

Risky Business: Human Error & Organizational Resiliency

Michael E. Legatt, Ph.D., CPT

CEO and Founder ResilientGrid, Inc. (512) 793-7137 legatt@resilientgrid.com

October 6, 2021



Introductions / Overview of Day



Perceptions of Human Error



ResilientGrid

Example: Human error has had a major impact

I knew a teacher who had multiple DWI's and on one occasion she jumped from a vehicle which caused her to have a TBI.

Not taking time or focus while cutting material on a project, which resulted in an injury that was fairly severe and could have been much worse. New processes implemented after

Medical errors (both related to clinical care and indirectly related to overall management of a case)



"All organizations are perfectly aligned to get the results they get."

Arthur W. Jones



Humans are like components of the grid. Interconnect them well, and allow them to operate within their tolerance ranges, and you have an efficient system.

Interconnect them poorly or let them operate outside of tolerances, and you create inefficiency, heat, and the occasional explosion.



Where Were We? Technology, People, Organizations





Where Are We Now? Technology, People, Organizations



ResilientGrid

8 November 2018



* Scheduled and Non-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)



Where A Organiza

Effectiveness

"We've learned that automation does not eliminate errors. Rather, it changes the nature of the errors that are made, and it makes possible new kinds of errors. The bottom line is this: Systems that integrate the best of human abilities and technology are the safest for all concerned."

> Captain Sully Sullenberger, LinkedIn.com, "Technology Cannot Replace Pilots"







Complex vs. Complicated

Complex: Many interdependent components

 Hard to get order, control, or predictably. "Emergent system"

Complicated: Many independent components

Once you can separate components, you can deal with each of them systematically



 Presidential Policy Directive 21: Energy and communications infrastructure especially critical because of their enabling functions across all critical infrastructure areas

 DOE: "A resilient electric grid... is arguably the most complex and critical infrastructure."







Situation Awareness





A quick thought exercise...

- A baseball and bat together cost \$11. The bat costs \$10 more than the ball. How much does the ball cost?
- Did you say \$1 for the ball?
 - Most people do, but:
 - The correct answer is \$0.50:
 - \$10.50 \$0.50 = \$10.00
- Why do many of us make these kinds of mistakes?
 - Mental shortcuts tend to shorten the amount of time it takes us to come up with an answer, but doesn't necessarily work in all situations.



Creating Change



The Cobra Effect: Unintended Consequences





8 November 2018

Human Performance Rooted in Psychology

Negative (Reinforcement / Punishment)

Pathology:

What's wrong?

How can we tell when it's wrong?

How can we predict when it's about to go wrong?

How to we minimize how bad things are?

Distress

Positive (Reinforcement)

Positive Psychology:

What's right?

How can we spread that right to other areas and strengthen it?

The belief that people want to lead meaningful and fulfilling lives, to continue to improve, and to enhance their experiences of love, work, and play.

Eustress



What is Resilience?



What is Resilience?

How well/quickly can a system bounce back/transform from an adverse event?

- "Evaluating the ability of the system to reduce the magnitude and/or duration of disruptive events...depends upon its ability to anticipate, absorb, adapt to, and/or rapidly recover from a potentially disruptive event." (NIAC, 2009)
- Essentials include "flexibility, coping with the unexpected and unplanned situations, and responding rapidly to events, with excellent communication and mobilization of resources to intervene at critical points." (Hollnagel, 2011)



Components of a Resilient System

- **Critical infrastructure resilience:** both physical infrastructure, and the human components
- Resilience Engineering: Humans are the <u>primary</u> source of resiliency for an infrastructure

• How do we make resiliency happen in humans? Resilience is not genetic. If the environment supports growth, people thrive.



What are humans, and What is human error?



Human Error





Goals

"Human error is a consequence, not a cause. Errors are shaped by upstream workplace and organizational factors... Only by understanding the context of the error can we hope to limit its reoccurrence"

James Reason



New security flaws found in popular IoT baby monitors

Even internet-connected baby monitors aren't immune to hacking, including some flaws that are easy to exploit.



By Zack Whittaker for Zero Day | September 2, 2015 -- 13:54 GMT (06:54 PDT) | Topic: Security





A popular Fisher-Price 'smart bear' failed to properly authenticate the device's user. Image credit: Amazon

Princeton researchers find security flaws in IoT devices engadget

Nest thermostats were leaking zip codes on the internet, for example.



Billy Steele , @wmsteele 01.21.16 in Home

Shares





Responding to Human Error



Outcome Bias

Over-Reaction

- Discipline of discrete error
- Discipline person who didn't see risk
- Over-reaction to singular events

Under-Reaction

- Turn a blind eye to risky choices
- Allow reckless people to go unchecked
- Pass over severe system design flaws



ientGrid

'The single greatest impediment to error prevention... is that we punish people for making mistakes." – Dr. Lucian Leape, Professor, Harvard School of Public Health, 1999 Testimony before Congress on Health Care Quality Improvement

Human Performance Under

Stress



A Dynamic Model of Stress and Attention, from Hancock & Warm (1989)

ResilientGrid

How we make mistakes



From: NERC Cause Analysis Methods

How we make mistakes





- Most difficult to process information under extreme stress
- Humans make 3 7 mistakes per hour awake, 11-17 under extreme stress.
- Working memory decreases under stress
 (7±2 => 3-5 or lower with long term damage)





Cognitive Biases



LifeLock CEO's Identity Stolen 13 Times –K. Zetter, Wired.com, April 2010



What is a bias?

- How we respond in ambiguity
- A deviation in judgment non-logical functioning
- Predictable, but not rational
- May be adaptive (e.g., speeding up decisions)
- Some biases prejudicial



ientGrid



- Retiring workforce, millennials and workplace diversity.
- Greater dependence on expertise and reliance on humans to understand "the big picture"



Information Processing in Humans

Fredrick Winslow Taylor

lientGrid

- Mechanical engineer who sought to improve industrial efficiency
- One of the first management consultants
- Wrote <u>The Principles of Scientific Management</u>:
 - Replace "rule-of-thumb" methods with those based on scientific study
 - Actively select, train, and develop each employee
 - Provide detailed instruction and supervision of each worker in the performance of that worker's discrete task
 - Divide work between managers and workers: managers plan/think, workers do.

