

# ISRCS 2009

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## **Tutorial**

### **Session 4a: Human Factors and Resilience**

David Gertman, PhD  
Idaho National Laboratory

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# Overview

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- ❖ Human actors and resilience examples
- ❖ Prediction and data
- ❖ Workload and situation awareness
- ❖ Human factors improvements to resilience

# Resilience

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- ❖ A functional perspective
- ❖ Beyond a complex linear model
- ❖ Adaptation beyond the base case
- ❖ Flexibility
- ❖ Ability to anticipate

# Humans support systems resilience thru: intelligence, adaptability, and flexibility

- ❖ Humans are uniquely capable to recognize and respond to the unexpected by applying general problem-solving to:
  - Recover, reestablish or maintain system functions, and prevent loss
- ❖ The challenge: incident conditions are dynamic, equipment may be unavailable, and information for operators regarding system status may be highly uncertain



*Machines are fast, accurate,  
and dumb.*

*Humans are slow, sloppy,  
and brilliant.*

*-unknown submariner*

# Human error detracts from resilience

- ❖ Reducing the type and number of human errors is also important to system response and restoration
  - Slips
  - Lapses
  - Mistakes
  
- ❖ For example.....

# Example

**Mechanic #1:** Hey man cut it out....Hey don't touch that it says "engine start" on it...

**Mechanic #2:** Don't worry....they always turn these things off while their at the gate.

*(Engine sounds in background....mechanics unaware)*

**Mechanic #2:** Ready for takeoff.....VRRRRRROOOOM VRRRRRROOOOM  
(Throttles rapidly moved from idle to full and back to idle and full again)  
WEEEEEEEE!

**Mechanic #1:** OH no were moving!!!

**Mechanic #2:** WERE GOING TO HIT THE WALL RUN  
(Cockpit door opens and slams shut. Occupants heard running to back of the airplane screaming and yelling)

30 seconds later..... Throttles pulled back to idle.

ental





Gate  
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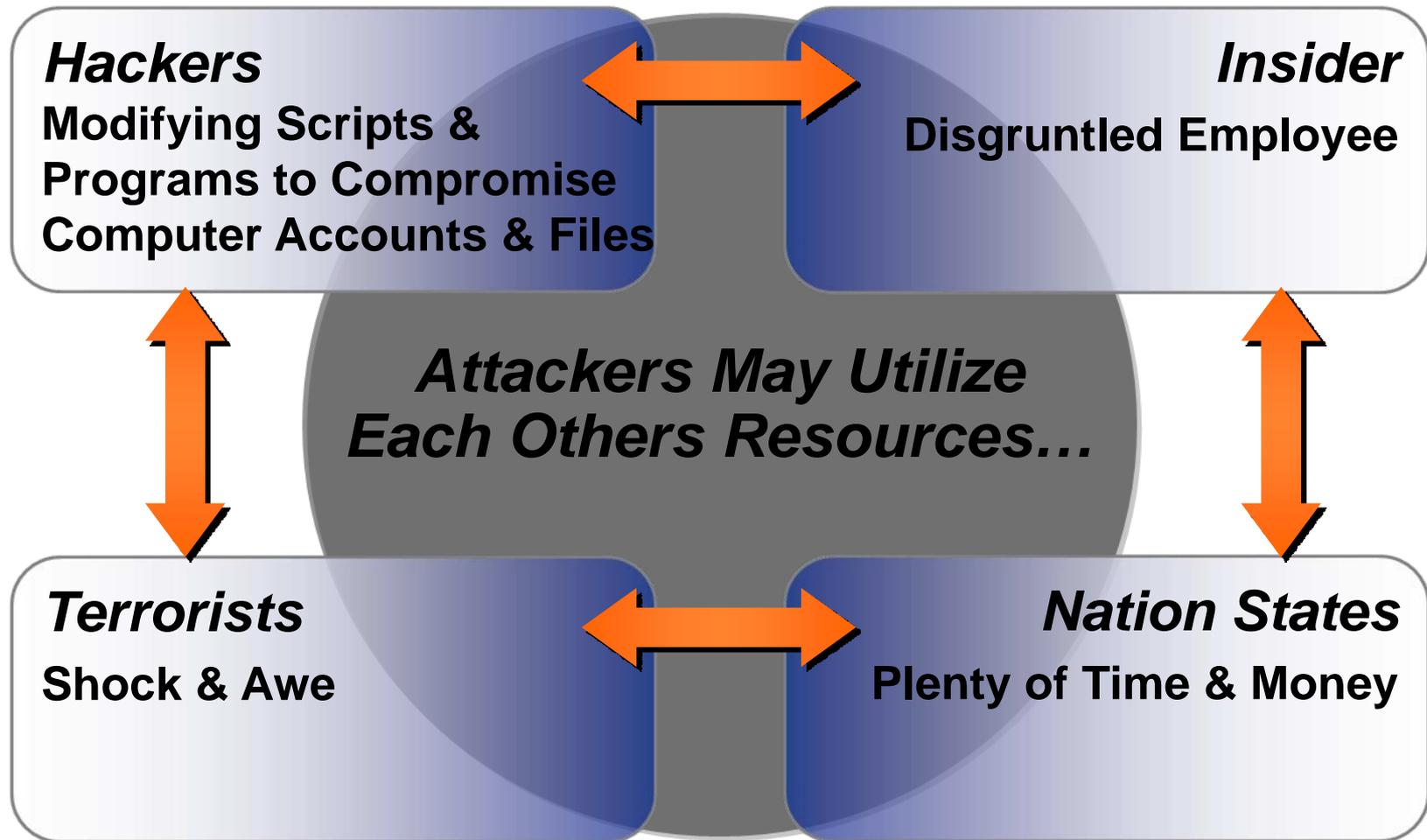
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Source: Google

