RELIABILITY 4 Life

Real Science. Real Results...**4Life**

Fundamentals of High-Reliability Organizing

Objectives

After participation in this session, the learner will be able to:

1. describe high reliability as an emergent property of the work system;

2. identify blunt end performance shaping factors for high reliability at the sharp end; and

3. describe the culture transformation process for foundational, accelerator and super-traits of high-reliability organizations.

Craig Clapper PE is a systems engineer who specializes in improving human and machine-based systems using evidence-based methods from high-reliability organizations.

He is a founder of and the chief knowledge officer of Reliability 4 Life Group (R4L) with 30 years of experience in improving reliability in power, transportation, manufacturing, and healthcare industries. He specializes in failure analysis, event analysis, reliability improvement, and safety culture improvement.

Craig has led safety culture transformation engagements for Duke Energy, the US Department of Energy, ABB Automation Company (formerly ASEA Brown Boveri, a Swedish-Swiss multinational corporation headquartered in Zurich, Switzerland, operating mainly in robotics, power, heavy electrical equipment and automation technology areas), Westinghouse, Framatome ANP (Advanced Nuclear Power), Sentara Healthcare, and Sharp Healthcare. Prior to entering private practice, Craig was the Chief Knowledge Officer of Healthcare Performance Improvement (HPI), the Chief Operating Officer of HPI, the Chief Operating Officer of Performance Improvement International, Vice President of Failure Prevention Inc. (FPI), Systems Engineering Manager for Hope Creek Nuclear Generating Station, and Systems Engineering Manager for Palo Verde Nuclear Generation Station.

Clapper holds a Bachelor of Science degree in Nuclear Engineering from Iowa State University, a Professional Engineer (PE) license in Mechanical Engineering from the State of Arizona, a Certified Reliability Engineer (CRE) certification from the American Society for Quality (ASQ), and a Certified Manager of Quality (CMQ) certification from the American Society for Quality (ASQ).

Publications: *Zero Harm: How to Achieve Patient Safety in Healthcare*
Chapter 5, Safety Science and HRO, *The Healthcare Quality Book 5th Ed*
Maximize Patient Safety with Advanced Root Cause Analysis

Reliability

Reliability is the probability that a system will function successfully.
Reliability (R) = total demands - failures (system error)

$$R = 1 - \varepsilon$$

Reliability

| Reliability (R)	Reliability (R)	Nines	System Error (ε)	System Error (ε)
90%	0.9	1	0.1	10^{-1}
99%	0.99	2	0.01	10^{-2}
99.9%	0.999	3	0.001	10^{-3}
99.99%	0.9999	4	0.0001	10^{-4}
99.999%	0.99999	5	0.00001	10^{-5}
99.9999%	0.999999	6	0.000001	10^{-6}

Not quite exceptional

Patient Safety	1.48 days a serious harm
Workforce Safety	16 hours a DART injury
Clinical Quality	0.98 risk-adjusted mortality
Patient Experience	70.2% top box-rate hospital

Typical reliability data for a system with 10-20 medical centers

80% reduction

in loss events every macro-improvement cycle
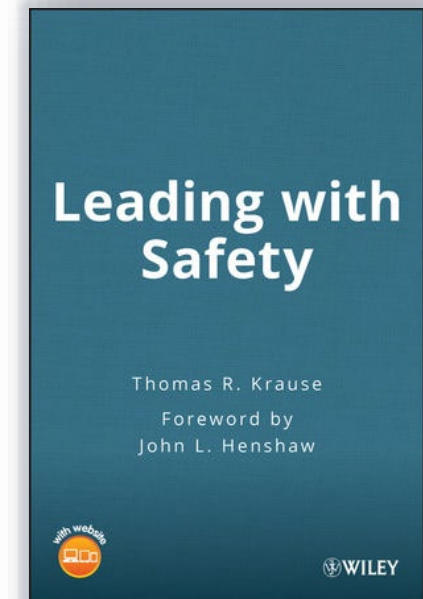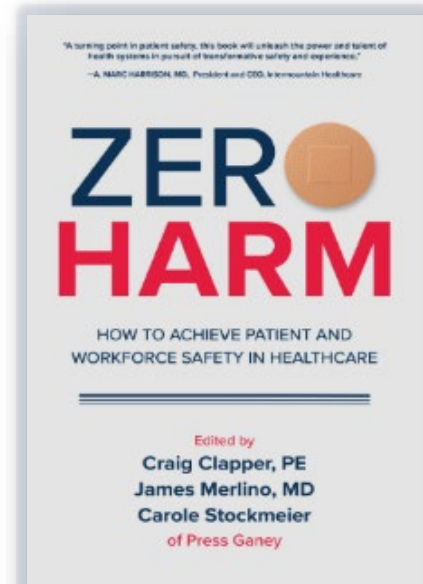
high reliability / HRO

"High reliability describes the system."

