

NERC

NORTH AMERICAN ELECTRIC
RELIABILITY CORPORATION

Human Performance

Explain, Predict and Change Human Behavior

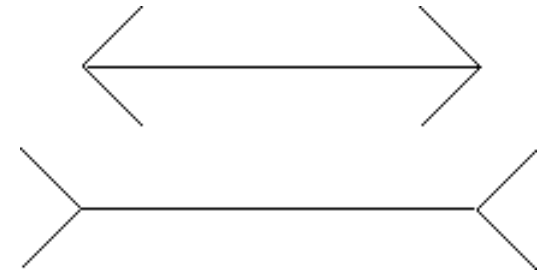
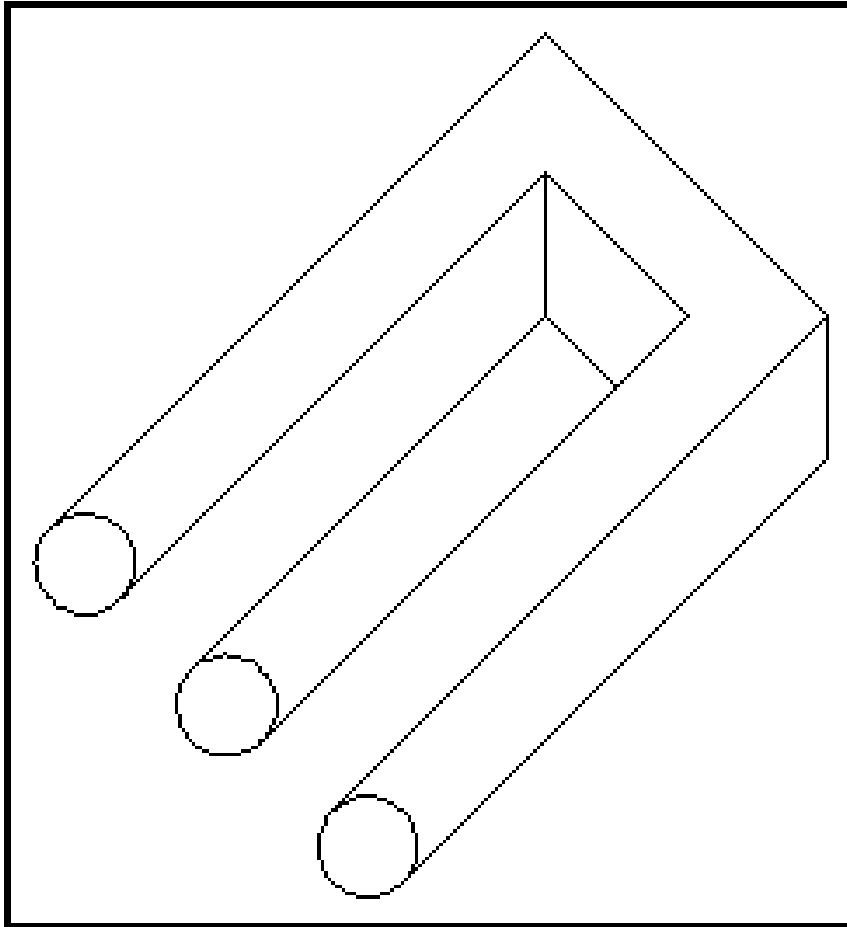
James Merlo, PhD, Senior Director of Reliability Risk Management
Human Performance Conference
March 17, 2015

RELIABILITY | ACCOUNTABILITY



- Reliability – addressing real problems to improve the reliability of the grid.
- Accountability – being accountable to customers, the industry and government for the performance of the grid.
- Learning – enabling the industry to learn from experience to improve future reliability performance.
- Risk-based model – focusing actions and programs on issues most important to grid reliability.

- Changing Resource Mix
- Cyber Attack
- Extreme Physical Events – Acts of Nature
- Extreme Physical Events – Man-made
- Failure to Maintain and Manage BPS Assets
- Generator Unavailability
- Loss of Situational Awareness
- Pandemic
- Poor Event Response/Recovery
- Poor Human Performance
- Poor Resource Planning
- Protection System Failures
- Regulatory Uncertainty
- Uncoordinated Planning



