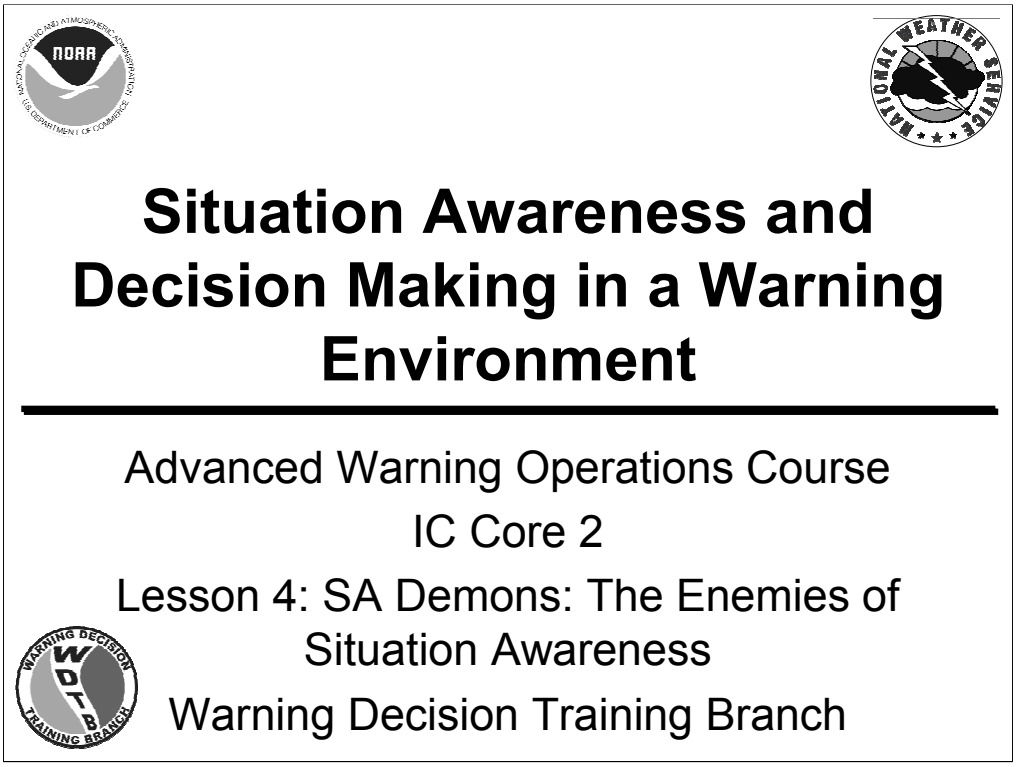


Lesson 4 will focus on the SA Demons, which are the enemies of SA. These are elements in the warning environment that can give these demons more or less impact, depending on system design. “System design” is not limited to hardware and software, but human interactions as well.

Lesson 4: SA Demons: The Enemies of SA

Learning Objective

- Identify the SA demons and how they can inhibit SA.

"Wise men learn many things from their enemies."
Aristophanes

The Learning Objective for Lesson 4 applies to the SA demons, identifying them as well as how they can inhibit SA. The Learning Objectives will be tested when you take the on-line exam for IC Core 2.

Lesson 4: SA Demons: The Enemies of SA

Performance Objective

1. 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 Objective for Lesson 4 applies to post event analysis during this course as well as after completion. Though they are not tested formally, understanding SA demons and their impact as part of post event analysis will improve your ability to build and maintain good SA in future events.

SA Demons Overview

- Attaining and maintaining good SA is a function of
  - Human performance and processing
  - The complex “domain” of the forecast office during a warning event
- SA Demons are factors that inhibit SA

Summarizing the previous lessons of IC Core 2, getting and maintaining good SA is dependent on how humans perform in the complex domain of the warning environment. SA Demons are elements to look for in this environment that inhibit SA.