"High-Reliability Organizing means using super-traits of socio-technical systems."
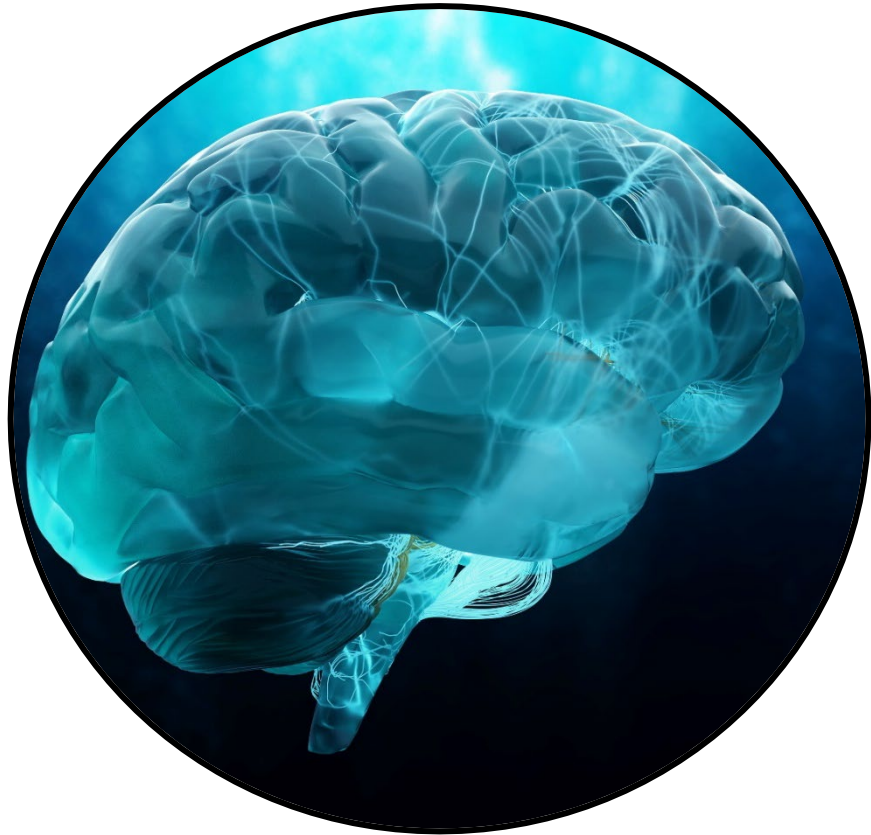
New Thinking

Bad Apple Theory

- People make errors.

- People who make errors are poor performers.

- Improvement comes through removing poor performers.
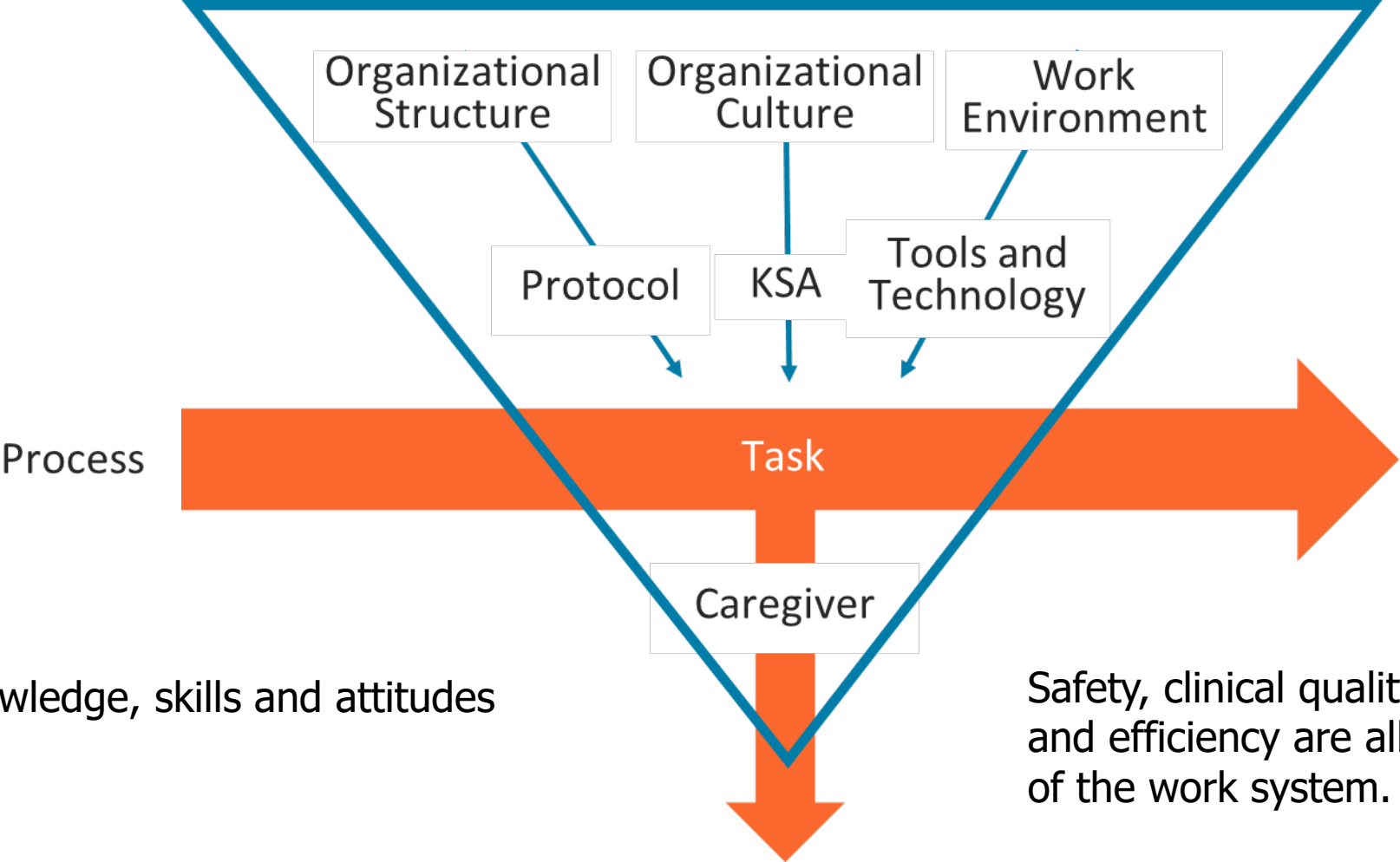
Systems Thinking