Source: McChrystal, S. (2015). Team of Teams.

Information Processing in Humans

- Fredrick Winslow Taylor
 - Moved from skilled individuals doing many things to less skilled individuals, each doing one thing over and over
 - Motivating them simple: financial awards can make them work faster


- Taylor efficiencies not working in today's world
 - Much of what we do is now on thought not repetitive, automatic actions.
 - Financial bonuses now decrease performance and increase error rates.
 - Many employees now searching for more meaning in their work; cultural and short term KPI misalignments abound.

Sources: McChrystal, S. (2015). Team of Teams. Duhigg, C. (2016). Smarter, Faster, Better.



Managing Human Beings and Organizations





W. Edwards Deming (1900-1993)

Source: deming.org



Managing Human Beings and Organizations

"It is wrong to suppose that if you can't measure it, you can't manage it – a costly myth...

It is the relationship with people, the development of mutual confidence, the identification of people, the creation of a community.

This is something only you can do. It cannot be measured or easily defined.

But it is not only a key function. It is one only you can perform."

ResilientGrid



W. Edwards Deming (1900-1993)

Source: deming.org

We pay attention to things...



Simons & Chabris: Selective Attention Test (1999)



http://youtu.be/vJG698U2Mvo

• "Losada Line" / "Critical positivity ratio"







Corporate Culture



Use a **positive psychology** principle:

- Critical Positivity Ratio
- Ratio of **positive** to **negative** > 2.901 to 1
- > Linked to higher performance, lower anxiety
- > 7:1 for "superstar" teams
- < associated with **punitive / fear-based** cultures.











8 November 2018

 Habit executors vs. JIT (just-in-time) performers







- Self-control is a limited resource, and like a muscle, it tires out (Baumeister et al, 1998)
- ... or does it?







Concepts to carry through:

- Modes of operation:
 - Compliance
 - Reliability
 - Resilience
- Stress?
 - Distress
 - Eustress
- Cascades in human error



Multitasking and Human Error



Take out a paper and pen

• When you see the next slide, write down exactly what you see on the slide.

• As soon as you're done, raise your hand.

• The first person to complete this gets \$20!



Jewelry is shiny

1 2 3 4 5 6 7 8 9 10 11 12 13 14



Source: JMA Human Error Solutions

How fast was that?

- How hard was it?
 - Did any of you make any errors?
 - Did any of you have any near misses?



- Now, let's try that again, but this time do it differently.
- We'll write out the same lines,
- Except we'll take turns, going between letters and numbers. For example:

• The first person to complete this gets \$20!



J

How fast was that?

- How hard was it?
 - Did any of you make any errors?
 - Did any of you have any near misses?
- So, wait a minute... what just happened here?



Problems with Visual Attention

 Change Blindness – Sometimes we don't see changes in a scene or some critical detail





- "Multitasking" is the attempt to carry on two or more tasks or activities at the same time.
- But, really what is happening is both
 - Habit / automation learned behaviors being repeated with little thought
 - Frequent "mental set shifting" / "context switching" which is computationally intensive and risky.
 - Should something (e.g., driving a car) need a jump in attention, there may be insufficient resources available to help.



- Generally, we can do more than one thing, as long as:
 - Only one thing requires our conscious attention and the other tasks can be processed automatically
 - e.g., Sending an email while chewing gum
 - The task that is requiring our conscious attention can be immediately stopped without consequence and there is time to re-orient
 - e.g., we can pause writing out the email when we start to choke on our gum, knowing we can pick up the email later.



- A circuit from Motivation -> Attention -> Memory.
 - Therefore, weaknesses in attention mean we have weaknesses storing, holding on to, and recalling memories
 - Ever find you had a conversation while driving and a critical detail you knew you needed to know, but couldn't recall?
- Abilities to multitask not significantly different by sex or generation.
- It has been estimated \$650 billion a year is wasted in the US business sector due to multitasking: errors and loss of productivity



- When we're mental set shifting,
 - We need extra time every time we move from one task to another, to readjust.
 - We lower our performance speed (tasks take between 1½ and 3 times as long
 - Our chances of making a mistake grow significantly
 - Our IQ temporarily drops by about 10-15 points (worse than a night of no sleep, alcohol, marijuana, or a stroke)
 - Our bodies show signs of stress: increased blood pressure, salivary cortisol, heart rate
 - We are more likely to cut corners on a task

http://business.tutsplus.com/tutorials/how-to-do-one-thing-at-a-time-and-stop-multitasking--cms-25159



- However, this also may feel exciting, and even have addictive components
 - More dopamine is released in the brain when we're trying to multitask
- High prolonged multitaskers tend to have smaller anterior cingulate cortex
 - A region of the brain responsible for empathy, and mental/emotional control.
- Multitasking in meetings and other social settings tends to relate to lower self- and social-awareness / lower EQ.

http://www.forbes.com/sites/travisbradberry/2014/10/08/multitasking-damages-your-brain-and-career-new-studies-suggest/2/



"Multitasking" or switchtasking: Cell Phones while Driving

- Drivers trying to talk and drive at the same time are both:
 - Worse drivers
 - 4x more likely to be in a vehicle accident
 - Reacted more slowly to brake lights and stop signs
 - Involved in more rear-end collisions
 - Sped up and braked more slowly than intoxicated drivers (BAL = .08)
 - Worse conversationalists
 - More forgetful about what discussed
 - Struggled to maintain the conversation especially when it was complex
- Whether a handsfree device was used or no effect.
- Listening to audio books did not have a negative effect on driving performance
- New infotainment systems, GPS devices, etc., seem to have similar distracting properties

http://www.apa.org/research/action/drive.aspx



- "Super-taskers"
 - About 2 3% of the population can perform better when multi-tasking than when unitasking. There is likely a genetic influence – they're born with it, and you can only learn to improve slightly.
 - However, people's ability to gauge their own multitasking abilities is usually inaccurate.





