ARUP LABORATORIES | NATIONAL REFERENCE LABORATORY

Error Proofing the Laboratory

Bonnie Messinger, CPHQ, CMQ/OE(ASQ)

Six Sigma Black Belt

“Error”

- failure of a planned action to be completed as intended

or the

- use of a wrong plan to achieve an aim

(IOM)

“Error”

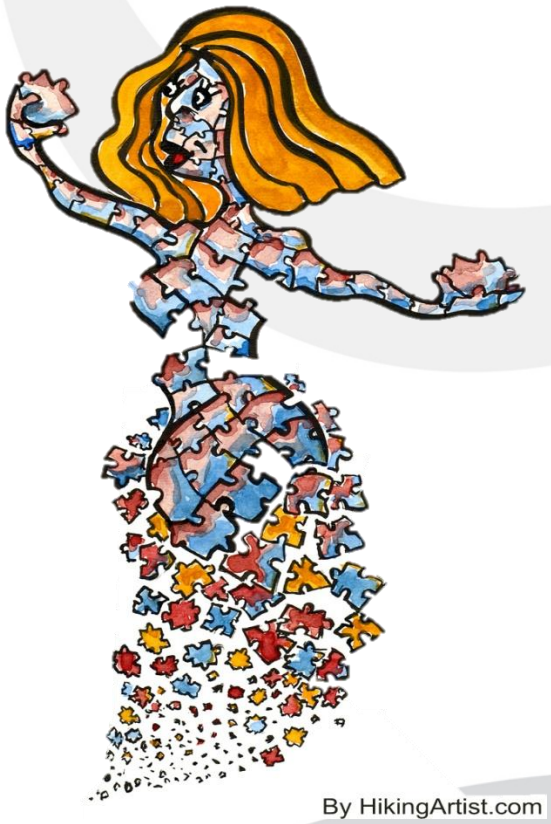
(IOM)

Error in Healthcare Systems

Human error arises from the

- Expectations
- Resources
- Setting
- Flow
- Incentives
- Information
- Skills and attitudes

of the person performing the work



The Problem of Quality

Fact:

Suppressing human error often results in suppressing innovation

Objectives

Attendees will be able to:

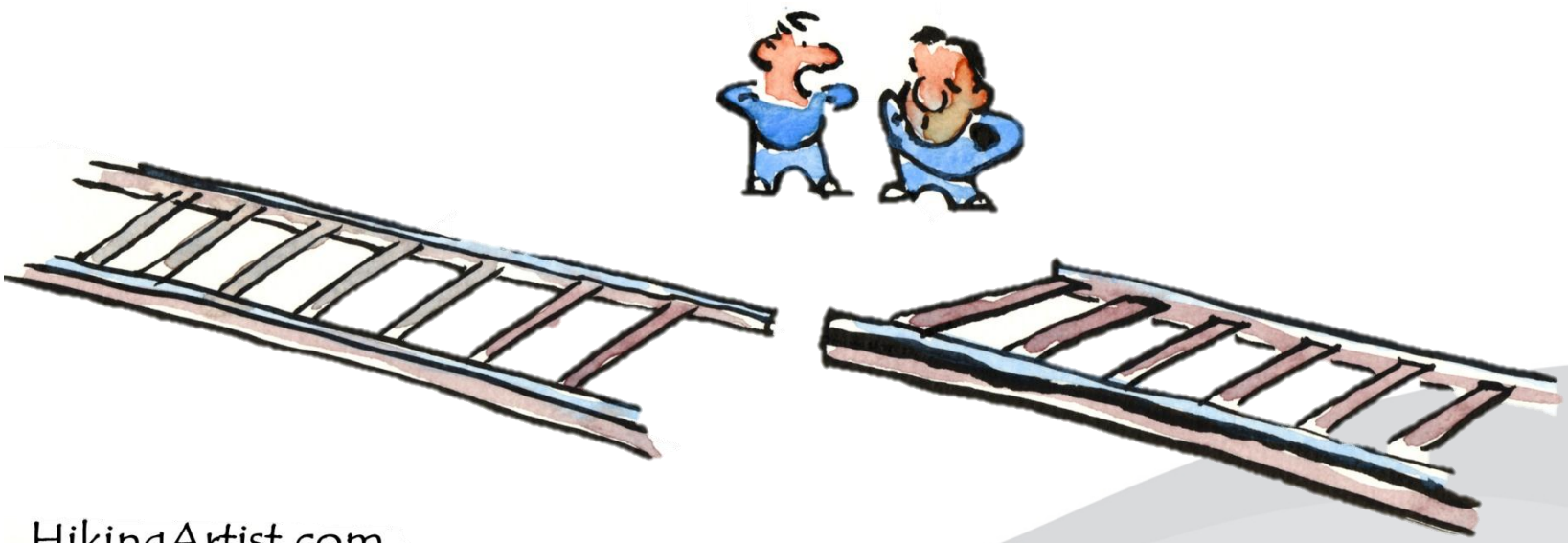
- Describe the three components of laboratory error
- Use the principles of process to design to eliminate the potential for error
- Differentiate between manufacturing and service systems and identify the most appropriate improvement strategies for each

