

Building Team Situation Awareness in Power Systems

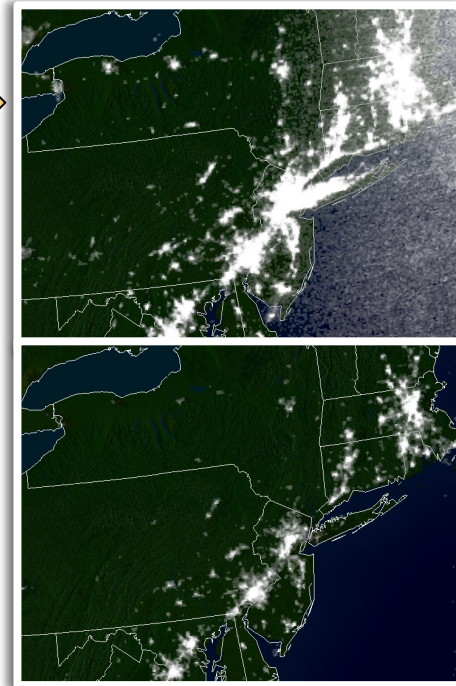
Mica Endsley, PhD
SA Technologies



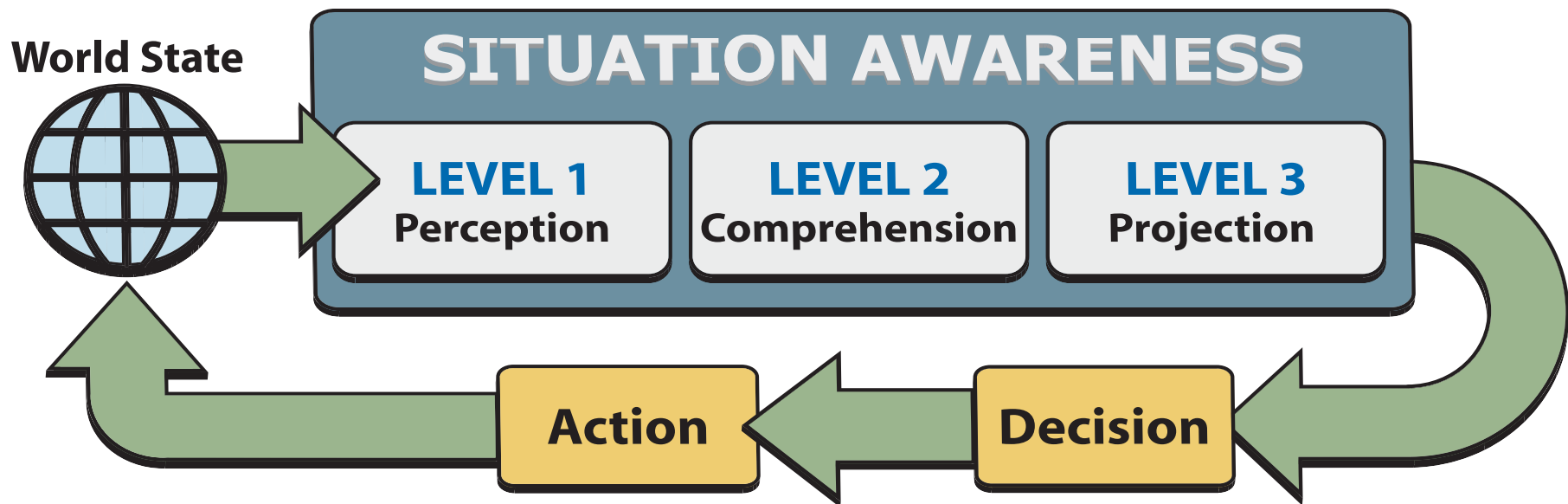
Situation Awareness is Critical to Power Transmission & Distribution



