



Expertise and Effective Office Warning Strategies

Advanced Warning Operations Course

IC Core 3

Lesson 1: Expertise



Warning Decision Training Branch

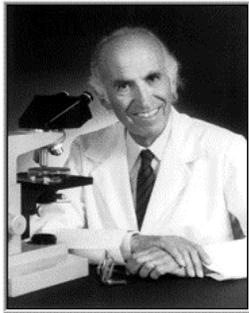
IC Core 3 will begin with a discussion of Expertise. It will be important to understand what we mean by this term in order to appreciate its value throughout the remainder of this IC.

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)

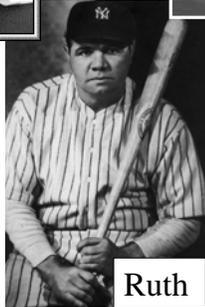
Lesson 1: Expertise



Barton



Churchill



Ruth



Yeager

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. The 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.

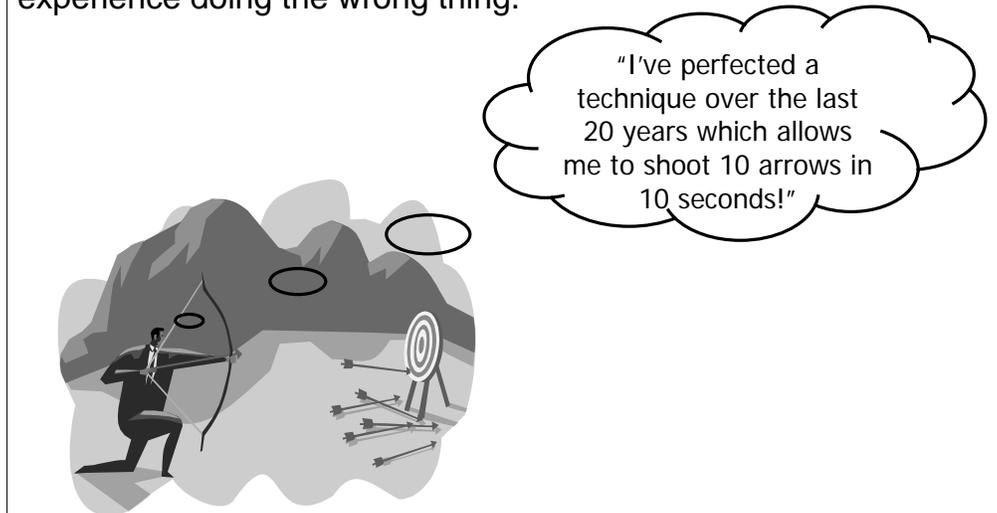
What is an Expert?

- 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.

Experience vs Expertise

It could be that someone has a great deal of experience doing the wrong thing.



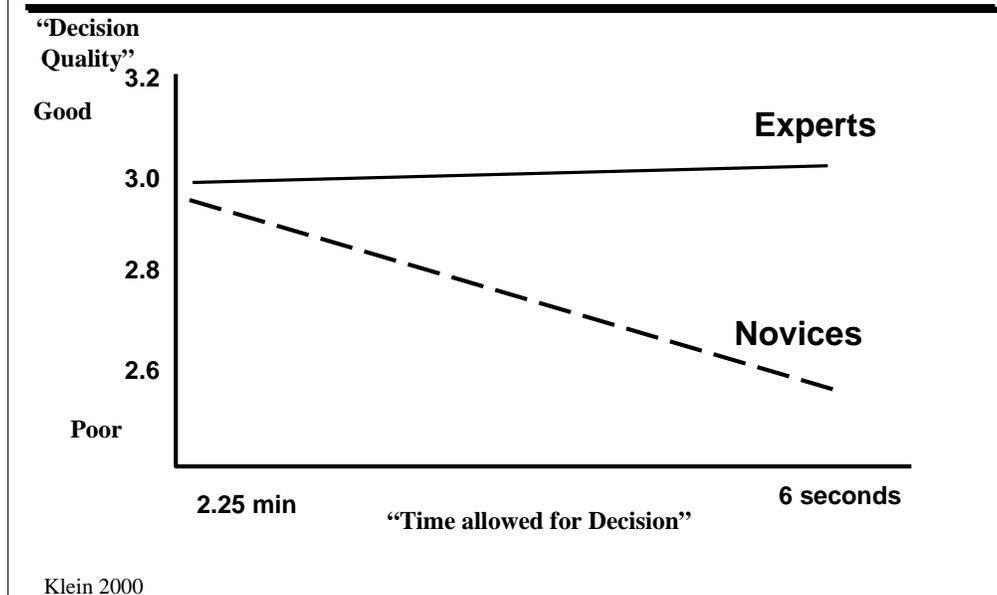
First we should stress that experience alone does not guarantee one develops expertise. This guy is fast but is he really good? Perhaps he's good at being fast but that's about it. This person in a forecast office may always get the products out on time but their content leaves something to be desired. 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 under pressure



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?