Human Cause

Process Cause

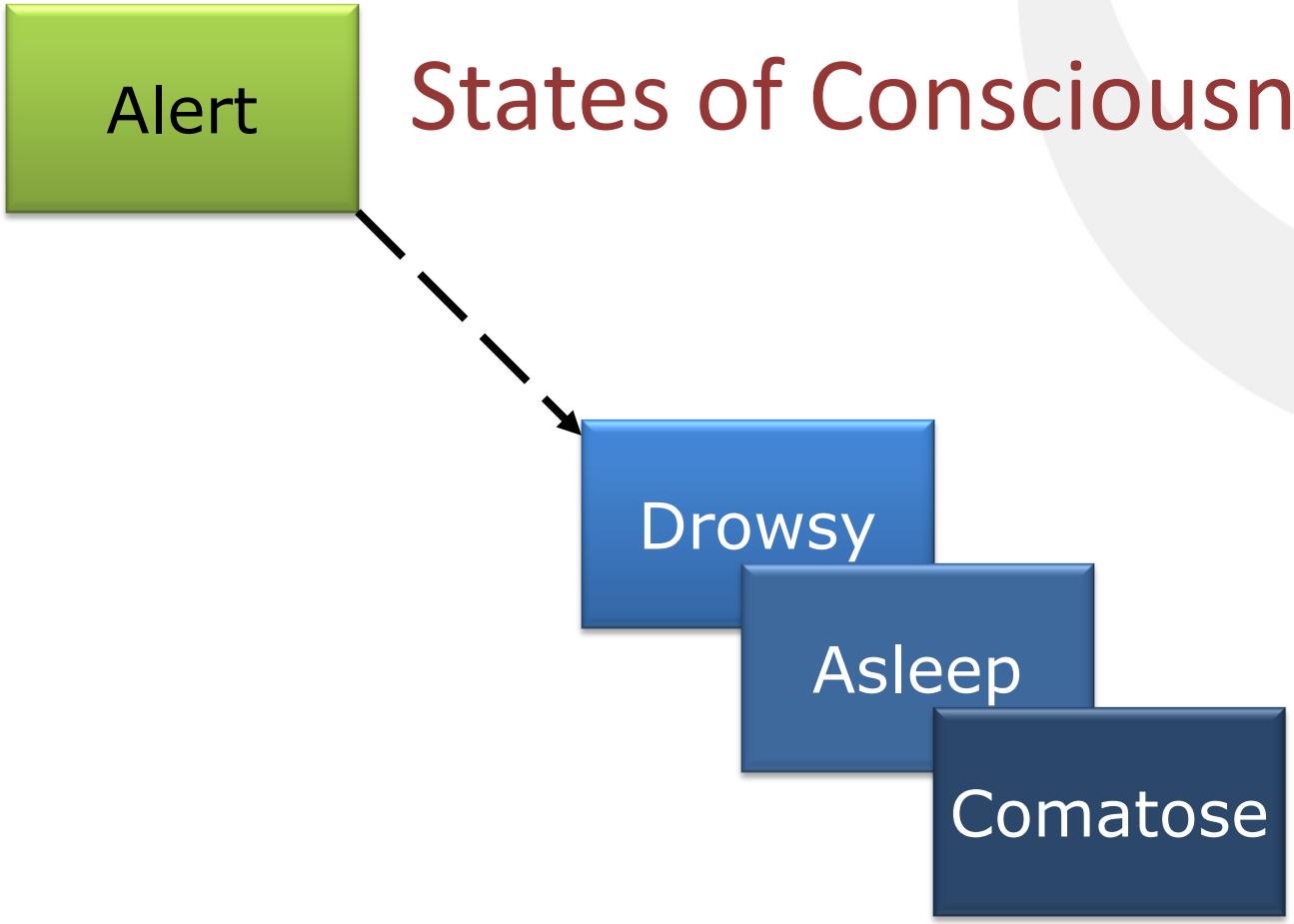
Systemic Cause

Human Error



ARUP LABORATORIES

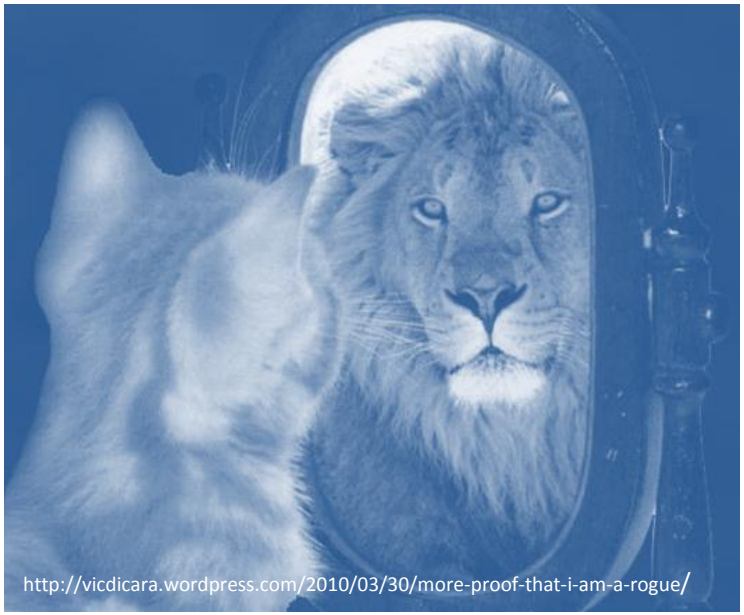
Information Processing & Response



(Roth, *Scientific American Mind,* Jan 2004)