SA Demons Overview

- Attentional Tunneling
- Requisite Memory Trap
- Workload, Anxiety, Fatigue, and Other Stressors (WAFOS)
- Data Overload
- Misplaced Salience
- Complexity Creep
- Errant Mental Models
- Out-of-the-Loop Syndrome

"Designing for Situation Awareness" Endsley, Bolte, and Jones

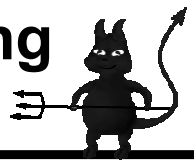
There are eight different SA demons, each of which will be defined and examples provided. The concept of SA demons comes from a new book by Mica Endsley, "Designing for Situation Awareness".

SA Demons: Attentional Tunneling

- Good SA dependent on switching attention among multiple data streams
- Locking in on certain data sources and excluding others is attentional tunneling

In most domains, good SA requires regularly switching your attention among multiple data streams. In highly dynamic domains like warning operations, the number of data sources is very high and their relative importance changes. Attentional tunneling is becoming overly fixed on certain data sources to the exclusion of others. A sometimes tragic example from everyday life is making calls on a cell phone while driving. Loosing your SA on the driving task for even a few moments can sometimes have terrible consequences.

Attentional Tunneling NWS Example

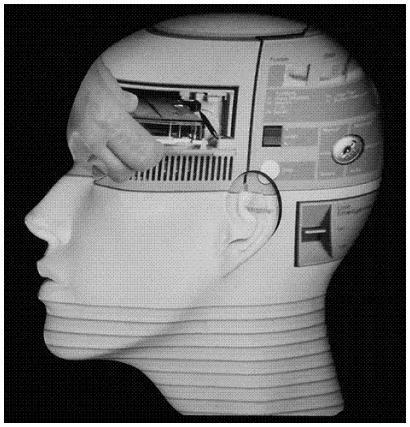


- Today's expectations: thunderstorm chances diminishing
- Warning forecaster busy working equipment problems
  - Doesn't notice the BWER in a strong thunderstorm
  - Unwarned tornado
- Attentional tunneling on the equipment caused loss of SA on developing convection

In this example, the day's expectations were for a low probability of thunderstorms. Thunderstorms did develop in the midst of some equipment problems. The warning forecaster was part of the group working the problem. Since his attention was tunneled toward the equipment, he missed a BWER in a particularly strong thunderstorm. The storm did produce a damaging tornado.

SA Demons: Requisite Memory Trap

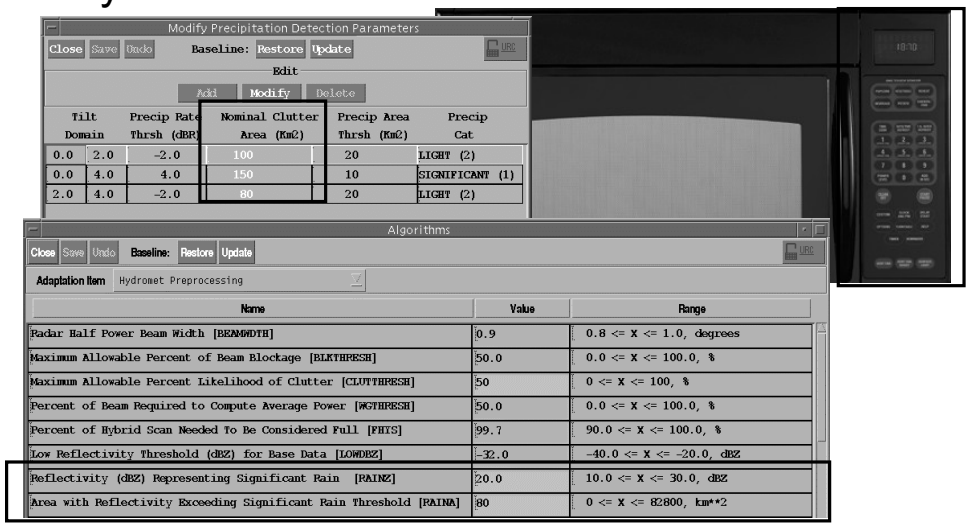
- Working memory processes and holds chunks of data to support SA (level 2)
- Working memory is a limited resource, no matter how highly developed!
- Systems that rely on robust memory do not support the user
  - "Systems" can be technology or human interactions (organizational structures)



Working or short term memory is the part of our cognitive load that "caches" chunks of data. Good SA (level 2) is dependent on holding sufficient data chunks to apply a conceptual model. Research has shown that working memory can be better developed, but is still a limited resource. Technology that is designed in a way that requires significant memory just for operating the system is eroding working memory.