- All people are human first then an expert or novice second (Jef Raskin).

- All human error is system caused.

- High reliability is an emergent property of the socio-technical system.

- People experience system-caused error – and people are also the best prevention of errors becoming events.

Our Brains Help Us by Compensating

Aoccdrnig to rscheearch at Cmabrigde Uinervtisy, it deosn't mttaer in waht oredr the ltteers in a wrod are, the olny iprmoetnt tihng is taht the frist and lsat ltteer be at the rghit pclae. The rset can be a toatl mses and you can sitll raed it wouthit a porbelm. Tihs is bcuseae the huamn mnid deos not raed ervey lteter by istlef, but the wrod as a wlohe.

Sharp End / Blunt End Model

KSA is knowledge, skills and attitudes

Safety, clinical quality, patient experience, and efficiency are all emergent properties of the work system.

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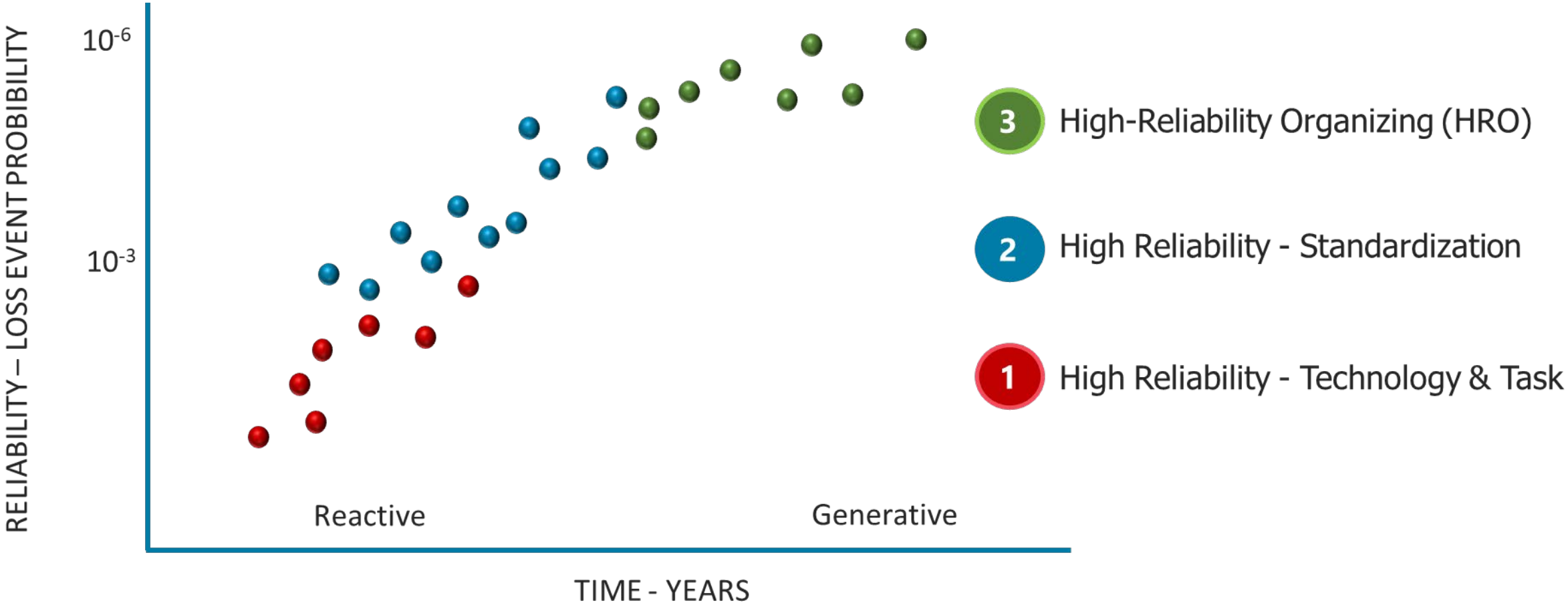"At the sharp end, there is almost always a discretionary space into which no system improvement can completely reach. Systems cannot substitute the responsibility borne by individuals within that space."