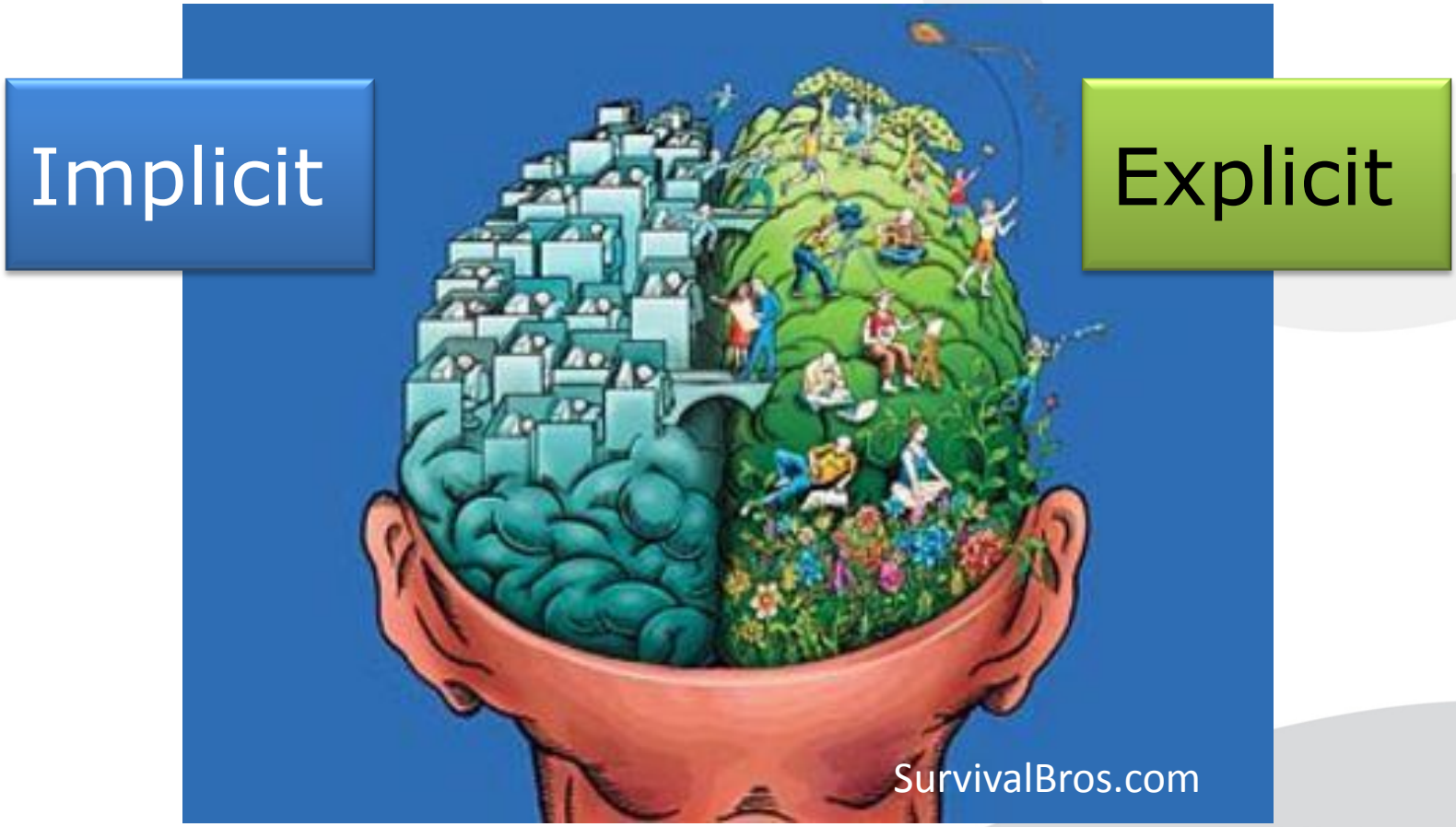
ARUP LABORATORIES

Streams of Consciousness

Background	Actual
	
http://vicdicara.wordpress.com/2010/03/30/more-proof-that-i-am-a-rogue/	http://astridterese.files.wordpress.com/2011/05/6.jpg

(Roth, *Scientific American Mind*, Jan 2004)

Perception and Learning



(Roth, *Scientific American Mind,* Jan 2004)

ARUP LABORATORIES

Information Processing & Response

Unimportant

Important but Known

Important and Unknown

(Roth, *Scientific American Mind,* Jan 2004)

Competition between coalitions promotes (or demotes)

explicit
attentional
awareness

(Dobbs, *Scientific American Mind*, June 2005)