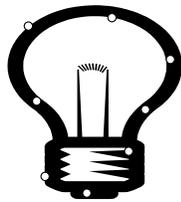
1. Recognize patterns
2. Detect anomalies
3. Keep the big picture (SA)
4. Understand the way things work
5. Observe opportunities, able to improvise
6. Relate past, present, and future events
7. Pick up on very subtle differences
8. Address their own limitations

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

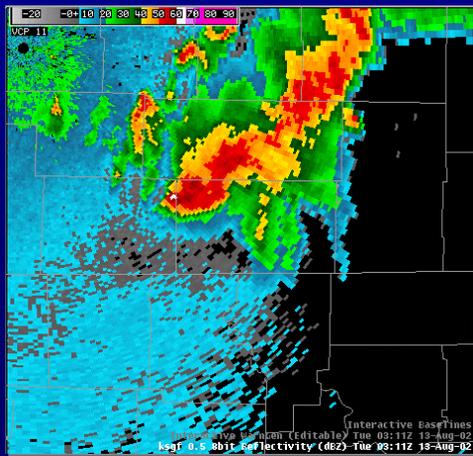
- Fireground commanders
 - Look at burning building and can infer what's happening inside. They relate cause and effect by connecting the dots.



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

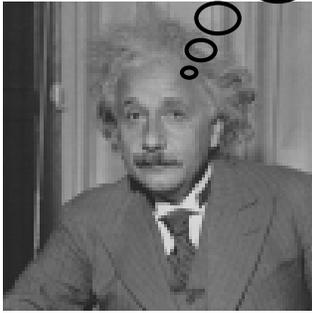
Most experts in the warning environment recognize those patterns using base data. That may mean hi-res velocity and reflectivity data, or mesonet observations, or upper air analysis, or live TV video. They get to the data which has gone through the least amount of processing.

2) Experts detect anomalies

Including: Erroneous events and Missing events

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“There seems to be a problem on line 4.”



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.

8) Experts address their own limitations

- See inward – thinking about thinking
 - Have good SA and can tell when losing it
 - Perform self evaluation
 - Personal post-mortems
 - Modify strategy when necessary
 - Work around memory limitations

“An error doesn’t become a mistake until we refuse to correct it.”

Orlando A. Battista



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



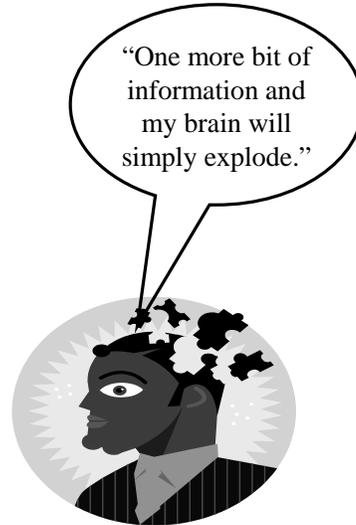
- Plane ascending through 24Kft
- Alarm triggered: “ovht eng pressure”
- Additional alarm: “eng 1 oil pressure”
- Alarms continue – a total of 54 alarm messages will be received
 - Many conflicting
 - Crew lead to suspect #1 engine is the problem
- Pilot enlists help of 2 additional off-duty pilots
- 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.

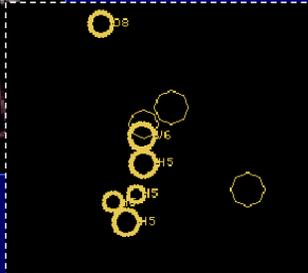
Interactions with automation can hinder expertise

2. Slow the rate of learning

- Can't make connections between guidance and data
- Auto-pilot mentality



“Who am I to argue with a TVS detection?”



“One of the consequences of automation...is that operators become de-skilled in precisely those activities that justify their existence.”

Reason, *Human Error*

When the automation does not provide a means for the user to evaluate its validity, it can actually reduce the decision makers confidence in 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

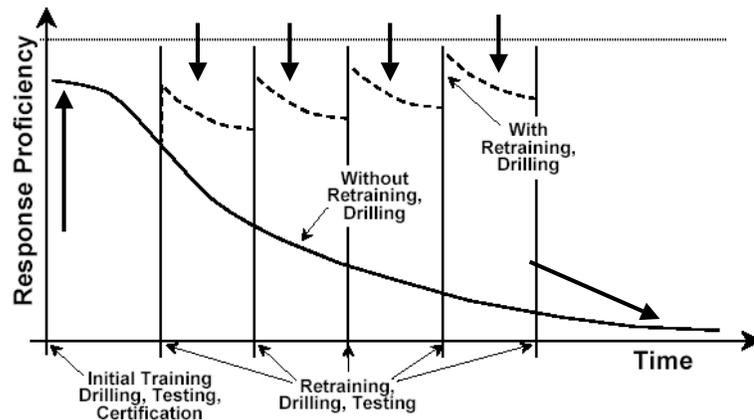
So what do we do? The process by which we assess, understand, and evaluate our decisions is very important. Automation, operations, and training which support the efforts to develop skills in pattern recognition and aid in constructing conceptual models are important. These efforts should also focus 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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Aviation Safety Network, <http://aviation-safety.net/index.shtml>

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