saved because of this unique partnership between volunteer storm spotters, emergency management and the National Weather Service.

For more information on the history of storm spotters, please read **Storm Spotting and Public Awareness Since the First Tornado Forecasts of 1948** by Dr. Charles Doswell III, Alan Moller, and Dr. Harold Brooks.

For basic information on becoming a spotter, please read **Getting Started in Tornado and Thunderstorm Spotting** by Dr. Keith Brewster.



- Planning
- Strategy
- Expertise
- Innovation

5/3/99

Planning… *what could be done*

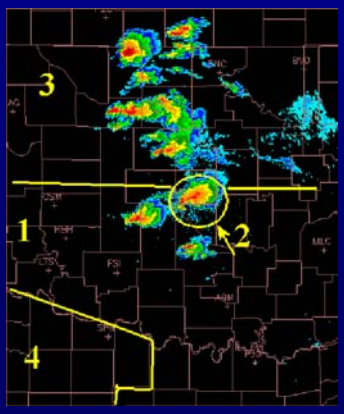
- Improve WARNGEN templates for high end outbreaks
- Establish coordinator staffing
- Identify methods to convey unusually high threats

- Planning
- Strategy
- Expertise
- Innovation

5/3/99

Strategy… *what was done*

- Sectored warning operations
- Focused on severe weather information flow almost exclusively
- Called in off duty personnel
- Monitored one TV channel



- Planning
- Strategy
- Expertise
- Innovation

5/3/99

Sectored operations helped distribute workload and was an important strategy which allowed forecasters to focus on information flow to the public.

Strategy… *what could be done*

- Develop technology and behaviors to improve SA
  - Product management
  - Manage information important to decision making
- Identify means to streamline preparation of routine products

- Planning
- Strategy
- Expertise
- Innovation

5/3/99

Expertise… *what was done*

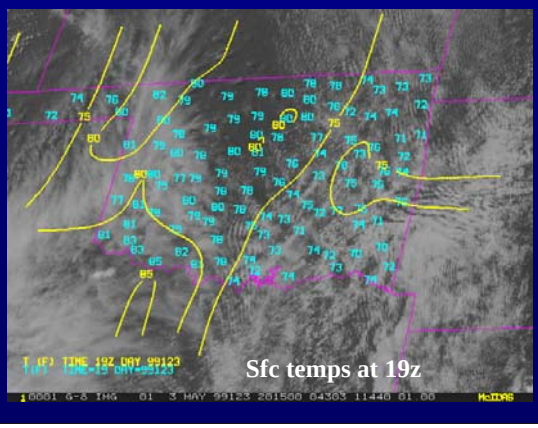
- Extensive training related to severe storm identification and warning operations

- Planning
- Strategy
- Expertise
- Innovation

5/3/99

Expertise… *what could be done*

- More specific information regarding path, timing, degree of threat
- Incorporate more near storm environment



Sfc temps at 19z

- Planning
- Strategy
- Expertise
- Innovation

5/3/99

Innovation… *what was done*

- Established ad-hoc coordinator
- Conceived and sent statements with unique phrases to draw attention to unusually high threat

SEVERE WEATHER STATEMENT
NATIONAL WEATHER SERVICE NORMAN OK
731 PM CDT MON MAY 3 1999

...LARGE DAMAGING TORNADO MOVING THROUGH OKLAHOMA CITY METRO...

A LARGE TORNADO HAS CAUSED EXTENSIVE DAMAGE IN SOUTHERN PORTIONS OFTHE OKLAHOMA CITY METRO AREA. AT 731 PM THE TORNADO WAS ENTERING SOUTHERN OKLAHOMA COUNTY JUST EAST OF INTERSTATE 35 AND SOUTH OFCROSS ROADS MALL. PERSONS IN SOUTHEAST OKLAHOMA CITY AND MIDWEST CITY ARE IN DANGER! IF YOU LIVE NEAR THESE AREAS TAKE IMMEDIATE TORNADO PRECAUTIONS! THE TORNADO WAS MOVING NORTHEAST.

THIS IS AN EXTREMELY DANGEROUS AND LIFE THREATENING…

- Planning
- Strategy
- Expertise
- Innovation

5/3/99

Innovation… *what could be done*

- Develop technology to improve SA (TV, environment, warnings, etc.)
- Develop product to convey specialized information to advanced customers (media, EM)
- Develop means to graphically convey threat on storm scale
- Improve ability to disseminate information to mobile users