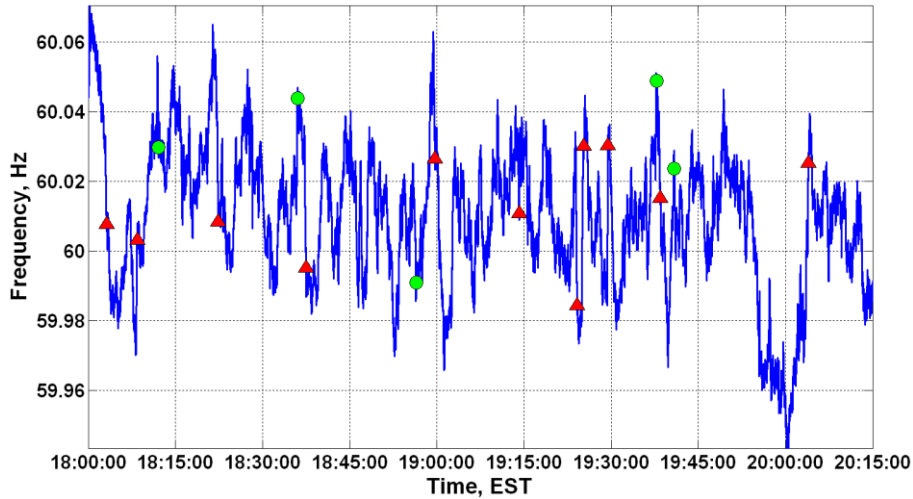


System Frequency During the Super Bowl System Event Distribution

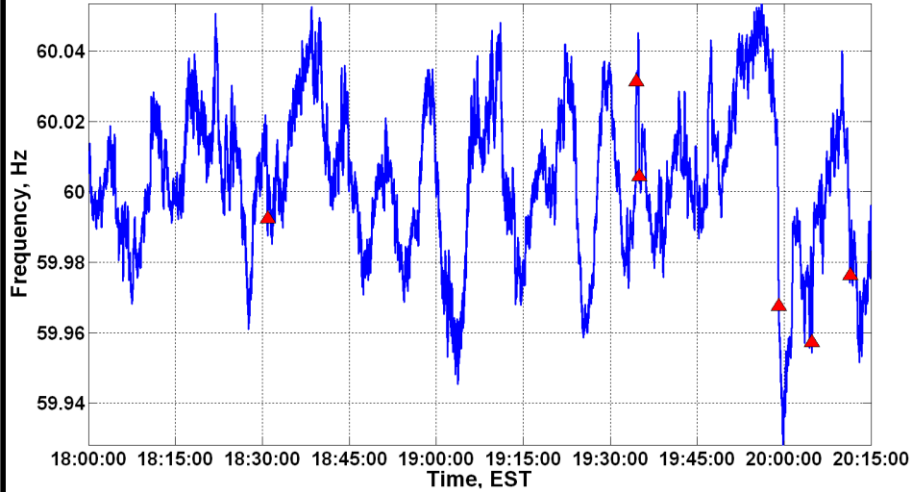
● Event During the Game

▲ Event During the Commercial

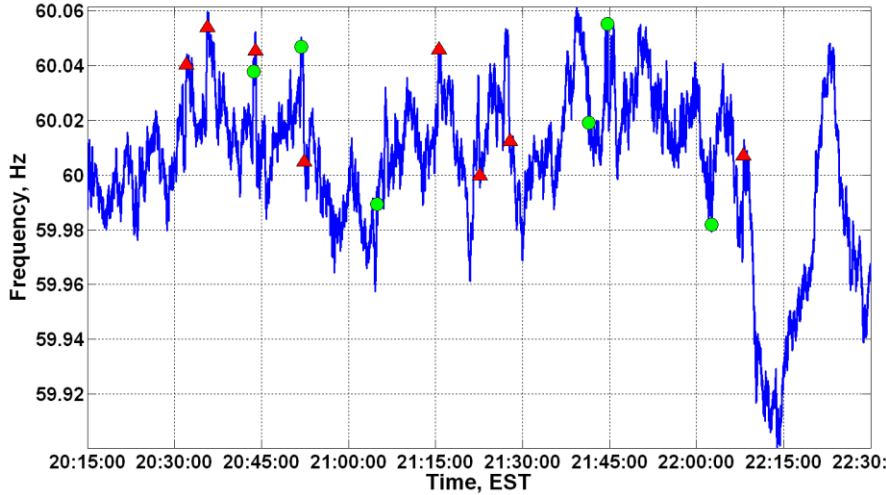
Super Bowl 2008 First Half



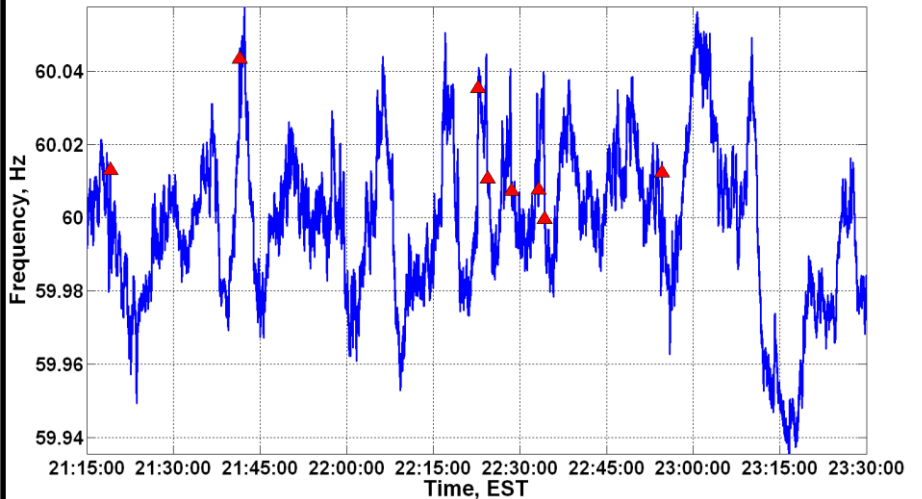
Super Bowl 2009 First Half

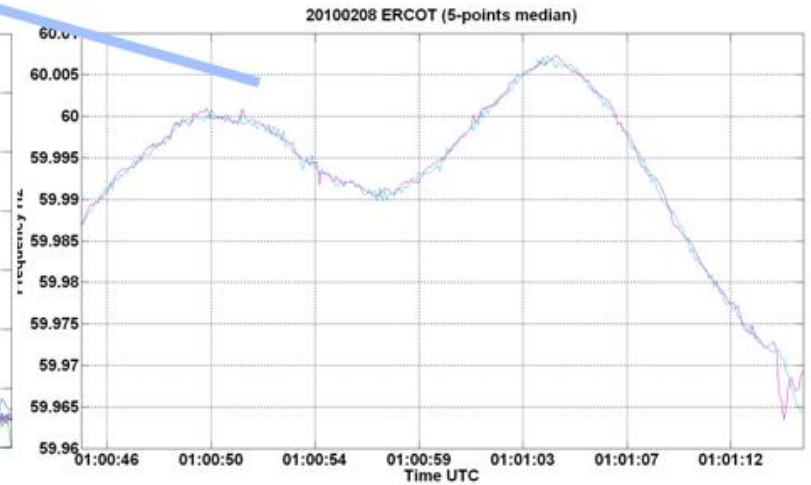
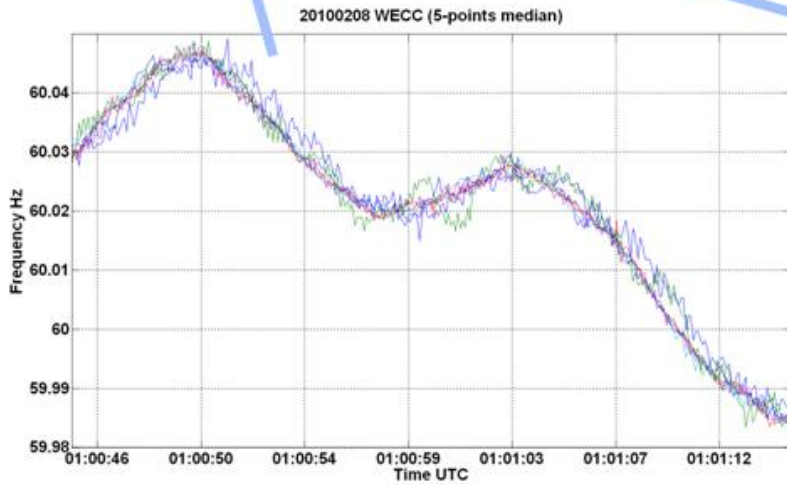
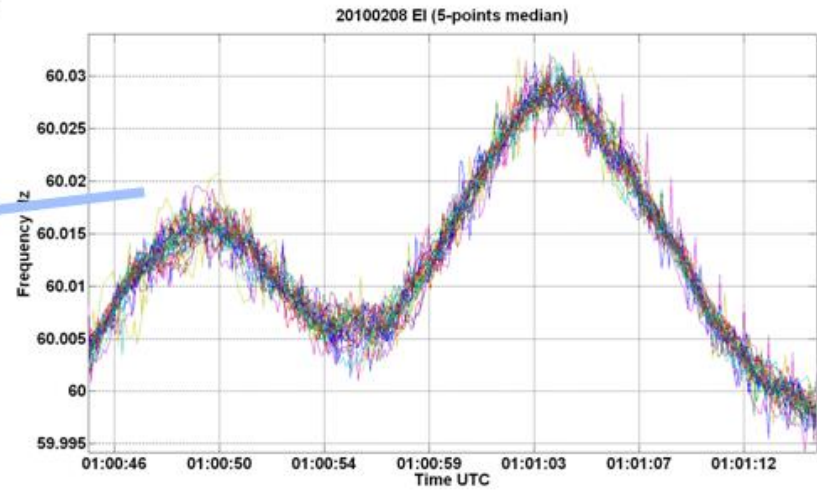
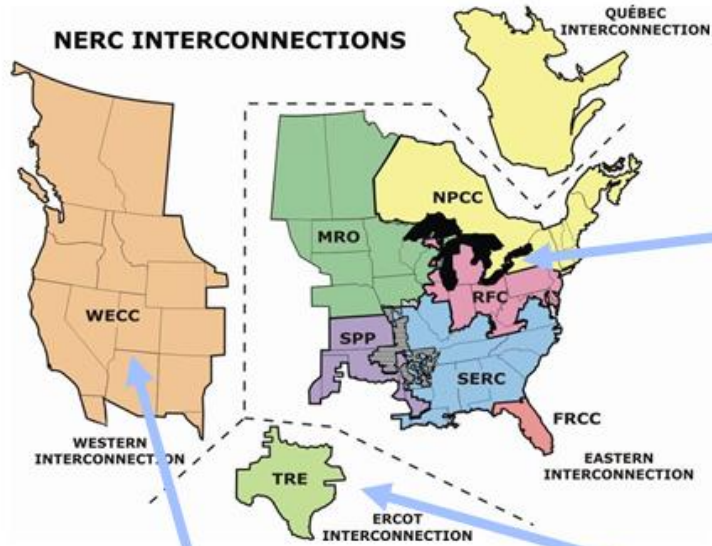


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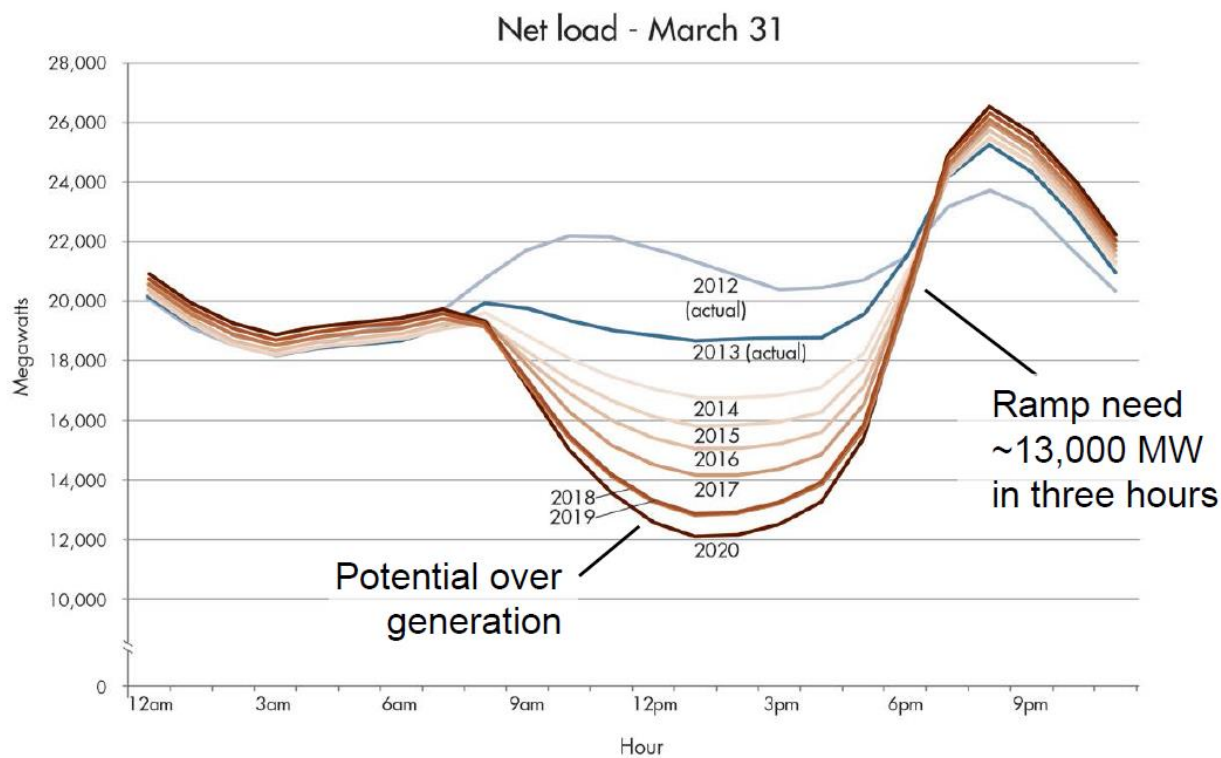






