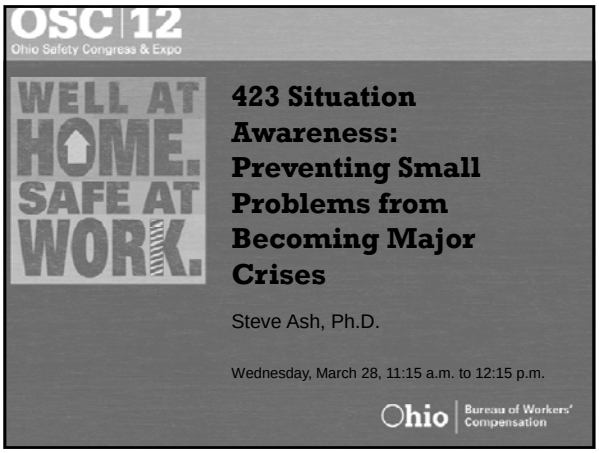

Situation Awareness: Preventing Small Problems from Becoming Major Crises

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General Sources of Human Error

- Poor Information (or Lack of)
  - Poor Communication or Data
- Inadequate Ability or Training
  - Knowledge or understanding is lacking
- Improper Tools/Equipment
  - Right tools not available
- Poor System Design
  - Improper Human Factors (man-machine interfaces)
- Environment not supportive of actions
  - Social environment
  - Physical environment
  - Weather, etc.

Human Frailties

- What is "pilot error?"
  - Why would a highly educated and trained pilot fly a perfectly good airplane into terrain?

Controlled Flight Into Terrain

- CFIT is a leading cause of airplane accidents involving the loss of life, causing over 9,000 deaths since the beginning of the commercial jet age.
- While there are many reasons why a plane might crash into terrain, including bad weather and equipment problems, pilot error is the single biggest factor leading to a CFIT incident.

Eastern Flight 401

Situation Awareness (SA)

- Human error seems to be at the core of most accidents and tragedies
- A significant amount of human error has at its root situation awareness
- Heightening situation awareness is a primary method of reducing human error

History of SA Research: Aviation Industry

- SA is the leading cause of accidents in military aviation (Smith and Prince, 1991)
- Problems with situation awareness are the primary factor underlying commercial aviation accidents (Jones, et al., 1996)
- NTSB found that for major carrier accidents 71% were caused by crew

Vehicles

- Aircraft
  - Military and Commercial
  - Multi-crew Planes
  - Single Seat Aircraft
- Ships
  - Submarines
  - Surface Vessels
- Automobiles

Road Safety

- A comprehensive study of road safety (Treat et al., 1977) found that human error was the sole cause in 57% of all accidents and was a contributing factor in over 90%. In contrast, only 2.4% were due solely to mechanical fault and 4.7% were caused only by environmental factors.

Large Systems

- Traditional Power Plants
- Nuclear Reactors
- Refineries
- Chemical Plants
- Manufacturing Facilities

Critical Operations

- Hospitals
- Command Centers
- Specialized Teams

Aviation Disasters

- Eastern Airlines Flight 401 (1972)
- Tenerife runway collision (1977)
- Air Florida Flight 90 (1982)
- Northwest Airlines Flight 255 (1987)
- Avianca Airliner Flight 052 (1990)
- Korean Airlines Flight 801 (1997)
- American Airlines Flight 587 (2001)
- Colgan Air Flight 3407 (2009)

Nuclear Power Plant Emergencies

- Oyster Creek (1979)
- Davis-Besse (1985)
- Oyster Creek (1979)
- Three Mile Island (1979)
- Ginna (1982)
- Chernobyl (1986)
- Fukushima (2011)

Situation Awareness and Perception

"Situation awareness involves interpreting situational cues to **recognize that a problem exists** which may require a decision or action."

- Orasanu, 1993

Perception

- Importance of perception
- What influences perception?
- What causes errors of perception?
- How aware are we of our perception?

Moon Illusion 1

Moon Illusion 2

Preconceptions & Expectations

- Projective Personality Tests
  - ex. Rorschach Inkblots
- Fuzzy Slides
- Loch Ness Monster
- Seattle Windshield Epidemic

Louie Louie

The Kingsmen 1963

Mistakes

- How is this possible?

Confirmation Bias

We find what we are looking for!

"There's the proof! I knew it all along."