Sidney Dekker

Just Culture: Balancing Safety & Accountability (2007)

Three Waves of Reliability

RELIABILITY – LOSS EVENT PROBIBILITY

10^{-6}

10^{-3}

TIME - YEARS

Reactive

Generative

3 High-Reliability Organizing (HRO)

2 High Reliability - Standardization

1 High Reliability - Technology & Task

Source: Hudson, Patrick. (2007). Implementing a safety culture in a major multi-national. Safety Science; 45(6), 697-722.
Read More: Ghaferi, Myers, Sutcliffe, and Pronovost, *The Next Wave of Hospital Innovation to Make Patients Safer*; HBR, 8 August 2016.

Individual

Socio-Technical System

1980

James Reason
GEMS

James Reason
Organizational Accident (orgax)

Sidney Dekker
Humans in Complex Systems

Jens Rasmussen
Skill-Rule-Knowledge

Jens Rasmussen
Cognitive Systems Engineering

HOP

Richard Cook
Sharp End

Nancy Leveson
Safety III

Chong Chiu
5 Characteristics

John Wreathall
Fracture Tough

David Woods
Stress-Strain

Herbert Heinrich
Accident Pyramid

**Safety
Culture**

Ronald Westrum & Patrick Hudson
Shell Hearts & Minds

Erik Hollnagel
Safety I and Safety II

**Resilience
Engineering**

Paul Fitts
Human Factors

Vernon Bradley
The Bradley Curve

Rene Amalberti
5 Barriers

Karl Weick
The Michigan School

Karlene Roberts
The Berkeley School

Mindfulness

Barry Turner
Man-Made Disasters

HRO

Timothy Vogus

Kathleen Sutcliffe

Gene Rochlin

David Obstfeld

Todd LaPorte

Diane Vaughn
Normalized Deviance

NAT

Charles Perrow
Normal Accidents

Scott Sagan
Limits of Safety

Nick Pidgeon
Man-Made Disasters

GEMS – generic error modeling system
HOP – human & organizational performance
HRO – high-reliability organizing
NAT – normal accident theory

Clapper: *Chapter 5 - Safety Science and High Reliability Organizing, The Healthcare Quality Book 5th edition,* Dr David Nash editor, Health Administration Press, 2022.

RELIABILITY
4Life

Table 1

HRO organizing principles and illustrative practices.[16]

Concept	Definition	Illustrative practice
Preoccupation with failure	Operating with a chronic wariness of the possibility of unexpected events that may jeopardize safety by engaging in proactive and pre-emptive analysis and discussion, and after action reviews.	Pre-operatively people spend time identifying activities they do not want to go wrong. In handoffs or reports to oncoming staff, people discuss what to look out for.
Reluctance to simplify interpretations	Deliberately questioning assumptions and received wisdom to create a more complete and nuanced picture of current situations.	People seek alternative perspectives and are encouraged to express different opinions. People feel free to bring up problems and tough issues.
Sensitivity to operations	Ongoing interaction and information sharing about current human and organizational factors to create an integrated big picture of ongoing situations so that small adjustments can be made to prevent errors from accumulating.	People interact often enough to build a clear picture of what is happening here and now. People have a good "map" of each other's talents and skills. People have access to a variety of resources whenever unexpected surprises crop up.
Commitment to resilience	Developing capabilities to cope with, contain, and bounce back from mishaps that have already occurred, before they worsen and cause more serious harm.	People incessantly talk about mishaps, their prevention, and what can be learned from them. People consistently work to improve their competence and develop new response repertoires.
Deference to expertise	During high-tempo times (i.e., when attempting to resolve a problem or crisis), decision-making migrates to the person or people with the most expertise with the problem at hand, regardless of authority or rank.	People are aware of each other's unique skills and knowledge and when problems arise take advantage of the unique skills of their colleagues. When a patient crisis occurs, people rapidly pool their collective expertise to attempt to resolve it.

