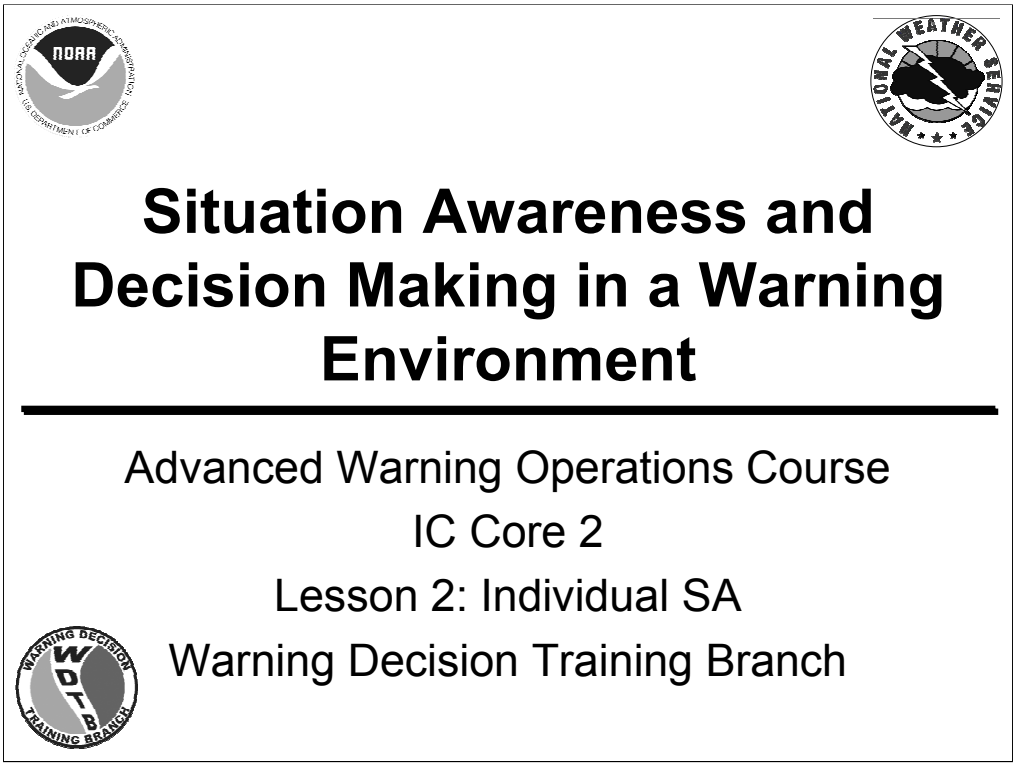


Lesson 2 will focus on the Situation Awareness (SA) of an individual. This lesson will take a look at the three different levels of SA, as well as examples of failures at each level.

Lesson 2: Individual SA

Learning Objectives

- Identify definitions, examples and failures of the three levels of SA.
- Identify factors that can impact getting and maintaining individual SA.

"To see, to hear, means nothing. To recognize (or not to recognize) means everything."

Andre Breton

The Learning Objectives for Lesson 2 apply to the definitions, examples, and failures of each of the three levels of SA. The objectives also address factors that can impact getting and maintaining SA. The Learning Objectives will be tested when you take the on-line exam for IC Core 2.

Lesson 2: Individual SA

Performance Objectives

1. Using specific data examples, identify the three levels of SA and how they are contributing to your warning decisions, while working:
   a) WES simulations, and
   b) Warning events.
2. As part of post-event analysis, determine the role that SA (good or bad) at the three levels played in the warning decisions that were made.

The Performance Objectives for Lesson 2 apply during this course as well as after completion. Though they are not tested formally, questions related to these Performance Objectives will be posed during the course simulations. Developing SA in the "domain" of the warning environment is a skill that evolves over time and is an important asset in making sound warning decisions.

Situation Awareness: The Ability to Maintain the Big Picture

Looks like one of the individuals is lacking SA in this domain…

SA Helps You Anticipate

SA supports your expectations. It also supports the process of shifting expectations during an event.

What SA is Not

"Howdy. My name is John. I am 18 years old and live in the USA.

I was born with brown hair, green eyes, and situation awareness."

SA is *not* an inherent ability. It is *acquired* for different domains, such as driving a car

SA is not something that you are born with. The ability to acquire SA is learned, and SA must be acquired for each domain. You already have SA in many domains in your life…for example, driving a car.

SA Research Has Been Ongoing in Many Domains

Situation Awareness: Its Role in Flight Crew Decision Making

Attention Distribution and Situation Awareness in Air Traffic Control

What Mishaps Tell Us About Crew Member Role Assignment and Air Crew Situation Awareness

Automation, Workload, and Situation Awareness

Measures of Infantry Situation Awareness for a Virtual Mout Environment

The Effect of Overview Displays on Situation Assessment

SA has been studied for many years in other domains. Here are examples of research papers from NASA, the FAA and others. There are many things in the NWS warning environment that are common to the military, aviation, emergency medicine, nuclear power, and other domains. All require decision making in high stress environments with significant uncertainty, time pressure and lives are often at stake.