SA Demons: Requisite Memory Trap

- Do you ***remember*** what ***all*** these buttons ***do***?



Systems that require “getting out the manual” for operations beyond the baseline are common in everyday life. Most microwave ovens have a myriad of features that aren’t used because the design requires too much memory. With the WSR-88D, there are many tasks that will optimize radar performance, but are difficult to do during warning operations.

SA Demons: Requisite Memory Trap

- Event anticipation and preparation can partially mitigate this demon
  - Radar optimization
    - RPS list adjustments
    - Algorithm parameter changes (e.g. Z-R relationship)
  - AWIPS configuration
    - Adjust/create procedures

Anticipation of events and setting parameters before the event begins can partially mitigate this demon. This is particularly important for tasks that require too much memory to be done on the fly. Examples include adjustments to AWIPS procedures, RPS lists, and radar algorithm parameter changes.

SA Demons: Workload, Anxiety, Fatigue, and Other Stressors

- Stress and anxiety are ***likely*** issues in the warning environment
  - Lives are at stake (sometimes office staff and/or family members)
  - Shift work and chaotic environment
  - Humans often misjudge their own ability to cope

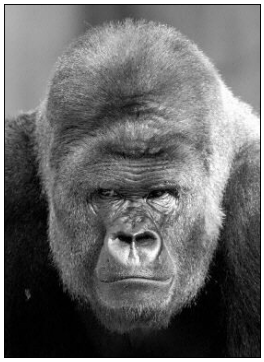
- WAFOS taxes attention and working memory

Workload, Anxiety, Fatigue, and Other Stressors (WAFOS) are human conditions common to dynamic domains. WAFOS is likely to be a significant issue in warning operations and should be monitored and adjusted as best possible. Humans often assume that they can "keep on going" despite stressful circumstances. The warning coordinator can often identify someone who needs a break well before the individual would know.

For example, during a historic tornado event, one of the warning forecasters, "Joe", was working a supercell with a large tornado that passed through his neighborhood. Phone communications were down and Joe could not reach his family. Joe did not ***ask*** if he could leave to check on his family…the warning coordinator ***told*** him to go. It took awhile for Joe to find out, but his family survived despite significant structural damage.

SA Demons: Workload, Anxiety, Fatigue, and Other Stressors

- WAFOS worsened by
  - Ambiguous roles and responsibilities
  - Poor communications among team members
  - Face Threat



There are non-meteorological factors that affect WAFOS as well, taxing attention and working memory. Ambiguous roles and responsibilities and poor communication among team members will worsen the “distraction” that WAFOS provides. Face threat is a particularly damaging hindrance to team communication, and ***all*** staff must be aware of the potential for face threat to get in the way.

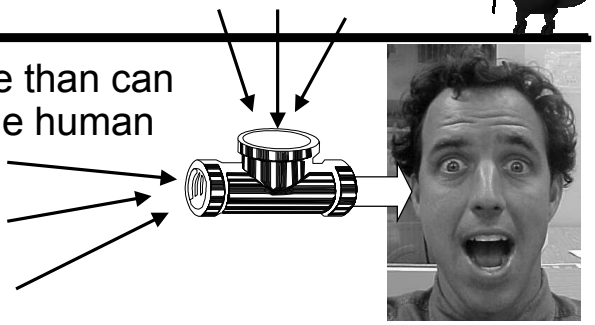
WAFOS
NWS Example

- Severe thunderstorm watch with moderate risk
- Poor understanding of conceptual models
- Storm interrogation procedures not in place
- Lack of warning coordinator
  - Roles and responsibilities ambiguous
  - Coordination and communication (internal and external) compromised
- Wording of products did not completely convey the threat

This example resulted in significant hail and wind damage in some unwarned counties. A number of factors came together to raise the WAFOS to the point of hindering storm recognition, internal and external communications and conveying the severity of the threat.