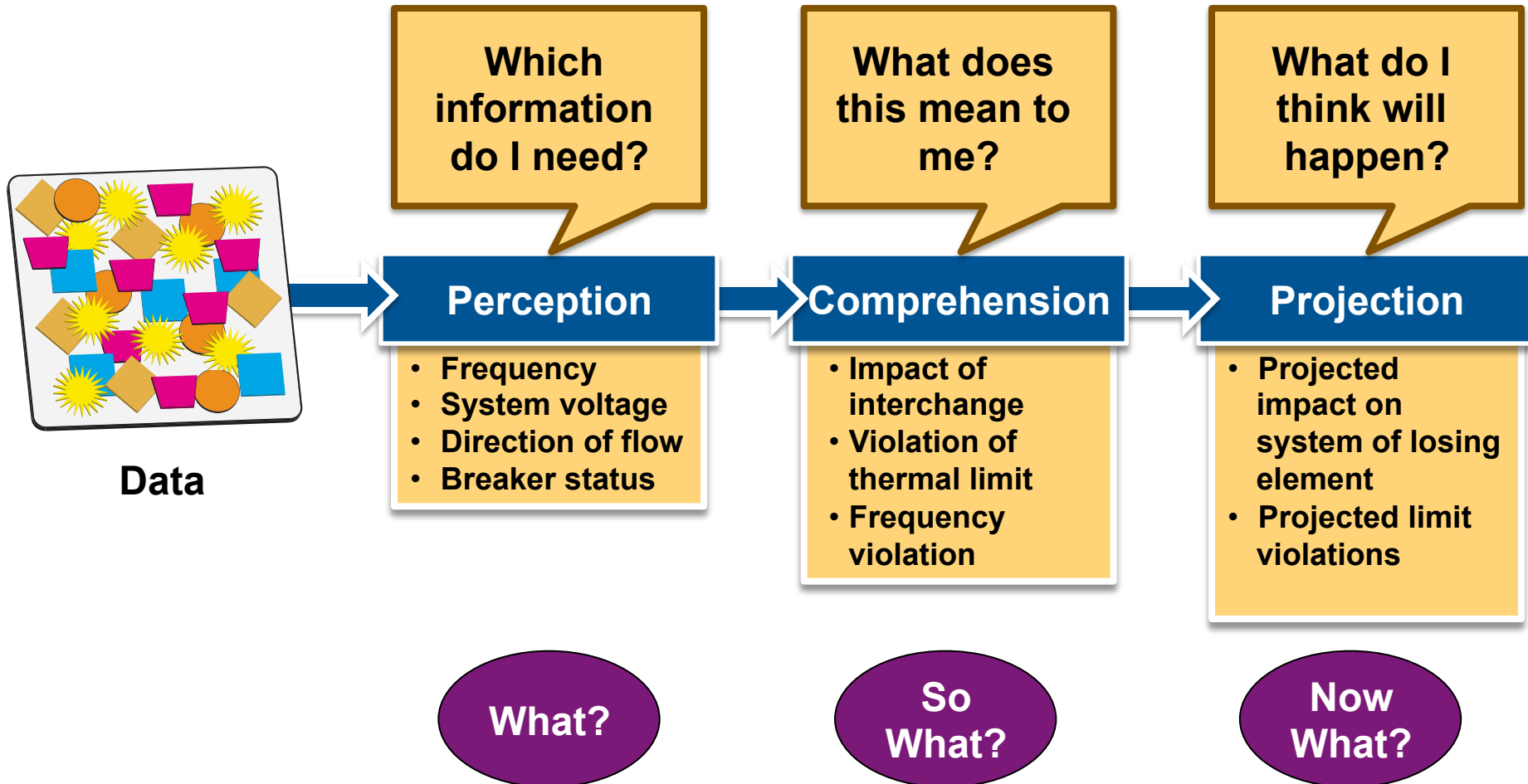
- **August 14, 2003 - Northeast US/Canada**
 - “Inadequate situation awareness”
- **August 10, 1996 - Western US**
 - “train operators to make them aware of system conditions and changes”
 - “develop displays that give operators immediate information on changes in status”
- **July 2, 1996 - Western US**
 - “review need ... to monitor operating conditions on a regional scale”
- **July 13, 1965 - Northeast US/Canada**
 - “System control centers should be equipped with display and recording equipment which provide the operator with as clear a picture of system conditions as possible”

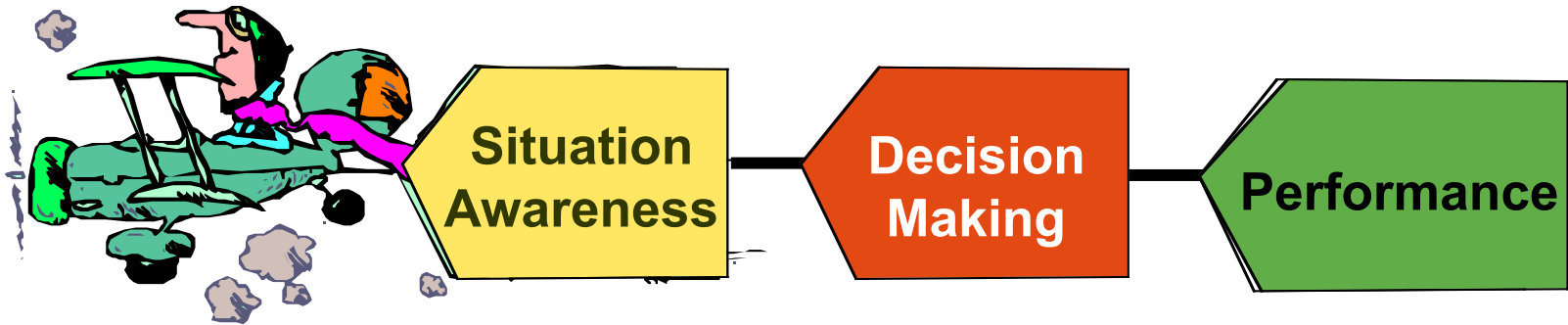


What is Situation Awareness?



