

# **Week 6: (1) Operational Health Physics** SAND2010-8214P **(2) Nuclear Safety Culture**

## Unit 2: Nuclear Safety Culture

### Main Teaching Points/Lessons

1. Nuclear Safety Culture Defined
2. Human Performance Basics
3. The Role of the Individual
4. The Role of the Organization
5. The Role of the Leader

# Nuclear Safety Culture

- Key Terms – Culture, Conservative Decision Making, Human Error, Latent Organizational Weaknesses, Error Precursors, Defense-In-Depth
- Key Concepts – Human Performance, Culture of Mindfulness
- Desired Student Outcomes:
  1. **Identify** defining characteristics of a strong nuclear safety culture
  2. **Improve** overall performance using a coherent, strategic, and proven approach.
  3. **Understand** how implementation of human performance improvement principles enhances productivity, reliability, efficiency, and quality.
  4. **Implement** techniques that identify and eliminate error-likely situations, flawed defenses, and latent organizational weaknesses.

# Nuclear Safety Culture

## Primary Resources

1. Organizational Culture and Leadership, Edgar H. Schein (Recommended)
2. IAEA-TECDOC-1329, Safety Culture in Nuclear Installations: Guidance for use in the enhancement of safety culture (Recommended)
3. Managing the Unexpected: Resilient Performance in an Age of Uncertainty, by Karl E. Weick and Kathleen M. Sutcliffe (Recommended)
4. DOE-HDBK-1028-2009, Human Performance Improvement Handbook, Volume 1 & 2 (Recommended)

# Nuclear Safety Culture

- Can this topic be taught in a single lecture? No
- If no, how many lectures will it take? 6 hours for lecture series with an additional 3 hours for practical exercises
- Can these “sub”-lectures consist of the main teaching points? Yes
- Other comments/concerns:

# LESSON 1

## Nuclear Safety Culture Defined



# Lesson 1 Objectives

Participants will be able to....

1. **Define** culture.
2. **Describe** the three levels of culture.
3. **Understand** the attributes of a mature nuclear safety culture.
4. **Explain** how conservative decision making relates to nuclear power plant operation.

# Culture Defined

- Simple “The way that we do things around here”
- Accurate, more correct definition:

***“Culture is a pattern of basic assumptions—  
invented, discovered or developed by a given  
group as it learns to cope with its problem of  
external adaptation (how to survive) and internal  
integration (how to stay together) - which have  
evolved over time and are handed down from one  
generation to the next.”***

***- Dr. Edgar Schein  
Organizational Culture and Leadership***

# Three Levels of Culture

## *Level One*

### **Artefacts & Behavior**

- Visible, greeting rituals, dress
- What we see, hear and feel

## *Level Two*

### **Espoused Values**

- Strategies, goals, philosophies
- Values that people say they support
- Can be elicited

## *Level Three*

### **Basic Assumptions**

- Strategies, goals, philosophies
- Values that people say they support
- Unconsciously held and usually tacit

# Culture is...

- Culture is **deep** ...culture controls you more than you control culture
- Culture is **broad**...deciphering can be an endless task
- Culture is **stable**...people want to hold onto cultural assumptions, which provides meaning and makes life predictable

# IAEA-TECDOC-1329

## Safety Culture in Nuclear Installations



# Rule Based

- Accidents are not anticipated
- When an accident happens, employees are blamed for not following the rules
- Employees are rewarded for obedience and results
- Management's role is seen as enforcing the rules
- There is not much listening or learning inside or outside the organization
- Communications between departments and functions is poor

# Goal Based

- The organization remains reactive in relation to accidents
- Response to accidents focuses on controls, procedures, and training
- Employees are rewarded for exceeding goals
- Management's role is to assure that goals are achieved and work objectives are clear to employees
- The organization is willing to learn from external groups
- Communications between departments and functions is encouraged

# Learning (Improvement) Based

- Problems are anticipated and dealt with before they occur
- Accidents are viewed in terms of process variability with emphasis on understanding, not blaming the employee
- People are rewarded for improving processes, as well as achieving results
- Management's role is seen as coaching employees
- Learning from others, both inside and outside the organization, is valued
- Good collaboration between departments and functions

# On Organizational System

- Only people hold this patchwork of processes together in reality
- People are necessary to create safety through practice
- There are always multiple goals in conflict
- In pressurized systems, right decisions do not always get made.
- Systems as a norm are reliable and dependable – we can normally depend on these systems so that when we go in to ETTO we can rely on the system filling in the blanks.

# Conservative Decision Making defined....

***“When conditions arise which are unexpected, or are outside the scope of normal operating conditions or procedures, management promotes a culture which ensures that operations personnel do not proceed in the face of uncertainty, but instead place the plant in a safe condition and then obtain the appropriate guidance before proceeding.”***

***- Terence J. Sullivan, Executive Vice President  
Institute of Nuclear Power Operations***

# Conservative Decision Making

- Basing decisions on the best facts available, and where facts are not available, taking the most conservative choice to protect public and staff safety
- Never compromising safety for productivity
- Taking a cautious, well considered approach to reactor operation
- Never proceeding in the face of uncertainty

# IAEA Safety Culture Principles

- Safety is a universally recognized value
- Leadership for safety is clear and understood
- Accountability for safety is clear and moves upward
- Safety is integrated in all activities
- Safety is learning driven

# LESSON 2

## Human Performance Basics



# Lesson 2 Objectives

Participants will be able to....

1. **Identify** the primary factors that lead to unwanted outcomes (events).
2. **Understand** the difference between violations and human error.
3. **Understand** the formula for performance improvement
4. **Identify** the goal of human performance improvement.
5. **State** the five principles of human performance improvement.

# Human Fallibility

***“... human fallibility is like gravity, weather, and terrain, just another foreseeable hazard. Error is pervasive ... What is not pervasive are well-developed skills to detect and contain these errors at their early stages.”***

***- Weick and Sutcliffe  
Leading with Resilience in the Face of the Unexpected***

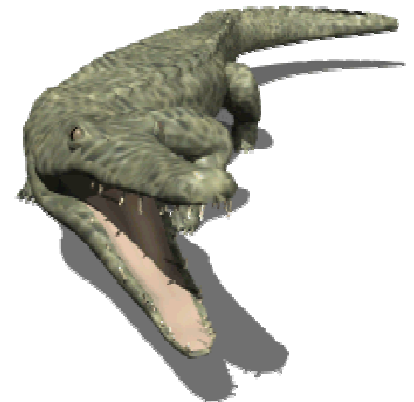
# To Err is Human



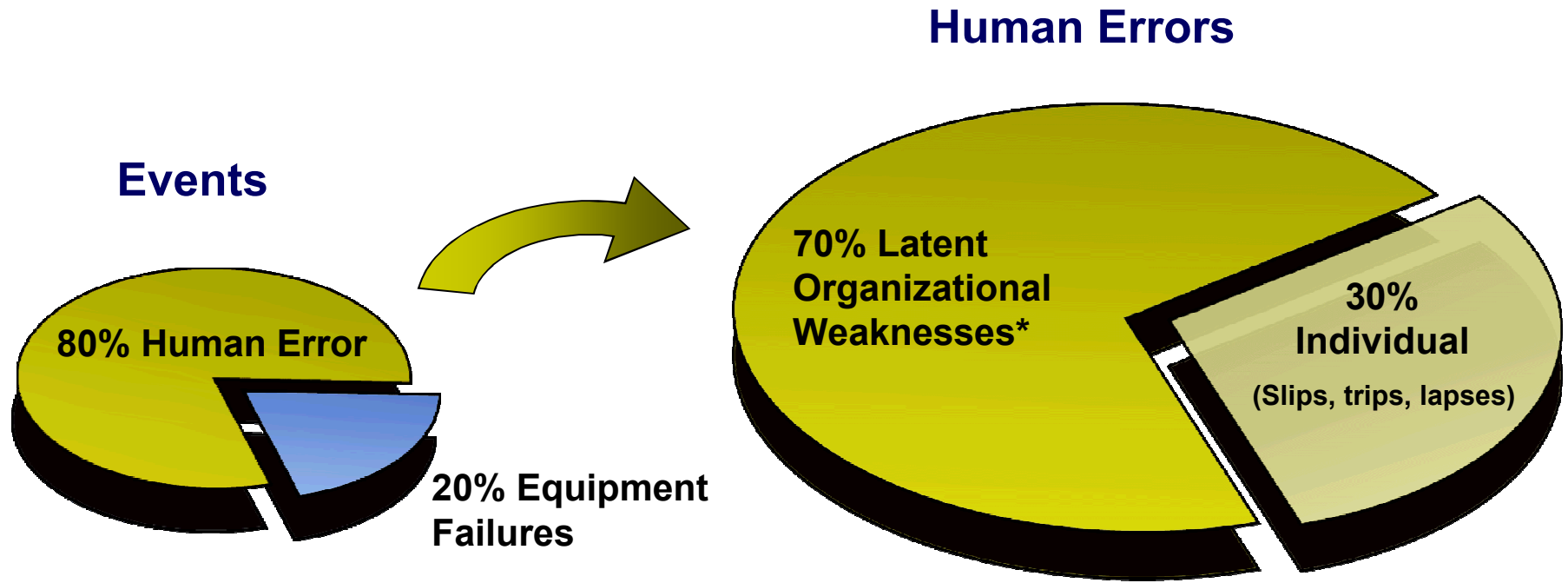


# Discussion of Kenny Video

- What is your impression of Kenny?
- What error(s) did Kenny make?
- What condition(s) provoked the accident?
- What could be said about defenses?
- What error(s) did the organization make?
- Are there any Kennys in your organization?