Organizational Culture and Human Error



Google Oxygen / What Makes a Good Leader?

- Most positive (in order)
 - Being a good coach
 - Empowering / not micromanaging
 - Being interested in direct reports, success & wellbeing
 - Being productive and results-oriented
 - Being a good communicator and listener
 - Helping employees with career development
 - Having a clear vision and strategy for the team
 - Having technical skills that could help advise the team



Google Oxygen / What Makes a Poor Leader?

- Most negative (in order)
 - Having trouble making a transition to management/leadership
 - Lacking a consistent approach to performance management
 - Spending too little time managing (servant leadership) and communicating.



Google Aristotle / What Makes a Good Team?

- No significant relationships between team members' distribution of IQ, friendship, diversity alone.
- Significant relationship: Group norms
 - Most important: habits of how team members treat each other
 - Not important: dynamics of one/few leaders vs. distributed leadership. As long as everyone agreed.



- Rhode Island Hospital
 - A top medical institution
 - Deep tensions between doctors and nurses
 - "This place can be awful. The doctors can make you feel like you're worthless, like you're disposable. Like you should be thankful to pick up after them." (A nurse interviewed by a reported in 2000)
 - "Time-out" procedure called by a nurse
 - Surgeon stormed out, saying "If I want your damn opinion, I'll ask for it. Don't ever question my authority again. If you can't do your job, get the hell out of my OR". (Duhigg, 156)



- Compensatory techniques informally developed
 - Doctors names written on whiteboards different colors depending on their abrasiveness
 - Nurses would communicate ad-hoc when a doctor made a mistake; nurses tended to check up on more error prone doctors



- July 30, 2007
- Neurosurgeon J. Frederick Harrington Jr., asked to perform an emergency surgery on an 86 year-old patient with a subdural hematoma on the left side
- At the time, Dr. Harrington was in the midst of a lumbar laminectomy – quickly reviewed the slides but didn't write down the side of the hematoma; his nurse failed to note it as well



- In the surgical suite..
- A nurse noted that the consent form lacked a side, and asked for a time out
- Harrington snapped "we have no time for this!" and encouraged the nurse she could log into a computer and check the CT scans, but he would have her terminated if she did.
- He misremembered the side of the hematoma, and operated on the wrong side of the patient's skull.



- When Harrington realized the mistake, sealed up the skull and skin, turned the patient over and operated on the correct side, a great deal of time was lost. The patient died two weeks later.
- State board fined the hospital \$50k



- A few months earlier, a doctor and nurse both admitted they weren't trained to use a checklist, having failed to mark the spot of another neurosurgery.
- A few months later, a doctor and nursing staff discussed a surgery (identifying the correct side), then proceeded to operate on the wrong side of an elderly woman.
 - "I don't know if [the nurse] even knows why she didn't speak up"



- A year and a half later, a surgeon operated on the wrong part of a child's mouth during cleft palate surgery
- Ten months after that, a drill bit was left inside a patient (\$450k fine)



Mike Legatt

The case for just culture

- Traditional management styles lagging research & employee expectations
- Vast amount of work frustration due to inequity and ambiguous signals



72 ResilientGrid Directors/Managers April 23, 2014
Ways of addressing events



Barriers

Recovery

Redundancy

First, we must first identify At-Risk Behavior Types



Mike Legatt

Types of Risk Behavior

Human Error (5-7 to 11-15 errors per hour)





Directors/Managers April 23, 2014

Mike Legatt

Types of Risk Behavior

At-Risk Behavior (The better we are the harder it is to perceive drift)



Directors/Managers April 23, 2014



Mike Legatt

Types of Risk Behavior

Reckless Behavior (< 2% but extremely dangerous)



76 ResilientGrid Directors/Managers April 23, 2014

Just Culture Approach



Managing Risk – Fairly and Consistently

- One approach that works across all values
- One approach that works both pre and post event
- One approach that applies to everyone at all levels





Social Dynamics, Situational Awareness and Human Error



- "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 into the near future" (Endsley, 1988).
- "Continuous extraction of environmental information, integration of this information with previous knowledge to form a coherent mental picture, and the use of that picture in directing further perception and anticipating future events" (Dominguez, 1994).



- "Loss Of Situational Awareness" is NOT:
 - One of many phrases to represent individual human error, leading to punishment of that individual.
 - Instead, it is one of several lenses into human performance that helps to understand why a mismatch between environment and human capabilities occurred.



Situational Awareness

Attention • What am I seeing <u>Scan</u> Sensation ٠ or can I see? Perception Focus What does it Cognition ٠ mean? **Decision making** What am I going ۰ <u>Act</u> to do about it? Action ۰



- Three levels of situation
 awareness:
 - Level 1: Perception
 - What is going on?
 - Level 2: Comprehension
 - What does it mean?
 - Level 3: Projection
 - Where is it going? What am I going to do about it?
- Situational awareness is necessary both in individuals and within teams.



"The fuel light's on, Frank! We're all going to die! ... We're all going to die! ... Wait, wait. ... Oh, my mistake—that's the intercom light."



- Three components of situational awareness:
 - Spatial awareness where you and other objects are in space, orientation to location.
 - System awareness understanding about the state of the system(s)
 - Task awareness understanding about the tasks being engaged in



Situation Awareness

Components of situational awareness



Situational Awareness - Status Quo Result

FOCUS

MISSED THREAT!!!

SCANNING

Situational Awareness – Status Quo Result



Situational Awareness



SITUATIONAL AWARENESS

Some lessons can only be learned once.



fakeposters.com

Situational Awareness – or safety – or common sense?