Situation Awareness is the *Perception* of elements in the environment within a volume of time and space, the *Comprehension* of their meaning, and the *Projection* of their status in the near future.*





***Situation awareness is key to
good decision making and
good performance***

– Collaborative & Joint Action

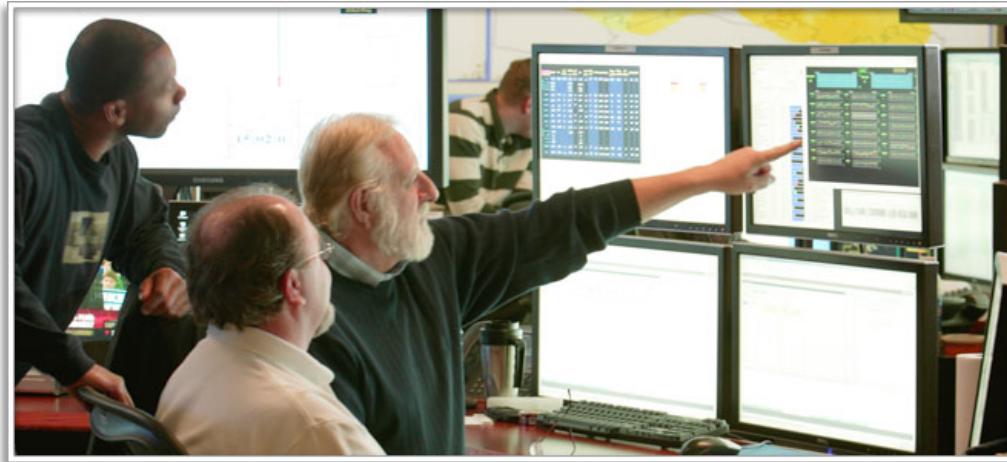
- Synchronization

– Team Situation Awareness

- Optimizes Decision Making of Whole Team
- Within Team
- Between Teams



Getting on the Same Page



- **What is the current status of the system?**
- **What has been done so far?**
- **What are they doing now?**
- **How will that affect my tasks?**
- **How does what I'm doing affect them?**
- **What will they do next?**

Team SA Challenge



Information falls between the cracks

**Information bridges between teams
are weak and easily broken**



- **US Air Crash on Take-off at LaGuardia (9/89)**
 - Mis-trimmed rudder, aborted take-off, but ended up in the bay
 - Captain said “Got the steering” and advised F/O to correct track with right rudder
 - F/O only heard “got the steering”
 - Each thought the other was in control
- **Air Florida Crash on Take-off at Washington National Airport (1/82)**
 - Icing
 - Captain failed to reject take-off although F/O repeatedly noted anomalous engine readings



- **Dryden - Air Ontario Accident**

- Flight attendant saw ice & snow on wings
- Passenger (off-duty pilot) also saw problem
- Did not pass information to cockpit
 - Culture did not encourage
 - Believed cockpit crew knew

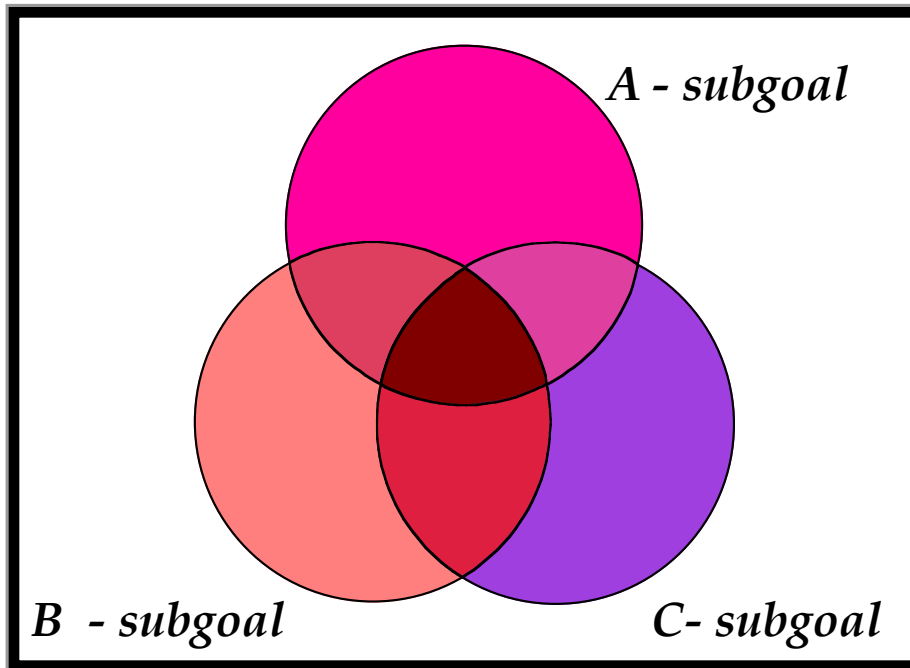
- **Kegworth - British Midlands Accident**

- Pilots incorrectly shut off # 2 engine
- Flight attendants and passengers saw flames coming out of #1 engine
- Did not pass information to cockpit