Information Processing & Response

Goals

what you are trying to do

Mindset

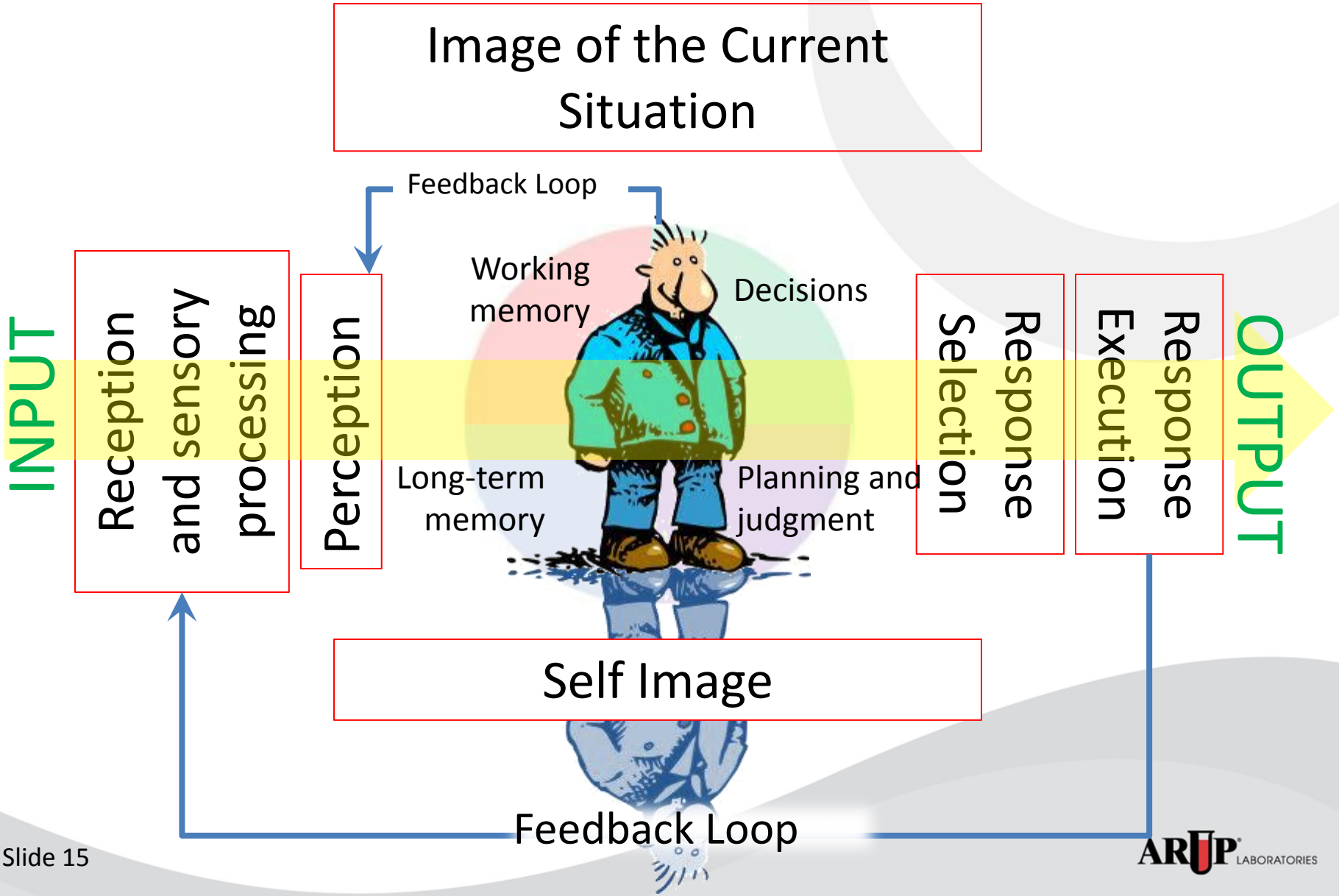
the situation as you perceive it

Knowledge

what you think you know

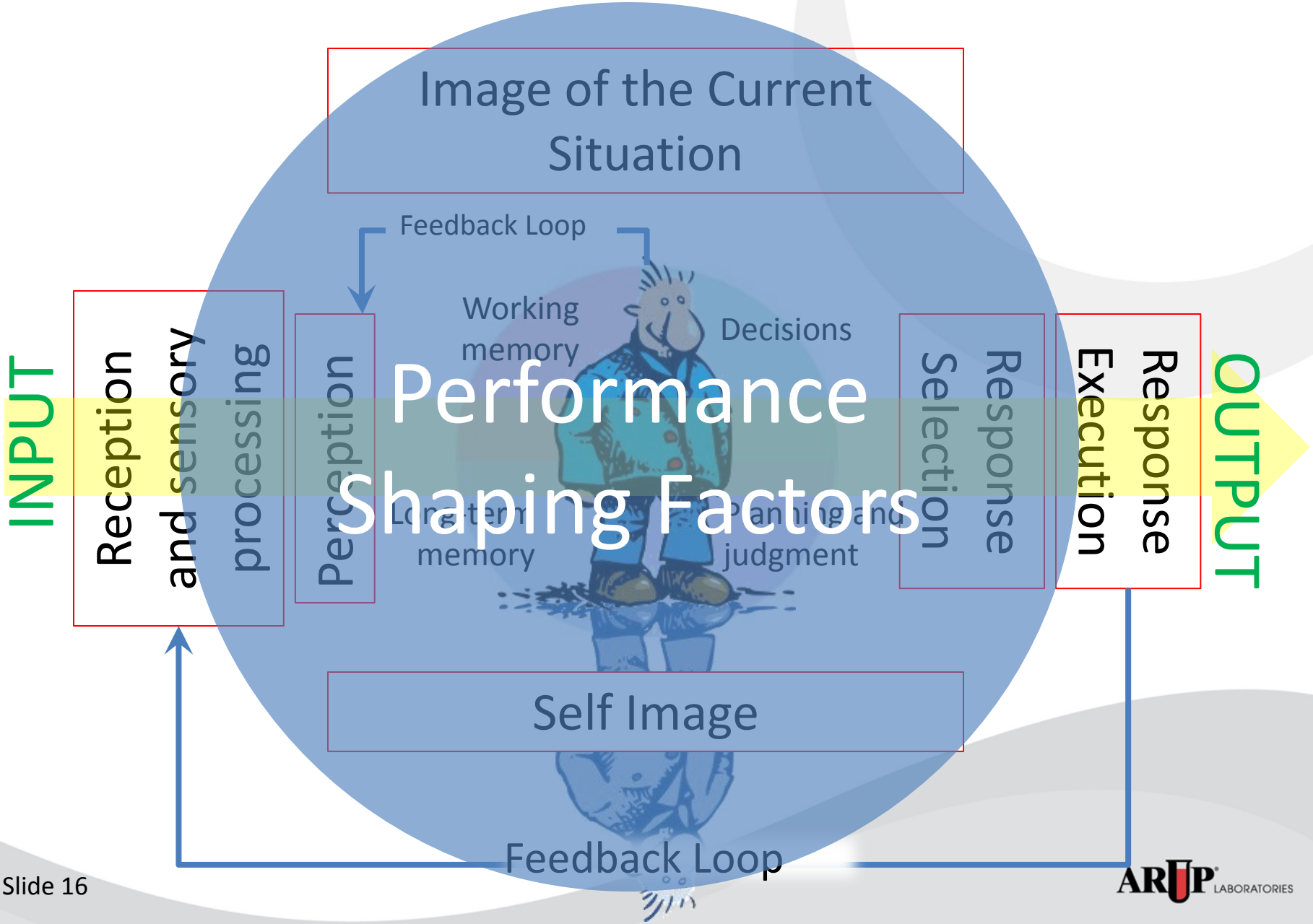
(Salvendy, Handbook of Human Factors and Ergonomics, 1997)