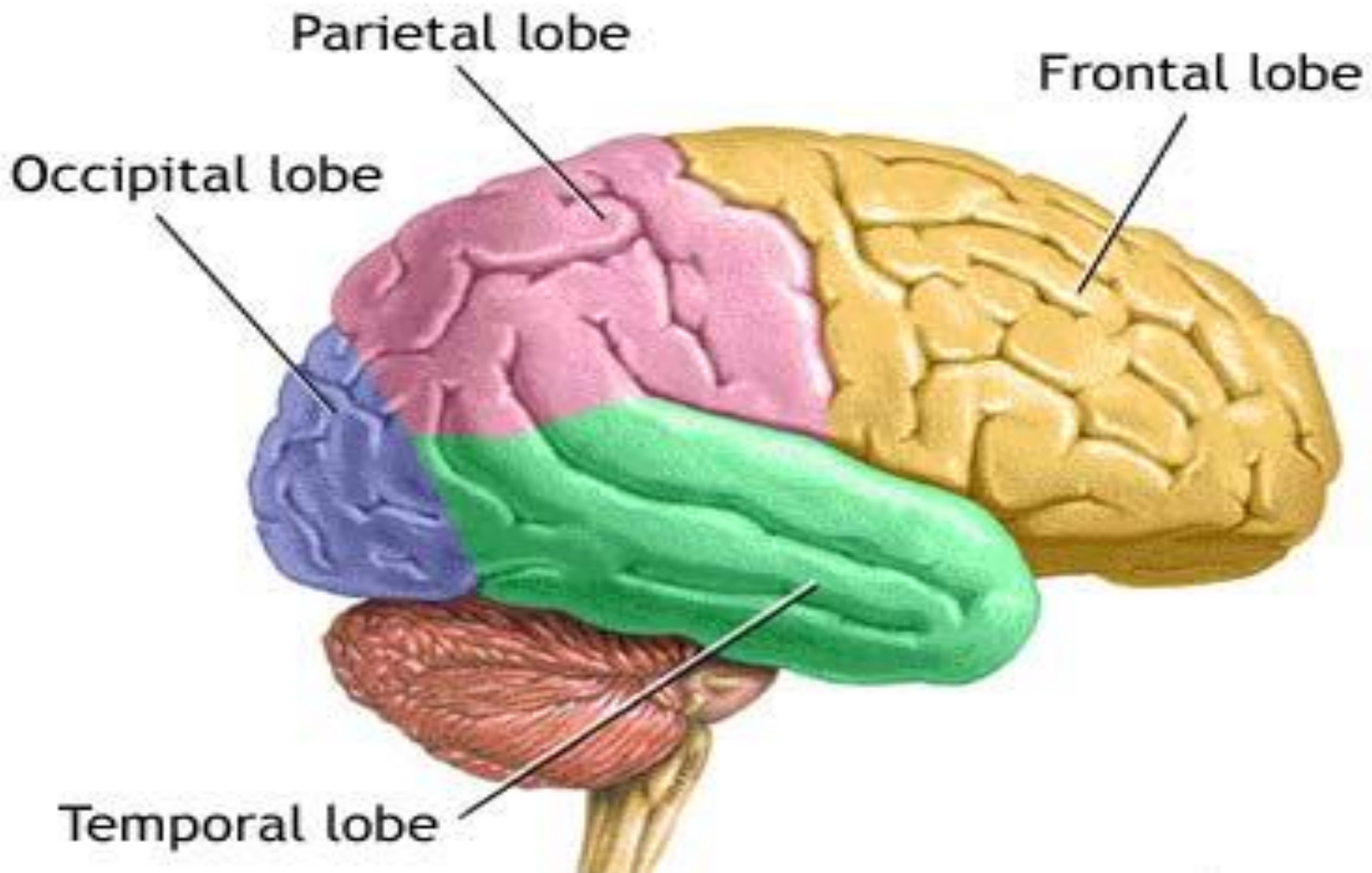


Non-summer months — Net load pattern changes significantly starting in 2014









Sensory Memory

- Very high capacity
- ¼ of a sec
- adaptive

Short Term (Working) Memory

- 7 +/- 2
- 10-20 seconds
- Chunking

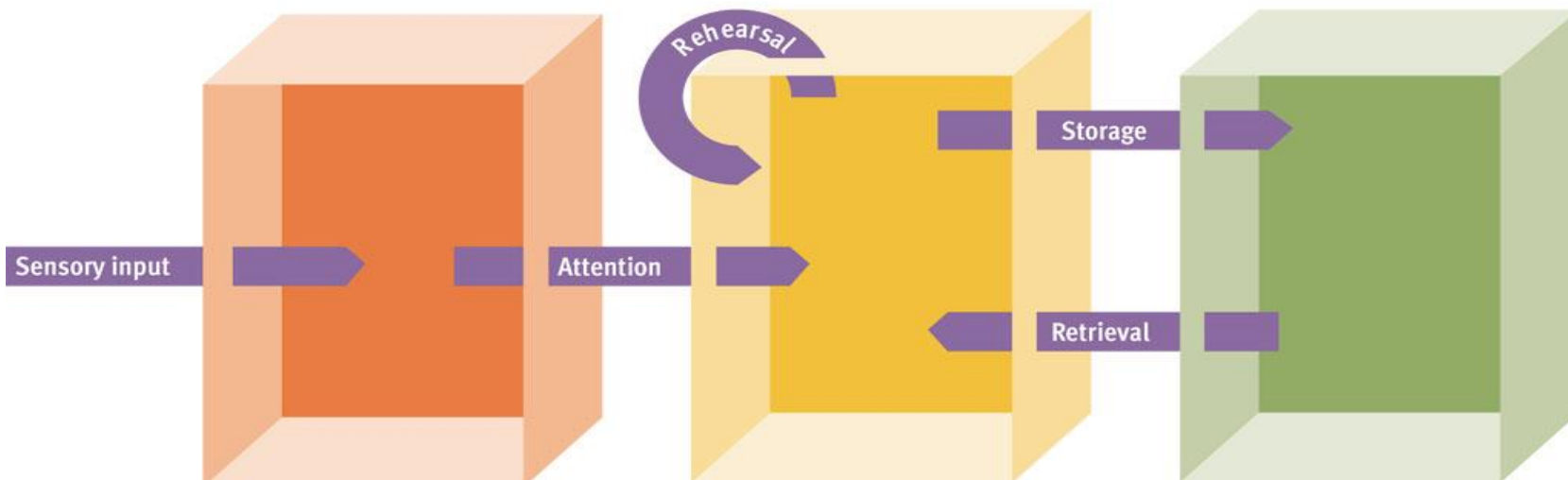
Long Term Memory

- Unlimited
- Indefinite

Sensory memory

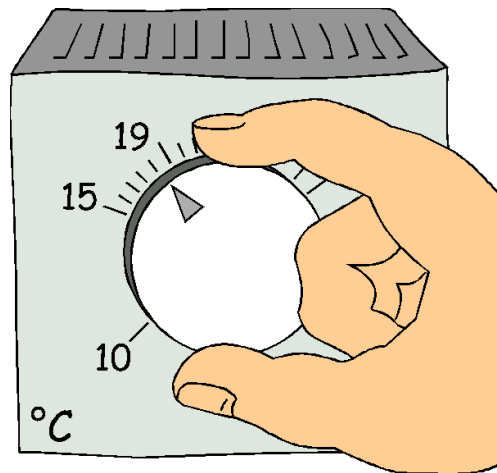
Short-term memory

Long-term memory



© 2005 Wadsworth - Thomson

Improper Mental Model Example

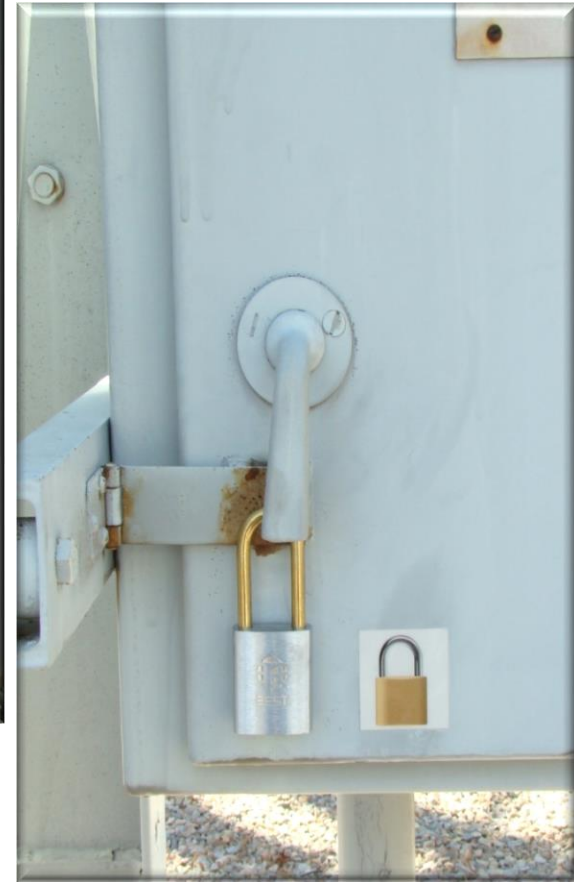


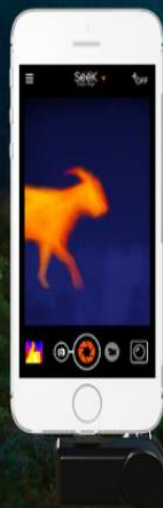
Some people believe that you can heat/cool a room faster by setting the thermostat to a higher/lower temperature than you really want, as if the thermostat were a valve for the heating/cooling system that lets more heat/cool air into the room the higher/lower you set it. In fact, the thermostat is simply an on/off switch for the heat/cool. It turns on as long as the room temperature is below/above the thermostat setting, and turns off when the thermostat setting is reached.

Breaker and Relay Cabinet Locks

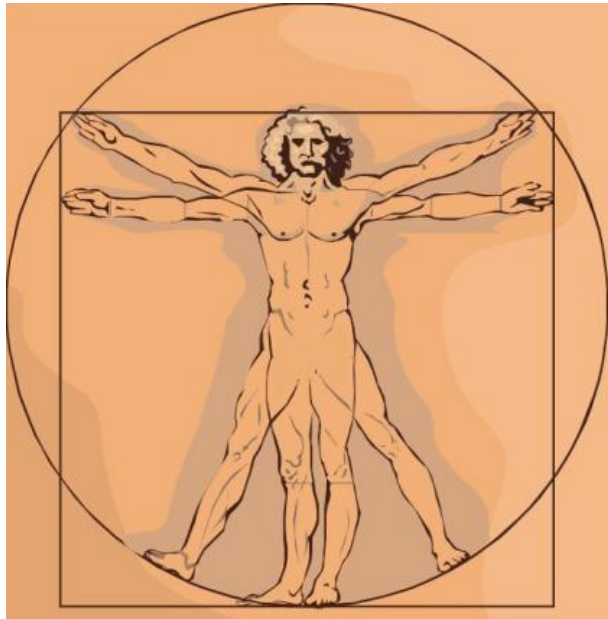


Stickers Create Expectations





WHAT DO YOU SEEK?



It is not a matter of if the automation fails, it is a matter of when.

- Attention
- Sensation
- Perception
- Cognition
- Decision making
- Action

- Attention
 - Sensation
- } Scan
- Perception
 - Cognition
- } Focus
- Decision making
 - Action
- } Act

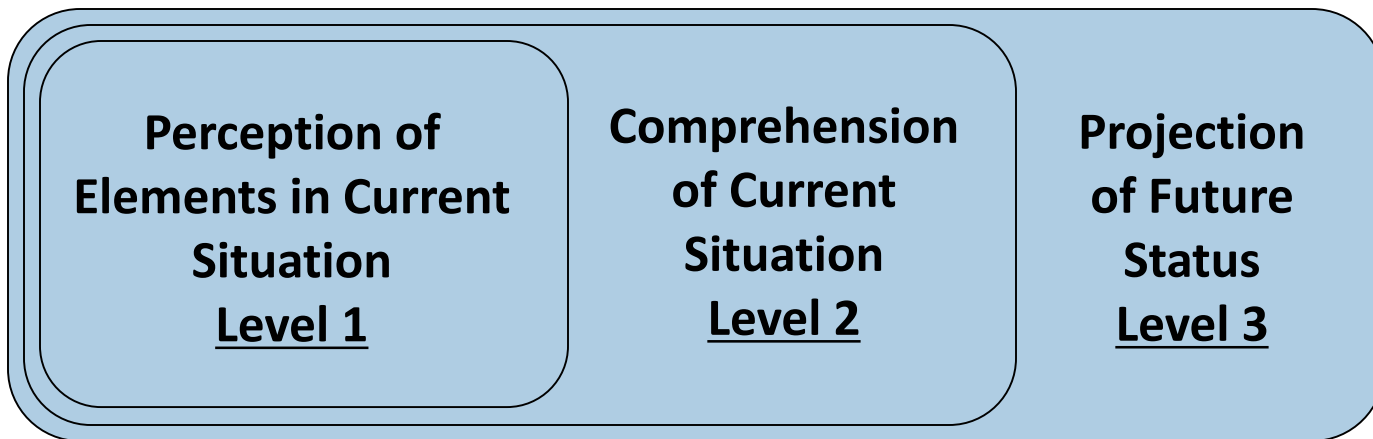
- Situational awareness is defined as the accuracy of a person's current knowledge and understanding of actual conditions compared to expected conditions at a given time. DOE
- The perception of the elements in the environment within a volume of time and space, the comprehension of their meaning and the projection of their status in the near future.

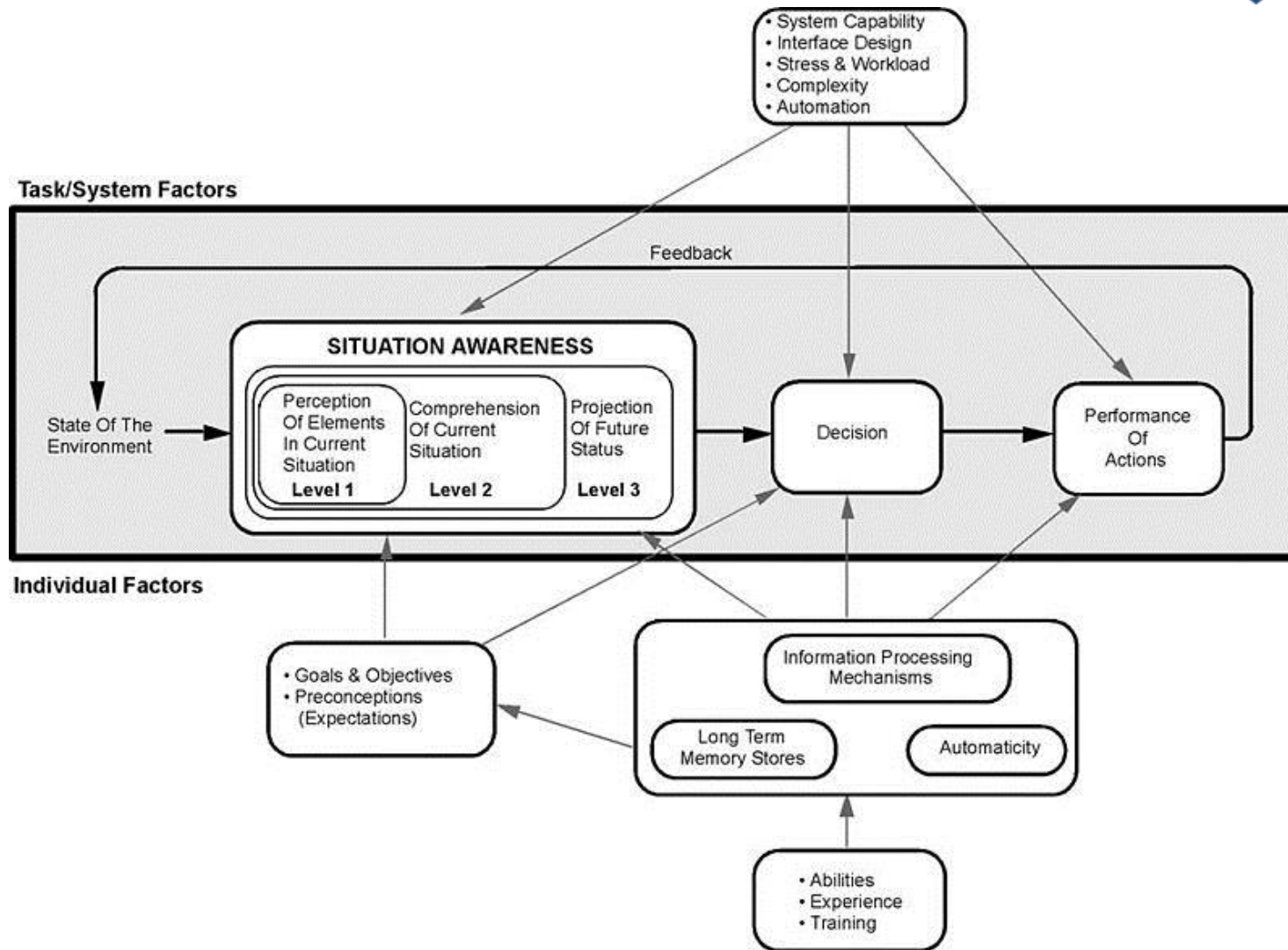
Endsley, M. R. (1995). Toward a theory of situation awareness in dynamic systems. *Human Factors*, 37(1), 32-64.