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High reliability organizations (HROs)

Kathleen M. Sutcliffe, PhD, Professor *

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Academic and professional disciplines, such as organisation and management theory, psychology, sociology and engineering, have, for years, grappled with the multidisciplinary issues of safety and accident prevention. However, these ideas are just beginning to enrich research on safety in medicine. This article examines a domain of research on system safety – the High Reliability Organization (HRO) paradigm. HROs operate in hazardous conditions, but have fewer than their fair share of adverse events. HROs are committed to safety at the highest level and adopt a special approach to its pursuit. The attributes and operating dynamics of the best HROs provide a template on which to better understand how safe and reliable performance can be achieved under trying conditions, and this may be useful to researchers and caregivers who seek to improve safety and reliability in health care.

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Safety challenges persist in many industries, but the problem in the health-care industry is particularly acute. In fact, health-care presents a challenging paradox by pairing the mandate to 'do no harm' with mounting evidence, over the past two decades, that much harm is done in the course of delivering care.[1,2] Much is known about the problem of safety in complex sociotechnical systems based on years of research in disciplines such as organisation and management theory, cognitive psychology, sociology and human factors engineering. However, it is only recently that findings from these disciplines have begun to permeate the patient-safety literature in medicine and health-care more generally. In part, this diffusion can be explained by the public spotlight on medical error that has followed high-profile events such as the British Royal Infirmary inquiry, to name one example,[3] and the publication of the United States Institute of Medicine's Report, *To Err is Human*,[2] which have called for a greater focus on organisational systems.

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Driver Diagram

Super-Traits
- Psychological safety
- HRO
- Learning Organization

Accelerators
- **Safety Culture**
- Standardization
- Best Practice

Foundations
- People
- Technology
- Process

Thought Leaders

Weick & Sutcliffe*
1. Preoccupation with failure
2. Reluctance to simplify interpretations
3. Sensitivity to operations
4. Commitment to resilience
5. Deference to expertise

Rene Amalberti*
1. Accepting limits
2. Abandoning autonomy
3. Transition to equivalent actor
4. Sharing risk vertically
5. Managing the visibility of risk

Chong Chiu*
1. Mission and Goals
2. Knowledge and Skills
3. Lateral Integration
4. Simple Work Process
5. Self-Improvement Programs

- Mutual respect
- Psych Safety

- Social
- Cognitive
- Resource

Just Culture

Tiered Huddles

Local Learning Systems

Daily Problem Solving

Life Skills

HRO

Leader Skills

* Illustrative descriptive theory. There are many thought leaders, and each has 5, 7, or 9 traits
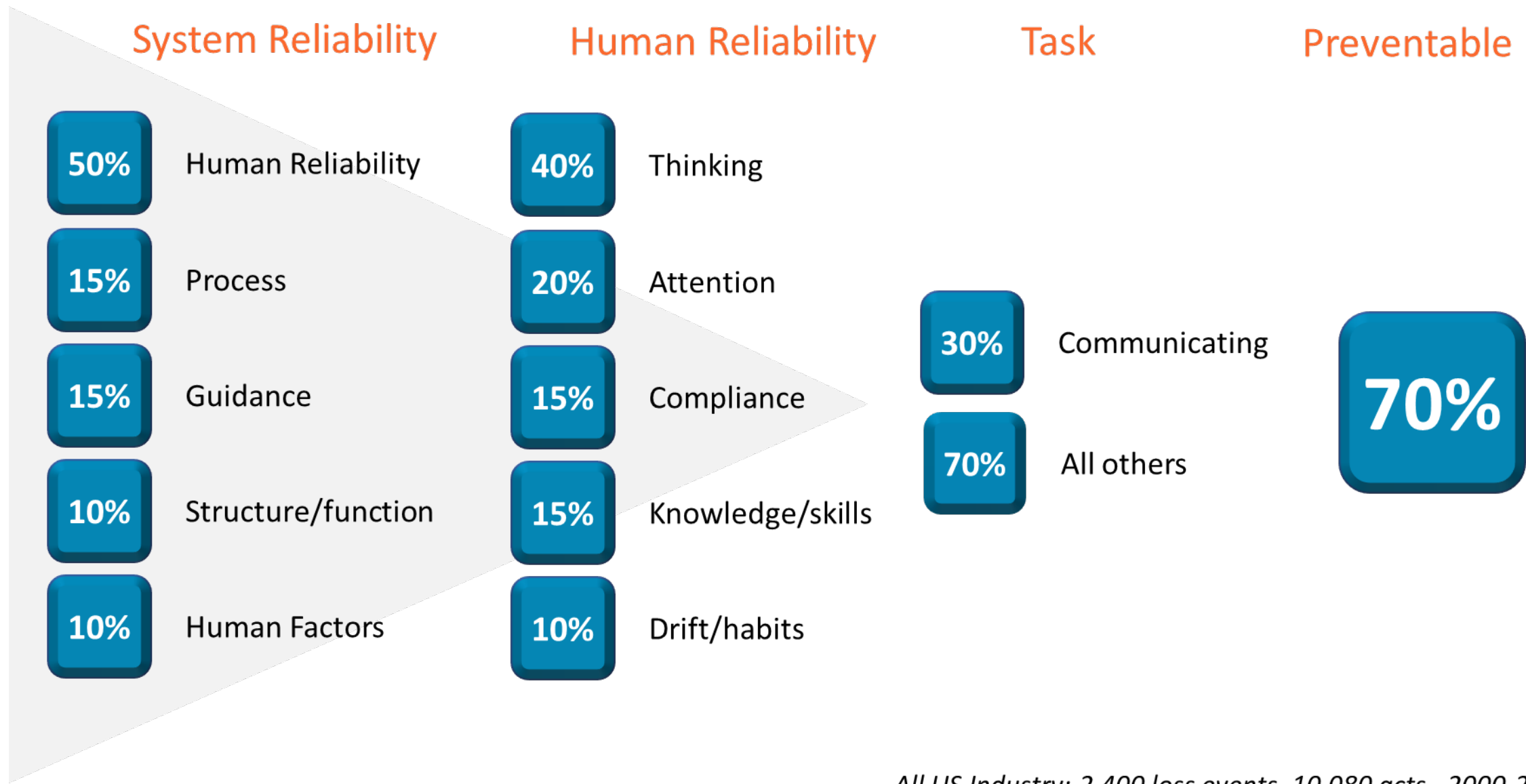
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All professionals use behavioral models of culture change:

1. Select target behaviors as a skill.

2. Enable use by providing people abilities needed to practice the skill.

3. Build practice habits through aligned measures, goals, rewards and reinforcements.

"Strategy without tactics is the slowest route to victory. Tactics without strategy is the noise before defeat."

Sun Tzu, *The Art of War*

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System Reliability

- **50%** Human Reliability
- **15%** Process
- **15%** Guidance
- **10%** Structure/function
- **10%** Human Factors

Human Reliability

- **40%** Thinking
- **20%** Attention
- **15%** Compliance
- **15%** Knowledge/skills
- **10%** Drift/habits

Task

- **30%** Communicating
- **70%** All others

Preventable

70%

All US Industry: 2,400 loss events, 10,080 acts, 2000-2020

Muller-Lyer Effect

Instant Poll: Which line is longer?

A

B

C   Equal

Life skills are non-technical skills

- Situational awareness
- Attention
- Communication
  - Closed-loop (repeat-back)
  - phonetic and numeric clarification
  - SBAR (situation, background, assessment, request)
  - inquiry, advocacy, assertion
- Thinking (especially cognitive debiasing)
- Guidance use and adherence
- Decision making

Clapper, Merlino, and Stockmeier
Zero Harm, 2018
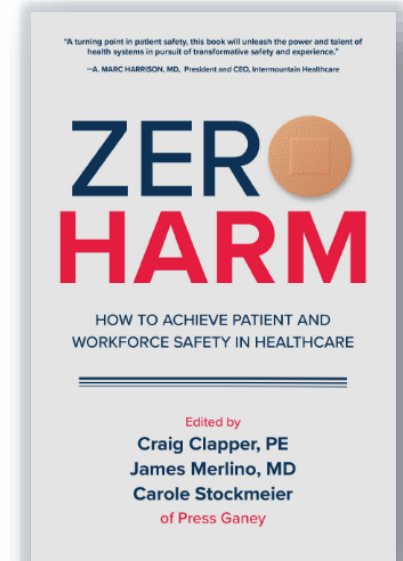
Flin, O'Connor, and Crichton
Safety at the Sharp End, 2016