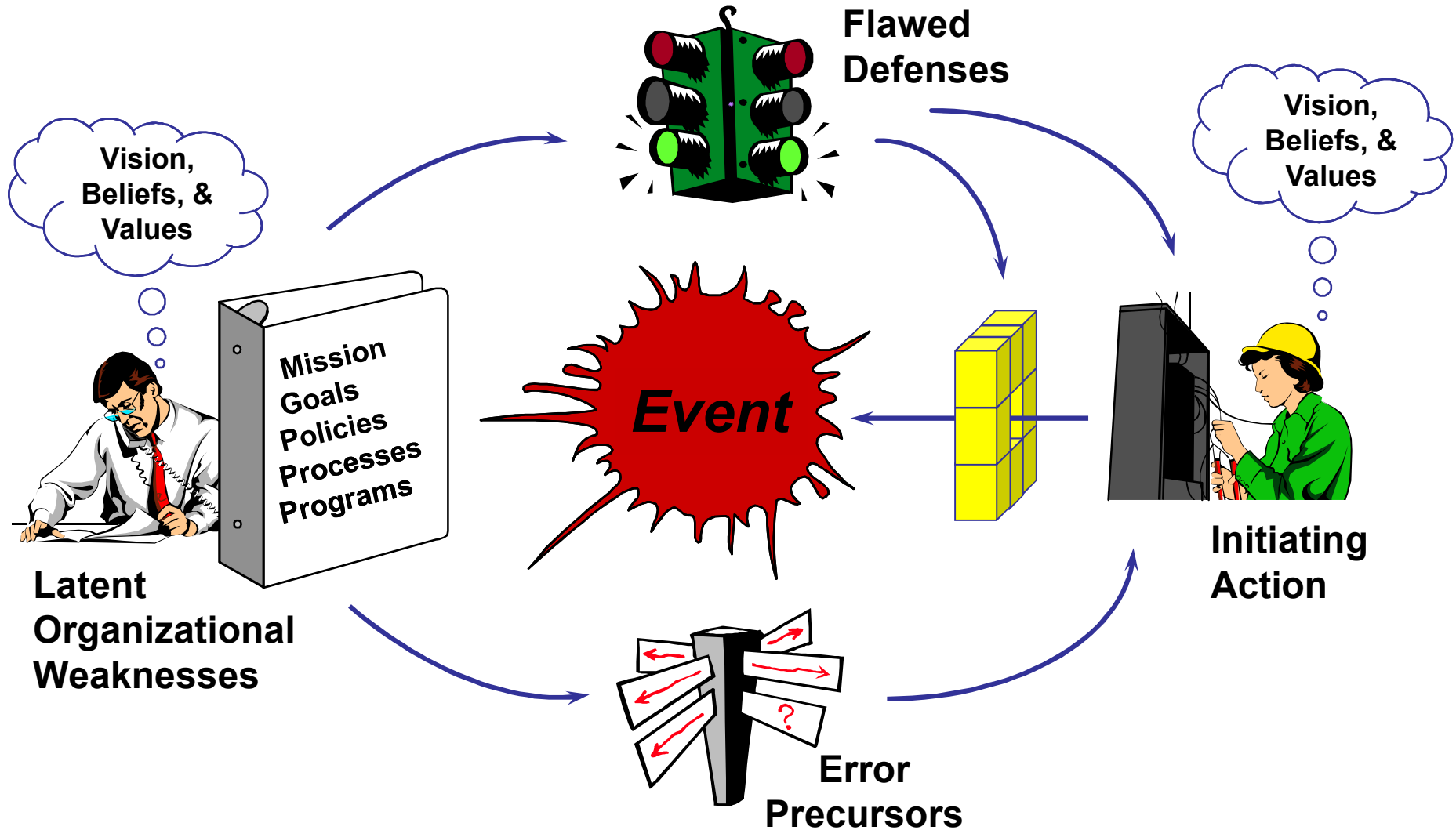


# What Causes Events?



\* Latent Organizational Weakness = Hidden deficiencies in management control process, values, or equipment.

# Anatomy of an Event



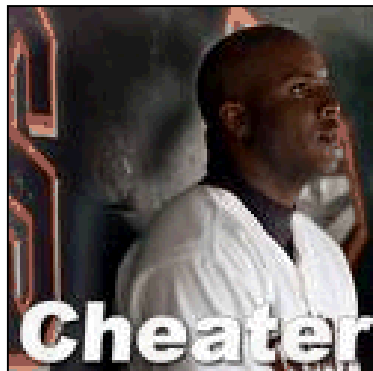
# **“The Past Settles its Accounts ...”**

***“...the ability to deal with a crisis situation is largely dependent on the structures that have been developed before chaos arrives. The event can in some ways be considered as an abrupt and brutal audit: at a moment’s notice, everything that was left unprepared becomes a complex problem, and every weakness comes rushing to the forefront.”***

***- Patrick Lagadec and Jocelyn M. Phelps  
Preventing Chaos in a Crisis: Strategies for Prevention, Control and Damage Limitation***

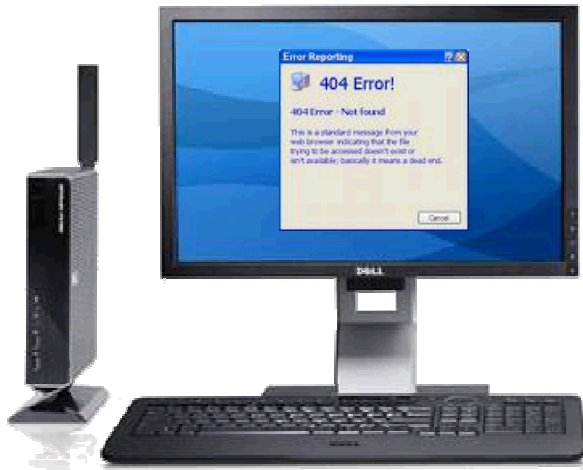
# What is a Violation?

**Intentional** acts to deviate from a policy or procedure for personal advantage, usually adopted for fun, comfort, expedience, or convenience.



# What is an Error?

An action that unintentionally departs from an expected behavior.



# Two Kinds of Error

**Active Error** →

Immediate consequences.  
Know “who did it.”



← **Latent Error**

Latent consequences.  
Do not know “who did it.”

# Fact About Human Error

*A 1999 study estimated that 45,000 – 95,000 people die each year due to human error in medical care!*



May 1, 2006

# Human Fallibility

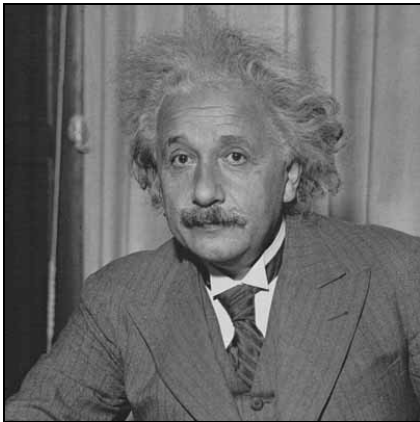
***“The single greatest impediment to error prevention in the medical industry is that we punish people for making mistakes.”***

***- Dr. Lucian Leape,  
Professor, Harvard School of Public Health  
Testimony before Congress on Health Care Quality Improvement***

# New Approach Needed

***“The significant problems we face can not be solved at the same level of thinking we were at when we created them.”***

***- Albert Einstein***




# Performance Improvement

$$P = B + R$$

***Performance = Behavior + Results***

# Goal of Human Performance Improvement

$$R_e + M_d \rightarrow \text{UO}$$


Reducing Error + Managing Defenses  Zero Events  
(Unwanted Outcomes)

*Focusing on error reduction reduces error frequency; focusing on improving defenses reduces error severity.*

# Principles of Human Performance

1. People are fallible - even the best people make mistakes.
2. Error likely situations are predictable, manageable, and preventable.
3. Individual behavior is influenced by organizational processes and values.
4. People achieve high levels of performance largely because of the encouragement and reinforcement received from leaders, peers, and subordinates.
5. Events can be avoided through an understanding of the reasons mistakes occur and the application of the lessons learned from past events (or errors).

# LESSON 3

## Reducing Human Error



***THE ROLE OF THE INDIVIDUAL***

# Lesson 3 Objectives

Participants will be able to....

1. **Recognize** the indications and characteristics of at-risk attitudes.
2. **Identify** common error precursors.
3. **Describe** how to predict, manage, and prevent error-likely situations.
4. **Understand** how individual behavior is influenced by organizational processes and values.
5. **Understand** basic human performance tools for reducing human error.

# Human Performance Improvement Principle #1

*People are fallible, and even  
the best make mistakes.*

# Common Traps of Human Nature

- Stress
- Mental Strain
- Avoidance
- Inaccurate Mental Models
- Limited Working Memory
- Limited Attention Resources
- Mind-Set
- Difficulty Seeing One's Own Error
- Limited Perspective
- Susceptibility to Emotional / Social Factors
- Motivated Toward Goal Accomplishment
- Fatigue



# At-Risk Attitudes

- **Inaccurate Risk Perspective:** *Guided by the heart, not by the head*
- **Pride:** *“Don’t insult my intelligence.”*
- **Heroic:** *“I’ll get it done, by hook or by crook.”*
- **Invulnerable:** *“That can’t happen to me.”*
- **Fatalistic:** *“What’s the use?”* or *“Que será será”*
- **Bald Tire:** *“I’ve gone 60K miles without a flat yet.”*
- **Summit Fever:** *“We’re almost done.”*
- **Pollyanna:** *“Nothing bad will happen.”*



# At-Risk Behaviors

**At-Risk Behaviors:** behavioral choices that increase risk where risk is not recognized, or is mistakenly believed to be justified.

## Driving a Car:

- ...
- ...
- ...
- ...
- ...

## In the Workplace:

- ...
- ...
- ...
- ...
- ...

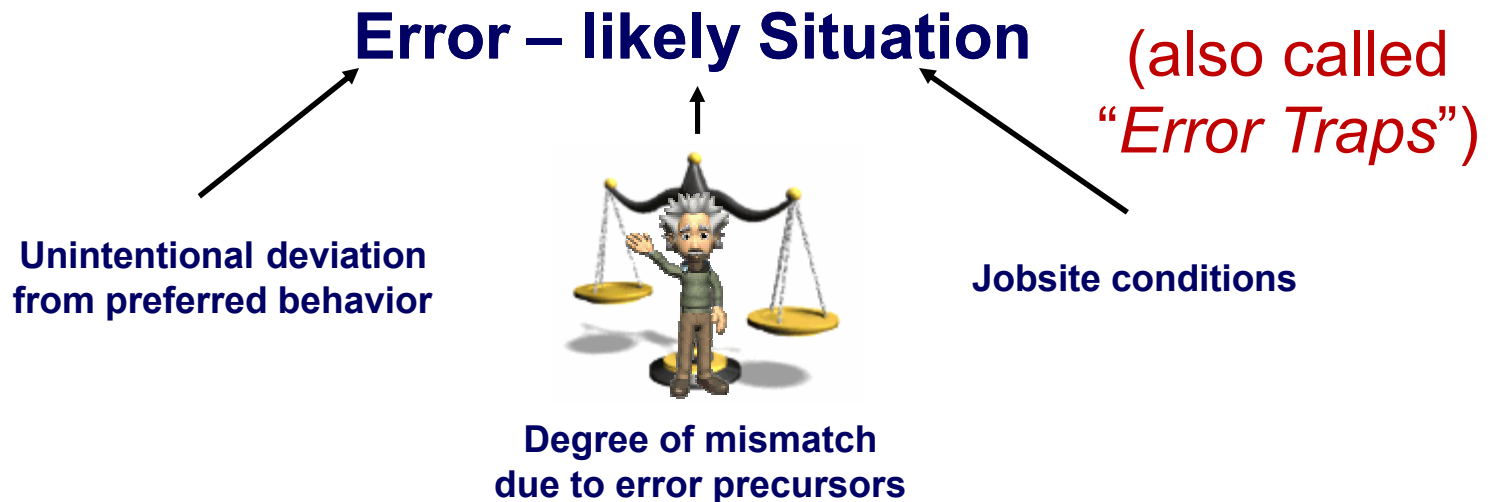
# Human Performance Improvement Principle #2