**Perception of
Elements in Current
Situation
Level 1**

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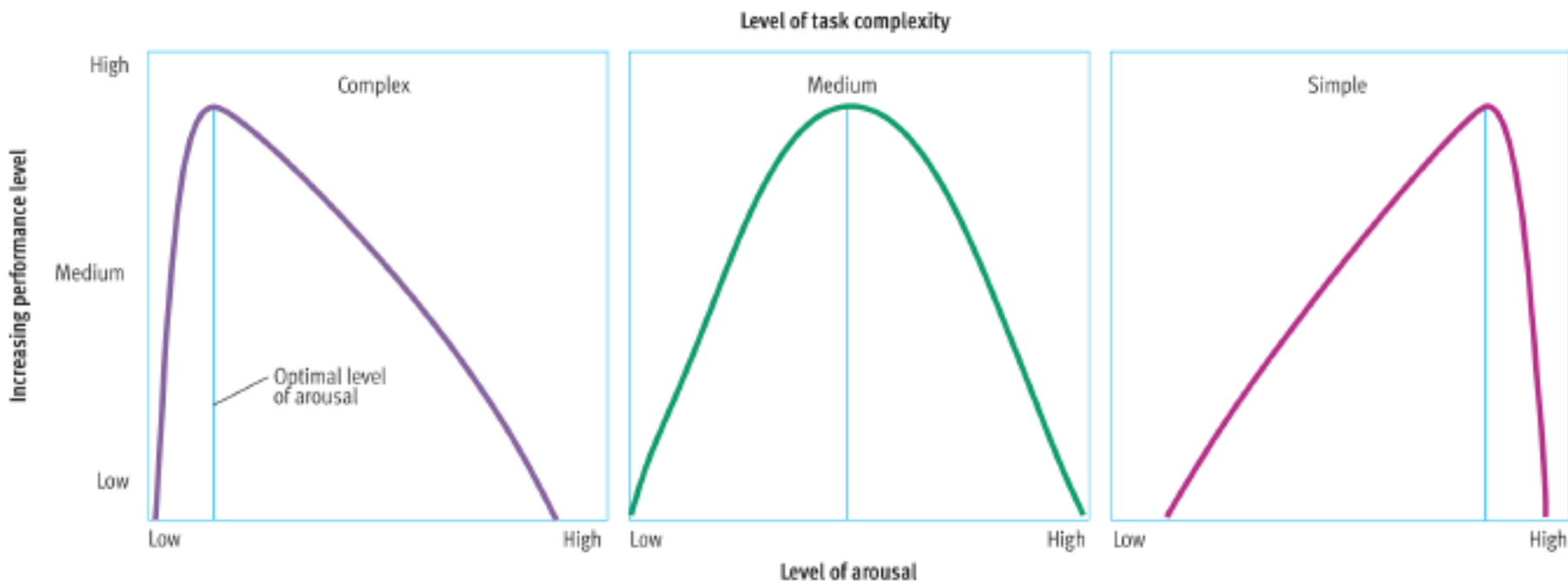
**Comprehension
of Current
Situation
Level 2**





- Stress is the body's mental and physical response to a perceived threat(s) in the environment. It is the perception one has about his or her ability to cope with the threat.
- Stress in itself is not a bad thing. Some stress is normal and healthy. Stress may result in more focused attention, which in some situations could actually be beneficial to performance.
- The problem with stress is that it can accumulate and overpower a person, thus becoming detrimental to performance. Stress increases as familiarity with a situation decreases. It can result in panic, inhibiting the ability to effectively sense, perceive, recall, think, or act. Anxiety and fear usually follow when an individual feels unable to respond successfully.
- Along with anxiety and fear, memory lapses are among the first symptoms to appear. The inability to think critically or to perform physical acts with accuracy soon follows.

emotional arousal vs task performance



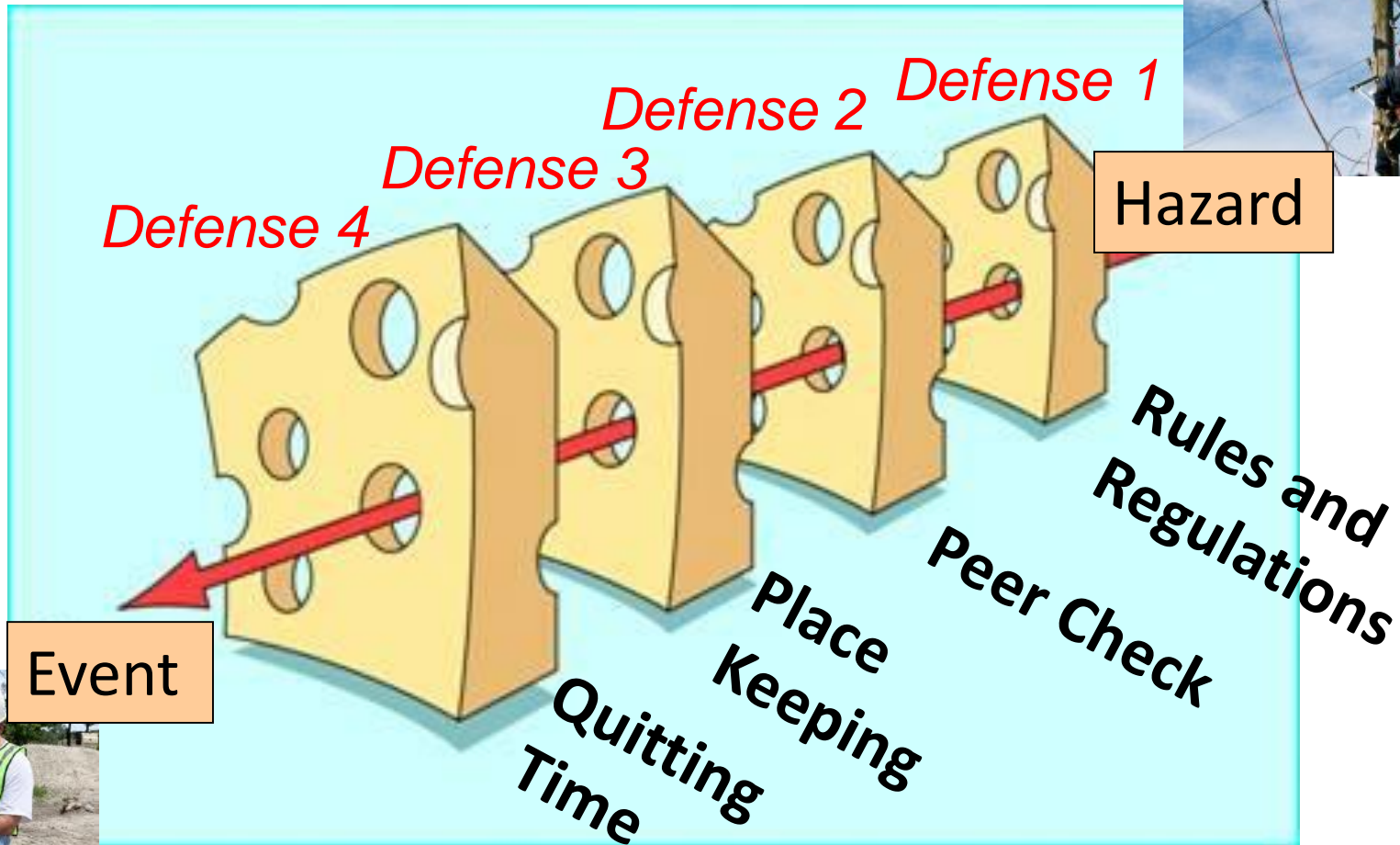
Inverted-U Hypothesis

Task Demands	Work Environment
Time pressure (in a hurry)	Distractions / Interruptions
High workload (memory requirements)	Changes / Departure from routine
Simultaneous, Multiple tasks	Confusing displays / control
Repetitive actions (monotony)	Work - arounds
Unclear goals, roles, or responsibilities	Unexpected equipment conditions
Lack of or unclear standards	Back shift or recent shift change
Complex / High information flow	
Individual Capabilities	Human Nature
Unfamiliarity with task (first time)	Stress
Lack of knowledge (faulty mental model)	Habit patterns
Imprecise communication habits	Assumptions
Lack of proficiency; inexperience	Complacency / over confidence
Overzealousness for safety critical task	Inaccurate risk perception
Illness or fatigue – Fitness for duty	Communication shortcuts
Lack of big picture	

Pre-Job Briefing	Values & Norms
Communications – Oral & Written	Maintenance Processes
Work Planning & Scheduling	Procedure Development
Controls, Measures and Monitoring	Goals & Priorities
Design & Modifications	Organizational Structure
Task Structure	Roles & Responsibilities
Written Guidance: Rules, Policies and Practices	Training & Qualification

- A review of the INPO industry event data base reveals that **events occur more often due to error-prone tasks and error-prone work environments than from error-prone individuals**
- Error-prone tasks and work environments are typically created by latent organizational weaknesses.

But it is possible that under the wrong set of circumstances, an event could occur....