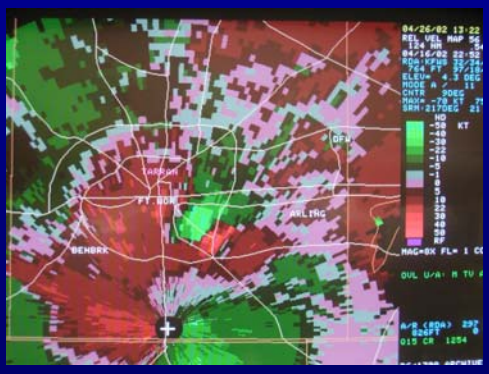
- Planning
- Strategy
- Expertise
- Innovation

5/3/99

Technology

- Situation Awareness Display System
  - Off-the-shelf hardware
  - Local software
  - TV, mapping, product status, objective analyses
  - Configured through AWIPS GUI
  - Cost about $15K

Example: F3 Tornado April 16, 2002



- F3 tornado in east Fort Worth
- Early morning expectations: mainly morning thunder; no severe thunderstorms
- SPC risk: general thunder (high risk in central and northern plains)
- Main challenges: modify initial conceptual model, ramp up warning operations, tornado in a highly populated area

Like many severe weather events, this one unfolded in a dramatically different fashion than initially anticipated. Experience suggests that forecasters must be willing to modify or change conceptual models as events unfold. Having the proper conceptual model influences not only the forecast and warning process, but also staffing decisions and work assignments.

Planning… what was done

- Good working relationships with local emergency officials
- Good information flow via phone, pagers, Internet, and weather radio

- Planning
- Strategy
- Expertise
- Innovation

4/16/02

Planning… what could be done

- Continued training on recognizing subtle clues to developing severe weather potential
- Develop even faster ways to communicate with local officials (instant messaging, hotline phones or radio systems)

- Planning
- Strategy
- Expertise
- Innovation

4/16/02

Strategy… what was done

- Once threat determined, rapid spin up for warning operations accomplished
- Coordinator appointed immediately
- Local television monitored for live video
- Very frequent SVSs updating position and damage
- Live broadcasts on weather radio updating storm location

- Planning
- Strategy
- Expertise
- Innovation

4/16/02

Strategy… what could be done

- Develop software to automate many internal tasks (logging calls, reports, briefings, etc.)
- Develop SA display to provide basic information to all members of warning team
  - Storm information (radar)
  - Warning information (AWIPS local warnings plot)
  - Report information (AWIPS plot or local software)

- Planning
- Strategy
- Expertise
- Innovation

4/16/02

Expertise

- Forecaster ability to recognize imminent potential for storms despite current expectations
- Need to transfer this expertise to all WFO staff through post-mortems, WES cases, and other training

- Planning
- Strategy
- Expertise
- Innovation

4/16/02

Innovation

- SA Display that can be viewed from within operations area
- Provides “big picture” overview of state of warning operations
- Effective as a briefing tool and also for media interviews

- Planning
- Strategy
- Expertise
- Innovation

4/16/02

Example: Shuttle Columbia Disaster – Feb. 1, 2003

- Space Shuttle Columbia breaks up en route to landing in Florida
- No significant weather forecast
- Routine shift staff on duty
- Challenge: what should Lead Forecaster do upon hearing the news?

Our last example occurred on a weekend with routine weather staffing.

Planning

- Lead forecasters given authority to use judgment and discretion in unusual situations

- Planning
- Strategy
- Expertise
- Innovation

2/1/03

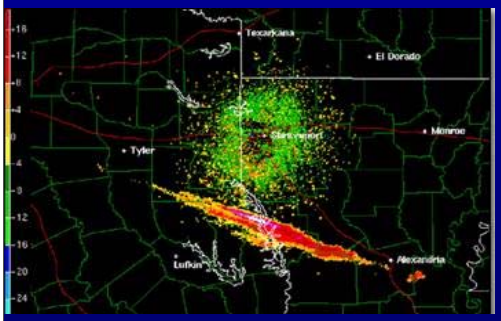
Planning… What could have been done

- Develop guidelines and recommendations for office actions during non-weather significant events
- Conduct training to develop expertise in responding to these events and understand needs of emergency responders

- Planning
- Strategy
- Expertise
- Innovation

2/1/03

Strategy



- Lead forecaster treated situation as a severe weather event
- Extra staff called in
- Media briefings
- Supplemental sounding
- CEM issued due to danger from debris
- Phone and on-site support for 3 weeks

- Planning
- Strategy
- Expertise
- Innovation

2/1/03

Expertise

- Recognition that a tragic event was unfolding and that the WFO was now part of this event

Civil Emergency Message
NWS Fort Worth TX
11 am CST Sat Feb 1, 2003

The following information is being transmitted at the request of the Texas Division of Emergency Management.

Citizens are advised not to touch or remove any debris from the space shuttle that may have landed in their area. Some of the debris contains materials that may be hazardous. If you find debris from the shuttle, contact local law enforcement immediately.