SA Demons: Data Overload

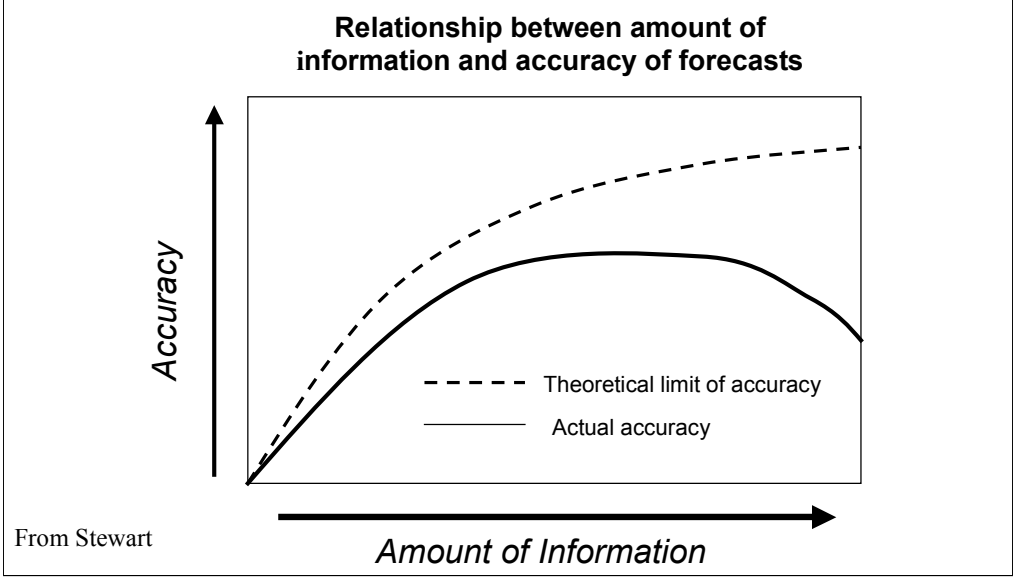
- More data available than can be processed by the human "bandwidth"



- Data flow and presentation often not designed to accommodate human bandwidth
  - Jumbled and disorganized data flows through the pipeline slowly
  - Streams of text move more slowly through the pipeline than the same information displayed graphically

Data Overload is a frequently cited problem in our culture. In warning operations, it can significantly inhibit good SA. Humans have a limited bandwidth, yet systems (technology and communications) are often not designed to accommodate this limitation.

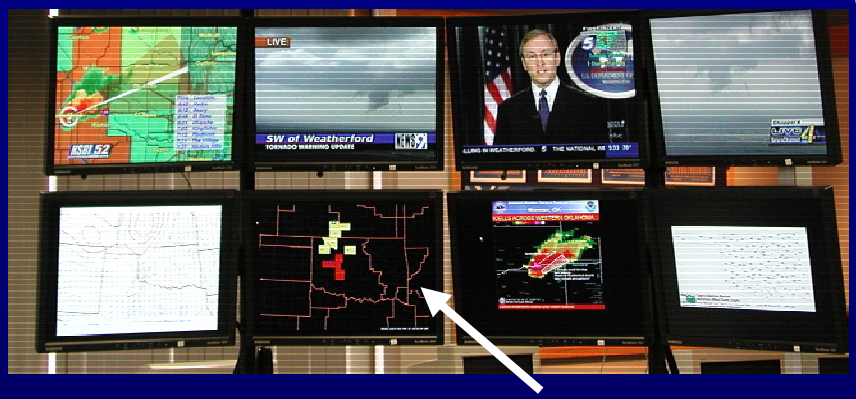
More Information is Not Always Better



This graphic is from a presentation made at the WDM II workshops, "Forecasting and Decision Making Under Uncertainty", by Dr. Tom Stewart. The ***theoretical*** relationship between the amount of information and the accuracy of forecasts shows that accuracy increases with increasing information. However, the ***actual*** accuracy decreases with increasing amounts of information. There is a point of diminishing return where humans can only process so much information. This problem is complicated by technological systems that are not designed to accommodate human processing limitations.