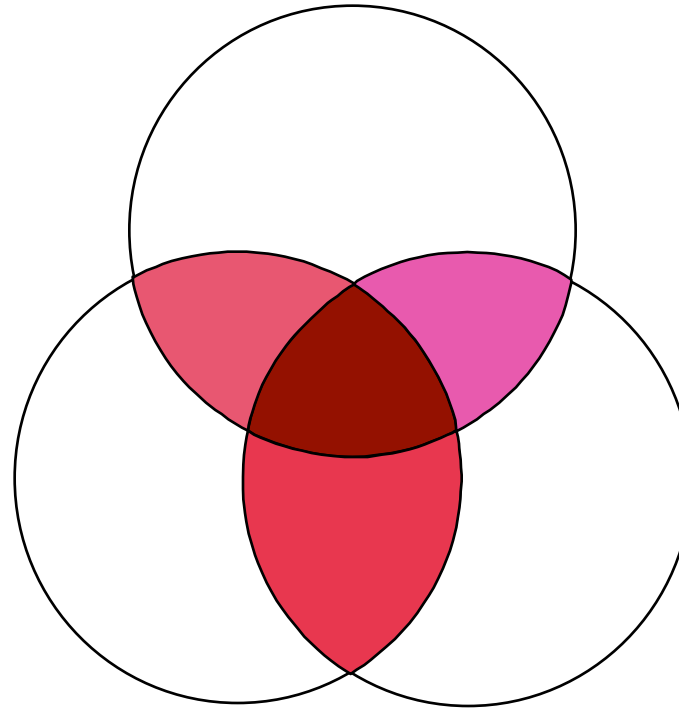


- **Incident on Mir**
 - Power cable accidentally disconnected during routine maintenance
 - Interrupted power to central computer and send Mir into a drift
 - Crew received never before seen computer messages & asked ground control for help
 - Part of communication garbled by static
 - Ground control did not understand problem and treated it as routine
“We’ll get back to you”
 - Had to wait for next comm pass to get help
 - Mir’s batteries were drained and station lost power





The Degree to Which Every Team Member Possesses the SA Required for his/her Job



**The Degree to Which Team Members Possess
the Same SA on Shared SA Requirements**

Meaning is not determinate

Workplace



Obstacle



Sightseeing



Terrorist Target



***Like Beauty.
Information is in the eye of the beholder***

Sometimes we just talk past each other.....



Off the coast of Newfoundland in October, 1995.

Americans: Please divert your course 15 degrees to the North to avoid a collision.

Canadians: Recommend you divert YOUR course 15 degrees to the South to avoid a collision.

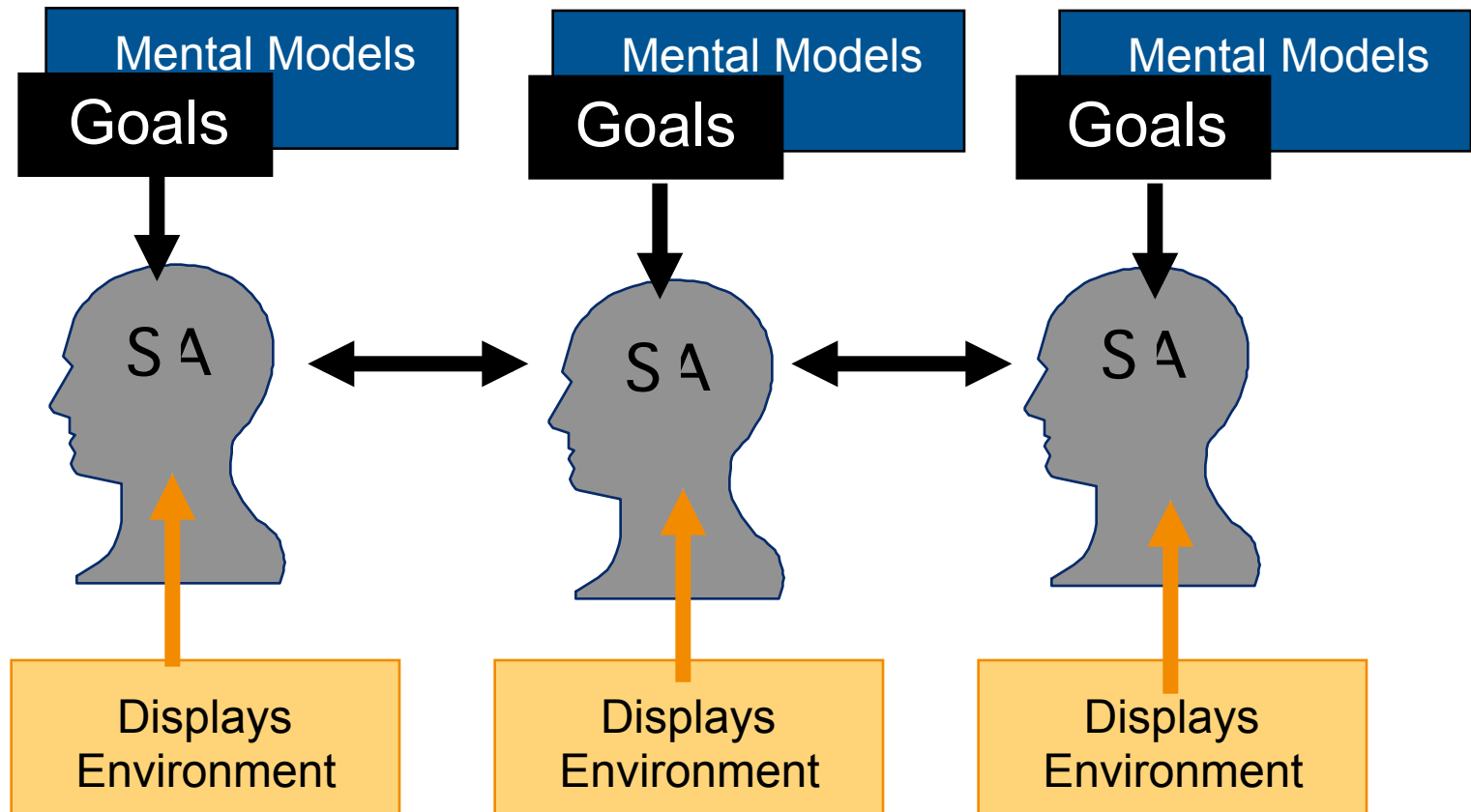
Americans: This is the Captain of a US Navy ship. I say again, divert YOUR course.