# Adversaries can also threaten resilience



# Improved prediction is an attribute of resilience

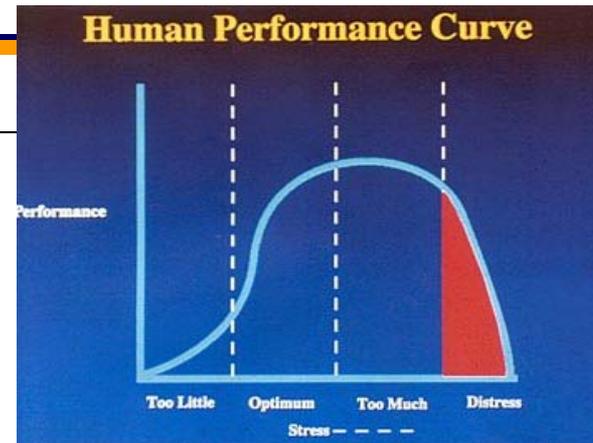
Prediction from smart systems and human agents



Humans continually learn & try to confirm and disconfirm hypotheses

# Data can aid prediction and recovery

- Data can confuse or clarify
- High bandwidth approaches can overwhelm operators
  - Overly high precision
  - Multiple and/or disparate data
- Data fusion and abstraction hold promise for enhancing situation awareness and human-system performance
- Anomalies should be identified by fusing combinations of multiple factors
- Challenge: To date people aren't thinking along the lines of fused information that cross cuts process control, cyber security and physical security data



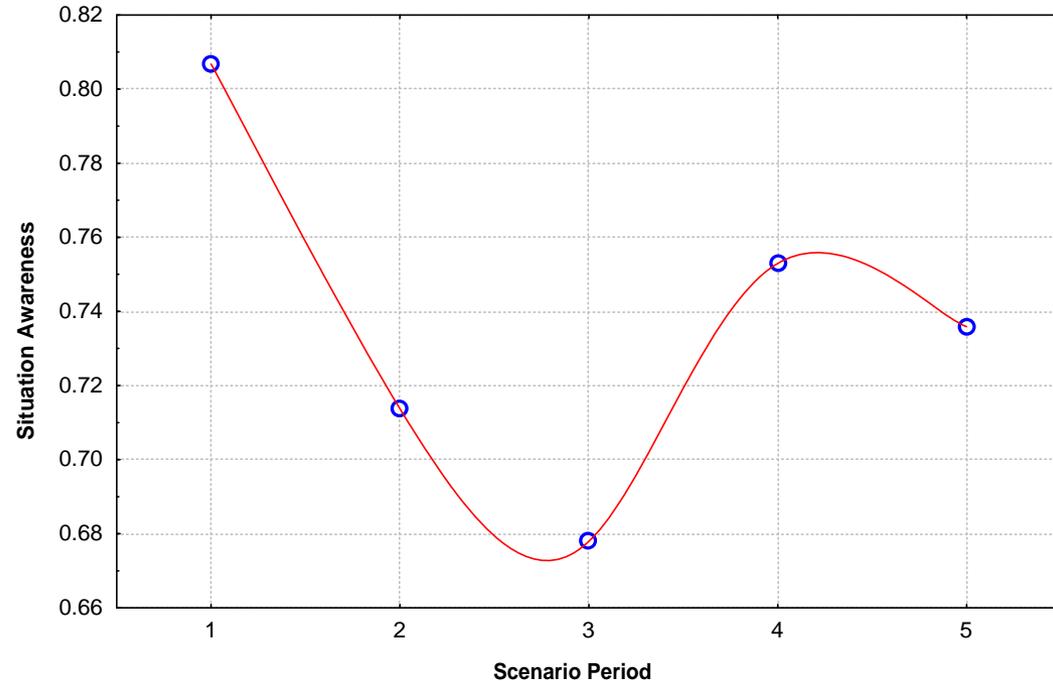
# Rule 1: Don't exceed human operator capabilities

- ❖ Avoid mental calculations
- ❖ Avoid ambiguous indication
- ❖ Reduce bandwidth
- ❖ Hide complexity, keep any interface intuitive
- ❖ Employ metaphors
- ❖ Transform complex raw data into meaningful information
  - This is often difficult
  - Mental data fusion is not preferred



# Situational Awareness

- ❖ Loss is common during disturbances
- ❖ Rate of recovery “approximates” loss
- ❖ Impairs understanding
- ❖ Affects decision making
- ❖ Ties up mental resources
- ❖ May be most affected when most needed



# Improved human resilience options

- ❖ Implement scalable autonomy
  - Independence where you need it
- ❖ Data fusion
  - Gain operator trust
  - Correct levels of data fusion
- ❖ Improve trending and state awareness
- ❖ Retrain to different types of challenges
- ❖ Provide context-based reasoning to augment operator decision making
- ❖ Consider personnel communications as part of resilience



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## Contact Information

David Gertman, Principal Investigator	David.Gertman @inl.gov	(208) 526-1756
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