Situation Awareness Definition

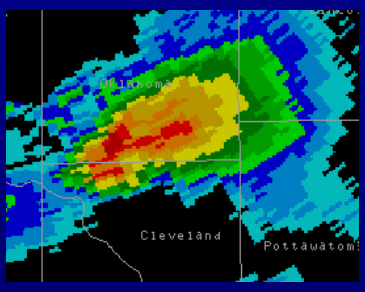
- ***Perception*** of the elements in the environment within a volume of space (Level 1)
- ***Comprehension*** of their meaning (Level 2)
- ***Projection*** of their status in the near future (Level 3)

Endsley 1988

There are three levels of SA, as defined by Mica Endsley. Each level will be examined separately. Notice that none of these definitions involves making a decision! SA forms the ***framework*** for making decisions.

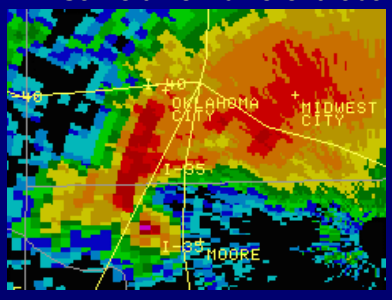
Situation Awareness Level 1

- ***Perception*** of the elements in the environment within a volume of space (Level I)



Is this what your decision is based on?

Same time…different radar



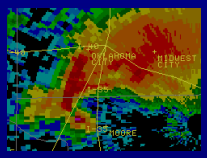
Or did you see this as well?

Level 1 SA involves simply seeing the relevant data in the domain. Since there is such an enormous volume of data available in the warning environment, success with level 1 SA requires looking at what is most appropriate. However, the most pertinent data may be unavailable, masked by system design or it may require a great deal of effort to see.

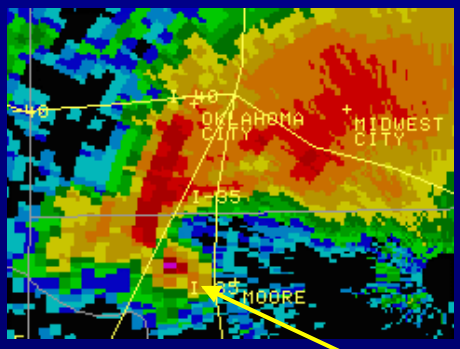
Situation Awareness Level 2

- ***Comprehension*** of their meaning

Perceive



Did you *see* this?



Now that you've seen this, do you *understand* what this is?

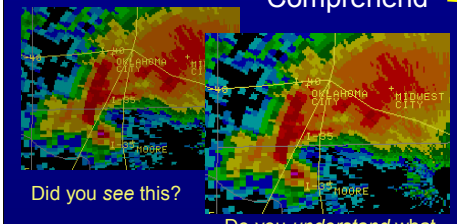
Hook echo with 65 dBZ in the hook → ***debris***

Level 2 SA involves your ability to comprehend the data and recognize patterns. In this example, you may understand the significance of a hook echo (and were able to see it in the data – level 1). The added significance of the high dBZ value in the tip of the hook is also (hopefully) comprehended. The radar beam is reflecting back from debris which has been lofted into the circulation.

Situation Awareness Level 3

- ***Projection*** of their status in the near future

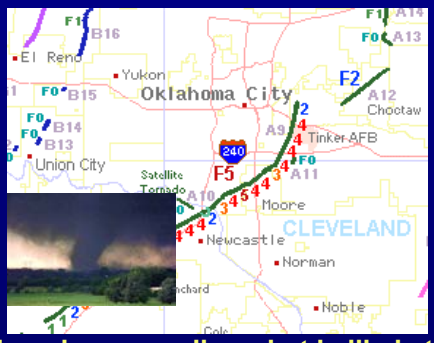
Perceive → Comprehend → **Project**



Did you *see* this?

Do you *understand* what this is?

(Hook echo with 65 dBZ in the hook: debris)



Now do you realize what is likely to happen? And what you should do?

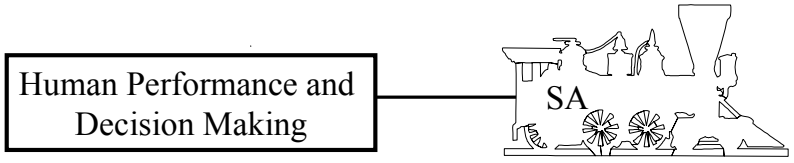
…Tornado Emergency for the OKC Metro……..

Level 3 SA involves mentally projecting this feature forward in time and understanding the associated consequences. With level 3 achieved, the decision on what to do next is usually straightforward.

Note that attaining the three levels of SA is not the same as making a decision. Attaining SA (what do I have?) supports the warning decision (what do I do?).

SA vs. Making a Decision

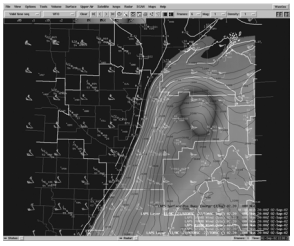
- The perception, comprehension and projection process *enables* the warning decision
  - Assessing what you ***have*** leads to deciding what you ***do***
  - SA drives the train

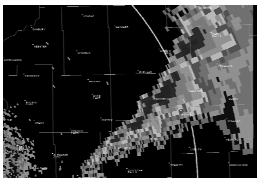


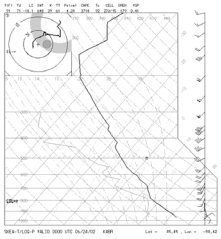
Though there are three levels of SA, none of these levels involves making a decision. Once all three levels of SA are achieved, the decision follows easily. SA provides the framework (drives the train) for making a decision.