Equipment Reliability

Human Performance

**Human Interaction with Equipment
(coupled w/Automation)**



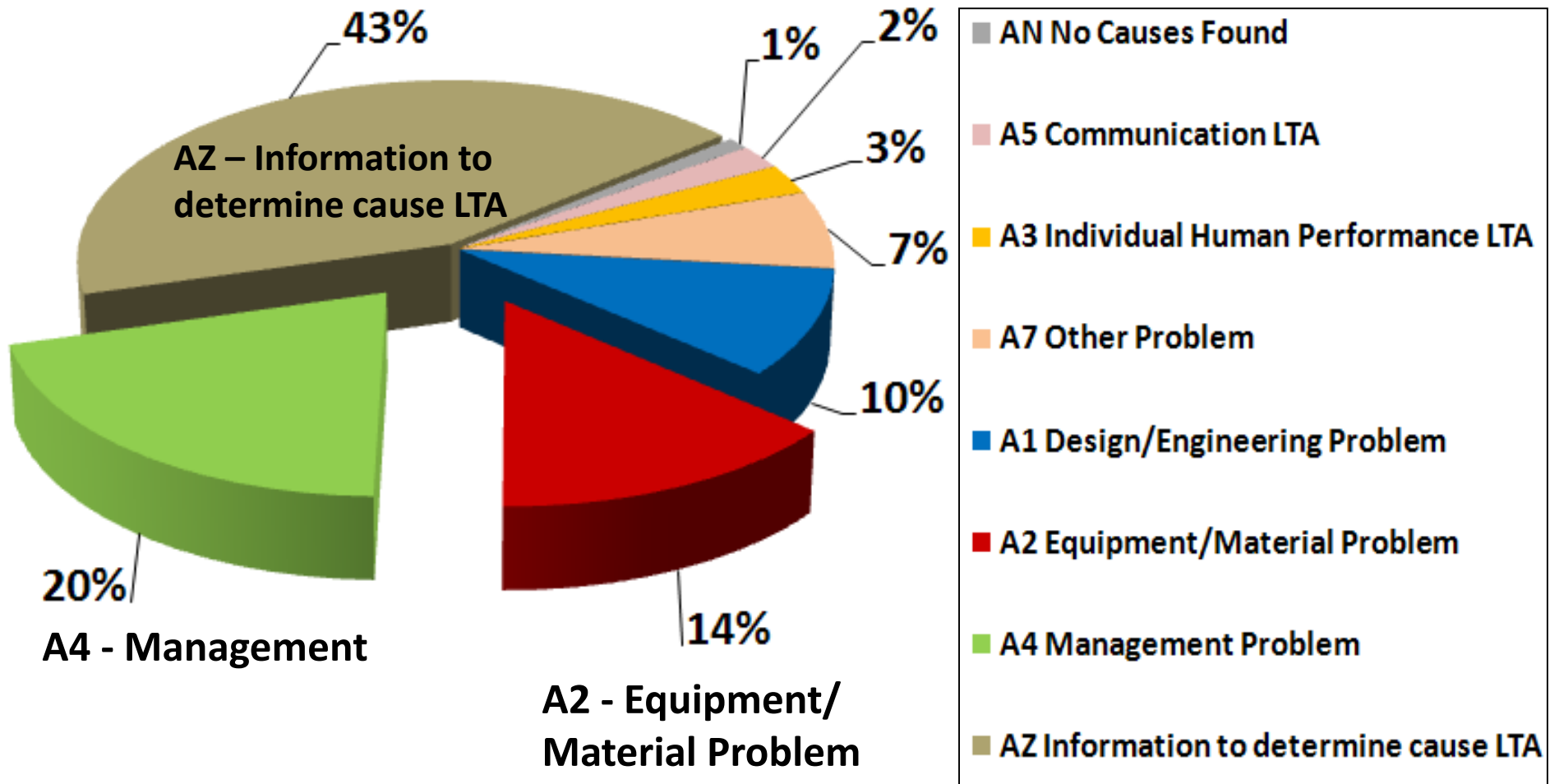
"Before you tell the "truth" to the patient, be sure you know the "truth," and that the patient wants to hear it."

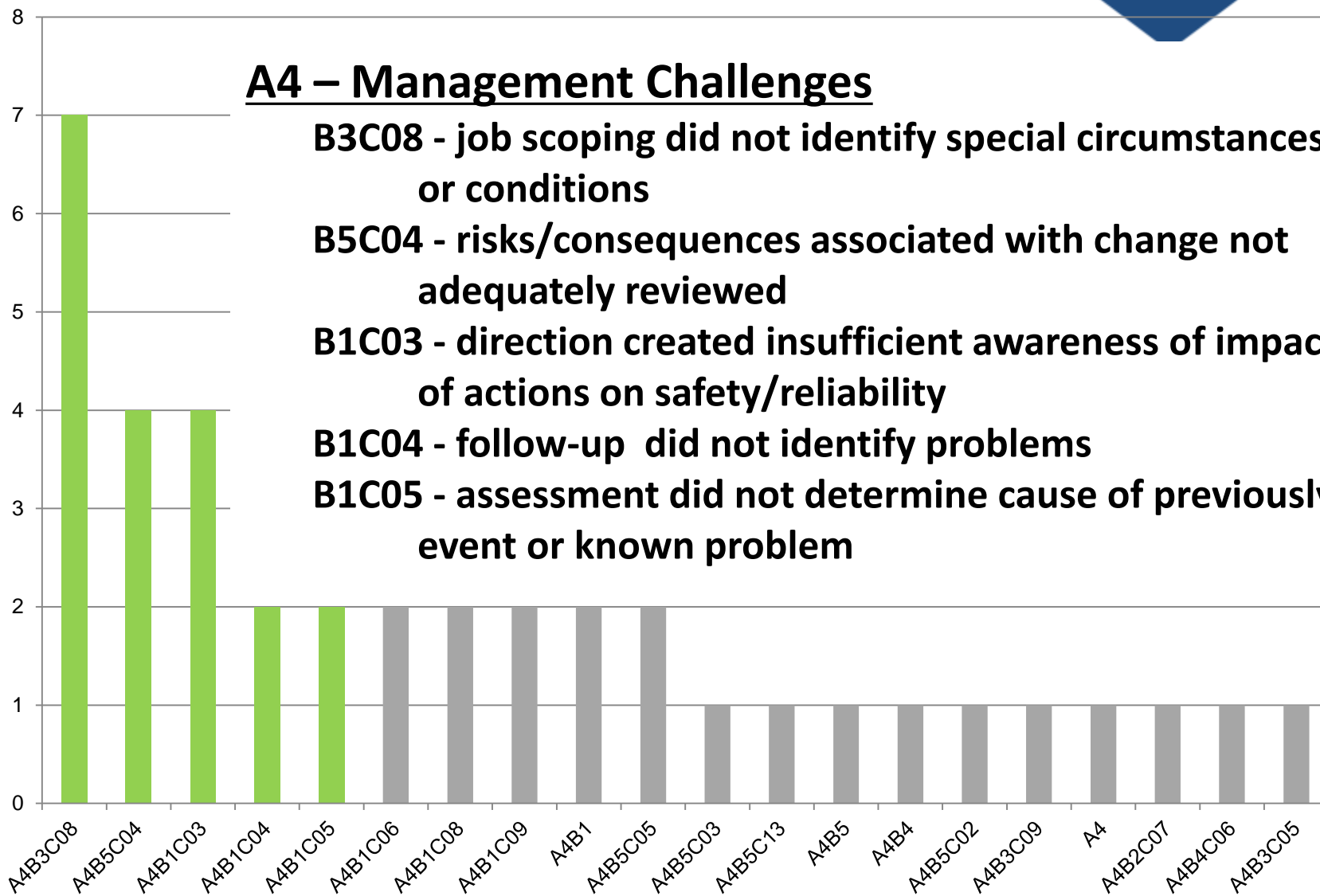
Journal of Chronic Diseases (1963)

Dr. Richard Clarke Cabot

(1868-1939)

Root Cause Determinations





A4 – Management Challenges

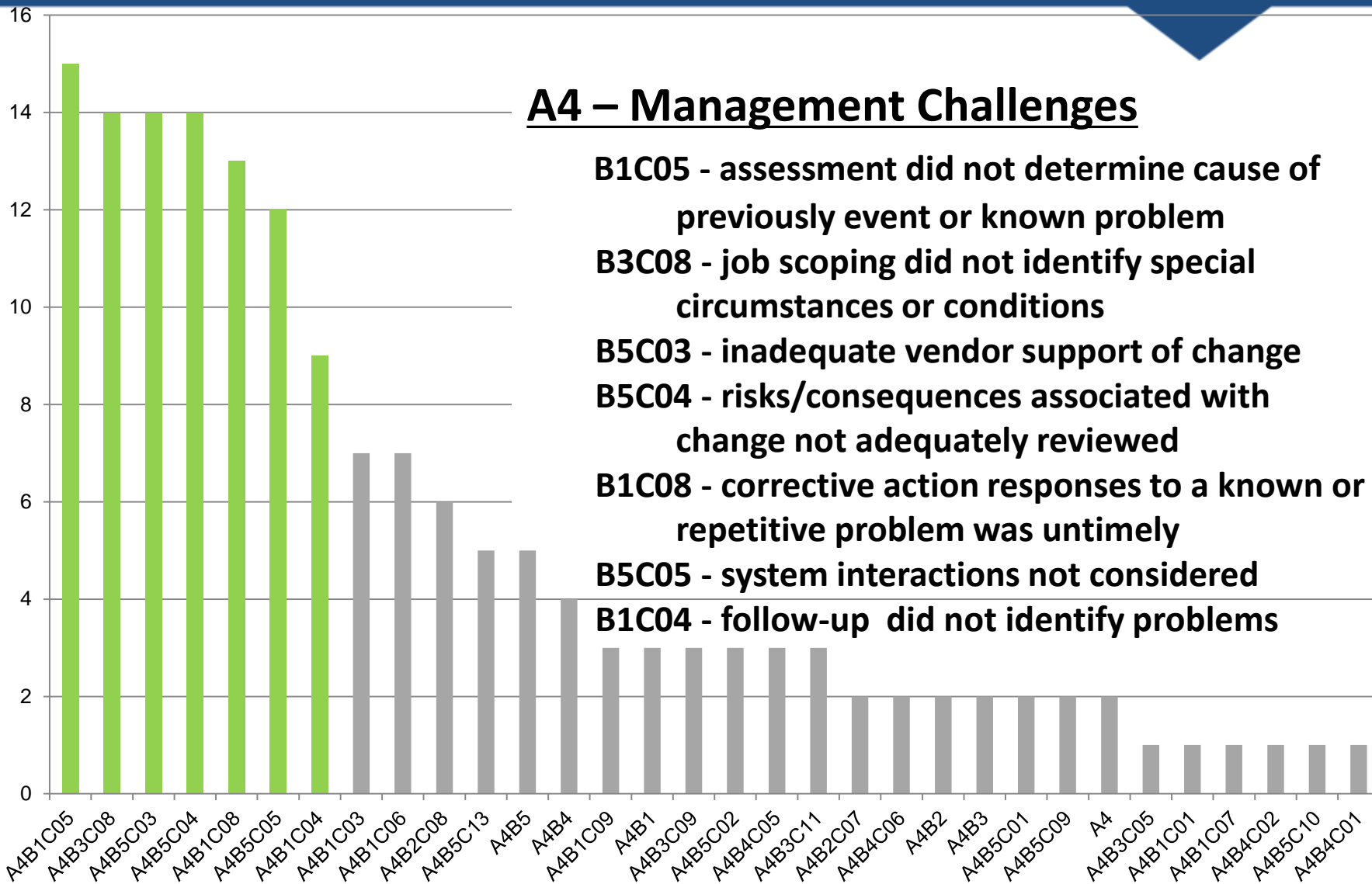
B3C08 - job scoping did not identify special circumstances or conditions

B5C04 - risks/consequences associated with change not adequately reviewed

B1C03 - direction created insufficient awareness of impact of actions on safety/reliability