*Error-likely situations are predictable,  
manageable, and preventable.*

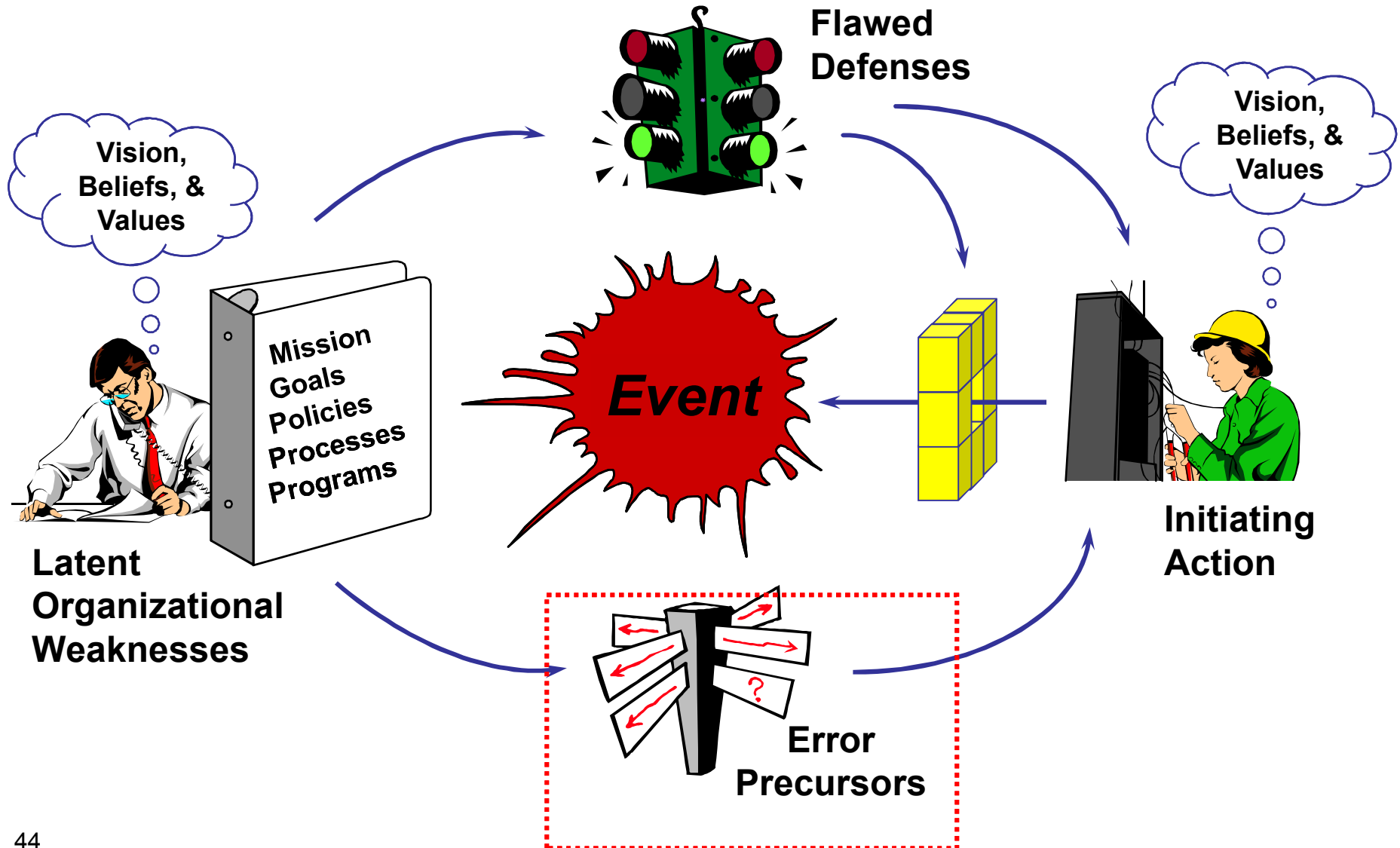
# Error-Likely Situation

An error about to happen:

- Typically exists when task-related factors exceed the capabilities of the individual (a mismatch)



# Anatomy of an Event



# Common Error Precursors

(Conditions that Provoke Error)

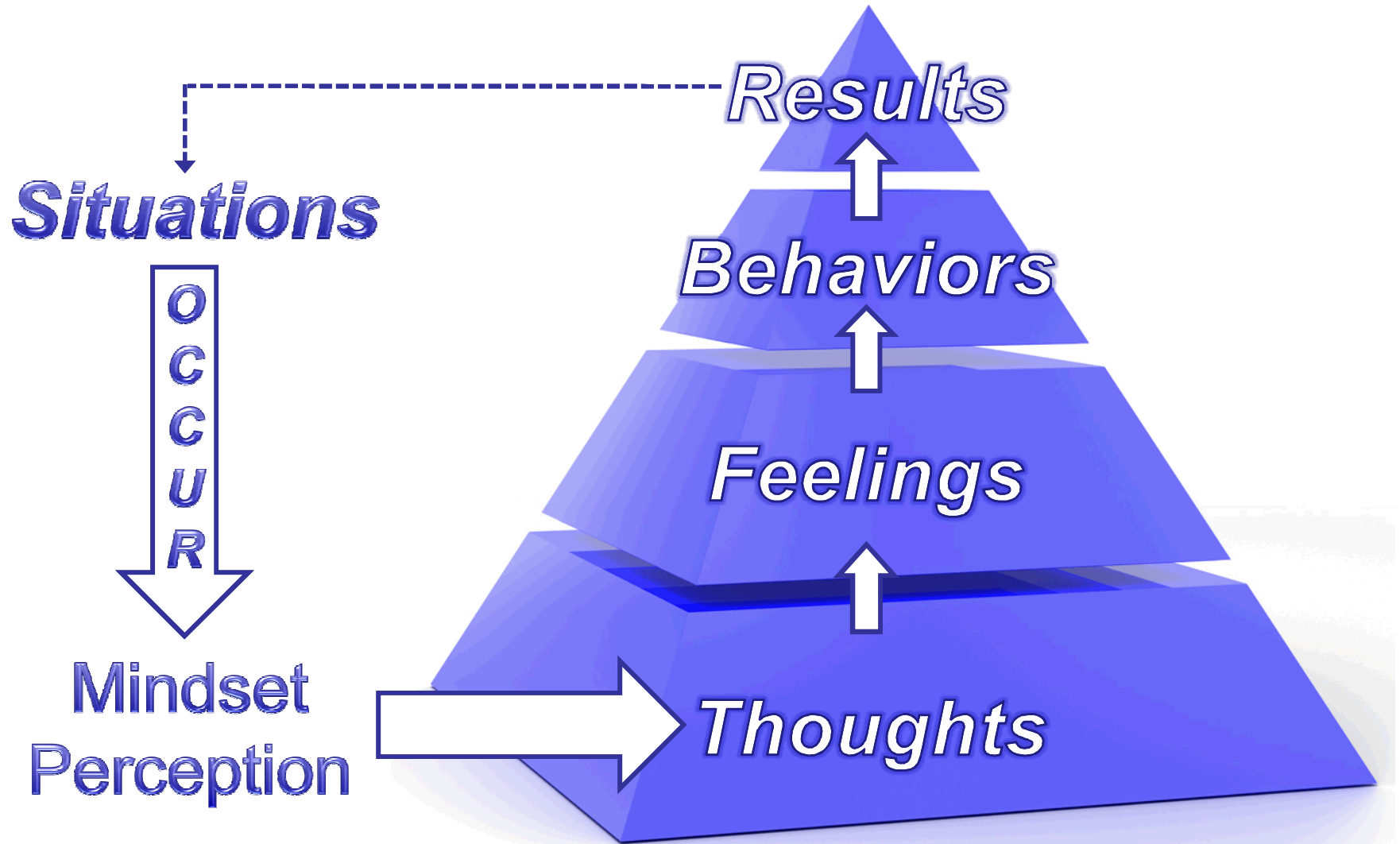
<b>Task Demands</b>	<b>Individual Capabilities</b>
<input type="checkbox"/> Time pressure (in a hurry)	<input type="checkbox"/> Unfamiliarity w/ task / First time evolution
<input type="checkbox"/> High Workload (high memory requirements)	<input type="checkbox"/> Lack of knowledge (mental model)
<input type="checkbox"/> Simultaneous, multiple tasks	<input type="checkbox"/> New technique not used before
<input type="checkbox"/> Repetitive actions / Monotony	<input type="checkbox"/> Imprecise communication habits
<input type="checkbox"/> Irrecoverable acts	<input type="checkbox"/> Lack of proficiency / Inexperience
<input type="checkbox"/> Interpretation requirements	<input type="checkbox"/> Indistinct problem-solving skills
<input type="checkbox"/> Unclear goals, roles, & responsibilities	<input type="checkbox"/> "Unsafe" attitude for critical tasks
<input type="checkbox"/> Lack of or unclear standards	<input type="checkbox"/> Illness / Fatigue
<b>Work Environment</b>	<b>Human Nature</b>
<input type="checkbox"/> Distractions / Interruptions	<input type="checkbox"/> Stress
<input type="checkbox"/> Changes / Departures from routine	<input type="checkbox"/> Habit patterns
<input type="checkbox"/> Confusing displays or controls	<input type="checkbox"/> Assumptions
<input type="checkbox"/> Workarounds / OOS instruments	<input type="checkbox"/> Complacency / Overconfidence
<input type="checkbox"/> Hidden system response	<input type="checkbox"/> Mind-set
<input type="checkbox"/> Unexpected conditions	<input type="checkbox"/> Inaccurate risk perception
<input type="checkbox"/> Lack of alternative indication	<input type="checkbox"/> Mental shortcuts (biases)
<input type="checkbox"/> Personality conflicts	<input type="checkbox"/> Limited short-term memory