Attaining and Maintaining Individual SA

- Cognitive load: Attention
  - Switching among multiple data streams and managing task priority





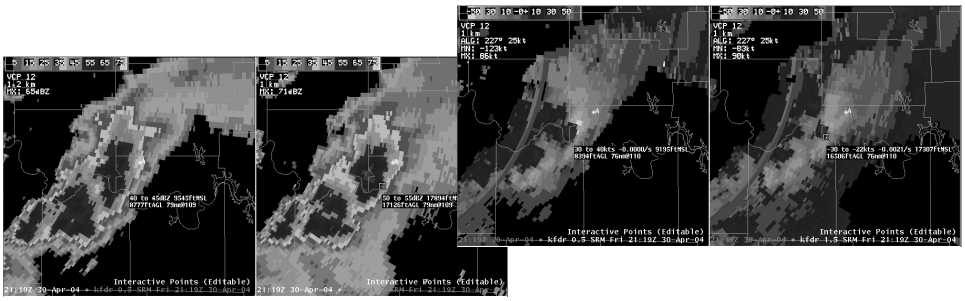


  - Screen out the “noise” (audio and video)
  - Domain can be designed to support attention

SA can be enhanced if the domain is designed to support human attention, which is a limited resource. Attention manages the multiple data streams, as well as their relative priority. Attention must also function to screen out information that is not relevant, audio and video noise. It is important that the domain (systems and people) does not overly tax human attention, and appropriate design can support attention.

Attaining and Maintaining Individual SA

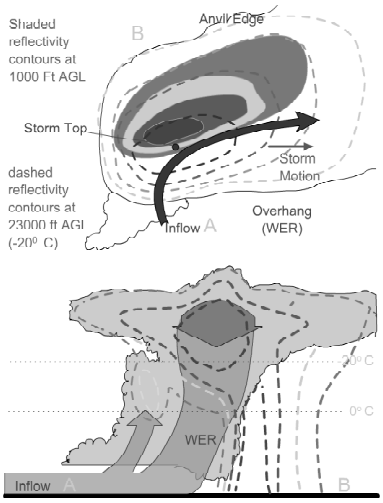
- Cognitive load: Working (short term) memory
  - Processes and holds data in chunks
  - A ***limited*** "cache" for storing data chunks that support pattern recognition



Another limited resource is working memory, where the data chunks found by attention are stored. A "cache" of these chunks is required to support pattern recognition, but this is a limited resource!

Attaining and Maintaining Individual SA

- Cognitive load: Long term memory
  - Conceptual models
  - Recognition of ***meaningful*** patterns
    - Conceptual models make the connections among the different chunks of information



You don't go around all the time thinking about HP supercells, but patterns associated with them reside in long term memory. This is where a number of conceptual models for severe weather would be stored. The conceptual model provides the necessary connections among the chunks of data in working memory. Accessing a conceptual model from long term memory during an event may not be conscious, but that feeling of "I've seen this before" means something!

Attaining and Maintaining Individual SA

- Attention and memory are limited resources significantly impacted by workload
  - As workload increases, SA decreases
  - Assumption is that automation decreases workload
  - ***Many aspects of workload are controllable***

> "Busy – Watch issued at ZFP issuance, stopped meso-analysis to 'fix' ZFP. Lost boundaries!"
>
> WDM IV Workshop Field Presentation

Workload has a significant impact on SA, and it can be made manageable. IC Core 2 has several examples from presentations made by field offices during the Warning Decision Making (WDM) IV Workshops. In this example, the warning forecaster was also managing routine product issuance and missed some important information. Perhaps someone else could have been available to update the zones!

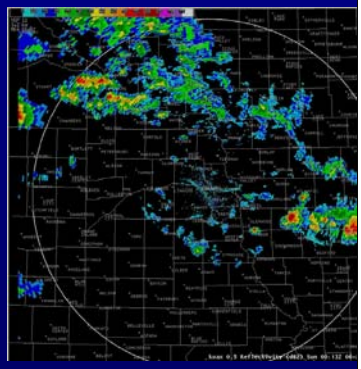
SA and Workload

- Low SA, low workload
  - Don't know anything, don't want to know
- Low SA, high workload
  - Don't know anything, but am trying way too hard to find out
- High SA, high workload
  - Do know plenty, but at great effort (can't keep this up for long!)
- High SA, low workload
  - Do know, and it comes easily
    - ***If you are not operating here….find out why and fix it!***

One significant way to support good SA is keeping the individual's workload at a manageable level. There are strategies to keep workload manageable. They will be mentioned here, and explored further in IC Core 3, Expertise and Effective Office Warning Strategies. With low SA, the workload can affect whether or not is it ever attained. Once high SA is attained, the workload can affect whether or not SA is maintained. High SA with high workload is like sprinting, which is hard work that you can maintain for only a short time. High SA with low workload is like running a marathon, which is still a lot of work but at a pace that you can maintain for a long time.