- Planning
- Strategy
- Expertise
- Innovation

2/1/03

Innovation

- Recognition that supplemental sounding may assist in predicting debris trajectories and keeping HMT past shift to release balloon

- Planning
- Strategy
- Expertise
- Innovation

2/1/03

Innovation …what has been done

- Prepare WFO staff to respond to hazmat or homeland security events through:
  - Incident Command System training
  - Dispersion forecasting and modeling (including available tools)
  - Weather information needs of first responders
  - Dispersion characteristics in urban or complex terrain areas
  - Media interview training

- Planning
- Strategy
- Expertise
- Innovation

2/1/03

Most of these skill sets have traditionally not been provided to WFO forecasters. By learning the “language” of emergency responders and understanding their information needs, a WFO is better positioned to respond to any crisis.

Significant Events: Operational Actions

- Anticipation
  - Correct conceptual model, updated continuously
  - Early transition to event operations (including staffing)
- Coordinator position
  - Removed from specific tasks; maintains “big picture SA”
- Appropriate staffing
  - Sectorized warning operations
  - Workflow management using defined roles and responsibilities
- Use of all available information
  - Workstation displays, integration of all datasets into decision process
  - SA display systems

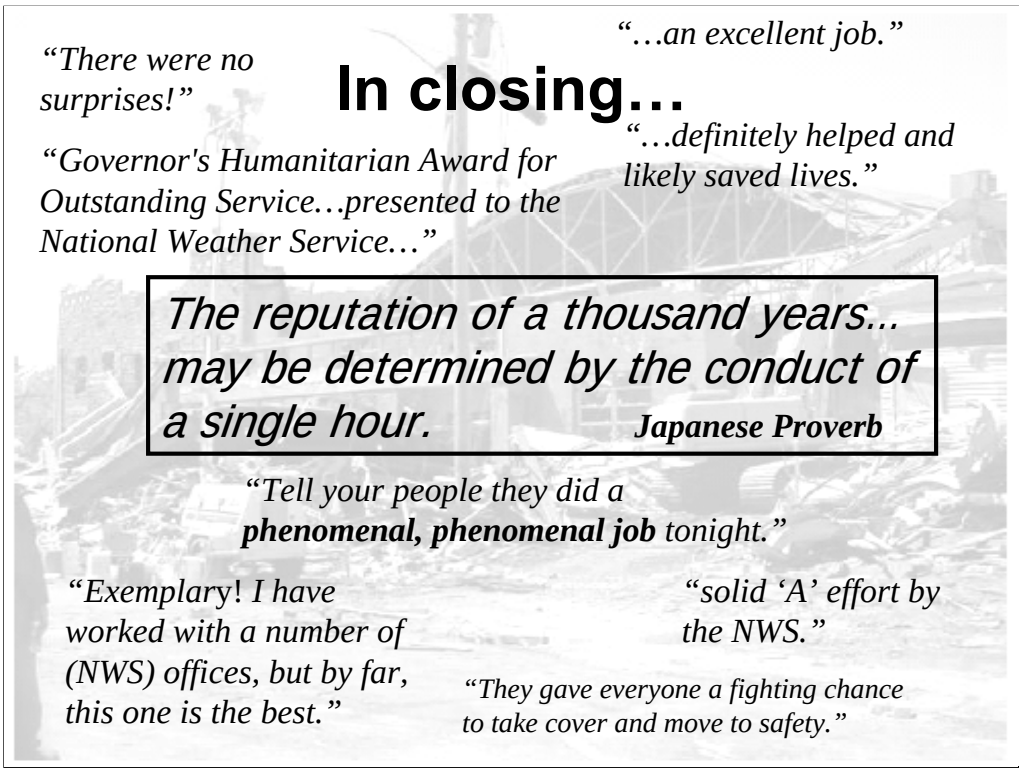
Through many discussions with WFO staffs nationwide, operational problems during significant events can often be traced to improper anticipation, slow transition to event operations and staffing, or workflow and information management. It is important to recognize these key decision areas, and to develop strategies that ensure proper response.

Significant Events

- Responding to significant events requires
  - Individual expertise and SA
  - Office organizational characteristics that foster good team SA and successful response
  - A willingness to learn from each event to reinforce what worked, and to identify solutions to problems that prevent optimum performance

IMET conducting a daily briefing, (Photo courtesy WFO Missoula)

Earthquake response team. (Photo courtesy FEMA)



As is indicated by this proverb, years of doing a great job at routine operations can be completely overshadowed by actions in response to an unanticipated event in a short amount of time. The ability to recognize a significant and ramp up accordingly is a challenge continually faced at an FO. Hopefully, your actions will be reflected in these actual quotes, which are in stark contrast to the ones you saw in Lesson 3.

Questions?

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

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