B1C04 - follow-up did not identify problems

B1C05 - assessment did not determine cause of previously event or known problem



A4 – Management Challenges

B1C05 - assessment did not determine cause of previously event or known problem

B3C08 - job scoping did not identify special circumstances or conditions

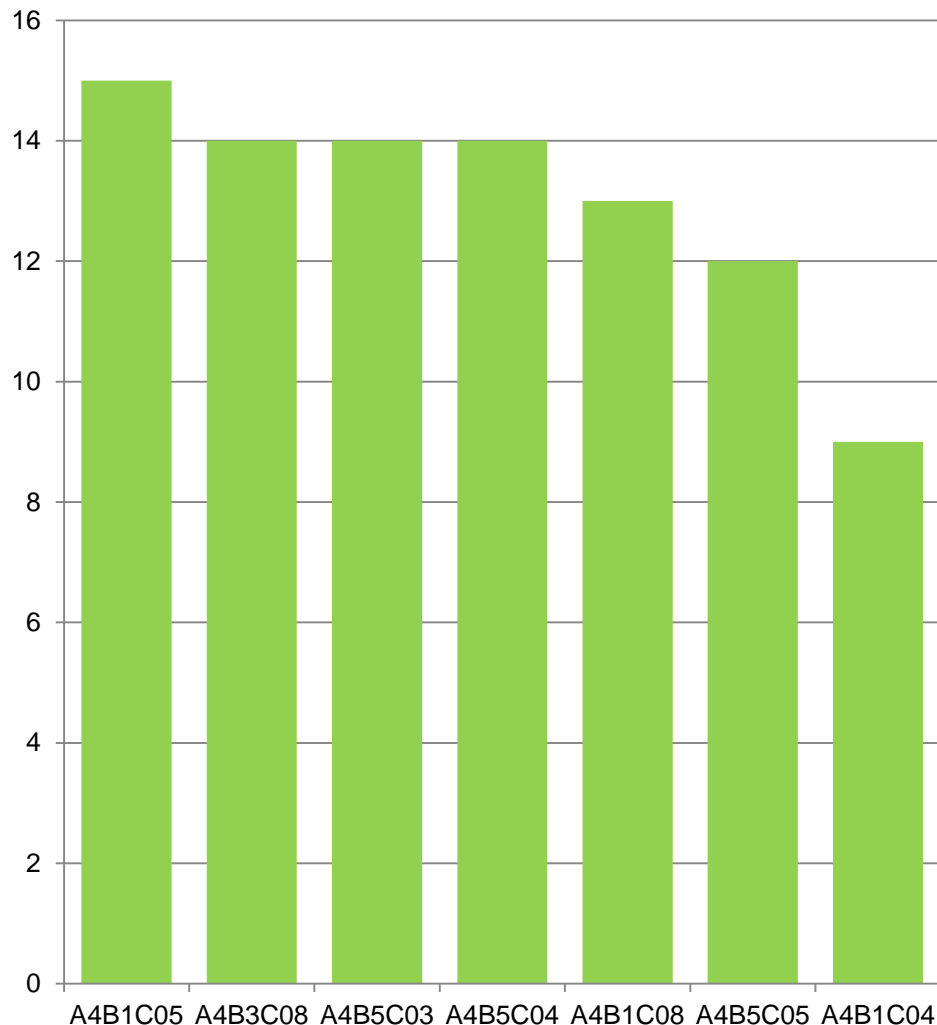
B5C03 - inadequate vendor support of change

B5C04 - risks/consequences associated with change not adequately reviewed

B1C08 - corrective action responses to a known or repetitive problem was untimely

B5C05 - system interactions not considered

B1C04 - follow-up did not identify problems



A4 – Management Challenges

B1C05 - assessment did not determine cause of previous event or known problem

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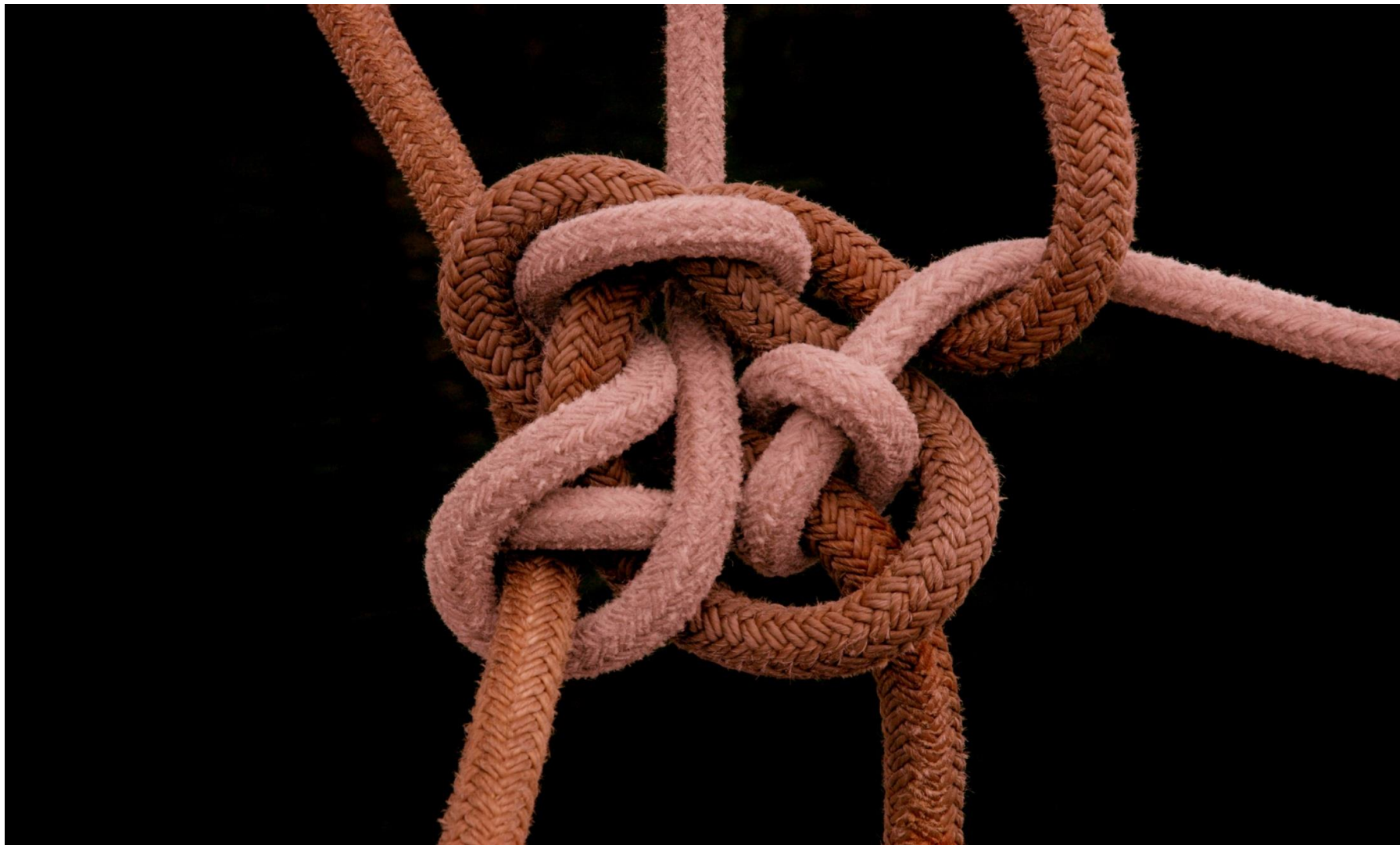
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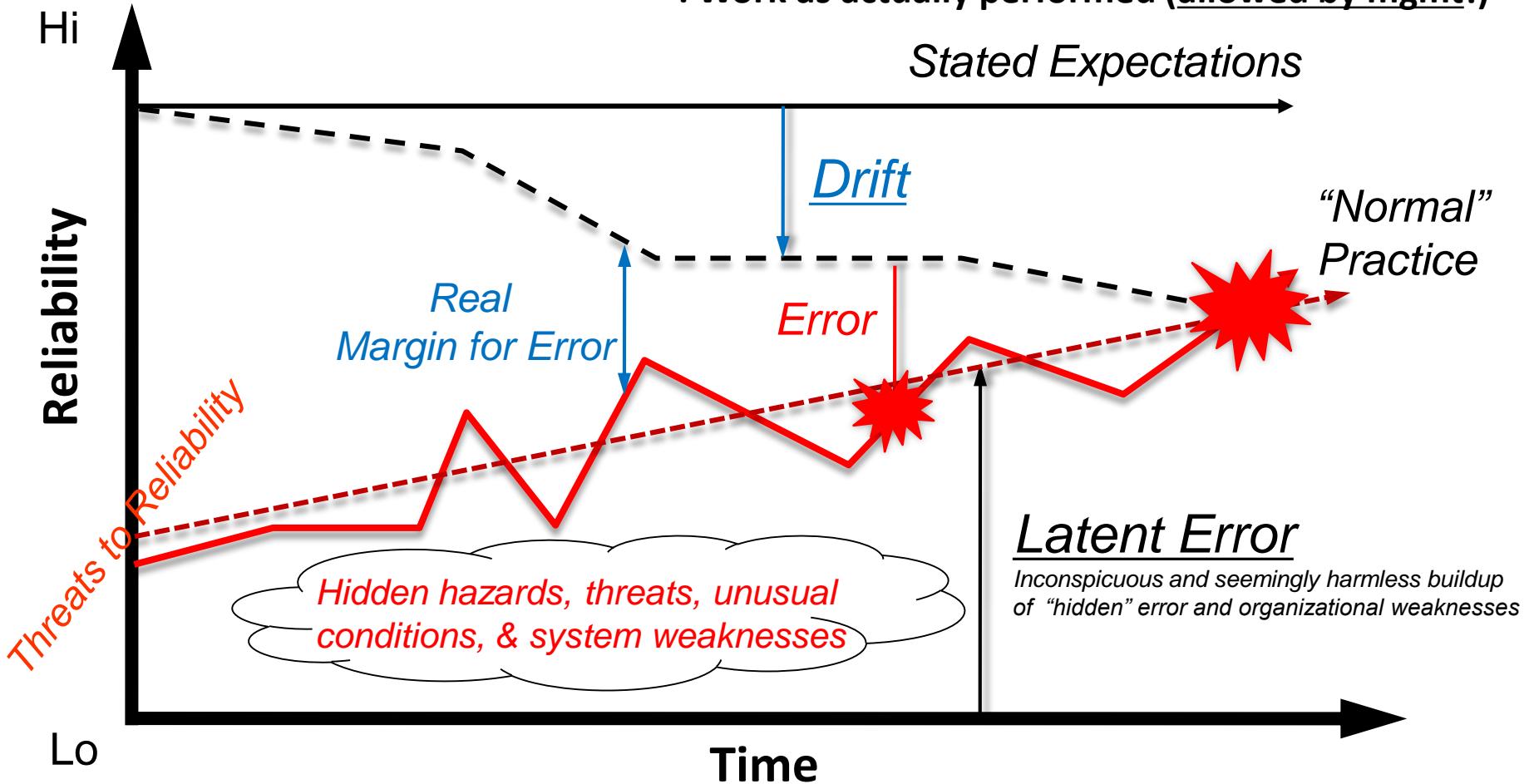
- Those things that “set-up” a mistake to happen
 - Task demands are greater than the worker’s abilities
 - Confusing conditions make the job harder
 - New techniques not used before
 - Mental shortcuts
 - Lack-of or unclear standards
 - Illness / Fatigue
- **Distractions**
- **Interruptions**
- **Unplanned changes**