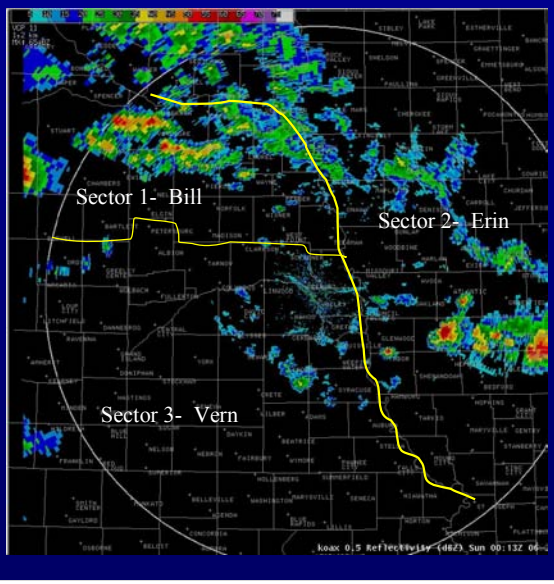
SA and Workload

- Warning decisions require all three levels of SA
  - ***Perception*** of radar data, spotter input, storm environment, etc.
  - ***Comprehension*** of patterns
  - ***Projection*** to the near future
- Requires proactive radar ***base data*** interrogation
- Warning forecaster must have ***manageable*** number of storms to monitor
  - Sectorize (re-distribute workload)
  - Assure staffing is appropriate



Why is workload so important? Appropriate storm interrogation requires proactive analysis of the radar base data. Sectorizing can ensure that each warning forecaster has a ***manageable*** number of storms to interrogate.

Sectorizing and SA



Advantages

- Divide the workload
- Focus on base data
- Maintain higher SA

Disadvantages

- Coordination becomes a challenge and must be managed

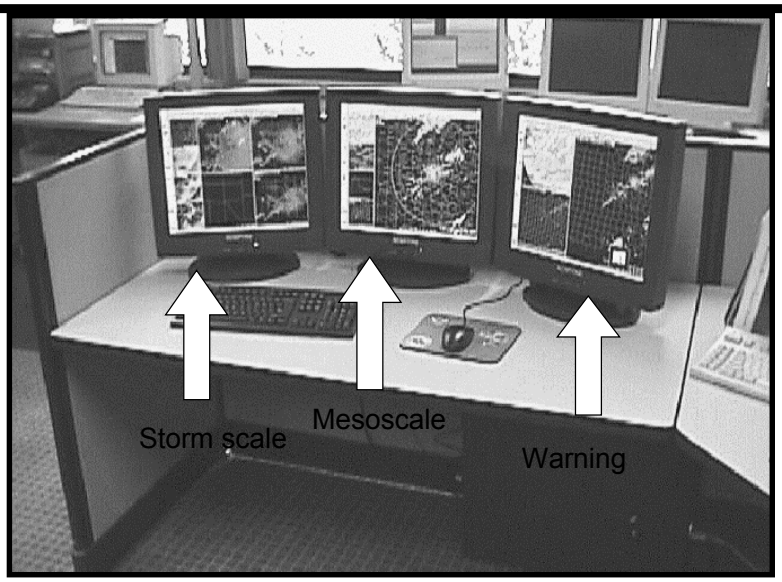
Sectorizing can have great benefits, but it requires oversight and coordination by someone…perhaps a warning coordinator. In this example, there are three sectors. The coordination challenges with sectorization include passing storms from one sector to the next or redefining sectors as needed. A designated warning coordinator can oversee this process and ensure that the storms are all “covered”.

SA and "Warning Coordinator" Maintain the Overall Big Picture

- Maintains "event level" SA (internal and external to office)
  - Oversees end-to-end office operations
  - Not a "catch all" person for unassigned tasks
- Monitors staffing and workload
- Doesn't know details such as storm scale structures
- Gages the office's message to the customer
  - Flow of products
  - Wording of products
- Ensure actions are documented

The warning coordinator oversees office operations, but is not a "catch all" person for unassigned tasks. The coordinator serves more as a coach: not actually performing tasks, but seeing that operations are flowing smoothly. Having a warning coordinator overseeing these tasks can significantly lower distractions for the warning forecasters, allowing them to better maintain their storm interrogation SA. Perhaps the most important contribution that the coordinator can make is to gage the office's message to the customer.

Workstation Configuration Can Maximize SA by Decreasing Workload



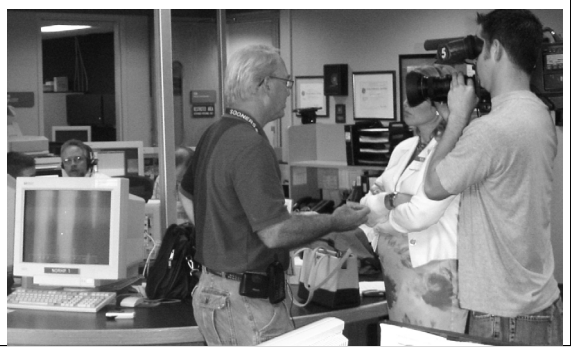
Workstations can also be configured to support your SA. There are many possible configurations. In this example, two monitors are set up for storm scale and mesoscale analysis, respectively. The third monitor is set up to process warnings.

SA and Workload
One Final Comment

"Keep an extra person* available for the one thing that you did not plan to happen...ie…the media showing up at our building wanting to do interviews while warnings were being issued."

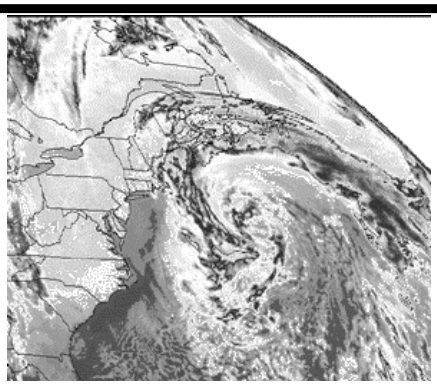
WDM IV Workshop Field Presentations

*having that extra person available is the coordinator's decision!