SA Demons: Data Overload

- Example of mitigating this demon: Monitor warning status graphically vs. text

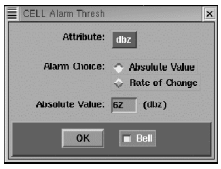


One example of mitigating this demon is using graphical vs. text displays for some types of information. Part of this situation display is a pane that displays the status of warnings currently in effect, including the numbers of minutes before they expire.

SA Demons: Misplaced Salience

- Salience is the “compellingness” of a piece of data, often dependent on how it is presented
  - Beeps, buzzers, and flashing red boxes!

meso	posh	poh	hSize	vil	dbz
MESO	70	100	1.25	45	63
UNCO	0	40	0.25	28	60
NONE	80	100	1.50	44	63
NONE	50	60	0.75	32	62
NONE	20	70	0.50	28	62



- Data given greater salience because ***it isn’t there***
  - Lack of information (we humans tend to think) means the phenomena doesn’t exist
  - May be “missing” due to sampling limitations

You are probably all too familiar with red boxes and banners and the associated audio alarms. It is often left to the operator to investigate and determine which of these alarms is actually relevant. Misplaced salience with these alarms is a typical example.

A more subtle example is misplaced salience on the ***lack*** of information. We humans tend to assume that the absence of information means that the phenomena doesn’t exist. For example, a lack of spotter reports from a storm is often interpreted to mean that the storm isn’t producing hail or strong winds.

Misplaced Salience
NWS Example

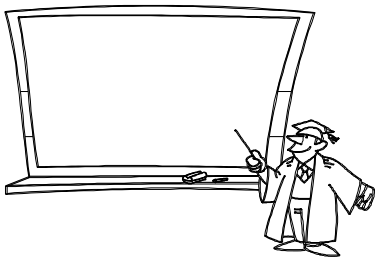
- Supercell had previously produced a tornado
- Desire to improve office performance metrics
- Looking for surface boundaries to enhance tornadic potential, but not seen in data
- Strong meso on radar, but no information below radar horizon: spotter reports “missing”

- Radar signatures and storm history given low salience

In this example, there was a supercell that had previously produced a tornado. The office staff wanted to improve their warning statistics, and were looking hard for clues from the environmental data. Surface boundaries were not seen in the data and assumed not to be there, reducing the tornadic potential. Though the radar showed a strong mesocyclone, spotter reports were not available, interpreted to mean that the storm was not tornadic. In both cases, the lack of data was interpreted to mean that the phenomena was not there. The radar signatures and storm history were given too little salience, and the storm produced an unwarned tornado.

SA Demons: Complexity Creep

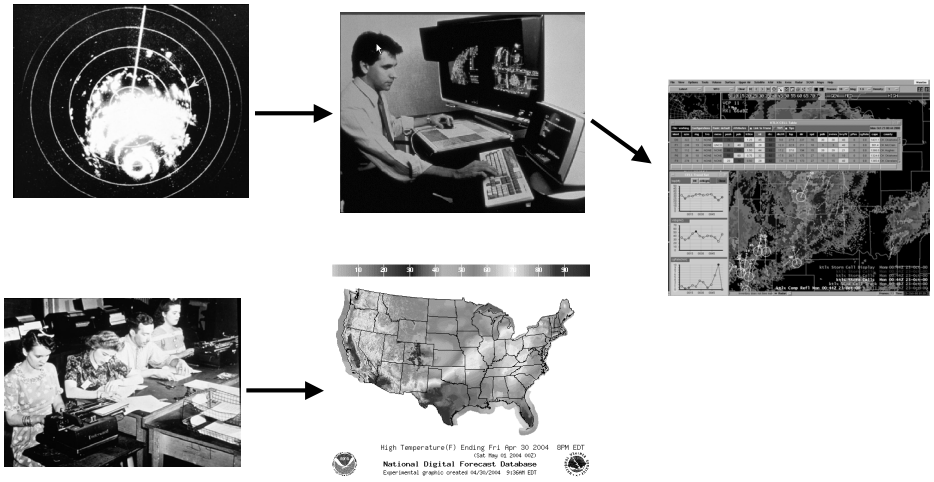
- Slows down perception of information (level 1)
- Primarily undermines understanding (level 2) and projection (level 3)
- Additional training is often proposed as the solution to this problem