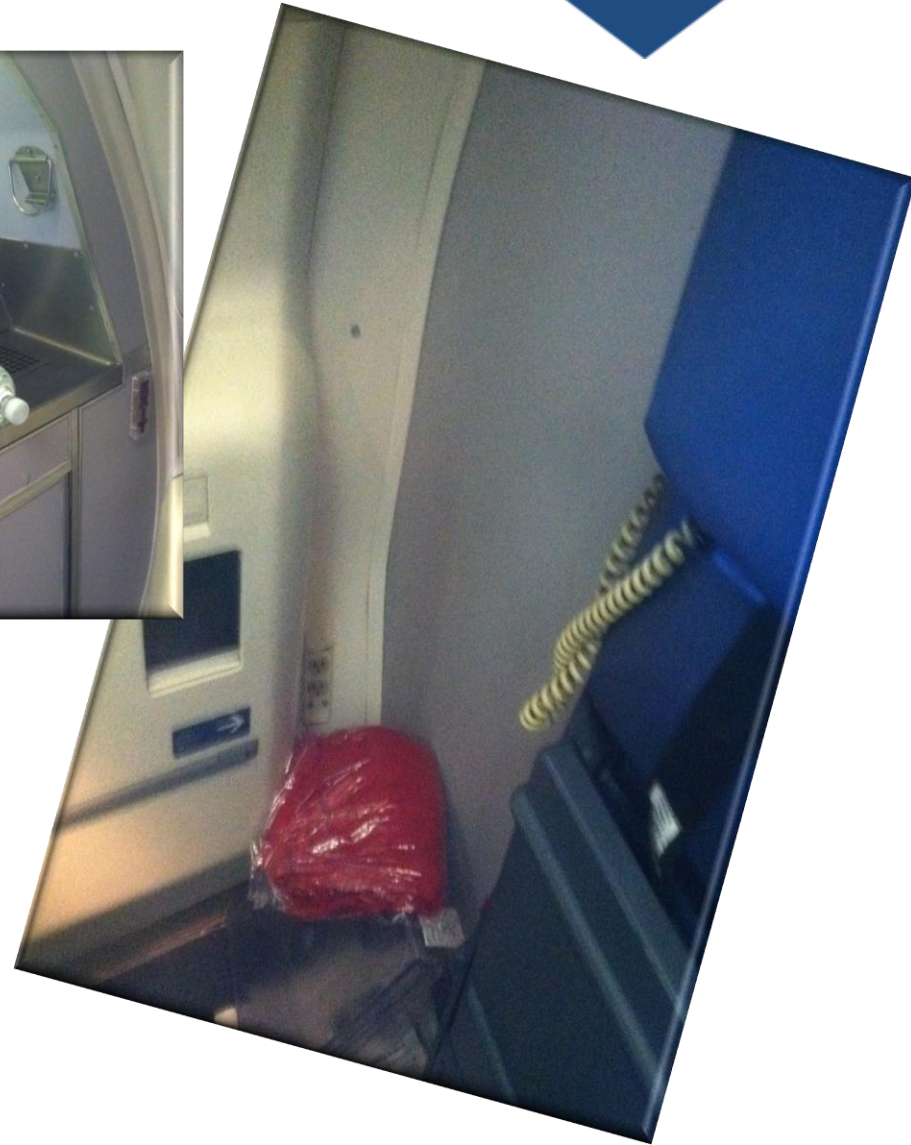
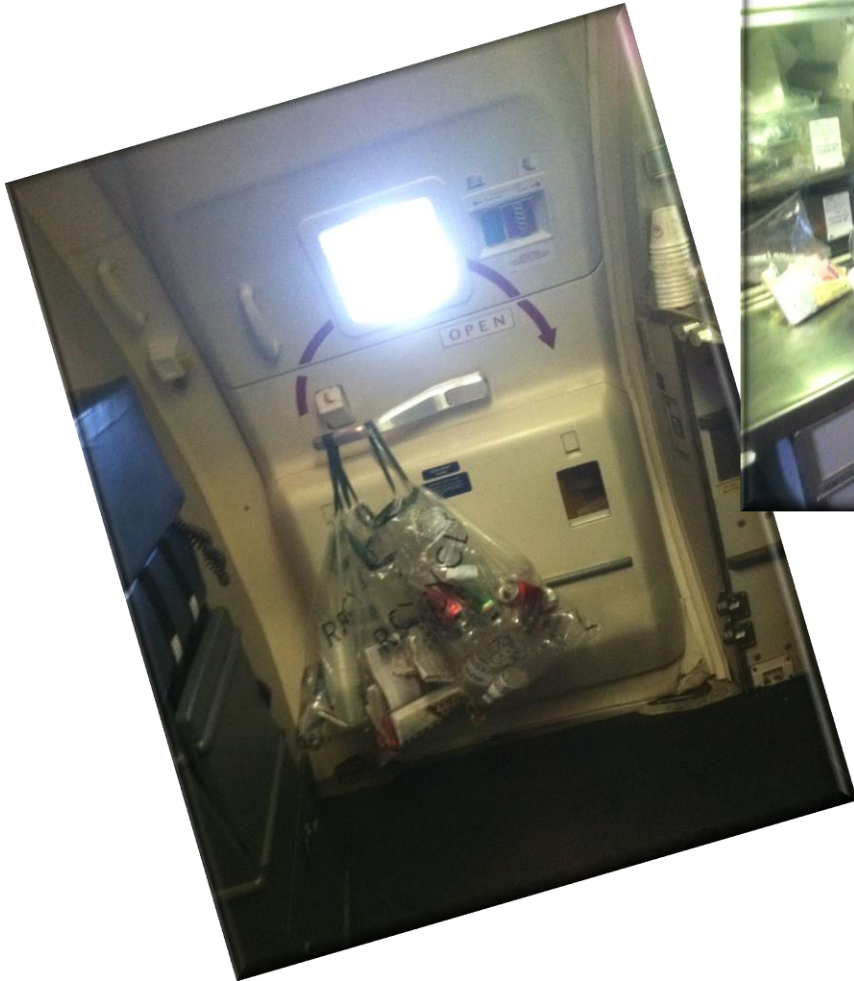
Solving Problems: Untying the Knot



: Desired approach to work (as imagined)

: Work as actually performed (allowed by mgmt!)





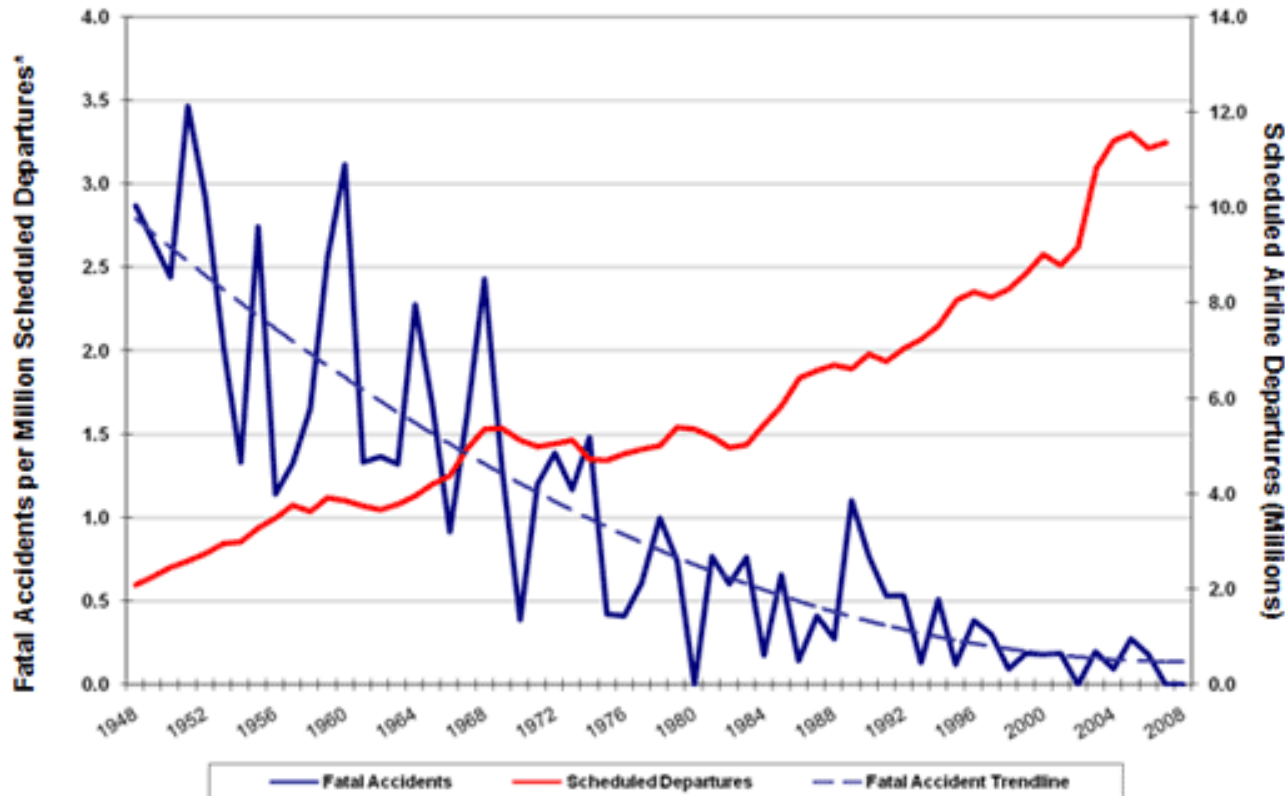




“Complicated Industry”
“Come along way”
“Can’t get to zero”
“Automate, technology reduces the need for human operator”



With Each Decade, U.S. Airline Safety Has Improved
Since Deregulation, < 0.5 Fatal Accidents per Million Departures



* Scheduled passenger and cargo operations of U.S. air carriers operating under 14 CFR 121; NTSB accident rates exclude incidents resulting from illegal acts
Source: National Transportation Safety Board (NTSB)

- We have not fully understood an event if we don't see the actors' actions as reasonable.
- The point of a human error investigation is to understand why people did what they did, not to judge them for what they did not do.
- The difference between an accident and a serious incident lies only in the result.



- Two Minute rule
- Stop when unsure
- Self checking (also called STAR and touch STAR)
- Procedure use and adherence
- Three way communication
- Phonetic alphabet
- Pre-job brief
- Peer check
- Concurrent verification
- Independent verification
- Flagging operational barriers
- Place keeping
- Post job interview
- First Check



HUMAN PERFORMANCE TOOLS

FPG-SPP-01.023 Human Performance Tools

Three-Way Communication: 1. Sender gives direction. 2. Receiver repeats direction to sender. 3. Sender confirms direction is correct.

Phonetic Alphabet: Use words instead of letters to eliminate communication errors.

Peer Checking: The act of a second person checking before an action is taken.

Independent Verification: Used to detect an error. The performer and verifier should be separated by time and space or physical barrier while performing the task.

Consensus Verification: Used to prevent an error. Performer and verifier rigorously review the intended action. The performer will take the action while observed by the verifier.

Flagging/Operational Barriers: Flagging is a form of marking used to identify component that are not to be worked or manipulated.

Operational Barriers: Operational Barriers are used to mark component that are not to be worked or manipulated.

Stop When Unsure: When in doubt about any step or part of the job, STOP and get others involved.

HUMAN PERFORMANCE TOOLS

FPG-SPP-01.023 Human Performance Tools

Flash Brief: Review of what you are going to do and potential hazards involved. Requires participation by everyone involved in the work.

Two Minute Rule: Take two minutes at the job site. Look for/mitigate hazards and potential for injury.

First Check: Validate that you are in the right place before you begin working alone.

Touch STAR (Self-Check): Touch component. Stop, Think, Act, and Review. job is complete to solicit feedback from the workers to identify opportunities for improvement.

Procedure Use & Adherence: Required of all personnel. There are four types of procedures: Continuous Use - in possession of the user and signed off; Reference Use - in immediate area with steps signed off; Information Use - review as needed; Multiple Use - when more than one of these levels of use exist within the procedure.

Checkkeeping: Marks completed or N/A in procedures/work documents, so they are not accidentally omitted or repeated.

Error Prevention Tools Improves Human Performance

What does human performance mean at PG&E? It refers to the set of tools that we use to perform our jobs safely, efficiently and error-free. Humans are fallible, but when used consistently and correctly, human performance tools will prevent hazards and events. This booklet will help you get started. It contains information on:

- Tailboards which are performed prior to work and after extended delays to discuss safety, hazards, work scope, personnel assignments, procedures, and contingencies.
- Stop When Unsure when you need help.
- Questioning Attitude to clarify any doubts by asking, "Why and what if...?"
- Three-Way Communication for improved information transfer through communication.
- Phonetic Alphabet when communicating the approved company guidance documents.
- Procedure Use and Adherence for following site conditions, evaluate hazards, stop, assess, and analyze.
- STAR for self-checking to ensure you follow steps accurately.

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5. Review previous experience and lessons learned relevant to the specific task and critical steps.