Performance Shaping Factors



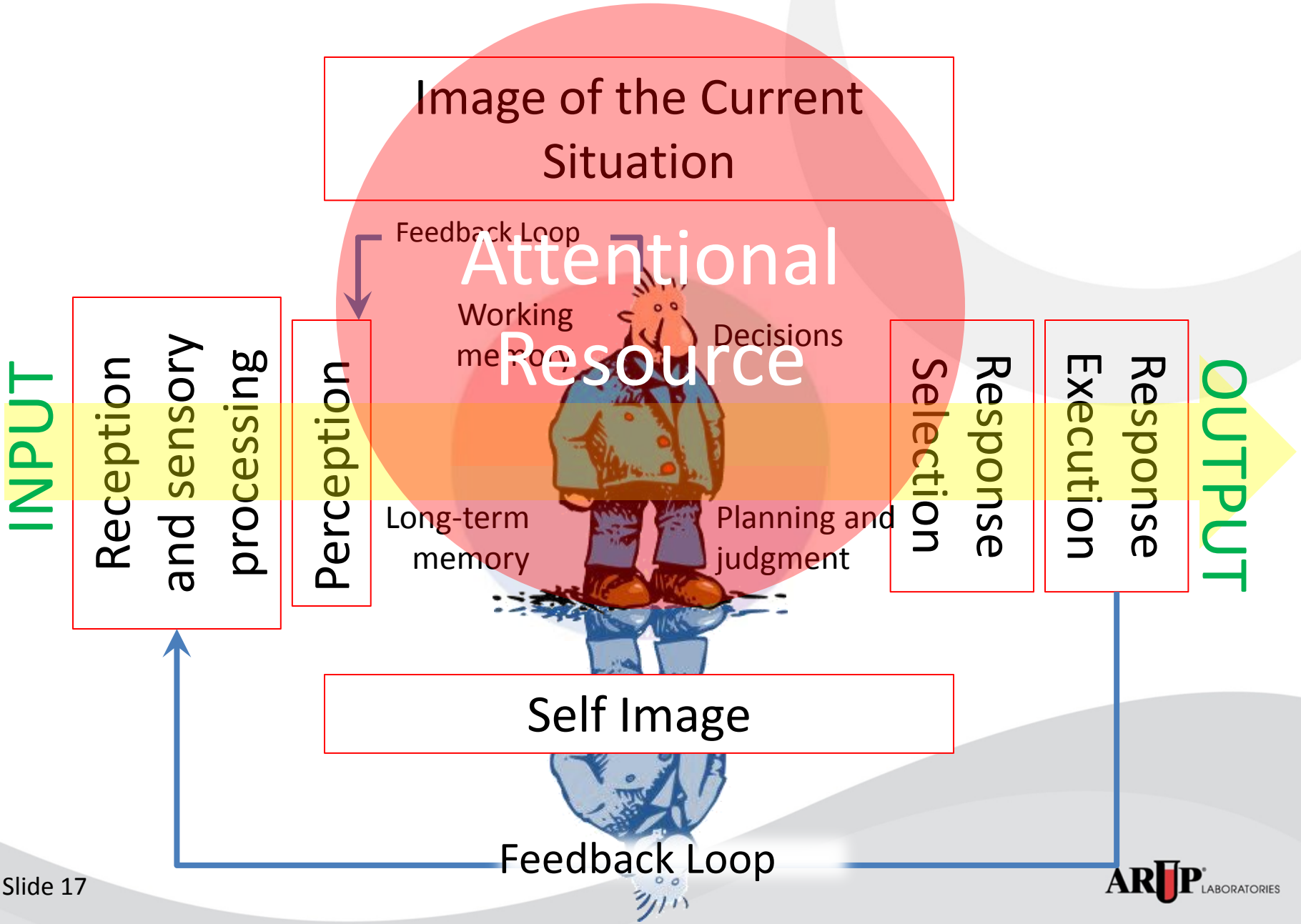
ARUP LABORATORIES

Performance Shaping Factors



ARUP LABORATORIES

Performance Shaping Factors



ARUP LABORATORIES

Slips & Lapses vs. Mistakes

Slips & Lapses	Mistakes
Execution failure	Cognitive failure
More frequent	Less frequent
False negative	False positive
Difficult to eradicate	Easier to eradicate
Main cause of liability	Main cause of disciplinary action

Action

- Done Right
  - executed by the rule, at the right time
- Not Done
  - failed to execute
- Done Wrong
  - executed the wrong rule,
  - over executed,
  - executed incompletely
  - executed at the wrong time

Trigger

- Awareness-based
  - consciousness
- Skill-based
  - familiarity and/or dexterity
- Knowledge-based
  - cognition
- Judgment-based
  - synthesis

What Were You Thinking?

Addressing Human Error

Our job is NOT making people understand how poorly they performed, our job is to figure out why that act seemed reasonable at the time and remove the "reasonableness" of the decision.