A recommendation from one of the WDM IV workshop field presenters! During a largely successful event, one thing that wasn't expected was a visit from the media. Having an extra person available for the unknowns can make a huge difference, and keeping that extra person available is the coordinator's decision. Though the warning coordinator may be able to do short interviews, his/her SA may for lost if too much time is spent away from maintaining the big picture.

Failures in Situation Awareness



"When you're in the denial business,
it's hard to know when to quit."

Sebastian Junger, The Perfect Storm

There are many different ways that each of the three levels of SA might fail. Denial is only one of the possibilities, but it was a factor in the loss of the Andrea Gail.

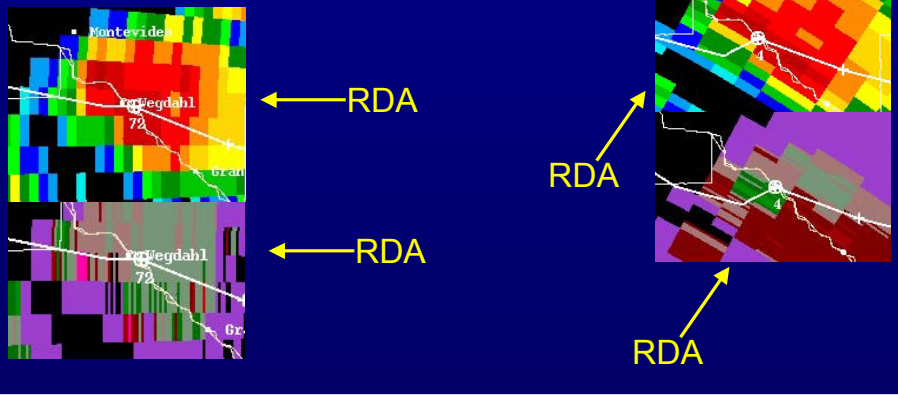
Level 1 Failures: What May Prevent Perceiving Data

- Most relevant data not available or obscured
  - Sometimes human intervention can correct this
- Data presented in too much detail
  - Must extract useful information from the glut
- User doesn't know what is relevant
- Distractions, workload

There are many barriers to perceiving data, which can result in failures of Level 1 SA. An important example for warning operations would be the masking of radar data by range folding. This problem can often be mitigated by changing the PRF, but workload may impact the ability to perform this function. Someone must be available to perform the PRF change and be familiar with the procedures. If the forecaster is inexperienced, there may be times when he or she is uncertain what is the most relevant data to seek.

Level 1 Failures: What May Prevent Perceiving Data

- Most relevant data not available or obscured
  - Radar sampling issues; PRF change?
  - Spotter reports?



In this example, there is a storm viewed from two different radars, but in each case range folding is a factor. A PRF change may have revealed more significant features. The velocity data with one radar is inconclusive, while the other radar shows a potential circulation. With these limitations to level 1 SA in the radar data, spotter reports are very valuable. However, there may be communication barriers that prevent a relevant spotter report from getting to the warning forecaster.

Level 1 Failures: What May Prevent Perceiving Data

- Recognition of significant cell delayed by:
  - AWIPS procedures rebuilt on the fly
    - Recent AWIPS upgrade and forecaster unsure if procedures survived
  - Initially using Base Velocity instead of SRM
  - Supercell in area of range folding
  - No reports from spotters viewing storm

WDM IV Workshop Field Presentations

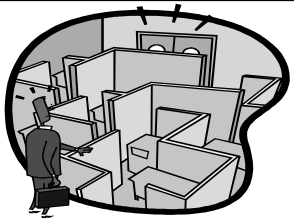
Here is an example of a Level 1 failure from one of the WDM IV Workshop field presentations. These problems slowed the recognition of a significant supercell. The lack of relevant data (spotter reports and range folding) as well as compromised storm interrogation delayed the development of good SA on this storm.

Failures in Level 1 SA
NWS Example

- ***Contributors*** to an unwarned tornado
  - Feature masked by range folding
    - PRF not changed
  - Storm at long range
    - Sampling limitations not well understood?
    - Data from other radars available?
  - Workload overwhelming
    - Sectorizing? Need additional staff?

There will be a number of “NWS Examples” presented in IC Core 2. Each of them is loosely drawn from service assessments, event reports or field presentations made by an office at the WDM IV Workshops. In this case, a tornado developed from a storm that was in an area of range folding. Perhaps the staff was unfamiliar with the procedure to change the PRF or just didn’t have time. Since the storm was at long range, perhaps other radar data, if available, would have been helpful. The workload was overwhelming, likely contributing a great deal to the lost perception of the significance of this storm. Additional staff and/or sectorization may have mitigated the workload impact.