**OOS – out of service**

# Human Performance Improvement Principle #3

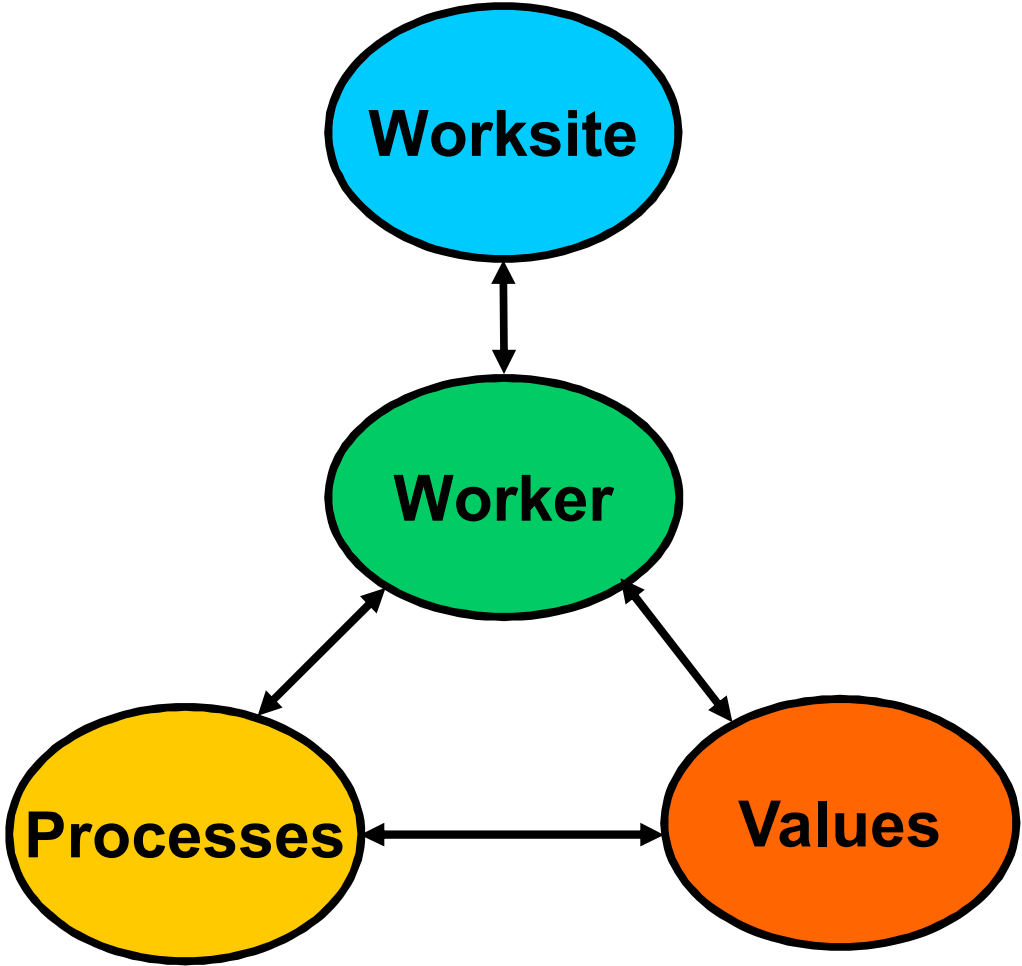
*Individual behavior is influenced by organizational processes and values.*

# Individual Performance Model



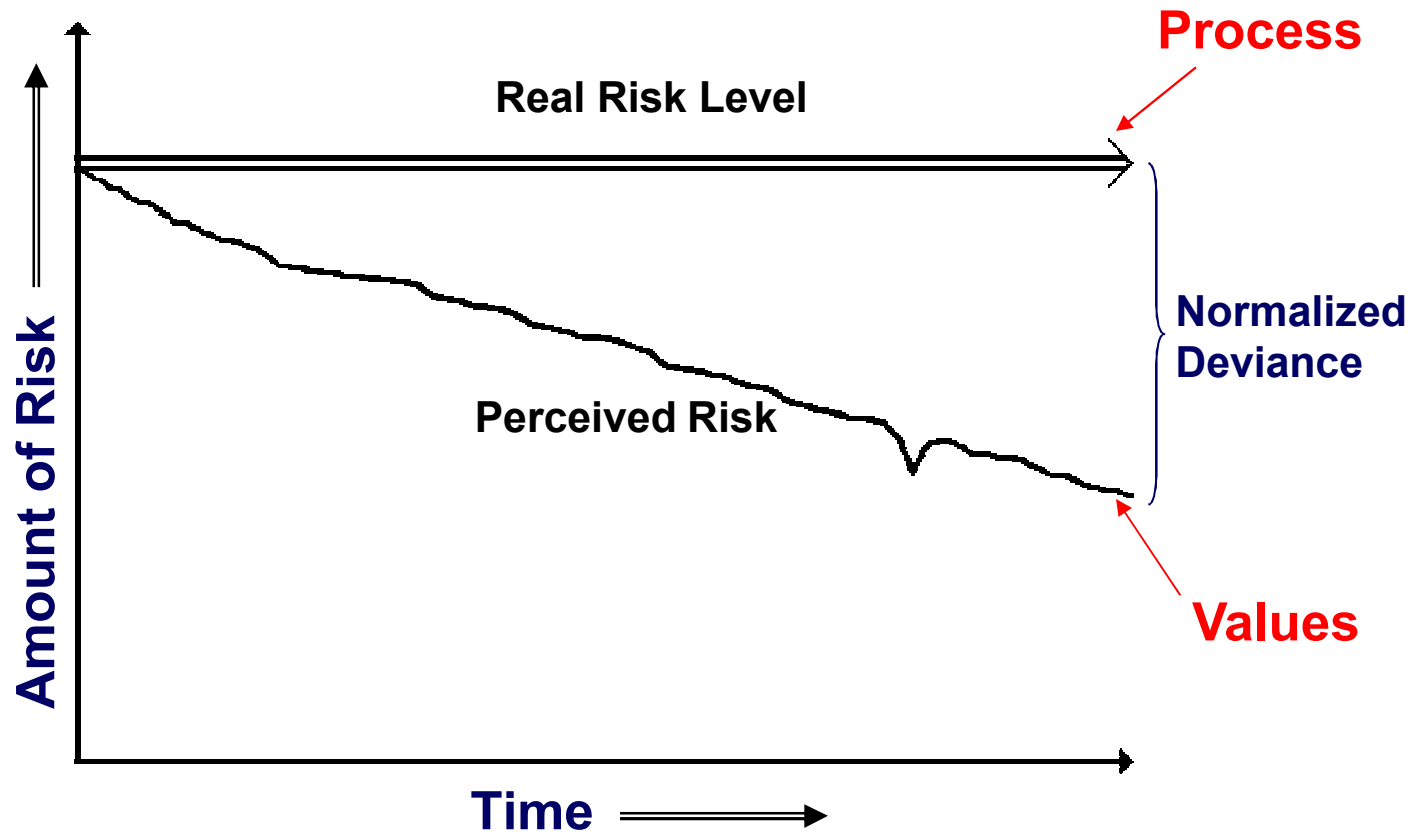
***WE PERFORM AS SITUATIONS OCCUR TO US!***

# Alignment

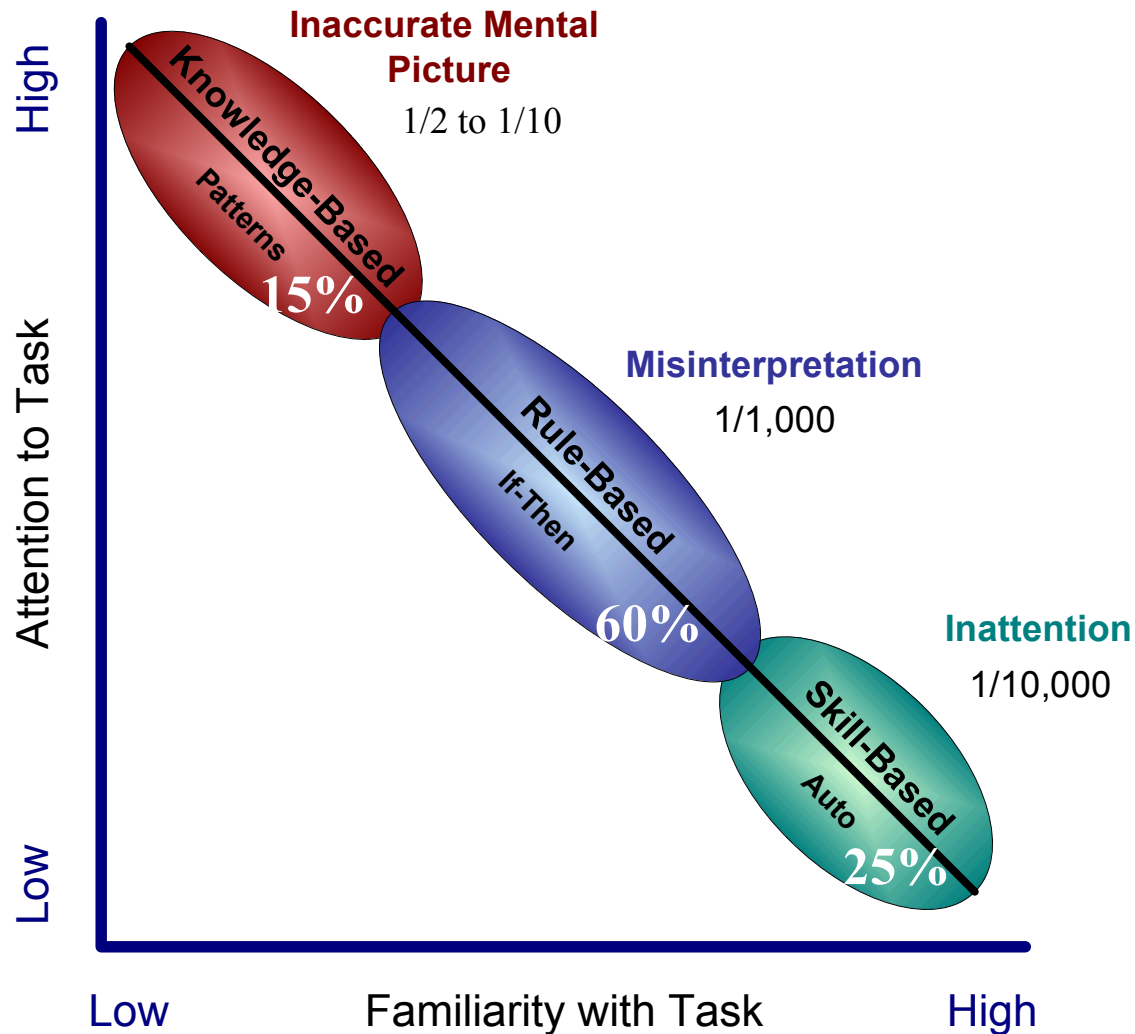


# Normalized Deviance

Focusing on one moment in time, you see negligence with respect to an old standard or norm.