Behavior Modification

Assessment

Employees bring

- Consciousness
  - Be awake, aware
- Dexterity
  - Able to manipulate objects and information
- Cognition
  - Know what should be done
- Synthesis
  - Apply in multiple contexts

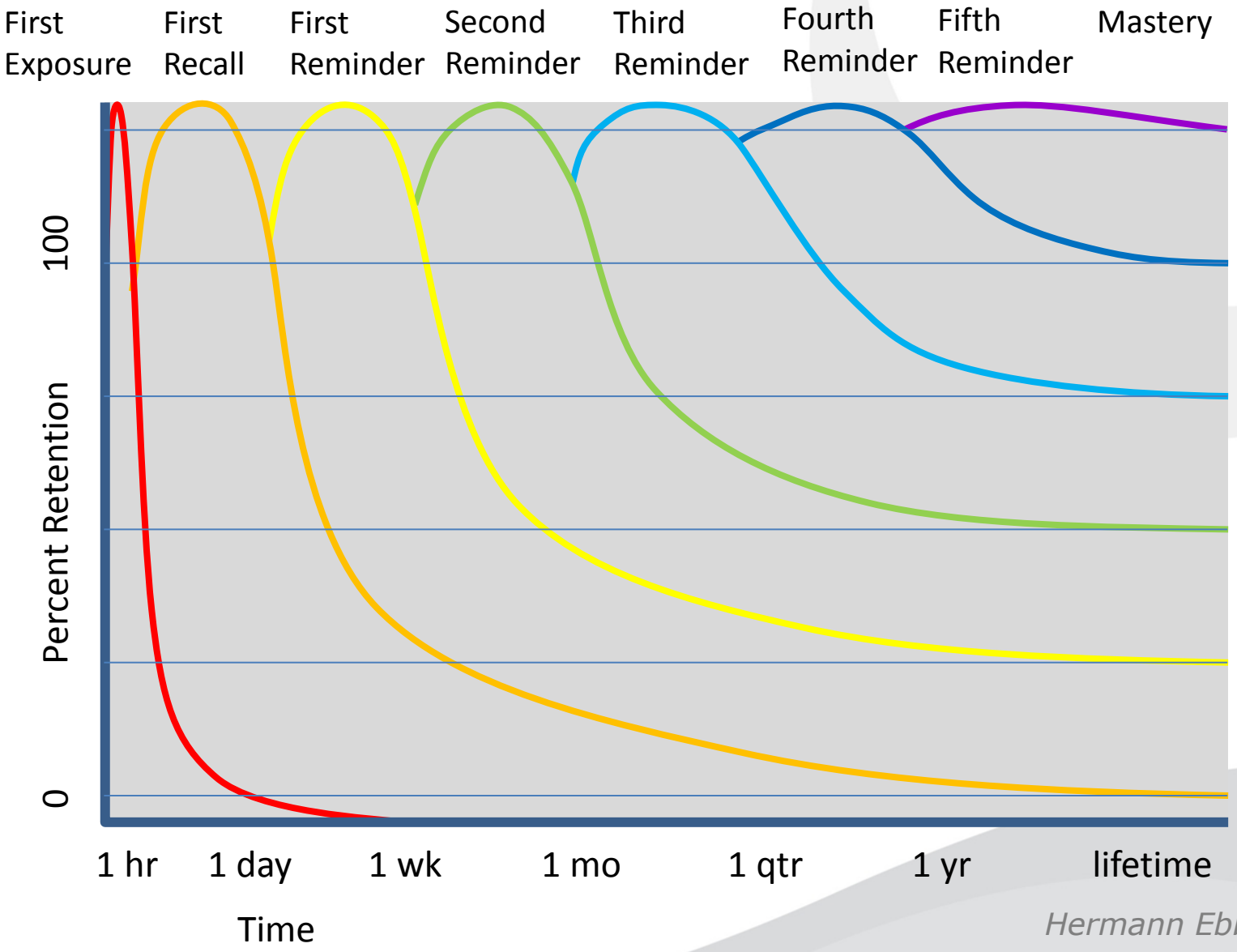
Traditional Response to Error

- Errors of ignorance
  - More training
- Errors of negligence
  - Punishment
- Errors of omission
  - Training and punishment

After four years of futile searching, five aficionados of paleontology failed to find the final frozen foot of the elephant in the pictograph.

After four years
of futile searching,
five aficionados of paleontology
failed to find the final
frozen foot of the elephant in the
pictograph.

Forgetting Curve



Hermann Ebbinghaus

ARUP LABORATORIES

Behavior Modification

Humans need …

- to be treated with dignity and respect,
- to make a contribution,
- to have a witness.

At low tide, no man is an island

You don't get to safe systems that have human beings in them by yelling at them or asking them to try harder.

-Donald Berwick

ARUP LABORATORIES

Error-Proofing through Behavior Modification

- Humans are complex and, thus, inherently fallible.
- Human error WILL occur.
- Fallibility varies from person to person.
- Humans are only one component of a working system.
- The effect of human error can be reduced in systems that are designed for minimal error.