Level 2 Failures: What May Prevent Comprehending Data

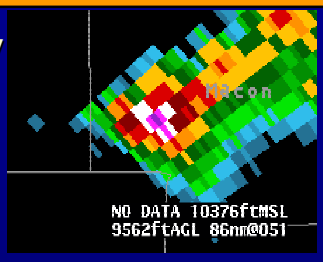


- Inability to recognize data features that represent a known conceptual model
  - Multiple data streams often needed to build connection to conceptual model
- Lack of a relevant conceptual model
- Lack of experience
- Distractions, workload

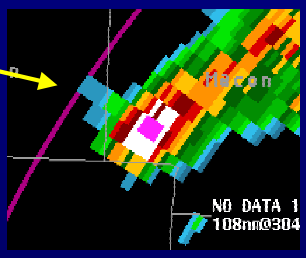
In the warning environment, level 2 SA requires comprehension of multiple data streams (radar images, spotter reports, near storm environment data) to support the pattern recognition and build the connection to the conceptual model. If the relevant data are seen but not understood, level 2 SA with respect to a conceptual model may be lost. Lack of experience can limit comprehension, even if the data are readily available. Distractions and a workload that is too high can also compromise level 2 SA.

Level 2 Failures: What May Prevent Comprehending Data

- Storm from radar A with very high dBZs: hail suspected as a threat



- Storm from radar B: do you know what the appendage means?



3 body scatter spike, which implies ***very large*** hail

In this example, the view from radar A depicts a storm with very high dBZs in its core. What is comprehended from radar A is that hail a suspected threat. However, the view of the same storm from an adjacent radar reveals a 3 body scatter spike. If you understand what that means, your level 2 SA on this storm now includes the likelihood of very large hail. In this case, the storm produced baseball size hail. The 3 body scatter spike adds significant additional information, if you understand what it means.

Failures in Level 2 SA
NWS Example

- ***Contributors*** to an unwarned tornado
  - Conceptual model of tornadic supercell not well understood
  - Report of previous tornado with storm not relayed to warning forecaster
  - 3D storm analysis incomplete
    - Inadequate RPS lists

In this event, a storm had previously produced a tornado, but a delayed report of the tornado was not relayed to the warning forecaster in real time. Additionally, the ability of the warning forecaster to interrogate the storm was compromised by inadequate RPS lists. The conceptual model of this tornadic supercell might have been better understood if the tornado report was passed on and the storm had been more thoroughly interrrogated.

Level 3 Failures: What May Prevent Correctly Projecting Data

- Limited understanding of conceptual model
- Inability to assimilate strengths and limitations
  - Data sampling limitations may result in incorrect or ambiguous expected storm behavior
    - Radar sampling
    - Near storm environment analysis
- Limited experience
- Distractions, workload

Level 3 SA requires a thorough understanding of conceptual models, sufficient to predict future threats. So lack of experience or lack of a relevant conceptual model (or both) greatly impact level 3 SA. The data streams used in warning decisions all have strengths and limitations, which must be understood. A storm's expected future behavior may be incorrect or inconclusive due to data limitations. The combination of limitations from radar and near storm environment may result in projections that are in conflict or in error.

Level 3 Failures: What May Prevent Correctly Projecting Data

- Ragged line of moderately intense cells
  - Concern is rotation; velocity data limited to SRM
  - Call to EM from county with most intense cell; no reports
  - Conclusion: all is well
  - Result: downburst damage to homes/businesses

- SRM not appropriate for ground relative winds
- Over reliance on null report

WDM IV Workshop Field Presentations

In this case, the projection (Level 3) was based on data choices (other data were available) with significant limitations. Had the Base Velocity been seen instead of SRM, the potential for strong straight line winds might have been detected. Had the EM from the county in question reported even minimal wind damage (or told them that no-one was in the suspected area), the need to more closely examine radar data might have been more apparent. The combination of both of these limitations in the data led to the poor Level 3 SA in this case.

Level 3 Failures: What May Prevent Correctly Projecting Data

- Conceptual models must be familiar enough to
  - Be understood from the data (Level 2 SA)
  - Know what the expect in the near future (Level 3 SA)
- Example: Storm has produced a tornado and now has the following attributes
  - Max reflectivity decreases and top has lowered
  - Less structure apparent on radar
  - Circulation has weakened
- Near storm environment not significantly different
- How does this behavior fit with the conceptual model of a tornadic supercell?

In this example, a storm has previously produced a tornado. Now the radar data shows a lowering top, lower max reflectivity and a weakening circulation. The near storm environment is not significantly different, so the question to ask is how does this behavior fit the model of a tornadic supercell?

Failures in Level 3 SA
NWS Example

- Supercell has previously produced a tornado, but radar features less significant
  - Conclusion: storm is weakening
  - Decision: warning allowed to expire
  - Result: new warning issued with no lead time when tornado redevelops

- Cyclic nature of tornadic supercells not well understood?
  - Near storm environment: has storm moved to an area where weakening makes sense?

In this example, the radar features were assumed to mean that the storm was weakening and the warning was allowed to expire. The cyclic nature of tornadic supercells was not sufficiently understood, thus not projected. This level 3 failure resulted in a reactive tornado warning with little lead time.