# Consider Performance Modes

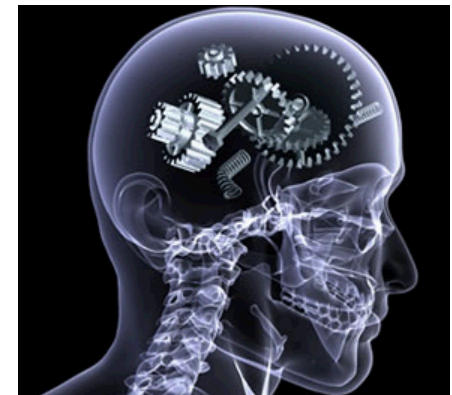


# *Fundamental* Human Performance Tools

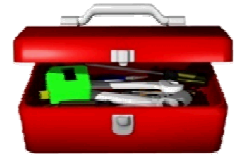


- Task Preview
  - Job-Site Review
  - Questioning Attitude
  - Stop (& collaborate) when unsure
  - Self-Checking
- 
- Procedure Use and Adherence
  - Effective Communication

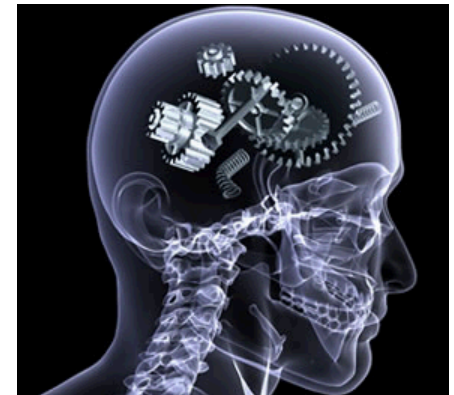
*SITUATIONAL  
AWARENESS*



# *Conditional* Human Performance Tools



- Pre-job Briefing
- Peer-Checking
- Concurrent Verification
- Independent Verification
- Flagging
- Placekeeping
- Turnover
- Post-job Review



# Team Errors



- **Halo Effect**: Blind trust in the competence of specific individuals
- **Pilot / Co-pilot**: Subordinate reluctant to challenge opinions, decisions, or actions of senior person
- **Free Riding**: One takes the lead while others tag along without actively scrutinizing the work.



# Team Errors (Cont.)



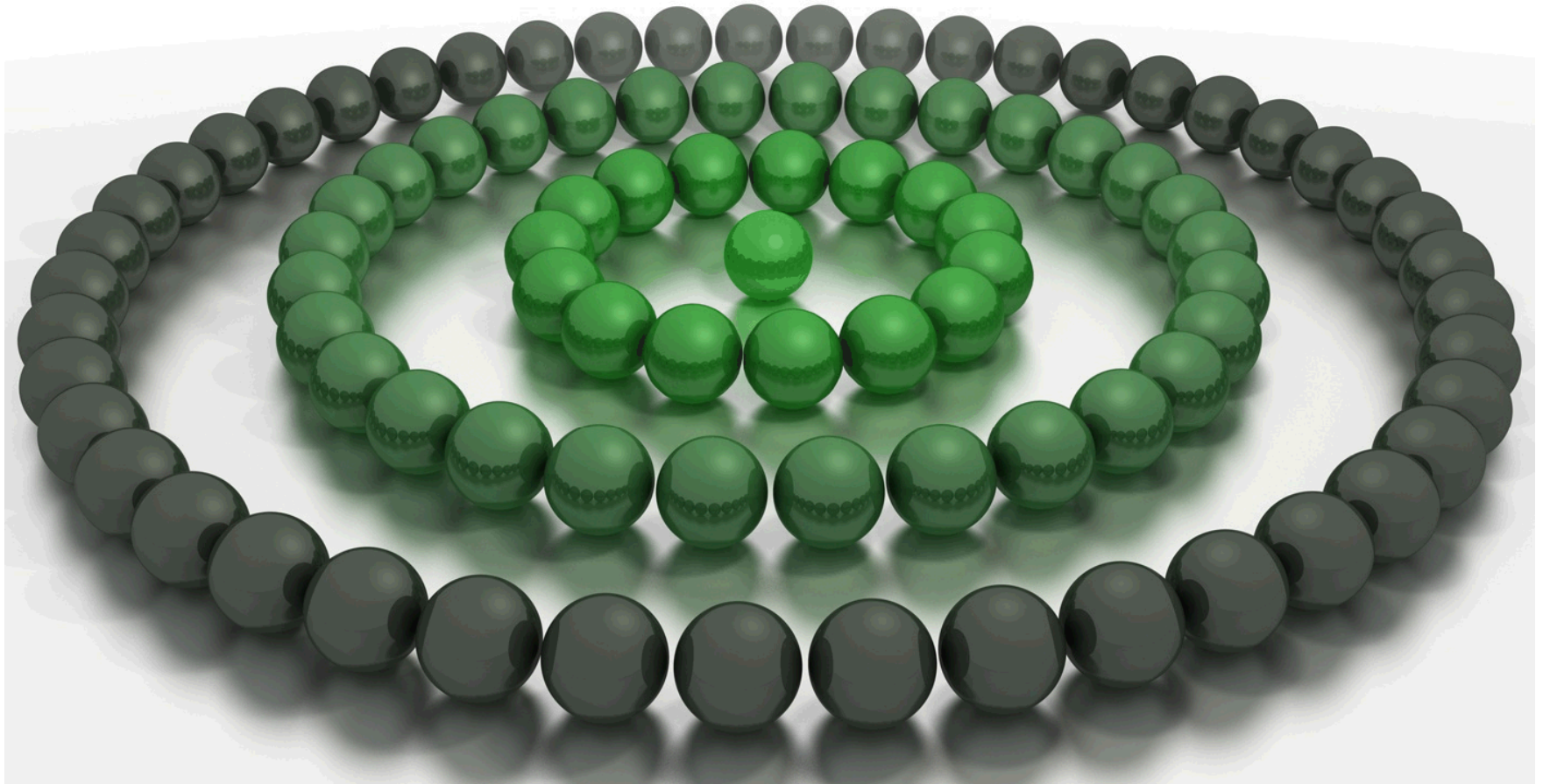
- **Groupthink**: Reluctance to share contradictory information for the sake of maintaining harmony
- **Risky Shift**: Tendency to gamble with decisions more as a group than if each member was making the decision individually – accountability is diffused (also called “*herd mentality*”)