$$1 = R + \varepsilon$$
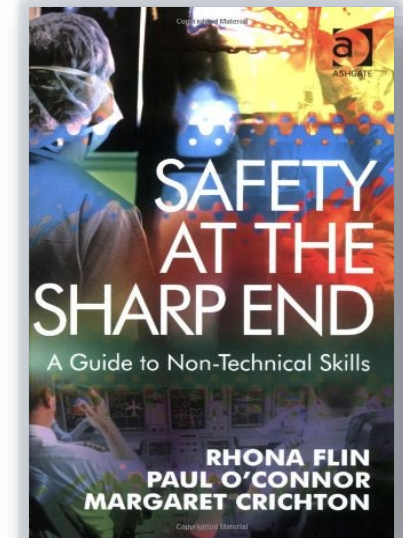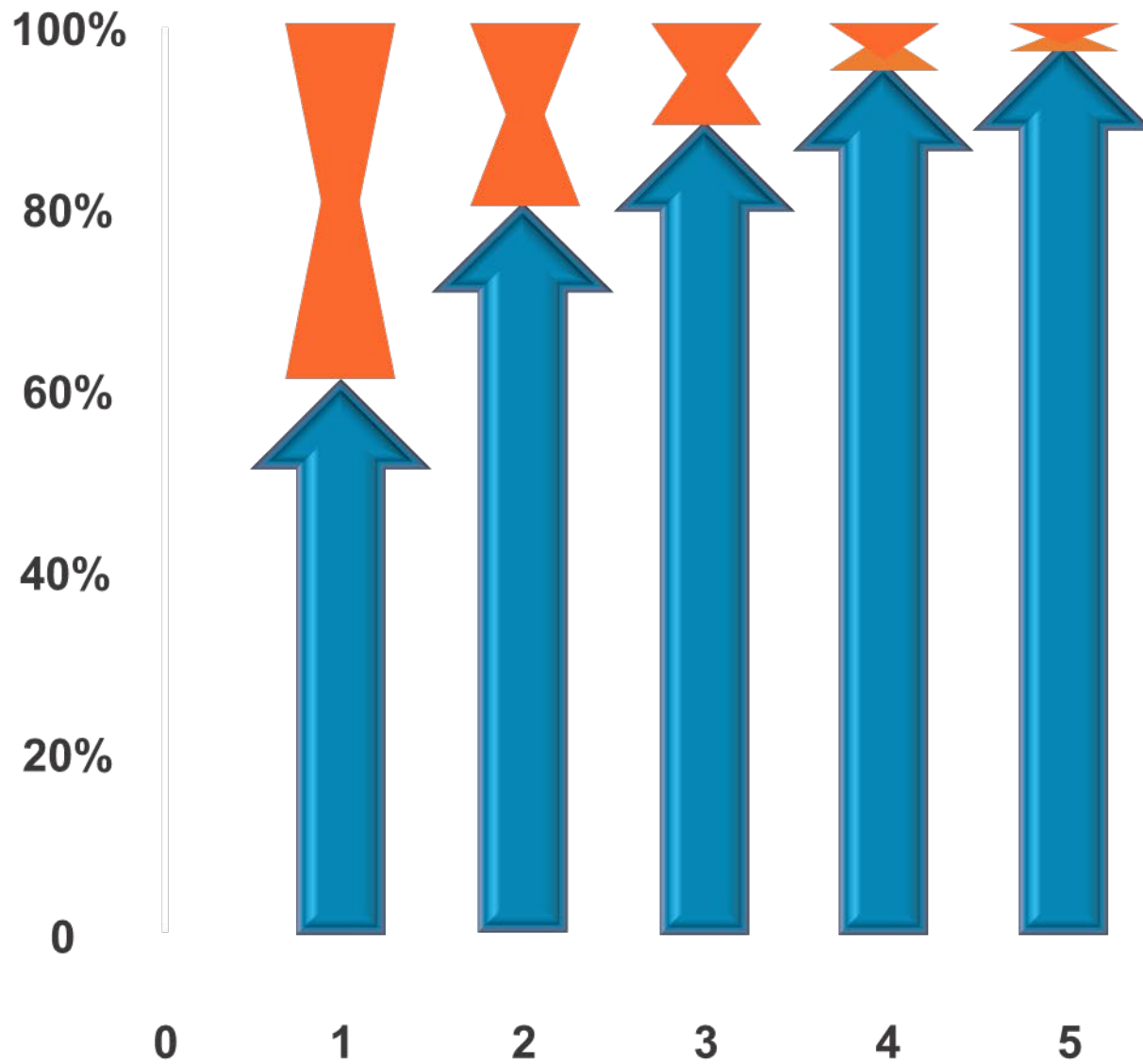
■ **System Error (ε)**

■ **System Reliability (R)**

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Life Skills – team thinking

A newspaper is better than a magazine. A seashore is a better place than a street. At first it is better to run than to walk. You may have to try several times. It takes some skills but is easy to learn. Even young people can enjoy it. Once successful, complications are minimal. Birds seldom get too close. Rain, however, soaks in very fast. Too many people doing the same thing can also cause problems. One needs lots of room. If there are no complications, it can be very peaceful. A rock will serve as an anchor. If things break loose from it, however, you will not get a second chance.

Let's practice

What is wrong with this picture?