Three Levels of SA
NWS Example

MORNING SOUNDING AT XXXXXX SHOWING PRECIPITABLE WATER VALUE OF .70 INCH. THUS ATMOSPHERE IS ALREADY GETTING PRIMED FOR WHAT APPEARS TO BE A GOOD PRECIPITATION EVENT LATER TODAY AND TONIGHT AS CONVECTION COMMENCES. CAP ALOFT ON THE SOUNDING...BUT IT IS NOT EXTREME AND SHOULD BE BROKEN RATHER EASILY AS UPPER RIDGING GIVES WAY TO APPROACHING TROF WITH DECENT COOLING ALOFT. UPPER DYNAMICS AND LIFT ASSOCIATED WITH APPROACHING SURFACE FRONT SHOULD PROVIDE MORE THAN ADEQUATE ENERGY FOR THE MOISTURE TO WORK WITH. FORECAST SOUNDINGS DIFFERING ON SOME ASPECTS WITH REGARDS TO SEVERE WEATHER POTENTIAL...BUT ENUF TO WARRANT CONCERN FOR AT LEAST ISOLATED SEVERE. FLASH FLOODING DOES APPEAR TO BE THE BIG GAME IN TOWN THO...AND WILL THUS KEEP FLASH FLOOD WATCH UP FOR THIS EVENING AND TONIGHT.

Level 1: Perception

Level 2: Comprehension

Level 3: Projection

As an exercise, take a look at this excerpt from a forecast discussion. Identify the different levels of SA represented in the phrases. Statements of perceived data represent level 1. Statements of the meaning of the data represent level 2, and statements projecting the consequences of that meaning represent level 3.

Three Levels of SA
NWS Example

MORNING SOUNDING AT XXXXXX SHOWING PRECIPITABLE WATER VALUE OF .70 INCH. THUS ATMOSPHERE IS ALREADY GETTING PRIMED FOR WHAT APPEARS TO BE A GOOD PRECIPITATION EVENT LATER TODAY AND TONIGHT AS CONVECTION COMMENCES. CAP ALOFT ON THE SOUNDING...BUT IT IS NOT EXTREME AND SHOULD BE BROKEN RATHER EASILY AS UPPER RIDGING GIVES WAY TO APPROACHING TROF WITH DECENT COOLING ALOFT. UPPER DYNAMICS AND LIFT ASSOCIATED WITH APPROACHING SURFACE FRONT SHOULD PROVIDE MORE THAN ADEQUATE ENERGY FOR THE MOISTURE TO WORK WITH. FORECAST SOUNDINGS DIFFERING ON SOME ASPECTS WITH REGARDS TO SEVERE WEATHER POTENTIAL...BUT ENUF TO WARRANT CONCERN FOR AT LEAST ISOLATED SEVERE. FLASH FLOODING DOES APPEAR TO BE THE BIG GAME IN TOWN THO...AND WILL THUS KEEP FLASH FLOOD WATCH UP FOR THIS EVENING AND TONIGHT.

Level 1: Perception

Level 2: Comprehension

Level 3: Projection

Three Levels of SA
NWS Example

THE EASTERN MOST STORM IN XXXX COUNTY SHOWING CHANGES WHICH MAY SIGNAL THE BEGINNING OF SURFACE BASED SEVERE STORMS. THE HIGHEST REFLECTIVITIES WITH THIS ECHO DEVELOPED AT HIGHER ALTITUDE THAN IN THE EARLIER STORMS. SINCE THIS CELL IS RAPIDLY MOVING ACROSS THE INSTABILITY GRADIENT INTO THE AXIS OF HIGHER CAPE VALUES...IT IS REASONABLE TO EXPECT A TREND TOWARD STRONGER CELLS. WE EXPECT THE LOWER LCLS IN THE INSTABILITY AXIS TO RESULT IN LOWER CLOUD BASES AND A TENDENCY TOWARD STRONGER LOW LEVEL ROTATION GIVEN SUFFICIENT MID-LEVEL MESOCYCLONES. WILL MONITOR SRM AT MULTIPLE LEVELS IN EACH STORM TO DETECT ROTATION DEVELOPMENT.

Level 1: Perception

Level 2: Comprehension

Level 3: Projection

As an exercise, take a look at this excerpt from a regional weather discussion. Identify the different levels of SA represented in the phrases. Statements of perceived data represent level 1. Statements of the meaning of the data represent level 2, and statements projecting the consequences of that meaning represent level 3.

Three Levels of SA
NWS Example

THE EASTERN MOST STORM IN XXXX COUNTY SHOWING CHANGES WHICH MAY SIGNAL THE BEGINNING OF SURFACE BASED SEVERE STORMS. THE HIGHEST REFLECTIVITIES WITH THIS ECHO DEVELOPED AT HIGHER ALTITUDE THAN IN THE EARLIER STORMS. SINCE THIS CELL IS RAPIDLY MOVING ACROSS THE INSTABILITY GRADIENT INTO THE AXIS OF HIGHER CAPE VALUES...IT IS REASONABLE TO EXPECT A TREND TOWARD STRONGER CELLS. WE EXPECT THE LOWER LCLS IN THE INSTABILITY AXIS TO RESULT IN LOWER CLOUD BASES AND A TENDENCY TOWARD STRONGER LOW LEVEL ROTATION GIVEN SUFFICIENT MID-LEVEL MESOCYCLONES. WILL MONITOR SRM AT MULTIPLE LEVELS IN EACH STORM TO DETECT ROTATION DEVELOPMENT.