***It takes a team error to have an event.***



# LESSON 4

## Managing Defenses



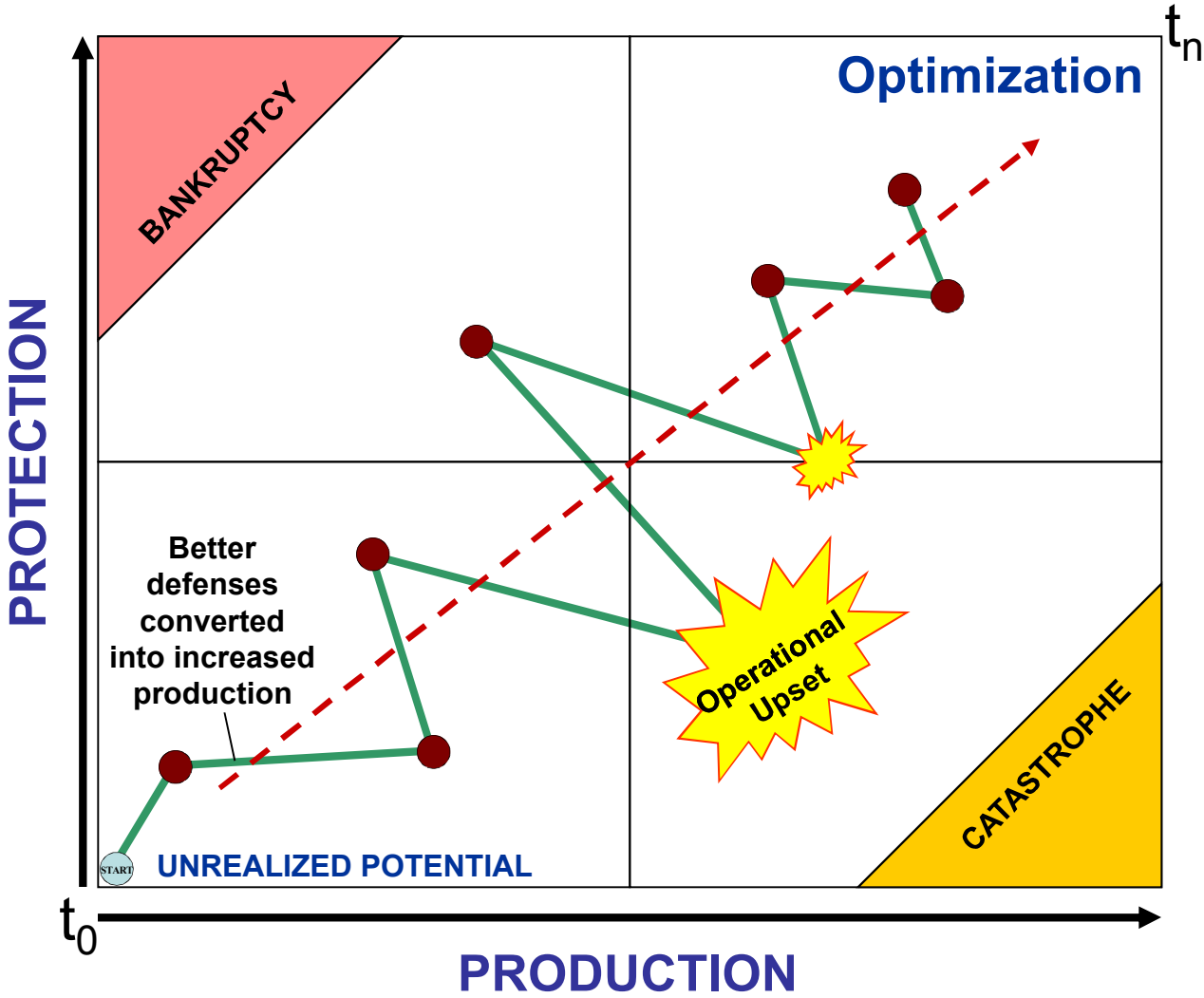
***THE ROLE OF THE ORGANIZATION***

# Lesson 4 Objectives

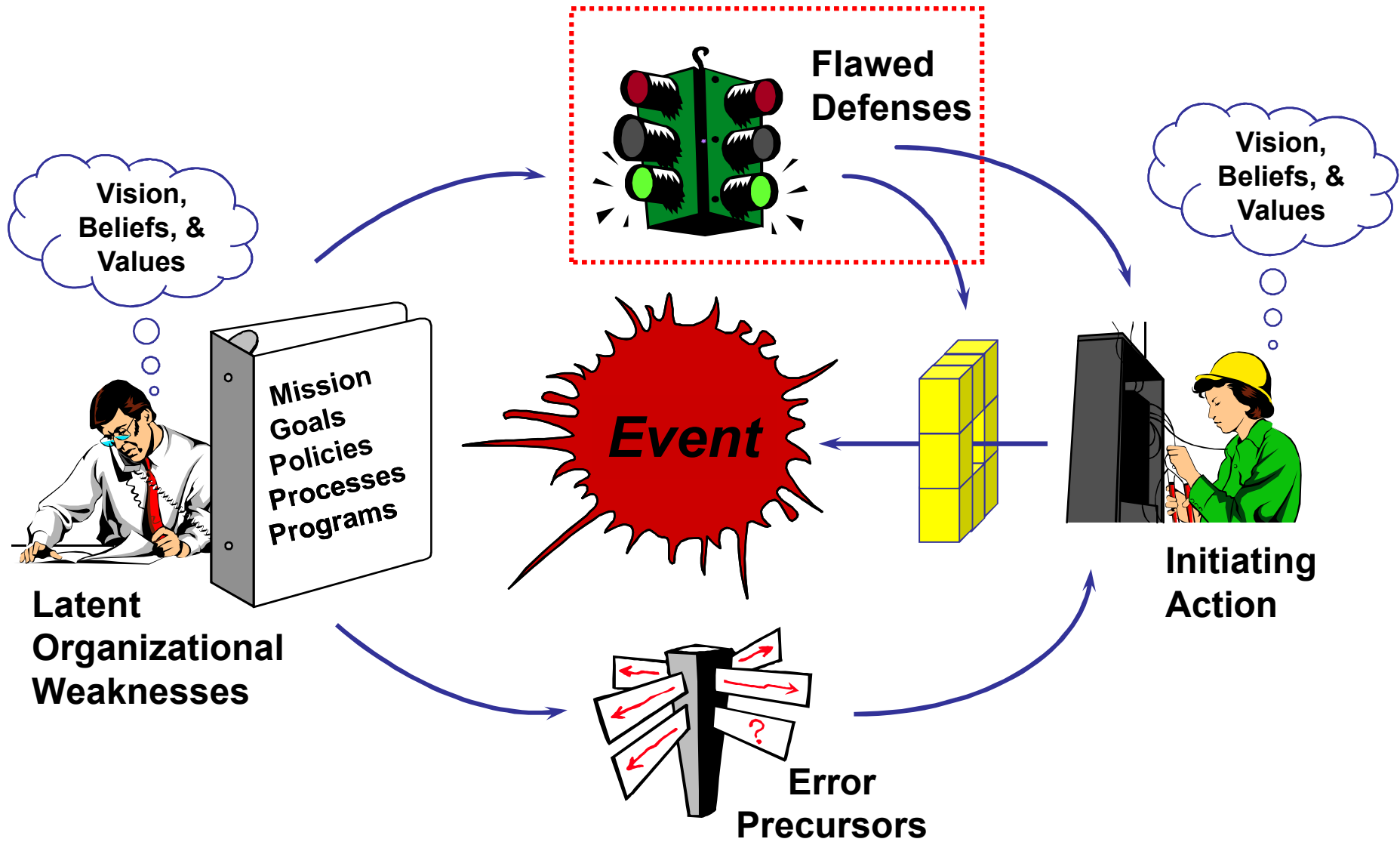
Participants will be able to....

1. **Describe** the functions and categories of defenses.
2. **Understand** basic human performance tools for finding latent organizational weaknesses.
3. **Describe** the value of error tolerant systems.

# Competing Priorities



# Anatomy of an Event



# Functions of Defenses

- Create Awareness and Understanding of hazards
- Give clear Guidance on how to operate safely
- Detect & Warn of imminent danger
- Protect against error / harm and potential losses
- Restore facility to a safe condition
- Contain/Mitigate the effects of errors and hazards
- Provide the means of Escape and Rescue should containment fail

$$R_e + M_d \rightarrow \text{UO}$$

# Categories of Defenses

- Engineered Controls
- Administrative Controls
- Cultural Controls
- Oversight Controls



# Defense-in-Depth

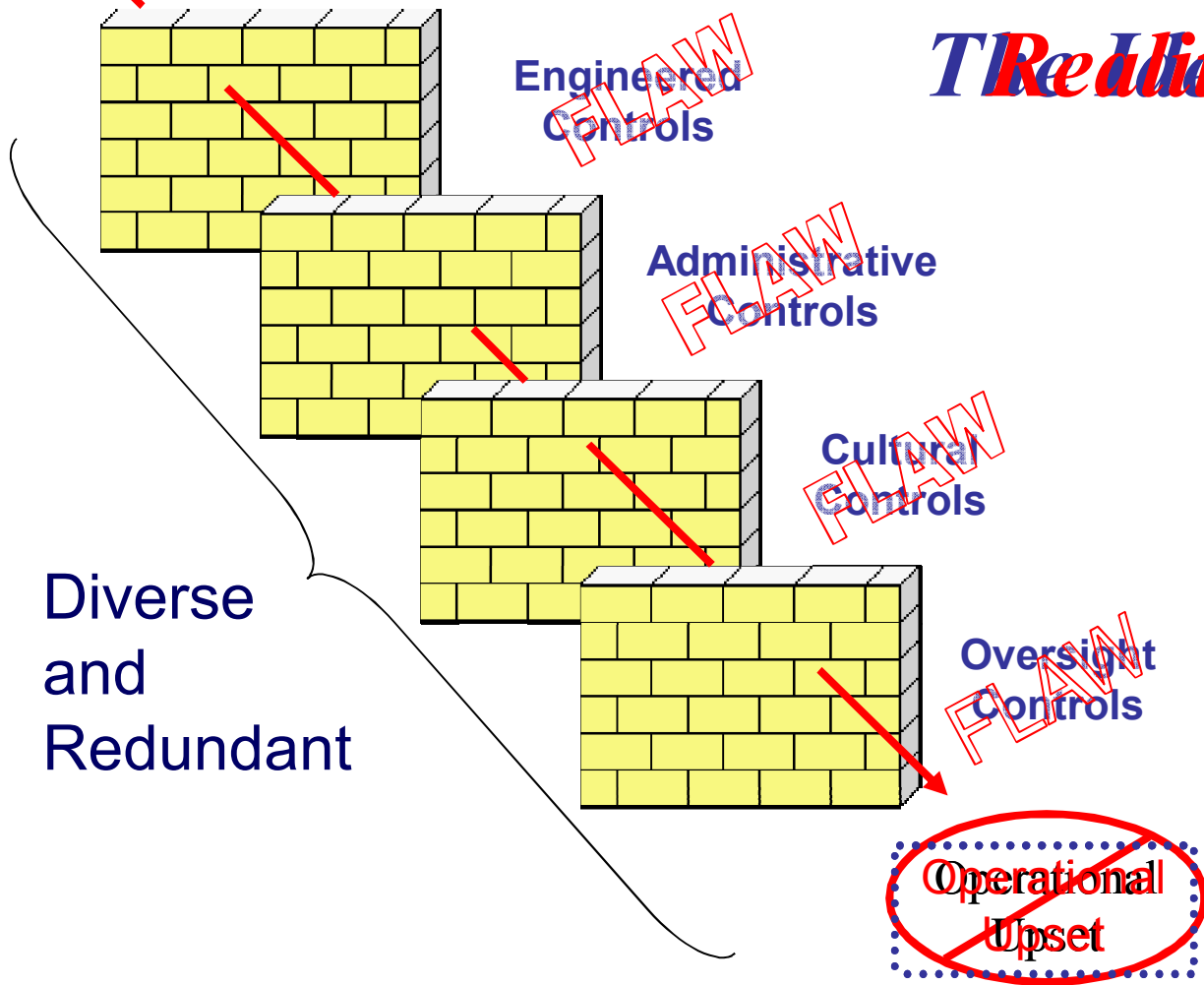
***“... assume that mistakes will happen, and have in place procedures {e.g., barriers, practices, etc.} that will catch and correct them before they snowball.”***