SITUATIONAL AWARENESS

Get Some



Information Processing in Humans

Triune Brain

Neocortex

Limbic System Reptilian Complex



- Most difficult to process information under extreme stress
- Humans make 3 7 mistakes per hour awake, 11-17 under extreme stress.





silientGrid

- How people internally represent the task they are performing / situation they're in.
- Schema Representing and organizing information into interconnected chunks
 - Experts organize into larger, more effective, more accessible chunks
 - Novices struggle to organize schemata



- Short-term / processing memory (7 ± 2; Miller, 1956)
- These 7±2 points can be "chunks", allowing for better storage and processing.
- Working memory decreases under stress (7±2 => 3-5, or even lower with long term damage)





747 cockpit



Attention and Human Performance



ResilientGrid

Situation Awareness Errors



🥳 ResilientGrid

Source: SATechnologies

Situation Awareness: Is this a good example?





Situation Awareness: Is this a good example?





Situation Awareness: Are these good examples?







- Attentional narrowing
 - Attention grabbed, drawing focus away from critical information
- Data overload
 - More/faster information presented than a human can process
- Misplaced salience
 - The wrong things standing and catching your attention
- "Out of the loop"
 - Uncertainty in data and system status not represented to users
- Short-term memory over-reliance
 - Holding too many chunks, or for too long (> 30 sec)

ResilientGrid

- Complexity Creep
 - Additions to a UI or procedure may affect far more than one screen
- Low operator confidence in systems
- Workload, anxiety, fatigue, loss of perceived safety
- Incorrect mental models
- Inattention



- Alarm screens
 - "Alarm storms" critical information scrolling off the screen due to other important alarms
 - "Dust storms" critical information scrolling off the screen due to unimportant alarms
 - Alarm accuracy False Alarms, percent correct



	Target	Noise
Response	Hit	False Alarm
No Response	Miss	Correct Rejection













Lunch



Fatigue, Diet, Exercise and Human Error



Human Factors Engineering

- Like much of power systems engineering involves applying knowledge from physics, so does human factors engineering apply knowledge from psychology, sociology & anthropology.
- New view of a power system: humans and technology intertwined into a larger system.
- Humans enhance (not threaten) reliability.
- Thus, co-optimizing both each part and their interaction is a key goal -- engineering for success.



- A great many human factors influence the overall reliability of the system, for example:
 - ExerciseVisual system functionSleepCognitive biasesCorporate cultureMoodGenetic factorsTrainingSelf-monitoringAbstract reasoning, empathyDietSelf-actualizationStress & fearPositive thinking
- For this discussion, we'll focus on one area:
 Diet, fatigue, stress and human error



Fatigue

- "After more than 100 years of research on fatigue, we do not really know very much about it" - Hockley
- "A lack of sufficient steady-state energy to power physical and/or cognitive work" – Hancock, Desmond & Matthews
- "Fatigue makes cowards of us all" Vince Lombardi


Fatigue

- Stark & Ash (1917): "When an error occurs it is followed immediately by other errors and more and more frequently as the period of work continues"
- Fatigue is not boredom!
- Every hour awake after 10 hours, the equivalent of .004% BAL decrease in reaction time (Dawson & Reid, 1997).
- Increased error risk, lowered selfmonitoring.



Diet and Fatigue

- Maintaining a fairly constant blood sugar level helps maintain energy levels
 - Eat within an hour of waking, snack every 2-4 hours
 - Make sure strong fiber (soluble and insoluble) in diet, especially at breakfast
- Fruits and vegetables good, but some are better than others
 - -Broccoli, kale, brussel sprouts, cauliflower
 - -Less processed generally better



Circadian Rhythms



Source: Neuroscience Education Institute

ResilientGrid

Serotonin

silientGrid

- Serotonin is a neurotransmitter (traveling between nerve cells)
- Low serotonin levels lead to clinical depression
- Excessive serotonin leads to extreme feelings of wellbeing and happiness
 - -Serotonin syndrome
 - Serotonergic neurotoxicity





- Digesting carbohydrates increases blood sugar, and the body in turn produces more insulin.
- Type 2 diabetes begins when muscle and other cells stop responding to insulin, and eventually insufficient insulin is produced and blood sugar levels stay too high.



Vigilance over time

- Vigilance is: The ability to maintain attention over long periods of time
- Vigilance can decrease due to:
 - -Memory load
 - -Event rate
 - -Adverse environmental factors
 - -Changes in motivation
- Maintaining vigilance is stressful, and exhausting (ego depleting), especially under high stress



Studies on fatigue

- Ford Motor Company (1917) found two 10-minute breaks every day produced greater worker output over the whole day.
- Fatigue is not "one size fits all":
 - Fatigued extroverts perform better in stimulating environments around people, worse in quiet steady-state environments
 - The opposite effect is observed for introverts



Time of day

- Chances of getting acquitted in a criminal trial is higher right after lunch, lower right before (Danziger, Levav & Avnaim-Pesso, 2011).
- Some cultures incorporate early afternoon / post-lunch rest / nap (siesta) to insulate against heat & fatigue.
- In the medical field, a higher probability of human error in the early afternoon (often on long shifts) as opposed to the beginning of a shift.

- Many drugs used to treat depression are SSRIs – they lead to more serotonin in the brain
- 95% of serotonin is secreted in the gut in response to food
- Under stress, most people tend to increase "snack food" intake, reduce "meal food" intake (Oliver & Wardle, 1998).



- Experimentally, stress tends to shift people towards higher saturated fat, sugar and calorie foods (Zellner et al, 2006).
 - After eating these foods, participants reported feeling better for a short while.
 - People already dieting reported much higher levels of stress during these times.
 - Suppressing the impulse to eat fatty foods, especially under stress, may increase the risk of ego depletion!



Diet and Fatigue

- There is a well-known relationship between what you eat and how tired you feel.
- Eating high-carbohydrate foods can lead to hyperinsulemia (excessive insulin)
- For people engaged in strenuous exercise, high-carbohydrate foods 3-4 hours prior lead to reduced fatigue.
- For people not engaged in strenuous exercise, high carbohydrate foods are associated with lightheadedness, fatigue, and occasional fainting.



Diet and Fatigue

- Fatigue is not just physical; people can also become fatigued mentally.
- The brain uses sugar as a fuel source.
- Complex mental problems (including vigilance and self-control) require increased use of sugar in the brain.
- People given complex mental puzzles tend to also search out high fat / sugar / calorie snacks, compared to people given simple mental puzzles.