Level 1: Perception

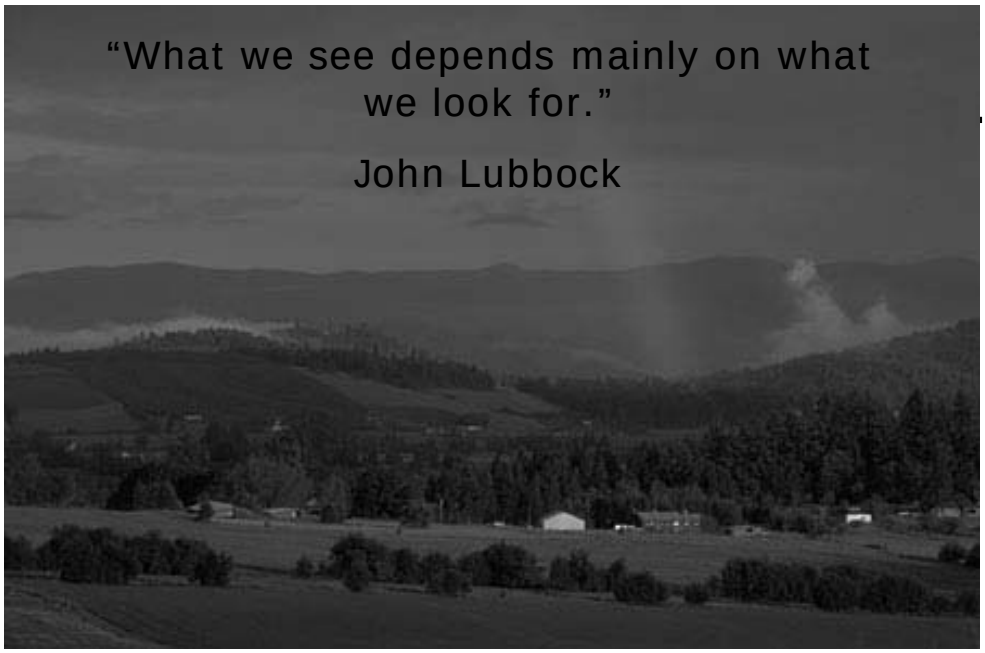
Level 2: Comprehension

Level 3: Projection

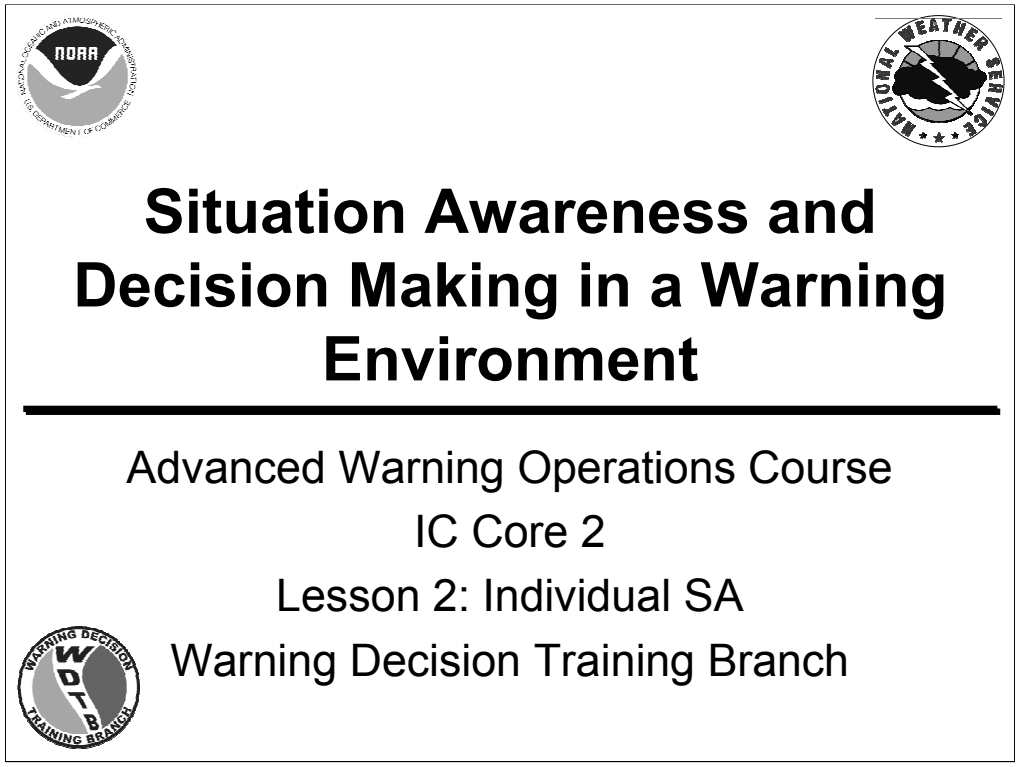
SA Summary

- SA is the ability to step out, construct and maintain the big picture
- Several controllable factors can impact your ability to have it and keep it
- Understanding how these factors will come together (or came together) can affect your ability to manage SA better in the future

In summary, SA is the ability to build and maintain the big picture, which supports your ability to make sound warning decisions. There are several controllable factors, such as workload, which can support your ability to have good SA. Developing the ability to have good SA in the warning environment in the future is dependent on understanding how these controllable factors some together.



John Lubbock reminds us that what we perceive is often limited to what we are looking for.



This concludes Lesson 2: Individual SA. There are two remaining lessons for IC Core 2.

Questions?

1. Check with your AWOC facilitator (most often the SOO)
2. Send your question to iccore2@wdtb.noaa.gov

If you have questions about the material from IC Core 2, first check with your AWOC facilitator (most likely your SOO). If your AWOC facilitator cannot answer your question, please send an email to iccore2@wdtb.noaa.gov.