Canadians: No. I say again, you divert YOUR course.

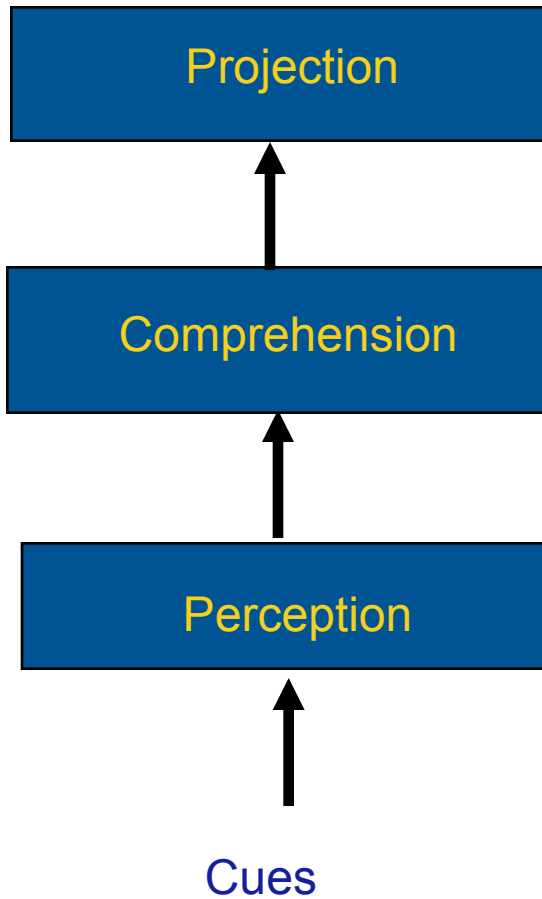
Americans: THIS IS THE AIRCRAFT CARRIER USS LINCOLN, THE SECOND LARGEST SHIP IN THE UNITED STATES' ATLANTIC FLEET. WE ARE ACCOMPANIED BY THREE DESTROYERS, THREE CRUISERS AND NUMEROUS SUPPORT VESSELS. I DEMAND THAT YOU CHANGE YOUR COURSE 15 DEGREES NORTH, THAT'S ONE FIVE DEGREES NORTH, OR COUNTER-MEASURES WILL BE UNDERTAKEN TO ENSURE THE SAFETY OF THIS SHIP.

Canadians: This is a lighthouse. Your call.

Individual SA vs. Team SA



Failures in Team SA



Is same projection of actions formed to guide expectations?

Is information interpreted in the same way?

Is needed information clearly passed?



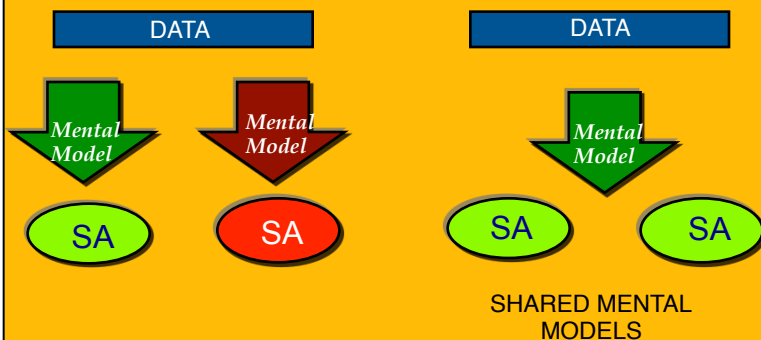
Team SA Requirements

- Data
 - system
 - environment
 - other team members
- Comprehension
 - status relevant to own goals/ requirements
 - status relevant to other's goals/requirements
 - impact of own actions/changes on others
 - impact of other's actions on self & mission
- Projection
 - actions of team members

Team SA Devices

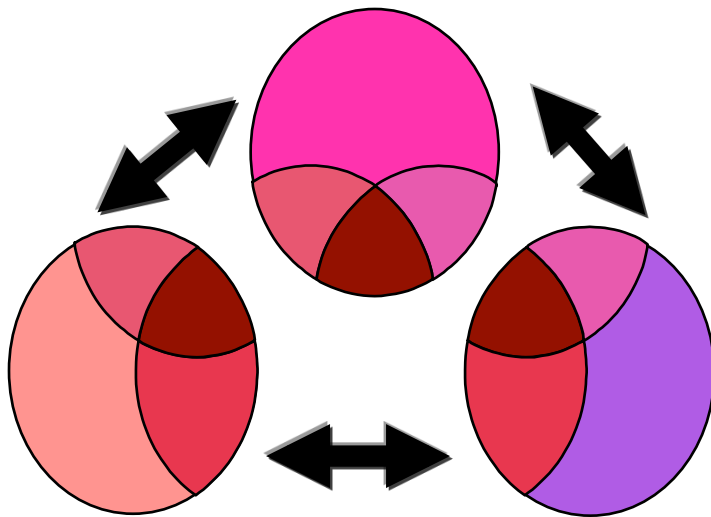
- Communications
 - Verbal
 - Non-verbal
- Shared Displays
 - Visual
 - Audio
 - Other
- Shared Environment