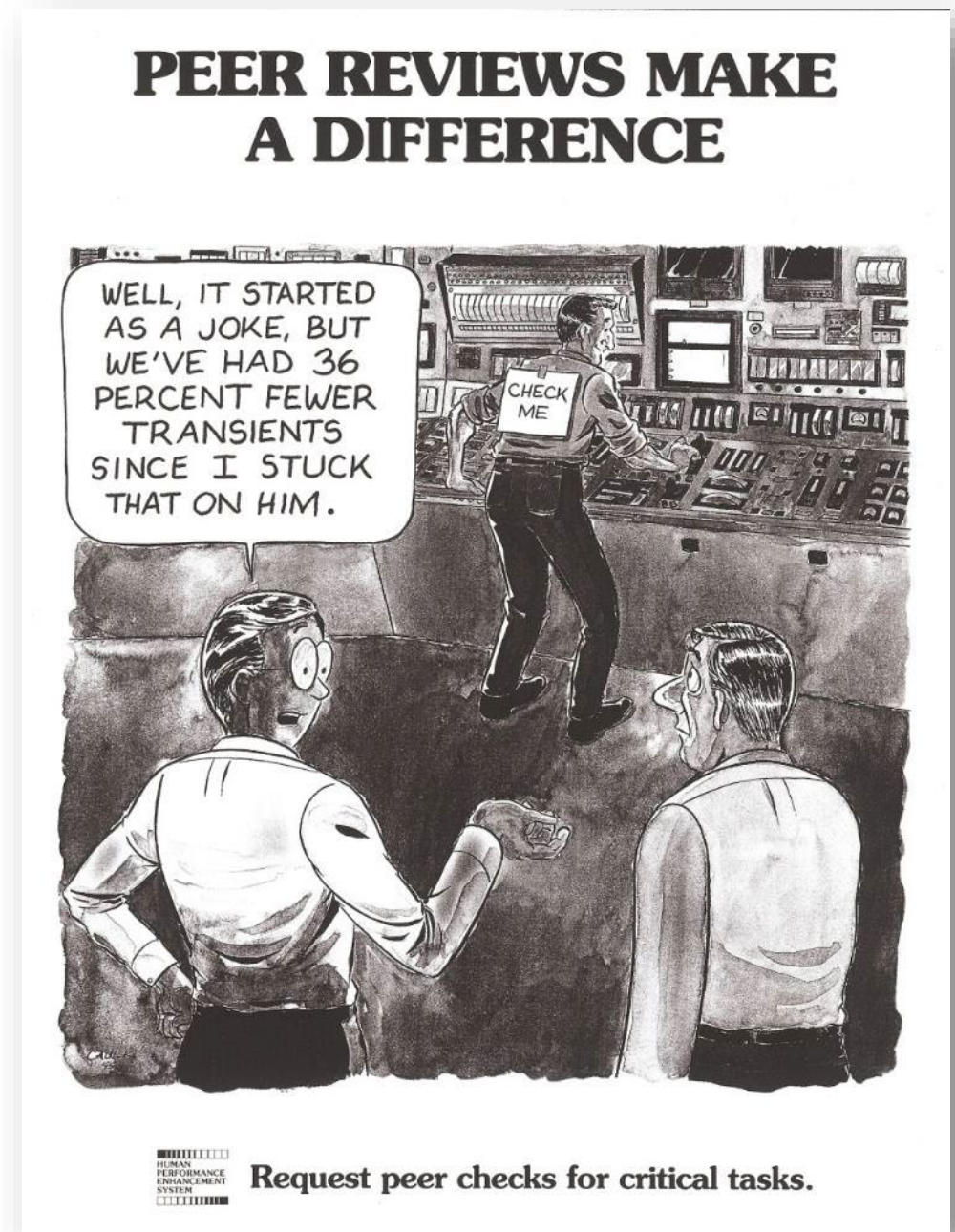What is the meaning?

Cross Monitoring

Cross Monitoring

Watching out for each other. Share situational awareness and provide on-the-spot second opinions.

Cross Coaching

Involves feedback. Peers provide a 5:1 ratio of positive to negative feedback to reinforce good habits, extinguish poor habits and build better practice habits.

Multiply Your Error Probability

$0.001 \times 0.001 = 10^{-6}$

PEER REVIEWS MAKE A DIFFERENCE

WELL, IT STARTED AS A JOKE, BUT WE'VE HAD 36 PERCENT FEWER TRANSIENTS SINCE I STUCK THAT ON HIM.

CHECK ME

Request peer checks for critical tasks.

Authority Gradient

The *perceived* steepness as seen by the *subordinate.*

Balance of decision-making power or the steepness of command hierarchy.

Members of a team with a domineering, overbearing or dictatorial team leader experience a steep authority gradient.

Expressing concerns, questioning or even simply clarifying instructions would require considerable determination.

Teams require some authority gradient - otherwise roles are blurred and decisions cannot be efficiently made.

Psychological Safety

- Although thought of colloquially as "I can speak up about concerns," the specific elements of psychological safety are much more nuanced and entail the following four attributes:

  1. Anyone can ask questions without looking stupid.
  2. Anyone can ask for feedback without looking incompetent.
  3. Anyone can be respectfully critical without appearing negative.
  4. Anyone can suggest innovative ideas without being perceived as disruptive.

- Each attribute emerges in different places and times within work settings and is supported by different activities. For example, asking questions without looking stupid relates to learning in the clinical environment, whereas asking for feedback without looking incompetent is a major component of how frontline staff relate to the person to whom they report.

Source: Edmondson, Amy. "Psychological Safety and Learning Behavior in Work Teams." Administrative Science Quarterly 44, no. 2 (1999).

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