Complexity creep is a long term problem with many science and technology driven organizations and has an impact on all three levels of SA. Training is typically cited as the solution to this problem. The real solution is careful consideration to the type of complexity that is being added to the domain, and how it is designed.

SA Demons: Complexity Creep

- A common trend in technology-based organizations



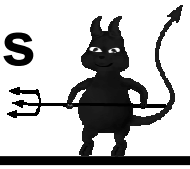
Complexity creep is a common trend in technology-based organizations.

SA Demons: Errant Mental Models

- Incomplete understanding of conceptual model hinders comprehension (level 2 SA) and projection (level 3 SA)
- Wrong mental model may result in incorrect interpretation of data
  - Prevents or slows shift in SA
- "People tend to explain away conflicting cues to fit the mental model they have selected" (Endsley)
  - "tornadoes don't happen here"

Errant mental models can have an impact in different ways. Though the appropriate conceptual model may have been anticipated, an incomplete understanding of that model may hinder comprehension and projection (level 2 and 3 SA). If the wrong model is anticipated, the data may be incorrectly interpreted. Humans have a tendency to explain away cues in the data that conflict with the mental model that they have selected. An extreme example is an underlying assumption that "tornadoes don't happen here".

Errant Mental Models
NWS Example



- Marginally severe storms expected, with small hail and strong winds reported
- No hail reported, but high radar rainfall estimates assumed to be hail contaminated
  - Storms missing gages; did not seek other ground truth
- Storms over area of new urban development
  - Detention ponds and other design elements assumed to be sufficient for runoff
- ***Result: flash flooding in small basin areas***

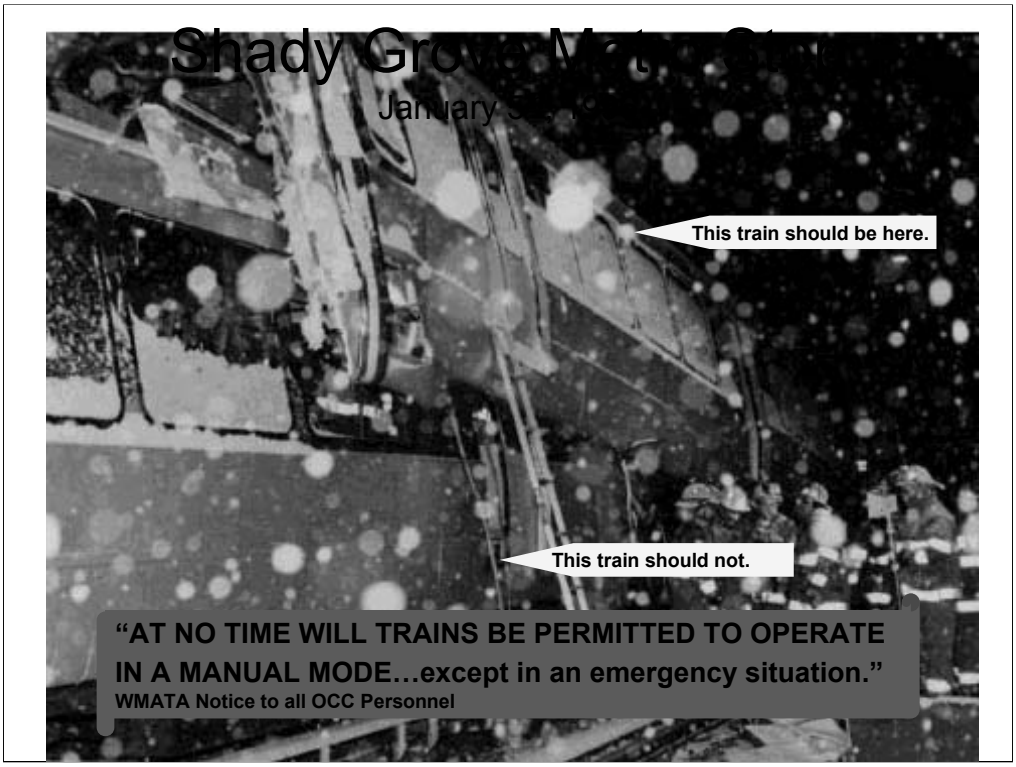
In this example, the primary threat expected is small hail and strong winds. No hail is reported, but high radar rainfall estimates are assumed to be hail contaminated. There's not much gage data, but no-one sought additional ground truth. The storms were over an area of new urban development and detention ponds were expected to be sufficient for runoff. Perhaps this new development has not been accounted for by all in the warning process (e.g. FFG may be too high). The mental model of hail and winds was used to explain away the potentially important cues of high radar rainfall estimates over areas of new urban development.