Team SA Mechanisms



Team SA Processes

- Self-checking
 - checked against others at each step
- Coordinated
 - to get information from each other
- Prioritized
 - set-up contingencies
 - re-joining
- Questioning
 - as a group

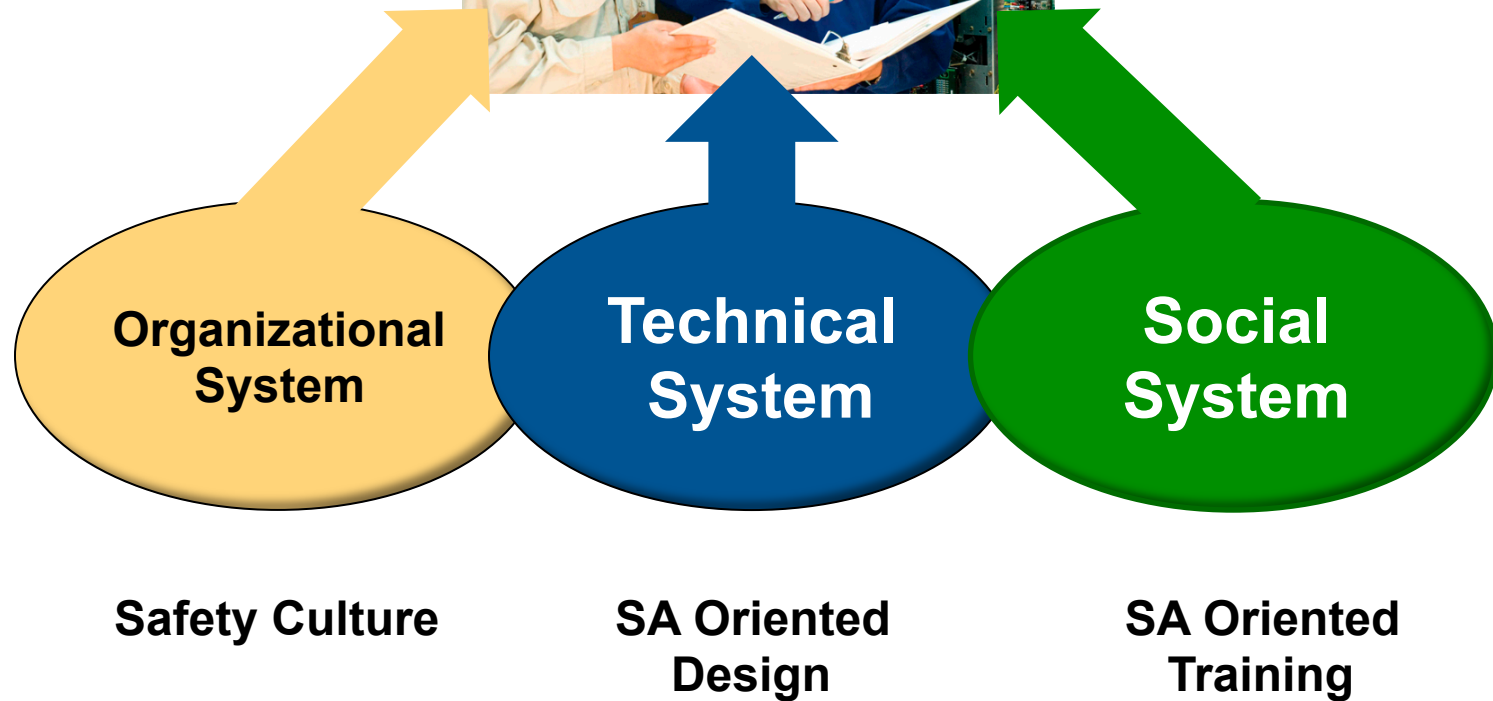


Maintaining SA in Teams in which Members are Separated by Distance, Time and/or Obstacles

- **Shared SA Requirements are the same**
- **However**
 - **Fewer Shared SA Devices**
 - No Shared Environment
 - No Non-verbal Cues
 - **Puts Heavy Load on**
 - Verbal Communications
 - Shared Displays if available
 - Often Becomes the Bottleneck
 - **Frequently Distributed Teams do not have good shared mental models**
 - Creates Opportunity for Mis-Understandings

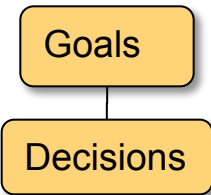
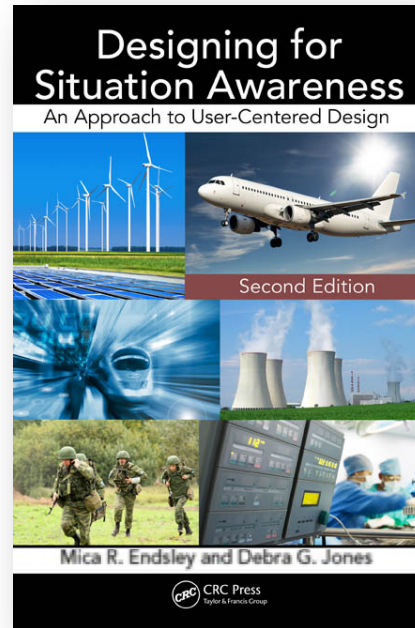
- **Different teams are not aware of what information needs to be passed**
 - One does not know what the other already knows
 - Don't pass higher level SA
- **Little support for good Team SA processes between teams**
 - Few shared devices
 - Shared Displays inadequate
 - Non-supportive culture or limited opportunities for communication
- **Information that gets passed may be interpreted differently**
 - Different mental models

How Do We Improve SA?