- Large food intake requires more blood flow to the gut, in order to support digestion & absorption.
- Carbohydrate intake also leads to decreases in blood pressure.



Diet and Exercise

 Central fatigue hypothesis: Increased serotonin in the brain can lead to decreased sport/exercise performance (<u>Davis</u>, 1996).



- Updated Macomber Map, including enhanced trending and alerting techniques and responsiveness
- Kelly & Stacy (our training manager and coordinator) ran an experiment during our dry run:
 - Lean pork in a light gravy or stuffed pepper with brown rice
 - Green beans with slivered almonds and light butter sauce
 - Fingerling whole potatoes



Results

- For the first time in training history, ran the full simulation day (7 A.M. – 5 P.M.) without a single identified switching error.
- This was during the dry run presumed to have had the highest risk of error:
 - It was a year since the last training
 - Operators were not yet observing other operators from their companies attending the training.



- The operators...
 –HATED IT!
- "You've got to be kidding me!" frequently heard.
- Several operators requested to come in early the following morning, so they could leave early and go out for a "proper meal".



High Reliability Organizations and Reducing Human Error



An example...

Rhode Island Hospital



What is a High Reliability Organization?





ResilientGrid

Photo Montage, Rizwan Shah, Department of Energy

What do High Reliability Organizations have in common?

- "Fishbowl" industries exceptionally strong social and/or political pressure crashing down in a failure event.
- Complicated systems/fields with a high probability of error.
- Major mistakes are so severe, you can't afford to learn by trial and error.
 - Human Error rates typically (3-7 errors per hour, 11-15 under high stress, fatigue, etc.)



What is a High Reliability Organization?

- An organization with relatively error free operations over a long period of time.
- An organization that again and again accomplishes a high hazard mission while avoiding catastrophic events.
- An organization in a field in which failures are so severe, they should be avoided at almost any cost.



- Five principles:
 - 1. Preoccupation with failure
 - Everyone within the organization focuses on how their processes can break down and fail
 - Focus on both small and large inefficiencies and risks
 - Destigmatization of human errors
 - Focus on near-misses as a path to resilience
 - Ever near miss is both a success and a learning opportunity



- Five principles:
 - 2. Reluctance to simplify
 - Not quick to jump into simple explanations for why something occurred.
 - Root cause analysis to determine both deep causes of problems, and track latent organizational weaknesses.
 - An avoidance of long-held beliefs challenging attitude around assumptions



- Five principles:
 - 3. Sensitivity to operations
 - An awareness by leaders and staff on how processes and systems affect the organization.
 - A strong focus on what is and isn't working data, not assumptions.
 - "Rounding" managerial walkthroughs, to ensure a correct understanding of a group that would be affected by a change.



What is a High Reliability Organization?

- Five principles:
 - 4. Commitment to resilience
 - A steadfastness to identifying causes, and continual improvement
 - Swift identification both of errors and nearmisses, and commitment to continue improving.
 - Strong and reliable evaluation tools measurable goals, well-engineered KPIs, etc.



- Five principles:
 - 5. Deference to expertise
 - Reaching out to SMEs on their issues regardless of their seniority
 - Ideas can come from anywhere and are encouraged from everywhere
 - Key decisions being made at the work areas and in the work environment, not in conference rooms and meetings.
 - Some HROs adapt "no meeting time zones" so managers can make rounds and observe, get feedback from employees, etc.



Management in a High Reliability Organization

- Constant training / learning growth of management and employees
- Matching of technical competence and high performance
- Oversight includes little close supervision
- Personnel never content "search continually to improve their operations" (Rochlin, 1993) through actively soliciting feedback



Focus in a High Reliability Organization

- Not "error free", but "not disabled by an error"
- Physical, social and external facets combine in complex operations
- Formal and informal expectations for peak performance
- Ability to decentralize in an agile fashion in emergencies. **TRUST**.
- Redundancy in people, roles, training



How are HROs different?



Compare and contrast: Normal and High Reliability

- Human errors
 - A cause
 - A mismatch of human capabilities and environment
- Reporting
 - Based on past events
 - Focused on conditions and future outcomes
- Workarounds
 - It's how we get things done
 - For only unexpected outcomes



Compare and contrast: Normal and High Reliability

- Accountability
 - Solves problems
 - A byproduct of participation
- System designs
 - Design to be successful
 - Design to be failure-tolerant and recovering
- Management
 - Producing short-term outcomes
 - Creating conditions and cultures that set people up to excel



- Mistakes
 - A source of stress, infighting, self-protection, and fear
 - An opportunity to learn and improve
- Error risks
 - Good people don't make mistakes
 - A systems approach needed no one can have a perfect day every day



- Culture
 - Not a strong focus; or a culture of safety.
 - A strong culture, not only focused on safety, but also looking for signals of weakness; searching for potential problems before they challenge the organization.
- Readiness
 - An organization is "ready" if nothing bad happened.
 - An organization is constantly trying to anticipate next problems but understands non-anticipatable problems may come up.



"As they strive for high reliability, organizations shift away from having outside bodies solely determine their quality agenda to developing an agenda that incorporates the organization's most important goals."

Mark R. Chassin, M.D., F.A.C.P. The Joint Commission & Joint Commission Center for Transforming Healthcare


Goals

"Human error is a consequence, not a cause. Errors are shaped by upstream workplace and organizational factors... Only by understanding the context of the error can we hope to limit its reoccurrence"

James Reason



- A group of "reliability professionals"
- Anticipation vs. resilience?
- Recovery a new performance mode
- Robustness a threat to reliability?
- "Just-in-time performance" pull and push



- Design <u>and</u> management of a system
- Focus on keeping many processes within acceptable bandwidths. Don't focus on just one metric.
- Centralization and interdependence among system components can help managers ensure reliability



What are the benefits of being a part of an HRO?



- Higher job satisfaction, lower turnover, greater willingness to share learning (Egan & Bartlett, 2004)
- Better at interviewing and selecting candidates who fit in well with HRO mission (Ericksen & Dyer, 2007)
- Less losses due to lost wages, training, severance, sick days, etc.