Seeing Patterns Where None Exit (Pareidolia)

- Pre-existing expectations (Confirmation Bias)
- Faces in particular seem to be innate
  - Our brains can distinguish between faces and other objects in less that .20 seconds (Hadjikhani, 2009)

- People tend to seek out and attend to information that supports earlier decisions, and ignore information that is contradictory

Perceptual Blindness

- People are blind to things they are not expecting.

Pattern Recognition

"When it works well, we can find our lost child in the middle of a huge crowd at the mall. When it works too well, we spot deities in pastries, trends in stock prices, and other relationships that aren't really there."

– Chabris & Simons, 2010

Application to Work Environment

- We all look at the world through colored glasses, the color is influenced by our background and expectations
- Information is influenced by context
- Our situation influences how we perceive
- Perceptions and cognitive biases associated with memory influence how information is acted upon

Expectations and Fixation

Deer Hunting Accident

- Deer Hunting Accident.docx

Expectations and Fixation

- Mann Gulch, Montana 1949
  - 16 smokejumpers – expected a 10 am fire
  - Explosive fire, wind shifted, 30 ft flames
  - Crew was trained to race to a ridge
  - Foreman headed them up a 76 degree slope
  - Told crew, "Drop your tools," but was ignored
  - Amazingly, foreman lit a fire in front of them and ordered crew to lie down in it, but was ignored
  - Thirteen died trying to outrace the fire
  - Only two that reached a rock crevice, and the foreman, lived

Expectations

- South Canyon, Colorado 1994
  - 14 firefighters lost their lives
  - Men moved on steep slopes in dense, dry gamble oak
  - Within seconds a wall of flame raced up the ridge toward men on west side
  - 12 men died trying to outrun the fire
- In both cases, all men died within sight of safety

Analysis

- Many firefighters refused to drop their tools
- Some died while carrying gas cans
- One dead man was found 250 feet from safety – with a full backpack on and a chainsaw in his hand
- One survivor remembered that, while running for his life, he searched for a tree to lean his shovel against
- Another survivor stated, "At some point, about 300 yards up the hill... I realized I still had my saw over my shoulder! I irrationally started looking for a place to put it down where it wouldn't get burned. I finally found a place. I remember thinking I can't believe I'm putting down my saw."

Why?

- Why wouldn't the men follow the foreman into the escape fire?
- Why didn't the men drop their tools?
  - Later calculations showed that if they would have moved at 8 more feet per second all would have survived
- Perhaps small changes seem like trivial changes, so nothing changes
- People revert to "engrained" behaviors during crisis

Other Examples

- Navy seamen sometimes refuse orders to remove their heavy steel-tipped shoes when they are forced to abandon ship
  - Many have drowned
  - Others have punched holes in life rafts
- The world-renowned high-wire artist Karl Wallenda, fell to his death still clutching his balance pole instead of grabbing the wire below him

Wrong Door

- In 1990, Martin Marietta deployed a satellite into the wrong orbit when engineers told the computer programmers to, "open the bay door to the hatch containing the satellite." The programmers complied, however they opened the wrong door. Today, the $150 million dollar satellite sits dead in orbit around the earth. The total cost of the single miscommunication is estimated to be $500 million dollars (AP,1990).

Three Mile Island

- Three Mile Island 1979: The operators did not recognize that the relief valve on the pressurizer was stuck open. The panel display indicated that the relief valve switch was selected closed. They took this to indicate that the valve was shut, even though this switch only activated the opening and shutting mechanisms. They did not consider the possibility that this mechanism could have (and actually had) failed independently and that a stuck-open valve could not be revealed by the selector display on the control panel.

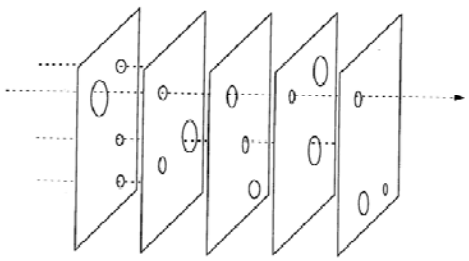
Hazardous Materials Test Incident

- NASA Johnson
  - JSC Building 353 Oxidizer Release Mishap (1994)
  - Aka BFRC
- Chronology

Error Chains

- Swiss Cheese effect (after Reason, 1990)
- Tragedies are seldom the result of a single error
- Serious errors are compounded, multiplying the impact
- There are often many opportunities to stop disasters

Swiss Cheese Effect



Error Chain Examples

- Case - Jose Eric Martinez
- Iatrogenic injury
  - An injury causing harm to a patient resulting from medical management rather than from the patient's underlying or antecedent condition

Error Chain Construction

- On Sunday April 14th, 1912, RMS Titanic sank, claiming the lives of 1513 of the 2224 people on board (711 lived).
- What were the causes of this tragedy?