***- Vincent Czaplyski,  
Boeing 727 Check Airman***

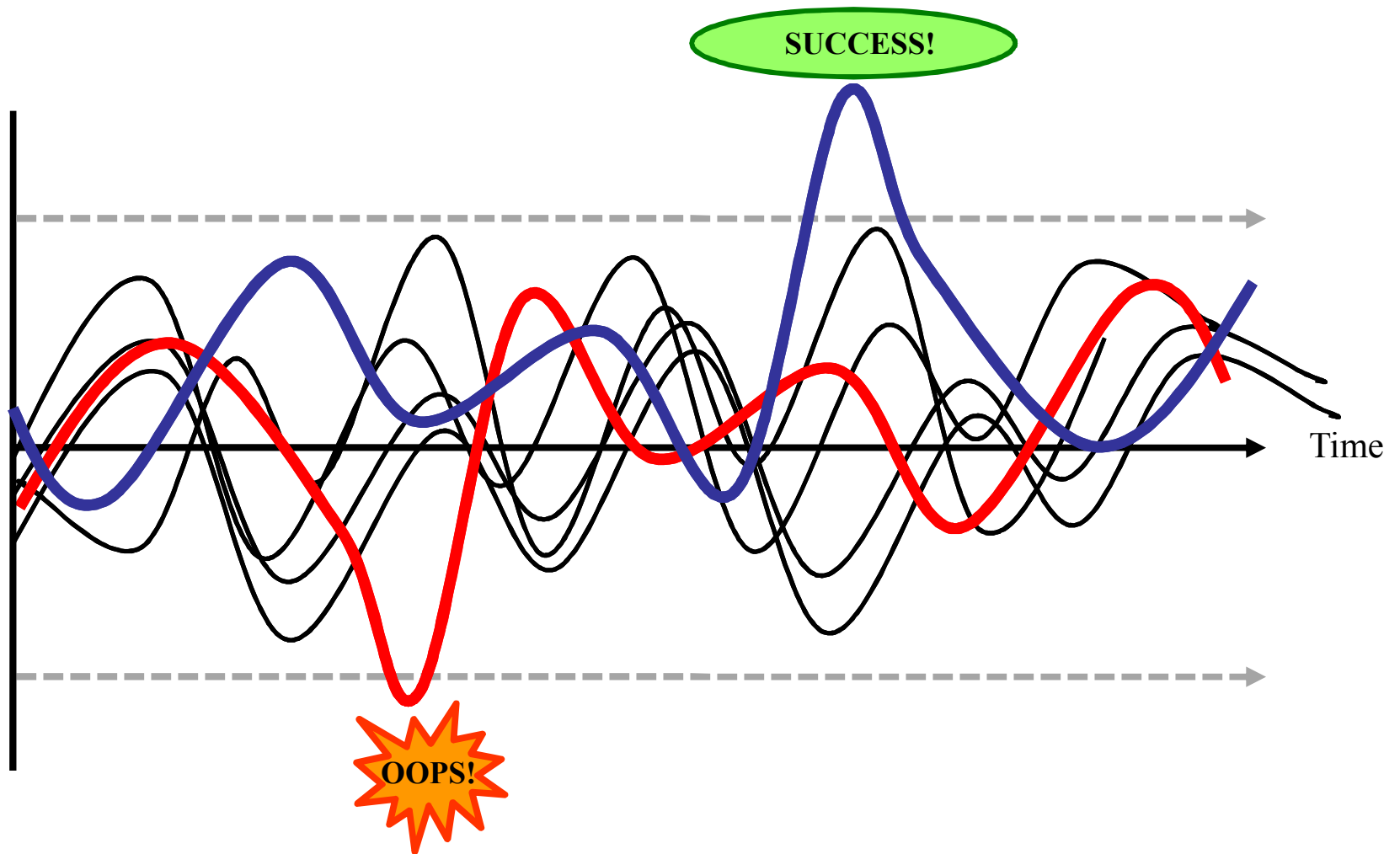


# Defense-in-Depth

Active Error



# Accidents as Unexpected Combinations of Normal Variability



# Value Prevention of Errors

Understanding human fallibility encourages a proactive perspective toward work:

- It is easy to err, and a person may not even know it
- Workers should possess a keen - and healthy - sense of uneasiness toward any activity
  - prompts the mindset: “*expect success but anticipate failure*”
  - fosters *intolerance for error traps / precursors*

# The Value of Error Tolerance

## *Error Tolerance:*

- Design processes, tasks, equipment, etc., such that the inevitable human error will not result in an event of consequence.



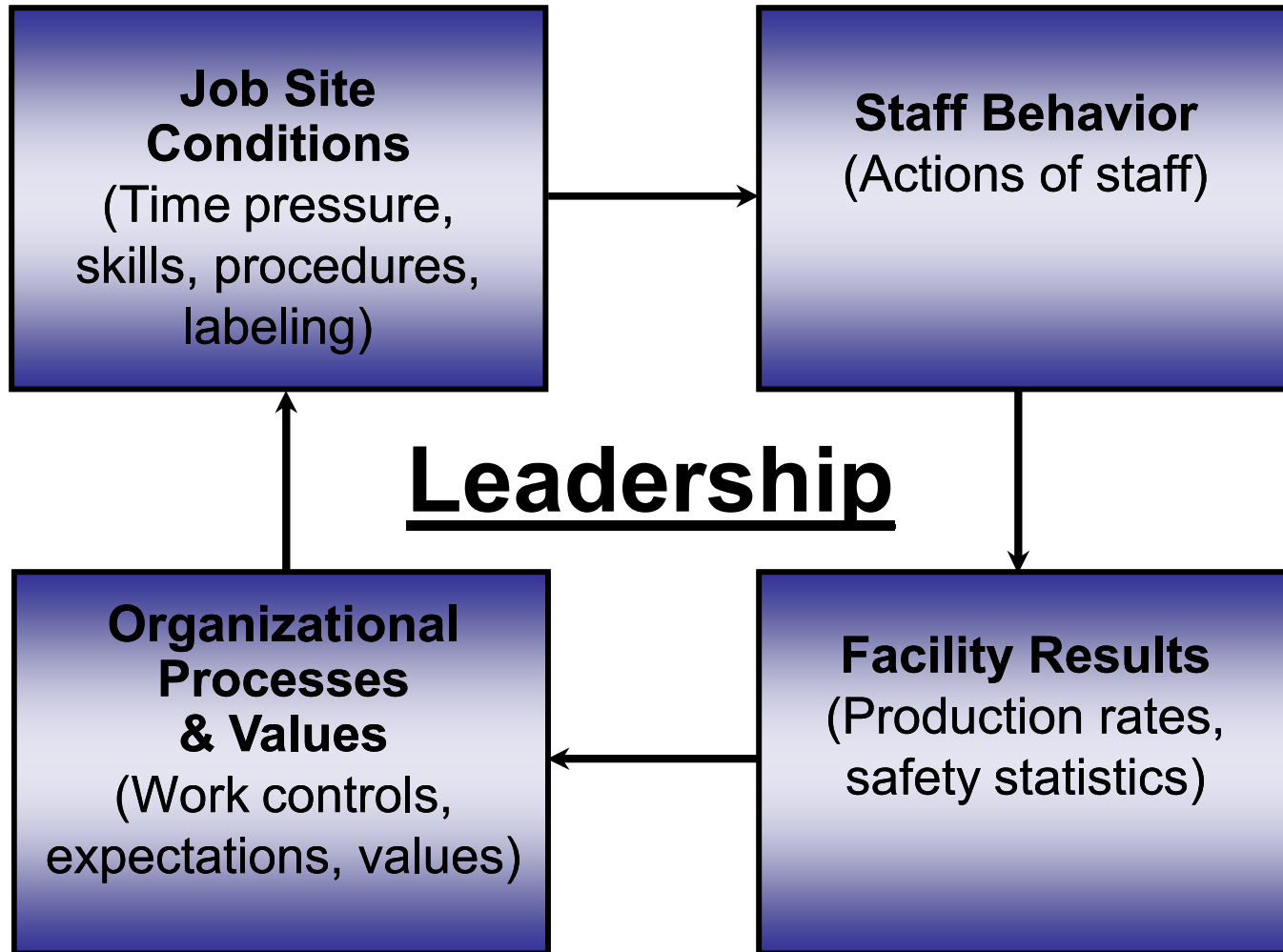
***Error without consequence shows that our systems are error-tolerant and that they are working.***

# Human Fallibility

***“Events are not so much the result of error-prone workers as they are the outcome of error-prone tasks and error-prone work environments, which are controlled by the organization.”***

***- James Reason  
Managing the Risks of Organizational Accidents***

# Organizational Performance Model



# Human Performance and the Organization

***“No matter how efficiently {plant} equipment functions; how good the training, supervision, and procedures are; and how well the best worker, engineer, or manager perform his or her duties, people cannot perform better than the organization supporting them.”***

***- Maurino, Reason, Johnston, and Lee,  
Beyond Aviation Human Factors, 1995.***

# Sources of Latent Organizational Weaknesses

## Processes (structure)

- Work Control
- Procedure Development
- Reviews & Approvals
- Engineering & Design
- Training
- Accountability Policy
- Resource Allocation

## Values (relationships)

- Priorities
- Communication
- Coaching & Teamwork
- Measures & Controls
- Attitudes & Norms
- Assumptions
- Rewards & Sanctions

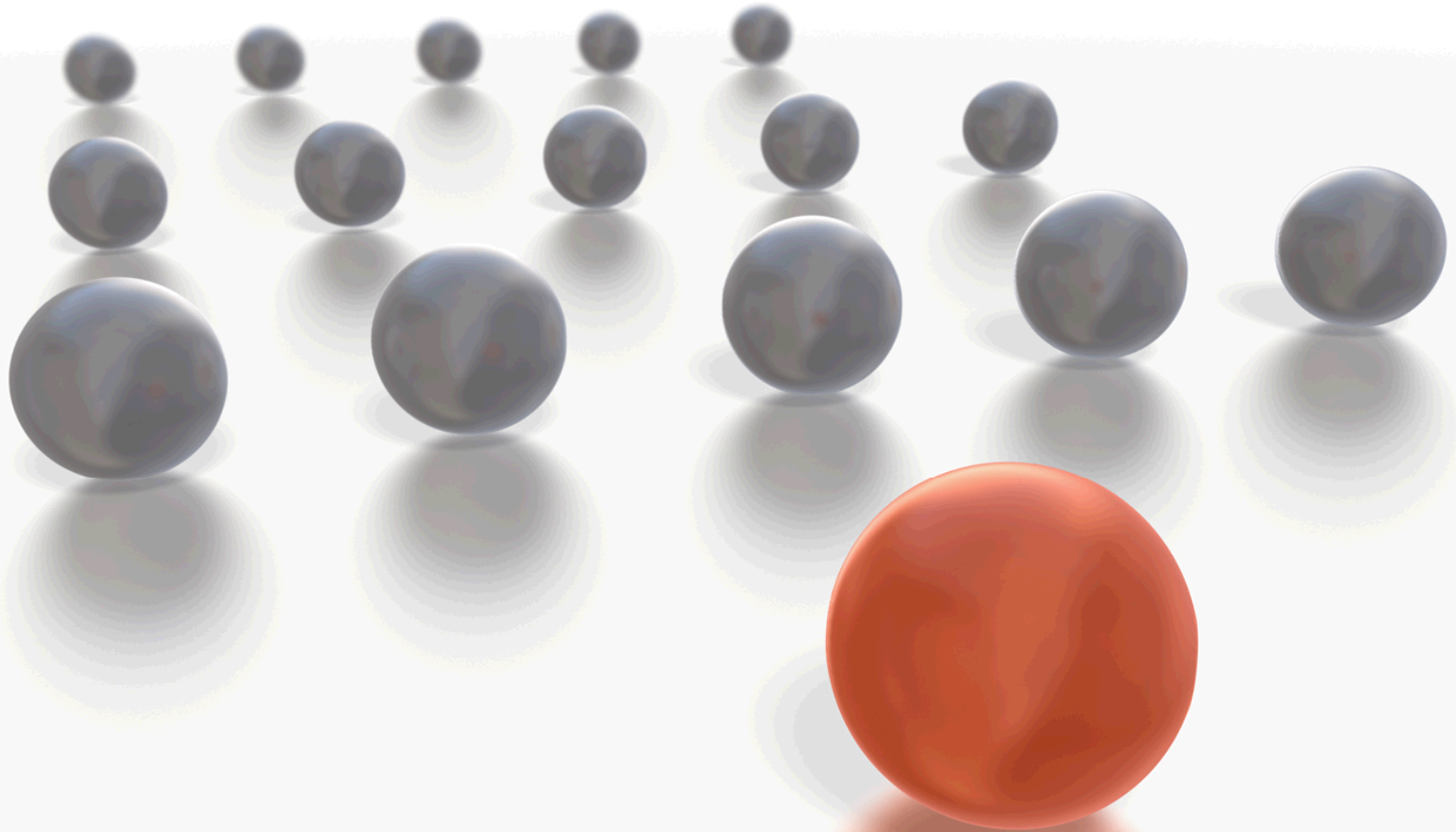
# Tools for Finding Latent Organizational Weaknesses

- Observations
- Self-Assessments
- Benchmarking
- Post-Job Critiques
- Key Performance Indicators
- Surveys & Questionnaires



# LESSON 5

## Leadership and Culture



***THE ROLE OF THE LEADER***

# Lesson 5 Objectives

Participants will be able to....