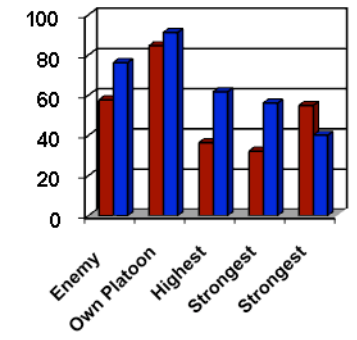




50 Design Principles

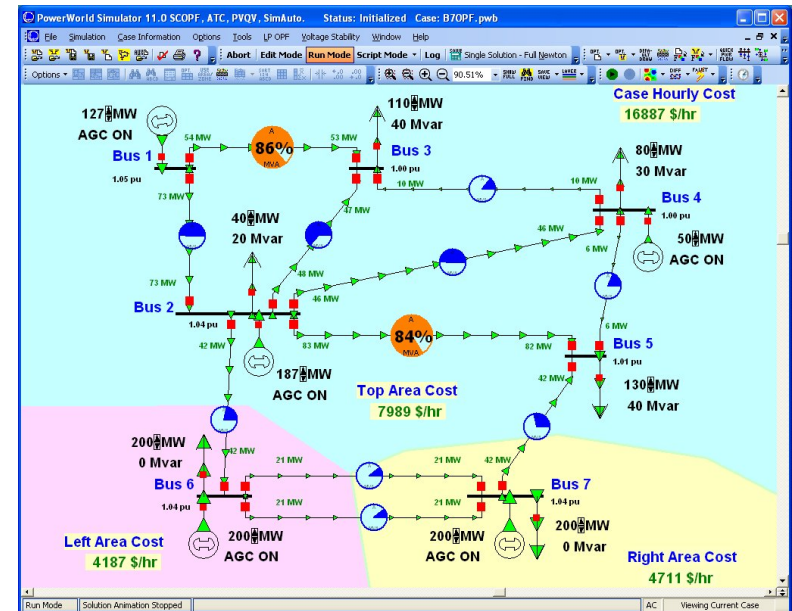
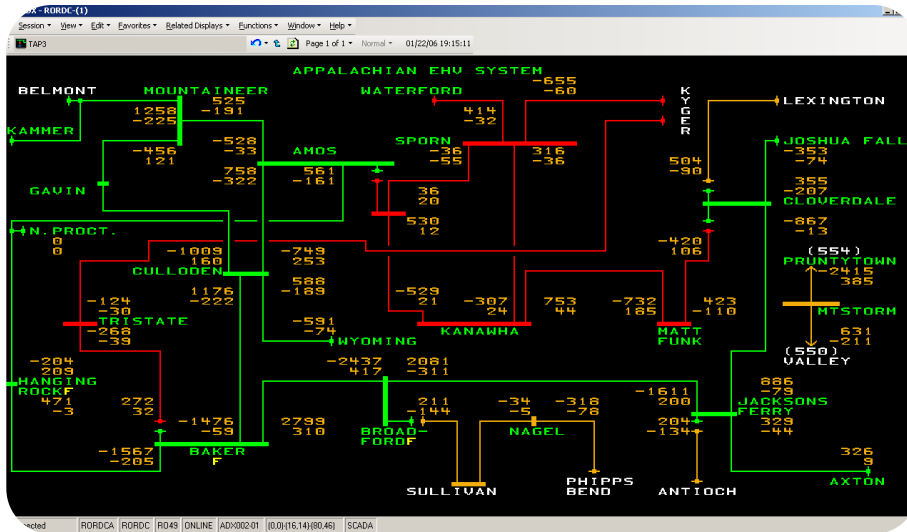


- Projection Requirements
- Comprehension Requirements
- Data Requirements



Current tools are not sufficient

- Does it have the right information?
- Does it support between teams?



SA Design Principles - Team SA



- 45 - Build a common picture to support team operations**
 - Information sources should be consistent
- 46 - Avoid display overload in shared displays**
 - Must be tailored to individual needs based on SA requirements of position
- 47 - Provide needed display flexibility to support shared SA across functions**
 - Goal orientation or comparative shifts
 - Vantage Point
 - Semantics



Know the Situation. Know the Solution.