Stop When Unsure

When confronted with confusion or uncertainty, a person is in unfamiliar territory. Given that the chance for error is particularly high in such situations, the best course of action, when unsure, is to stop and get help from other people.

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Four Pre-Job Questions	
Ten Post-Job Questions	
Definitions	

This is not a complete list of Human Performance concepts. Each job is unique. Use your best professional judgment, and when in doubt, get help. Call questions, concerns, suggestions! Contact the Human Performance desk at DVP Safety & Training at 804-713-3016.

Three-Way Communication

Promotes a reliable transfer of information and understanding, with the goal of assuring the correct action. (State, Repeat, Confirm).

The speaker will...

- State their message to the listener by clearly articulating the information.

The listener will...

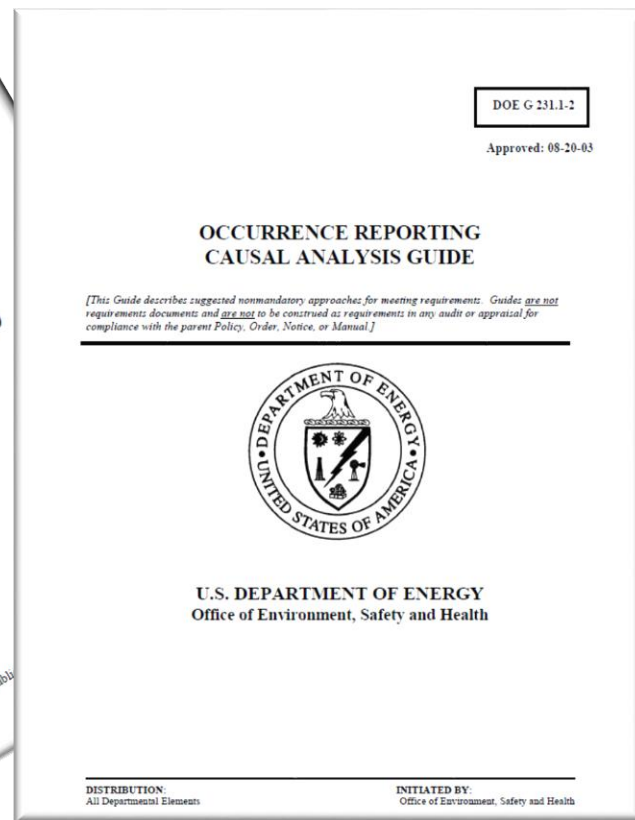
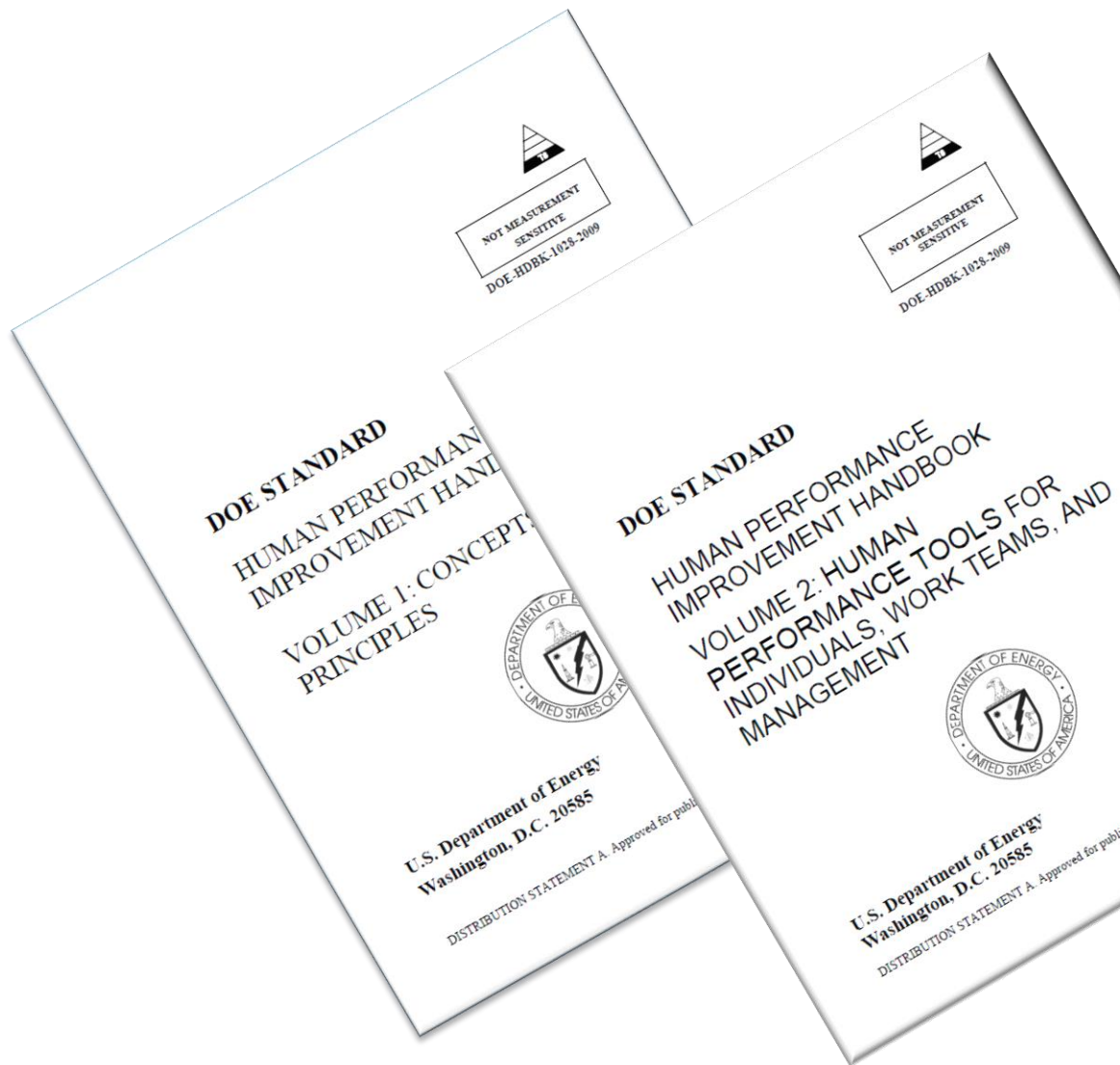
- Repeat or paraphrase his understanding of the message back to the speaker for verification.

The speaker will...

- Confirm that the listener understood and restated the original message.

Error Precursors (short list)

Task Demands	Individual Capabilities	Human Nature
<ul style="list-style-type: none"> Time pressure (in a hurry) High workload (memory requirements) Simultaneous actions / Monotony Repetitive actions Irrecoverable actions Interpretation requirements Unclear goals, roles, or responsibilities Lack of or unclear standards 	<ul style="list-style-type: none"> Unfamiliarity with task / First time Lack of knowledge not used before New technique not used before Imprecise communication habits Lack of proficiency / Inexperience Indistinct problem-solving strategy "Can do" attitude for crucial steps Illness or Fatigue 	<ul style="list-style-type: none"> Stress Habit patterns Assumptions Complacency / Overconfidence Mind set (intentions) Inaccurate risk perception Mental shortcuts (biases) Limited short-term memory
Work Environment		
<ul style="list-style-type: none"> Distractions / Interruptions Changes / Departure from routine Confusing displays / Controls Work-arounds / DOS Instrumentation Hidden system response Unexpected equipment conditions Lack of alternative indication Personality conflicts 		



- The Rat is Never Wrong
 - Behaviorism
 - Not enforcing a policy is like not having a policy at all
 - Don't have a rule that you aren't going to enforce

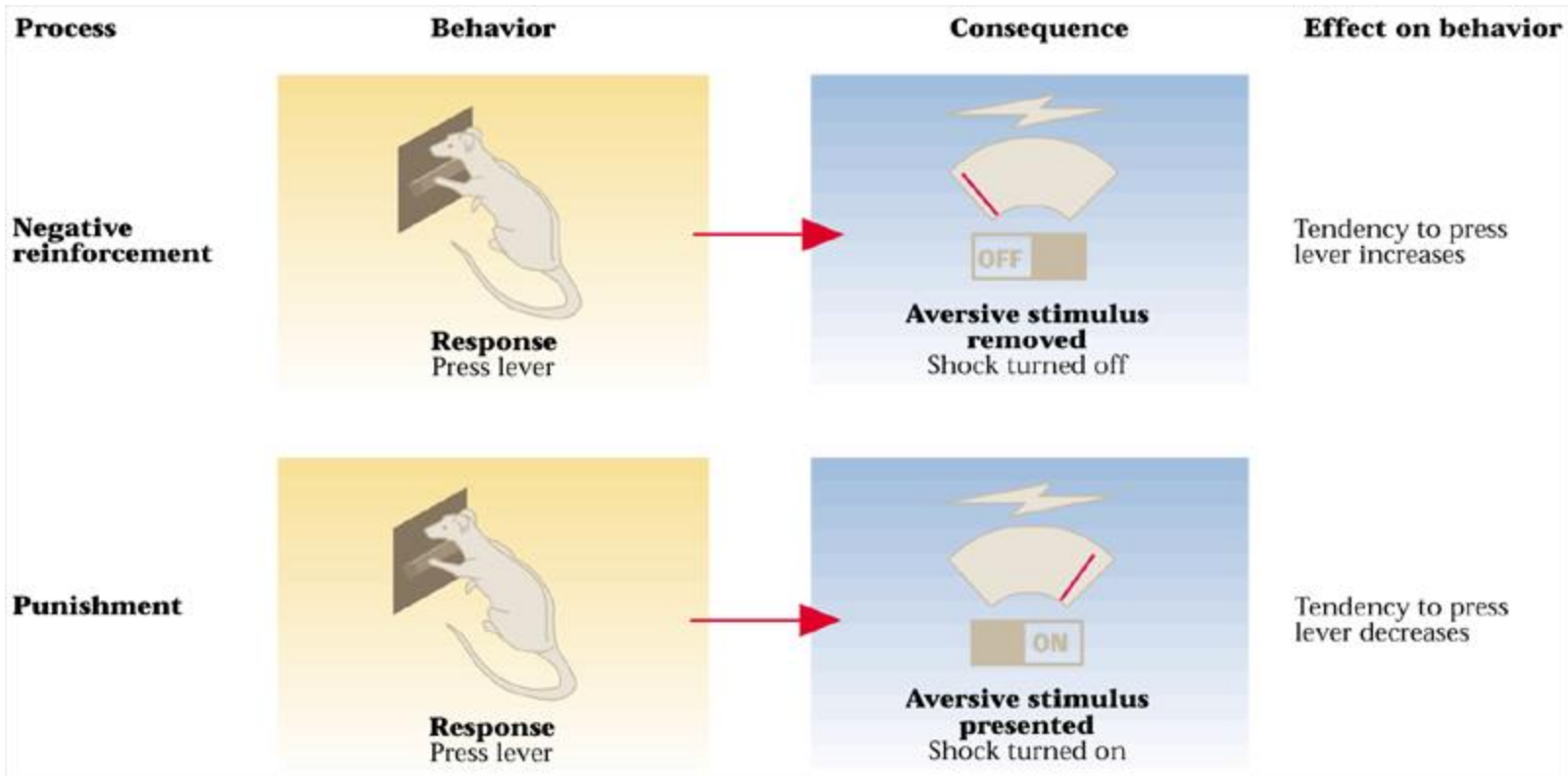


Human behavior is shaped by interaction in the world...

- Punishment stops behavior
- Reinforcement shapes and sustains behavior



Punishment vs. Negative Reinforcement



Does the behavior **increase**
or **decrease**?



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Questions and Answers

James Merlo, PhD

Senior Director

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