Human Performance Tools

Source: DOE Human Performance Improvement Handbook

An Example:

- September 8, 2011, 3:38 PM PDT
- APS technician opened a 500 kV line between Hassayampa and North Gila substations, in Arizona
- Operator had missed a critical step on the checklist
 - Telephone call in the midst of procedure
- Other system vulnerabilities led to cascading outages affecting California, Arizona, Mexico.



Location	In the Field (1)			In the Office (2)			Location	In the Field (1)			In the Office (2)		
HPI Tool	Prior to Start/ Re- Start	Perform Work	Complete Work	Prior to Start/ Re- Start	Problem Solving	Task Verification	HPI Tool	Prior to Start/ Re- Start	Perform Work	Complete Work	Prior to Start/ Re- Start	Problem Solving	Task Verification
Task Preview	x						Flagging		x				
Job-Site Review	x						Turnover		X			X	
Questioning Attitude	x	x	x	x	x	x	Post-Job Review			x			X Technical
Stop When Unsure	x	x	x	x	x	x	Project Planning	x			x		
Self-Checking	x	x	x	x	x	x	Problem					x	
Procedure Use & Adherence	x	x	x	х	x	x	(PACTS)					^	-
Validate Assumptions				x	x	x	Making					X	
Signature						x	Project Review Meeting						x
Three-Way Communication		x	x				Vendor Oversight	x	x	x	x	x	x
Phonetic Alphabet		x	x					(1) Ops, Ma	intenance, F	ield Support	(2) Engineer	ing, Science,	Tech Support
Place-Keeping		x	x			x							
Do-Not-Disturb Sign					x	x							
Pre-Job Briefing	x			X Technical									
Peer-Checking		х											
Concurrent Verification		x											
Independent Verification		x											
Peer Review						X							

Source: DOE Human Performance Improvement Handbook

ResilientGrid

Individual Human Performance Tools

Source: DOE Human Performance Improvement Handbook



- Task Preview
 - Purpose: Review / make sure familiar with procedures
 - 1. Identify critical steps
 - 2. Ponder "worst that could happen"
 - 3. Consider HP tools to be used
 - 4. Avoid interruptions or extended delays
 - S-A-F-E-R
 - Summarize critical steps
 - Anticipate errors for critical steps and precursors
 - Foresee likely and worst-case consequences
 - Evaluate controls or contingencies plan recovery
 - Review previous experience and lessons learned



- Job Site Review
 - Purpose: Improve situation awareness on site
 - 1. Explore the site walk-around, looking for risks, hazards
 - 2. Talk with co-workers or supervisors about risks and precautions
 - 3. Eliminate hazards, install appropriate defenses, and/or develop contingencies



- Questioning Attitude
 - Purpose: Prime yourself to think about safety
 - Stop, look, listen search for situations that highlight uncertainty, pause and focus on any when found
 - 2. Ask questions gather relevant information
 - 3. Proceed if sure / stop if unsure
- In work planning:
 - When a gut feeling "things not right"
 - FACTS:
 - Foresee by Asking open-ended questions
 - Confirmed knowns & unknowns for critical activities
 - Test the current situation; Stop when unsure



- Pause when unsure
 - Operating in unfamiliar territory: risk of error can be 50%!
 - Pause/time-out activity
 - Place equipment/site in a safe condition
 - Notify supervisor
 - Get help from SMEs





- Self-Checking
 - Purpose: plan before acting
 - STAR method
 - Stop pause before critical activities
 - Think What needs to be done?
 - Act Follow the correct action / correct plan
 - **R**eview Verify the anticipated result is obtained



- Procedure Use and Adherence
 - Purpose: Understand a procedure's intent and purpose before starting it
 - 1. Compare working copy to controlled copy make sure using correct version
 - 2. Review document: limits, initial conditions, instructions
 - 3. Use procedure according to its designated level
 - 4. Follow as written, but keep in mind impact an action can have
 - 5. Stop the task, place in safe mode if:
 - Step cannot be performed as written
 - Injury or damage will occur, or otherwise unsafe
 - Unexpected results occur, or procedure is incorrect or conflicting

ResilientGrid

- Validate Assumptions
 - Documentation write down assumptions
 - Evidence is there objective evidence to support the assumption?
 - Field walk-down were in-field factors considered? Ensure physical environment included in the review
 - Track and close out Close out all unverified assumptions



Signature

- Purpose: accountability on a technical document
- Knowledge: Signer has the appropriate knowledge, expertise, qualifications and authority
- Involvement Signer has been involved in the product being signed
- Independent Signer has "freedom of thought"
- Quality Signer feels it meets appropriate criteria
- Right and proper Signer believes it is correct thing to do
- No doubt Signer has no uncertainties with the product in its current state.

🔀 ResilientGrid

- Effective communications
 - Three-way communications
 - ITU Phonetic
 Alphabet



		ine i nonette	Alphabet
А	0.000	Alpha	(AL fah)
В	-	Bravo	(BRAH VOH)
С	-	Charlie	(CHAR lee)
D	-	Delta	(DELL tah)
Е	-	Echo	(ECK oh)
F	-	Foxtrot	(FOKS trot)
G	-	Gulf	(Gul uf)
н	-	Hotel	(hoh TELL)
I	-	India	(In dee ah)
J	(_)	Juliett	(JEW Lee ETT)
к	222	Kilo	(KEY loh)
L	-	Lima	(LEE mah)
М	-	Mike	(MIKE)
N	-	November	(no VEM ber)
0	-	Oscar	(OSS cahr)
P	-	Papa	(pah PAH)
Q		Quebec	(keh BECK)
R	-	Romeo	(ROW me oh)
S	-	Sierra	(see AIR rah)
т	-	Tango	(TANG go)
U	-	Uniform	(YOU nee form)
v	2	Victor	(VIK tahr)
W	-	Whiskey	(WISS key)
x	-	X Ray	(ECKS RAY)
Y	-	Yankee	(YANG key)
Z	-	Zulu	(ZOO loo)