SA Demons: Out-of-the-Loop Syndrome

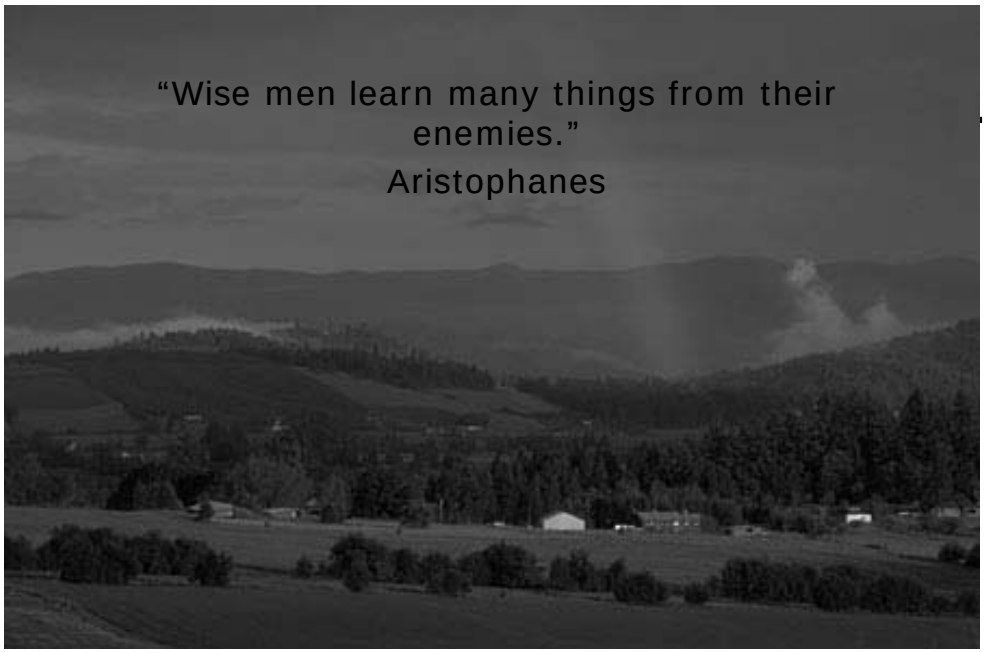
- Automated systems that don't involve the human until there is a problem
- Assumption is automating routine tasks will minimize "human error"

- In the not too distant future….
  - Imagine automation issuing all routine forecasts
  - You are a passive observer until the weather becomes severe
  - The skills needed for "routine" operations are essential for significant events!