1. **Understand** how encouragement and reinforcement affects individual performance.
2. **Describe** the elements of a culture of mindfulness.
3. **Discuss** the value of lessons learned.

# Leader Defined

**Any individual** who takes personal responsibility for their performance and the organization's performance.

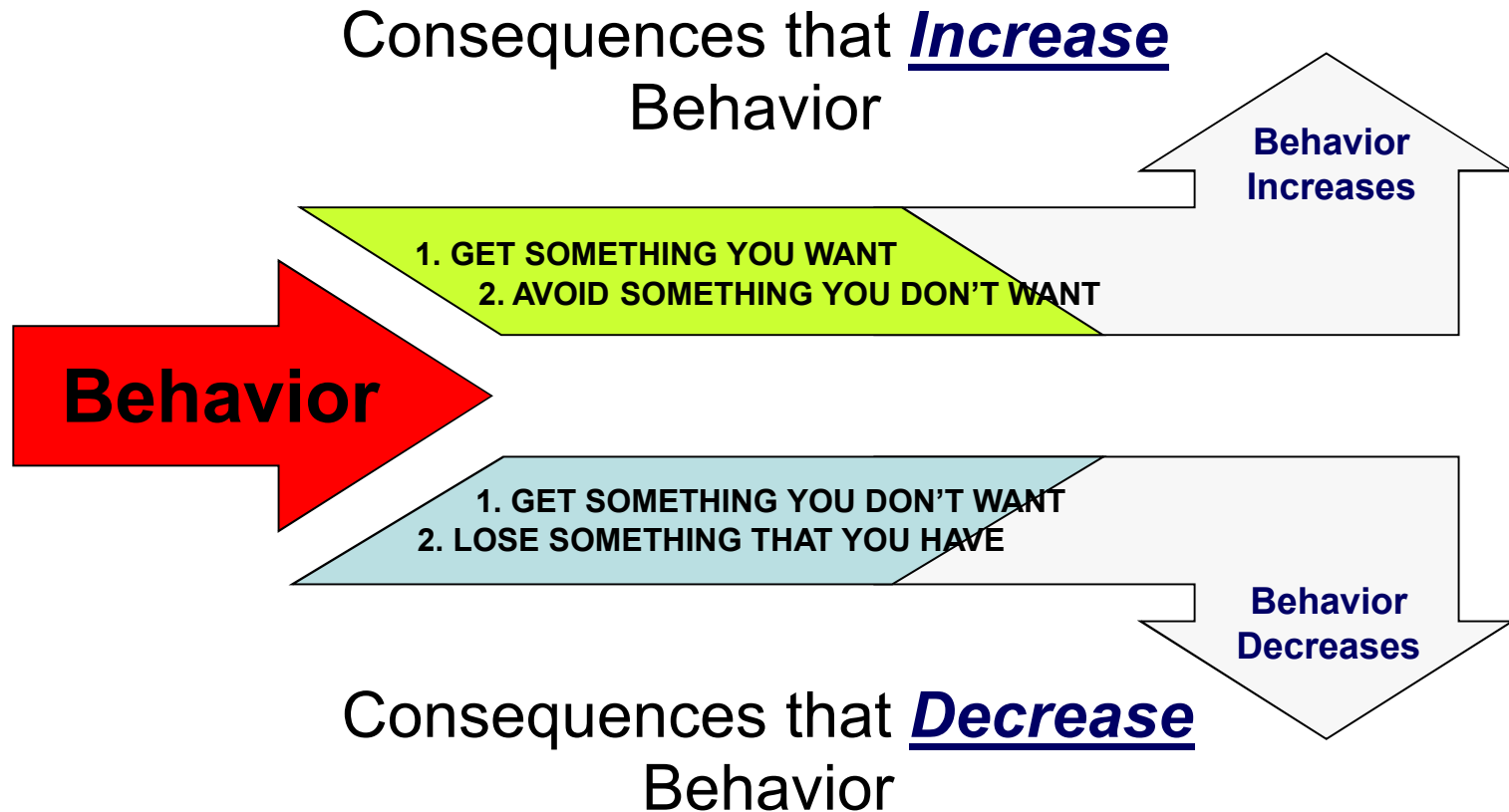
- Attempts to influence the improvement of organizational processes and values.
- Influences others through relationships characterized by respect, honesty, and fairness.



# Human Performance Improvement Principle #4

*People achieve high levels of performance largely because of the encouragement and reinforcement received from leaders, peers and subordinates.*

# Reinforce Desired Behavior



# Open Communication

## Managers:

*“Ask for what you need to hear, not for what you want to hear.”*



## Subordinates:

*“Tell your boss what they need to hear, not what you think they want to hear.”*



*-- Roger Boisjoly --*

*Former Chief Engineer, Morton-Thiokol, Inc.*

# Open Communication (Cont.)

***“With every problem, someone somewhere sees it coming. But those people tend to be low rank, invisible, unauthorized, reluctant to speak up, and many not even know they know something that is consequential.”***

***- Weick & Sutcliffe  
Managing the Unexpected***

# Elements of a Culture of Mindfulness

*A culture that creates and sustains intelligent wariness. To be mindful is to “see more clearly, not to think harder and longer.*

Consists of:

1. A learning culture
2. A reporting culture
3. A just culture
4. A flexible culture



# A Learning Culture

*Facilitates the learning of all its members and consciously transforms itself and its context*

- Possess a strong desire to find and fix flaws
- Quickly learn from mistakes
- Aggressively respond to problems
- Appreciate the impact of their actions on others
- Foster inquiry and open dialogue

***“Learning disabilities are tragic in children, but fatal in organizations.”***

*Peter Senge, Organizational Theorist*

# A Reporting Culture

*Basis of reporting = valid feedback on local and organizational factors promoting errors and incidents is far more important than assigning blame to individuals.*

## ***The Challenge:***

- **Natural disinclination to confess** – “Me?”
- **Suspicion** – “It will count against us!”
- **Skepticism** – “Management won’t act!”
- **Takes time and effort** – “Not worth it!”



# A Just Culture

*Atmosphere of trust in which people are encouraged, even rewarded, for providing essential information – but in which they are also clear about where the line is drawn between acceptable and unacceptable behavior.*

Zero tolerance for reckless behavior

balanced by:

Widespread confidence that the vast majority of unintended unsafe acts will go unpunished.



# A Flexible Culture

*Flexibility is one of the defining properties of High Reliability Organizations (HROs).*

- Characterized by a constant concern – an intelligent awareness – a proactive mental framework
- Promoted by:
  - Face-to-face communication
  - Divergent work groups
  - A highly trained staff
  - A balanced work control system

# Human Performance Improvement Principle #5

*Events can be avoided through an understanding of the reasons mistakes occur and the application of the lessons learned from past events (or errors).*

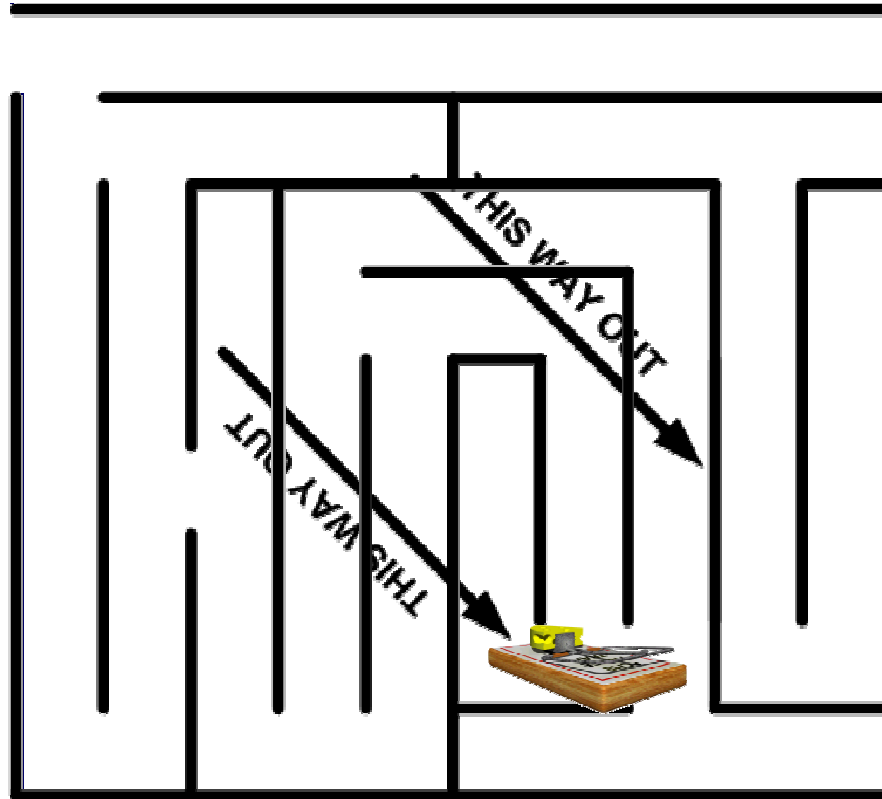
# How to Improve Human Performance

3 - Create error-tolerant systems



Individual

1 - Address limitations of human nature



Organization

2 - Remove error traps

4 - Reinforce desired behaviors

Incentives to meet leader's expectations