SA Design Principles - Team SA



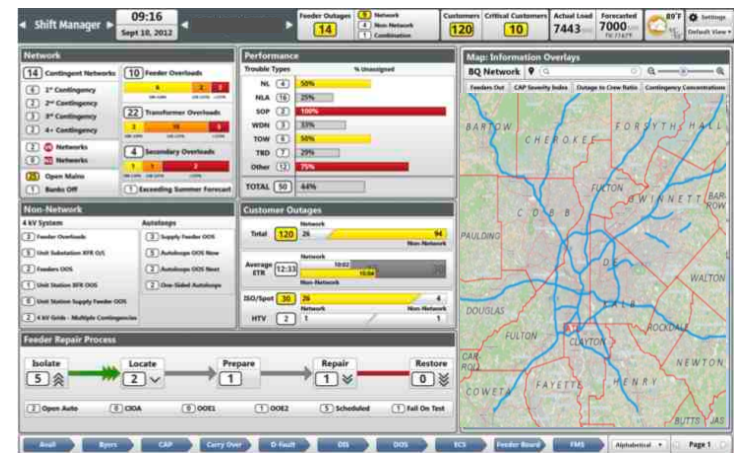
48 - Support transmission of different comprehension and projections across teams

- Quick look to other's perspective
- Build Team SA
 - What task is he on?
 - Is what she is doing going to effect me?
 - Is what I'm doing going to effect them?

49 - Limit non-standardization of display coding techniques

- Need to be able to communicate on consistent symbology, color coding

50 - Support transmission of SA within positions by making status of elements and states overt




- What is SA?
- SA Errors
- SA Demons
- How to Avoid Problems
 - Individual strategies
 - Individual skills
- Improving SA in Team
 - Techniques for building SA in co-located & distributed teams

What? So What? Now What?



- Foundational information on each topic
- Examples in domain
- Interactive exercises for class
- Handout materials for reinforcement

Get SA <i>Look, Think, Anticipate</i> 	
Level 1 SA	Have I looked for all the information I need? Did I double-check the readings? Is the information reliable? Can I check it? What information is missing? Are my teammates on the same page?
Level 2 SA	How does this information compare to the desired state of the system? What is the impact of this information on system safety and performance? Have I checked for information that supports alternate diagnoses? Have I cross-checked my understanding of the system with others?
Level 3 SA	What is likely to happen next based on the current system state? What could go wrong? What are possible contingency plans? Am I always trying to anticipate & think ahead of the system?

Communicate Effectively & Directly at all 3 Levels



Projection

Is same projection of actions formed to guide expectations?

**Projections —
“What’s Next”**

Comprehension

Is information interpreted in the same way?

**Interpretation —
“So What” of the data**

Perception

Is needed information clearly passed?

**Why as well as What
Transmit- Repeat-Confirm**



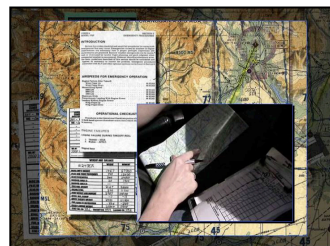
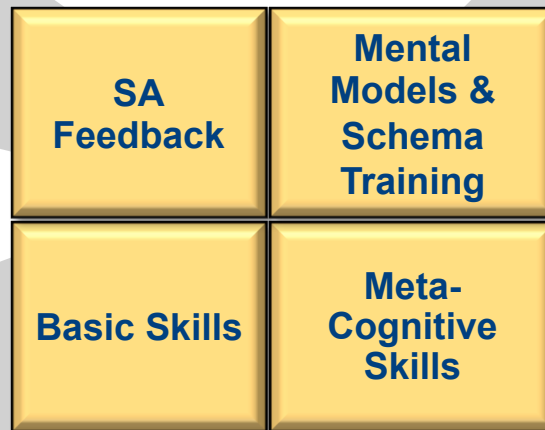
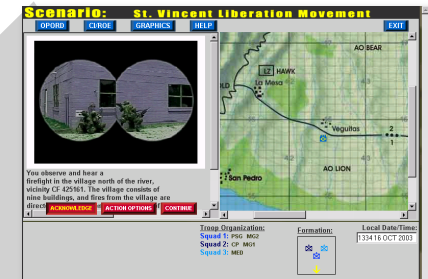
Training Situation Awareness Knowledge, Skills, & Behaviors



Virtual Environment Situation Awareness Rating System (VESARS)



Interactive Situation Awareness Trainer (ISAT)

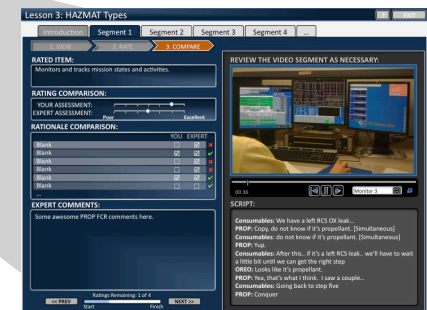


Checklists Are Not Used Properly

- vs/Distractions
- are
- Steps
- m Memory

5. Use of Personal Checklists
6. Complacency
7. Rushed Execution

SA Trainer



Situation Awareness Virtual Instructor (SAVI)

Know the Situation. Know the Solution.

- **Situation Awareness is critical for effective decision making**
- **Shared SA is an important component of the successful functioning of both collocated and distributed teams, and ad hoc teams of teams**
- **Situation Awareness can be directly enhanced through improved systems design to enhance information sharing and integration**
 - **Use a systematic approach to determining the individual and shared SA requirements**
 - **Tailor displays to support SA for each team member & shared SA requirements**
 - **Critical to support the relevant comprehension & projection analysis of data provided to the decision makers**
- **Training of Team SA Skills can improve effective information sharing and understanding**