Error-Proofing through Behavior Modification

Weak

Patches aimed at fixing people

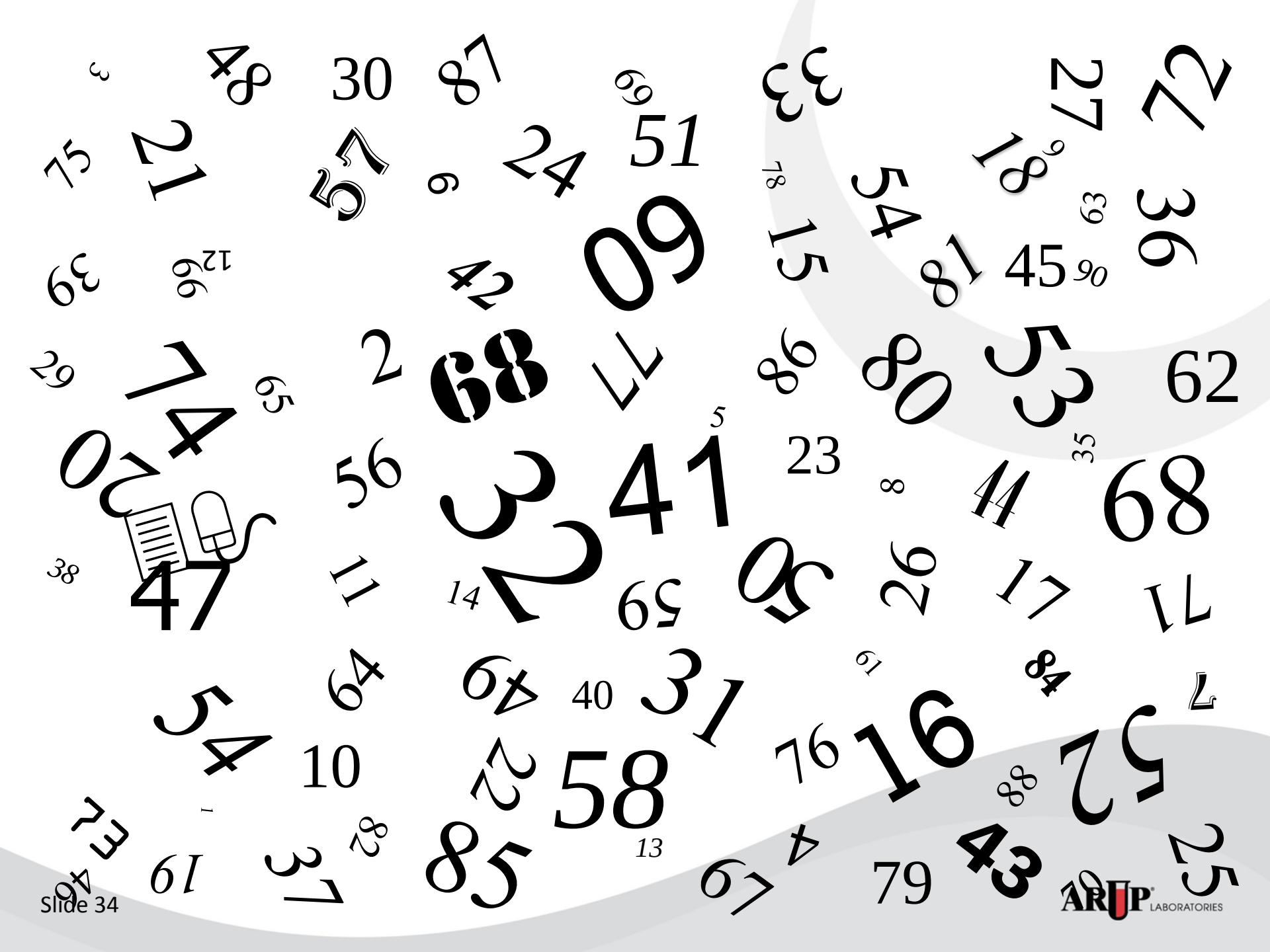
- Call for increased vigilance
- Training
- Memos
- Warnings
- Double checks

(Gosbee, *Laboratory Errors and Patient Safety*, May-June 2005)