Individual vs. Group SA

- An individual uses many complex interactions to maintain high situation awareness
- Groups use all the individual elements plus interactions based upon communication

Group Decisions

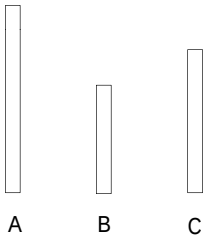
- When groups work well, synergy is the result (2+2=5)
- When they don't, outcomes can be catastrophic
- Potential Group Problems
  1. Conformity
  2. Obedience
  3. Groupthink

1) Group Conformity

- Asch experiments
  - Line length
  - Multiple confederates
  - Many unquestioningly went along with majority

Group Conformity

- Which line is longer?



2) Obedience to Authority

- Milgram experiments
  - Questions: How could the Nazis commit such atrocities?
  - White coated researcher, "you must continue"
  - Increasing amounts of voltage were administered

3) Groupthink

"When groups override a realistic appraisal of the situation in order to maintain unanimity and cohesiveness."

– Janis

Examples of Groupthink

- Bay of Pigs?
- Pearl Harbor?
- Space Shuttle Challenger?

Symptoms of Groupthink

1. Invulnerability
2. Rationalization
3. Morality
4. Stereotypes
5. Pressure
6. Self-censorship
7. Unanimity
8. Mindguards

Avoiding Groupthink 1

- Leader encourages open expression of doubt
- Leader creates climate where dissenting opinions are OK
- High-status members offer opinions last
- Received recommendations from duplicate group
- Periodically divide into subgroups

Avoiding Groupthink 2

- Get reactions from trusted outsiders
- Periodically invite outsiders to join discussions
- Assign role of devil's advocate
- Develop possible outcome scenarios

Environment

- Factors of the environment that influence Situation Awareness
  - Distractions
  - Time Pressure
  - Workload
  - Instrument Design
  - Stress

Distractions and Noise in the System

- Non-sterility
  - example MD-80 Detroit
- Phone calls, pagers, etc.
- People visiting (ex. customers)
- Channels of communication not fully open
- Noise in channels of communication
- Other activities on site
- Other crises

Time Pressures

- Lack of time to reflect and think critically
- Haphazard preparation and planning
- Shortcuts taken
- Lack of SOP
- External groups not notified

Workload

- Too many duties
- Too much responsibility
- Multiple bosses from multiple projects
- Lack of resources

Instrument Design

- The most critical values should be the easiest to observe
- Possibility of misreading values or data
- Possibility of inputting improper values or control
- Improper stereotypes used in design
- Designed to be easy to build instead of easy to use
- Information overload

Stress

- Too much stress influences cognition
- Very high stress produces “tunnel vision” and “fixation”
- Hard to focus on multiple issues with high stress
- World shut out under high stress conditions
- Too little stress = boredom and lack of vigilance

Loss of Situation Awareness

- Do you know when you have lost SA?
  - If you don’t think you have, be careful!
  - If you do think you have, you probably have!
  - If something doesn’t look or feel right, it probably isn’t!

Flying Tigers

- Kuala LumpurCrash Example

Clues to the Loss of SA (1)

- Some Operational Clues
  - Failure to meet targets
  - Departure from SOP
  - Violations of limitations and requirements
  - Unresolved discrepancies

Clues to the Loss of SA (2)

- Some Human Performance Clues
  - Confusion or bewilderment (gut feeling)
  - Complacency (automation keeps secrets)
  - Communication problems
  - Preoccupation or fixation
  - Distraction
  - No one monitoring the overall system

3 Keys to Maintaining/Regaining Situation Awareness in Teams

1) Inquiry
2) Advocacy
3) Assertion

1) Inquiry

- Asking the right questions
- Collecting and validating data
- Continuously updating information
- Testing for accuracy

2) Advocacy

- Frankly stating opinions
- Expressing concerns
- Seeking ideas from others

3) Assertion

- Being sure that your concerns are recognized
  - Speaking up
  - Repeating
  - Rephrasing
- Asserting is not Usurping
  - The boss is not always right, but the boss is always the boss

7 Tools for Improving Situation Awareness

1) Planning and Preparation
2) Good Communication
3) Vigilance
4) Distraction Avoidance
5) Workload Distribution
6) Training
7) Expanding the Team

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