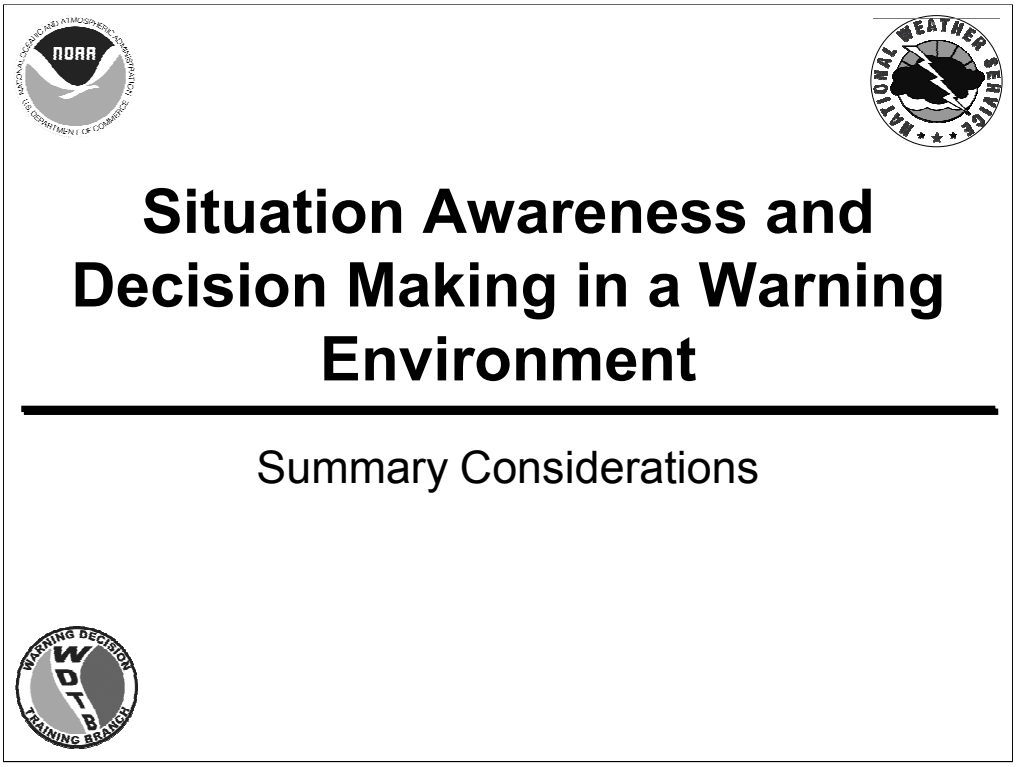
In many domains, much of the "routine" work that humans do forms the foundation of their skills. A misguided attempt to minimize human error has sometimes resulted in automating as much as possible of the routine tasks, leaving the human to intervene only when there is a problem. This approach can result in a loss of the skills that are built and maintained by doing the routine tasks.



Under the assumption that letting the computers run the trains would minimize wear on parts, train operators were not allowed to run the trains manually, unless there was an emergency. This policy impairs an operator’s ability to assess a problem, react quickly, and be sufficiently skilled to react effectively. Automation resulted in a train traveling too fast for the snowy conditions. The operator was unable to react quickly enough to avoid this accident, which unfortunately killed him.



Aristophanes says it best…



The next several slides will summarize a number of considerations from IC Core 2: Situation Awareness and Decision Making in a Warning Environment.

Considerations for Improving SA in Your Office

- How well are conceptual models understood?
  - Tornadic supercells?, Bow echoes?, Storms with high rainfall efficiency?
  - Are the case-by-case variations within a given conceptual model appreciated?
    - It's not always "classic"
- Can this understanding be applied in real time?
  - Use of radar base data
  - Environmental characteristics

Considerations for Improving SA in Your Office

- How proficient is the staff with AWIPS?
  - Are procedures available for proper 3D storm interrogation?
  - Are other radars queried often?
- Is there an effective configuration of AWIPS in place?
- How proficient is the staff with RPG changes (PRFs, VCPs, etc.)?

Considerations for Improving SA in Your Office

- What are the staffing practices during severe weather?
  - Do you sectorize? Use a coordinator? How is workload monitored?
- What is your organizational environment like?
  - Does the information flow of the office support good SA?
    - Access to all data sets (spotters, etc.)
  - How good is teamwork and communication?

Considerations for Improving SA in Your Office

- How long have you and others worked there and with each other?
- Are roles and responsibilities clearly defined and understood by all?
- How is the working relationship with partners (other WFOs, spotters, EMs, etc.)?

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.

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