The Phonetic Alphabet



- Place-keeping
 - Purpose: Tracking completed steps to maintain proper sequence
- Do not Disturb Sign
 - Purpose: Maintain attention during critical steps by avoiding distractions





Team Human Performance Tools

Source: DOE Human Performance Improvement Handbook

Pre-job briefings

 Purpose: To prepare and plan collaboratively for an upcoming task

Non-Technical Agenda	Technical Agenda
Purpose of task	Assign qualified reviewer
Procedures	Summarize task accomplishments & risks
Assignments (including risks and precautions)	Anticipate challenges during critical activities using S-A-F-E-R
Human Performance tools to be used	Requirements/methods
Operating experience – learn from prior jobs	Critical attributes/functions
Stop/pause criteria	Consequences of errors & defects
Oversight	Stop/pause/abort criteria
Questions and concerns	Track Individual readiness

🥳 ResilientGrid

- Peer Checking
 - Purpose: To augment self-checking, to further prevent an error by the person performing the task
 - 1) Performer self-checks the correct component
 - 2) Peer self-checks the correct component
 - 3) Performer + peer agree on the action to take, and on what component
 - 4) The peer observes the performer, before and during execution
 - 5) Peer stops the performer if an action is inconsistent, or
 - 6) Peer informs the performer their action is correctly taken.



- Concurrent Validation
 - Purpose: Two people working side by side, to confirm high risk equipment stays in correct conditions
 - 1. Performer and verifier agree on the action to take
 - 2. Performer self-checks the correct component
 - 3. Verifier separately self-checks the correct component
 - 4. Both agree on the final condition of the component
 - 5. The verifier observes the performer before and during execution
 - 6. The performer and verifier sign to record the verification

🥳 ResilientGrid

- Independent Validation
 - Purpose: Two people, separated by time and/or space confirm equipment in correct conditions
 - Tends to have higher probability of catching errors than PC or CV, as verifier not involved in changing state.
 - 1. Performer self-checks, performs actions, confirms, signs/initials, and informs
 - 2. Verifier self-checks, determines as-found condition, compares with guiding document/standards, signs/initials, and notifies if successful.

- Peer Review
 - Define review
 - Denote critical attributes
 - Dig for facts, with a questioning attitude
 - 1st reading Develop overview, highlighting critical attributes
 - 2nd reading Verify data and technical accuracy, validate assumptions
 - 3rd reading Identify and document concerns and possible resolutions



- Flagging
 - Purpose: Identify worked-on component so similar/adjacent components not worked on
 - 1. Identify component to be flagged using selfchecking
 - 2. Flag component
 - 3. Perform work
 - 4. Remove flag



- Turnover
 - Purpose: To transition operatorship from one team to another
 - 1. Maintain a turnover log
 - 2. Identify specific tasks
 - 3. Discuss information
 - 4. Review logs / move to work area
 - 5. Transfer responsibility



- Post-Job Review
 - Purpose: Solicit feedback from participants after a job completion, detect weaknesses, share feedback to ensure continuous improvement
 - Forum provide time for a post-job conversation (face to face when possible)
 - 2. Feedback identify what worked well (+) and what can be improved (Δ).
 - 3. Forums Submit feedback to appropriate channels
 - 4. Follow-up Ensure feedback on resolution on issues of high interest to individual performers.

ResilientGrid

- Problem Solving PACTS
 - Problem statement
 - Analysis
 - Causes
 - Testing
 - Solution
- "If I had an hour to solve a problem, I'd spend 55 minutes thinking about the problem and 5 minutes thinking about the solution." – Albert Einstein



- Decision Making
 - Purpose: Thinking ahead to anticipate the effects of a decision. Include
 - **Goal** What is the target result?
 - Options What are the ways the result can be achieved?
 - Analysis What are the risks and benefits of each option?
 - Plan Select the option(s) based on highest benefit and low risk (look for zero-risk biases)
 - Review Conduct independent review of proposal



What are the benefits of being a part of an HRO?



- Higher job satisfaction, lower turnover, greater willingness to share learning (Egan & Bartlett, 2004)
- Better at interviewing and selecting candidates who fit in well with HRO mission (Ericksen & Dyer, 2007)
- Less losses due to lost wages, training, severance, sick days, etc.



Human Factors Engineering



Visual System







8 November 2018

Visual System





Source: Chroma: A wearable augmented reality...



Visual Attention and Vigilan



p=.309

PIONI

Low

p=.221

P=.0012

Low

High

High



8 November 2018
A Practical Example in ResilientGrid Map







Translating Lessons From Today Into Practice



Protecting the Self From Consequence of Error

- Recognizing some of the factors that contribute to human error doesn't necessarily protect you from consequences of it
- Overconfidence can creep in, especially from feeling more competent than you actually are
- Danger exits from illusion of explanatory depth (IOED)



Illusion of Explanatory Depth

- People often overestimate their ability to explain mechanical, natural, and social processes (Alter, Oppenheimer, & Zelma, 2010; Keil, 2003)
 - You likely know that a zipper closes because teeth somehow interlock. But do you know how the teeth actually interlock to enable the bridging mechanism?
 - You probably have a vague notion that an earthquake occurs because two geological plates collide and move relative to one another. But do you know more about the mechanism that initially produces these collisions?
 - You may think you know your preferred political candidate's stance on a policy, but do you really know the intricacies of what they belief on an issue?



IOEDs At Work

- You look at a checklist or procedure, and think you understand the intent of the writers and that they anticipated all possible risks.
- You understand how a piece of equipment works in normal operations (> 95% of the time). Can you accurately anticipate how it will work in an abnormal condition?
- You think may think you know your coworkers' or employees' knowledge level and skill set, but do you actually know how they would respond to an emergency or crisis?
- Setting up a projector or conference call is simple... or not.

🥳 ResilientGrid

• People are better calibrated when assessing their knowledge for declarative facts and trivia (Rozenblit & Keil, 2002)

– E.g., country capitals

- Hints at why IOED occurs awareness of our lack of *specific* knowledge in these domains
- People know generally why manmade objects, natural events, and social events occur, but lack insight on specifically how they work or happen



IOED

- Confusion occurs between why and how, and people end up believing they understand complicated manmade, natural, or social concepts quite deeply
- Further, people are often surprised by the shallowness of their own explanations when prompted to describe the concepts thoroughly



- People understand certain concepts at an abstract level quite well
- But, they only superficially understand their more concrete characteristics
- So, when people mistake their mastery of abstract for concrete characteristics, IOED will emerge.



- Find a way to focus on the information that illuminates the depth of your understanding
- Steer away from focusing on uninformative cues
- Focus on concrete rather than abstract knowledge and you should realize your ignorance and <u>hopefully take steps to</u> <u>remedy it</u>



How Can You Shift Your Focus?

- Focus on differences rather than similarities (Namkoong & Henderson, 2014; 2016)
- Games played from a very young age encourage us to develop this skill



Spot the difference



How Can You Shift Your Focus?

- Focus on instances rather than categories (Fujita, Trope, Liberman, & Levin-Sagi, 2006)
 - Particularly necessary for people in a position of power (Smith & Trope, 2006)



As a New Manager, Get to Know Your Team

By EILENE ZIMMERMAN DEC. 19, 2009

Q. You're beginning your first job in a management role. You want to be taken seriously but also want your team to like you. How do you set the right tone?

A. Within the first few days of starting as a manager, set up a time to meet individually with everyone on your team. This is your chance to show that you understand the role of a manager, which is to help people achieve their goals and be successful at their jobs, said Beth Banks Cohn, a leadership development coach in Manalapan, N.J., and co-author of "Taking the Leap: Managing Your Career in Turbulent Times ... and Beyond."



JUL 25, 2013 @ 12:05 PM 46,879 VIEWS

3 Ways To Get To Know Your Direct Reports



CONTRIBUTOR

With a shiny new title, an office, and your very own team of employees, landing your first management gig is a pretty exciting time for you and your career. But as a new manager, you can't focus on *you* anymore—now, everything is about your direct reports.

So before you start changing processes, adding efficiencies, and whipping the department into shape, it's vital that you spend some time getting to know your team members. Why? Because

once you're on comfortable terms with the people you're managing, you'll have a much better idea of how to motivate and coach them—which will make your new job a whole lot easier.

If you're not quite sure how to spark these conversations—or even what to talk about—don't worry. I've been there, too. And I've learned a few ways to get to know a new team on both a professional and personal level.





FULL BIO > Opinions expressed by Forbes Contributors are their own.

How Can You Shift Your Focus?

Minimize psychological distance (time, space) during decision-making

(Trope & Liberman, 2010)

Revisiting issues that were settled in the distant past

Revisiting decisions that were made in distant locations
 (e.g., retreats, conferences, working from home)

Small Business Powered by studioD

Accounting & Bookkeeping | Advertising & Marketing | Bus Business Models & Organizational Structure | Business Pla Business Technology & Customer Support | Business & Wo

Small Business > Business Planning & Strategy > Business Plans

Goals of Long-Range Planning in Business by Vanessa Cross, Demand Media



HEALTH

Business planning involves setting short-term, mid-term and long-term objectives and scheduling the series of actions necessary to achieve them. Long-range business planning includes developing a mission statement, vision statement and ongoing business goals and strategies necessary to move the company's vision and mission forward. By focusing on key issues such as productivity, customer service and quality, business goals and objectives provide a sense of direction, purpose and urgency. It also motivates organizational teams to deliver the performance necessary to achieve targeted results.



5 Reasons Why a Retreat Is Good for Your Business



🥳 ResilientGrid

Protecting Others From Consequences of Error

- Altering things about yourself doesn't necessarily mean you won't experience consequences of error
- Most people work in collaborative settings



 Even people who work from home (9.4%), still depend on others making and executing decisions (hopefully) error free



Taking Lessons Today and Changing Others'

- Inherently involves social influence
- In other words, getting people to do things
- Psychology and marketing have a long history of studying the best request strategies
- Three simple, yet proven strategies:
 - Foot-in-the-door
 - Lowballing
 - That's not all technique







- Freedman & Fraser (1966) went
 door-to-door
- Asked homeowners to post small sign/sign petition for social issue
- **BIG** request

Small request

- 2 weeks later, asked them to put giant, gaudy "Drive carefully" billboard in front yard
 - Others only asked big request



Compliance with large request





- Why does it work?
 - Self-perception theory (Bem, 1967)
 - 1st agreement = People infer "I'm a nice person"
 - 2nd agreement = Pressure to be consistent ("I should help b/c I'm a nice person")







Field Observation of Lowballing

Cialdini (1984) Got a job as car salesman and observed techniques in use

- Offer car for good price (e.g., \$20K car for \$19,400)
- 2. Customer writes check to salesperson
- 3. Manager catches "mistake" actually \$20,400



Cialdini et al. (1978): Participation in psych experiment





Lowballing

- Why does it work?
 - Psychology of commitment (Burger & Petty, 1981)
 - Commitment to decision → hard to change course of action
 - Unwanted side effect of what normally promotes effective goal pursuit (prevents second-guessing and persistence)



Lowballing

- For the technique to work, whoever you use it on must be allowed to first state his or her agreement with the initial request before you increase the size of the request
 - If you present a small request and then interrupt the person before she or he responses and increase the size of the request, it actually will *decrease* compliance (Burger & Cornelius, 2003)



That's not all technique

Basically, leading people to believe you're sweetening the deal





Burger (1986)- Tested it selling cupcakes



Price of cupcakes



Sequential request strategies

Request shift	Technique
From small to large	Foot-in-the-door
	Low balling
From large to small	That's not all



- Pair up and demonstrate how you would use each of these to effect change
- Targeting others' behavior that is likely to lead to error



Review



Wrap-Up



"All organizations are perfectly aligned to get the results they get."

Arthur W. Jones



Thank You!!! Mike Legatt, Ph.D., CPT legatt@resilientgrid.com