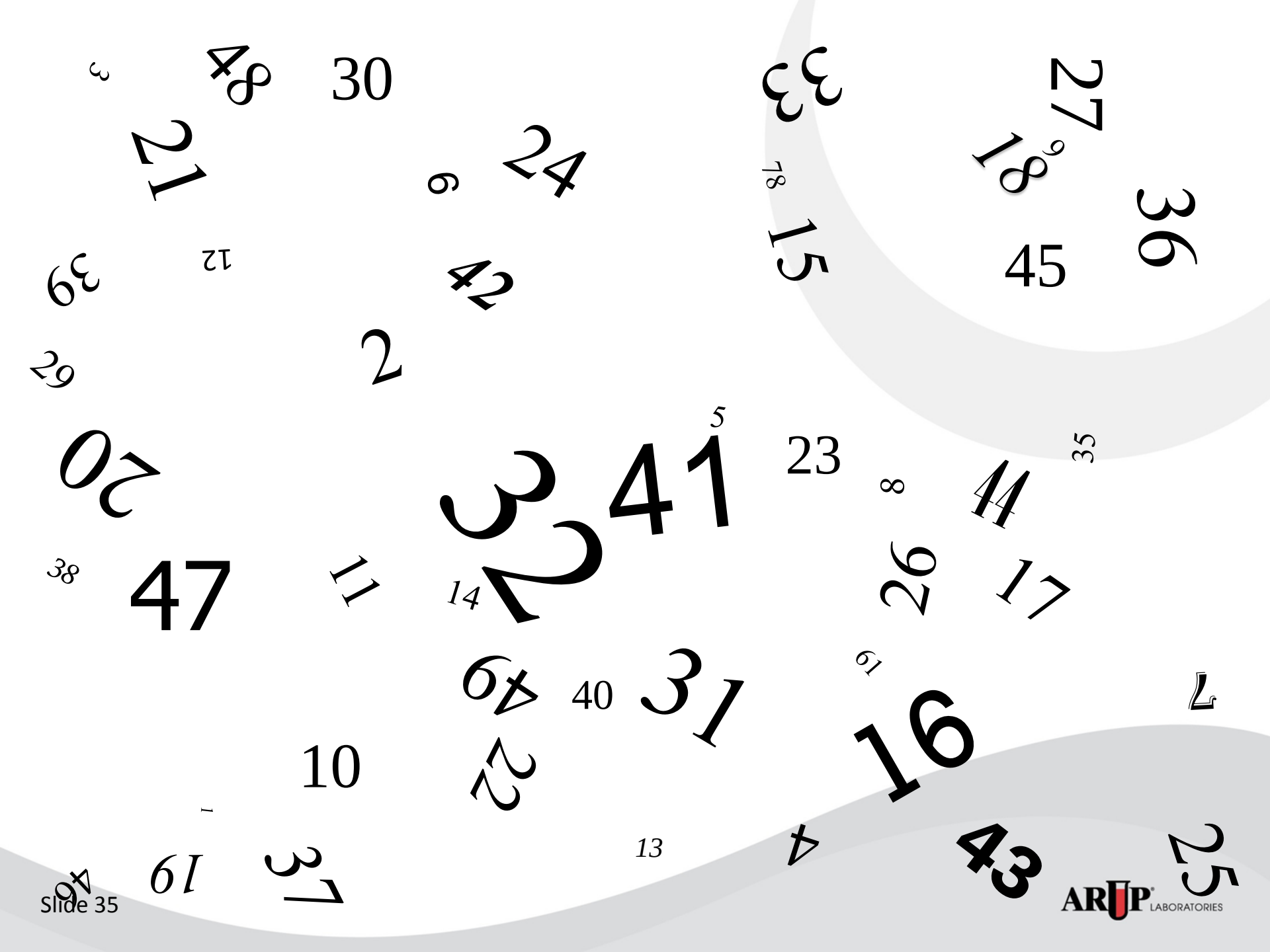
ARUP LABORATORIES

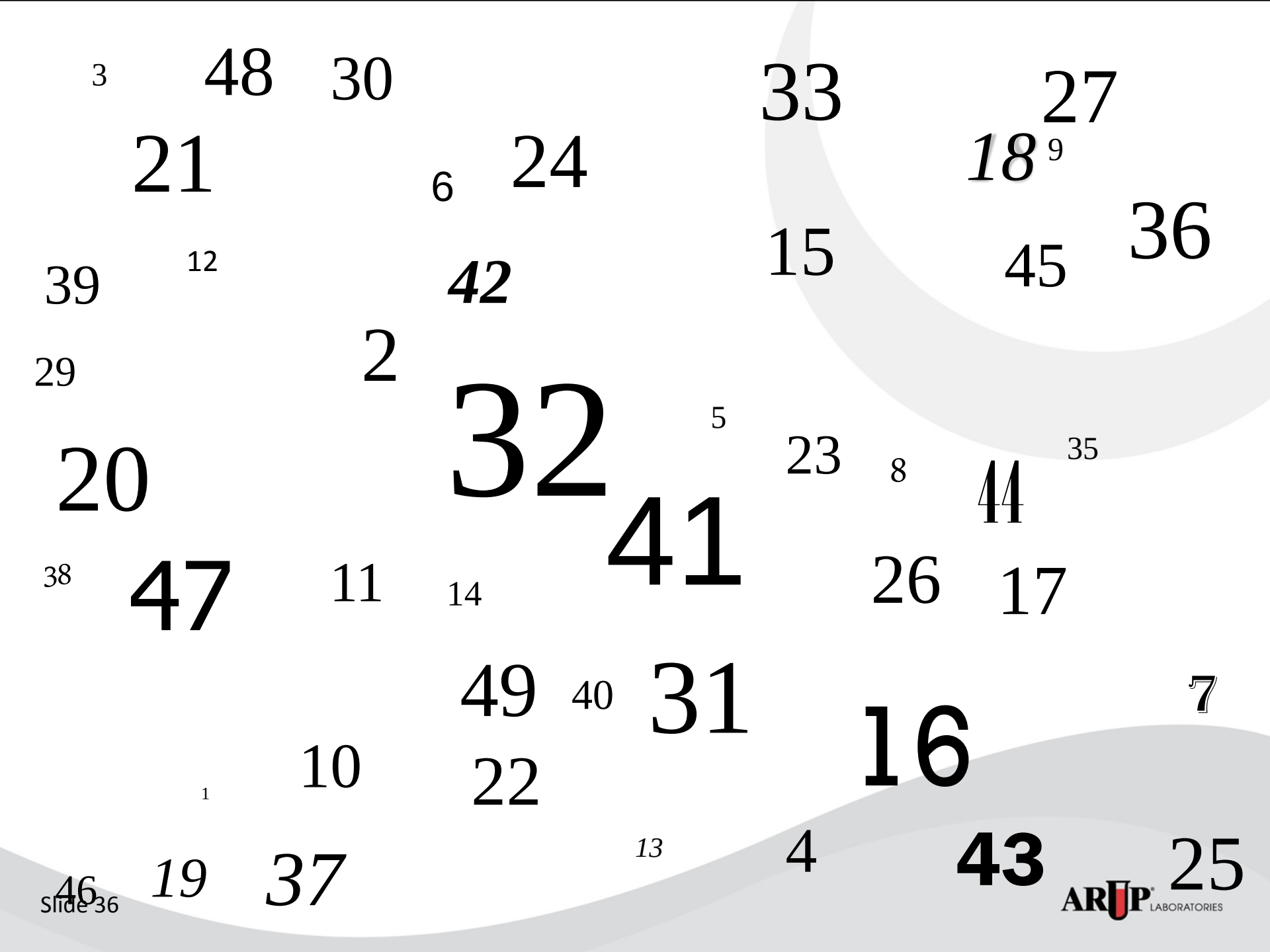
Process Design

ARUP LABORATORIES

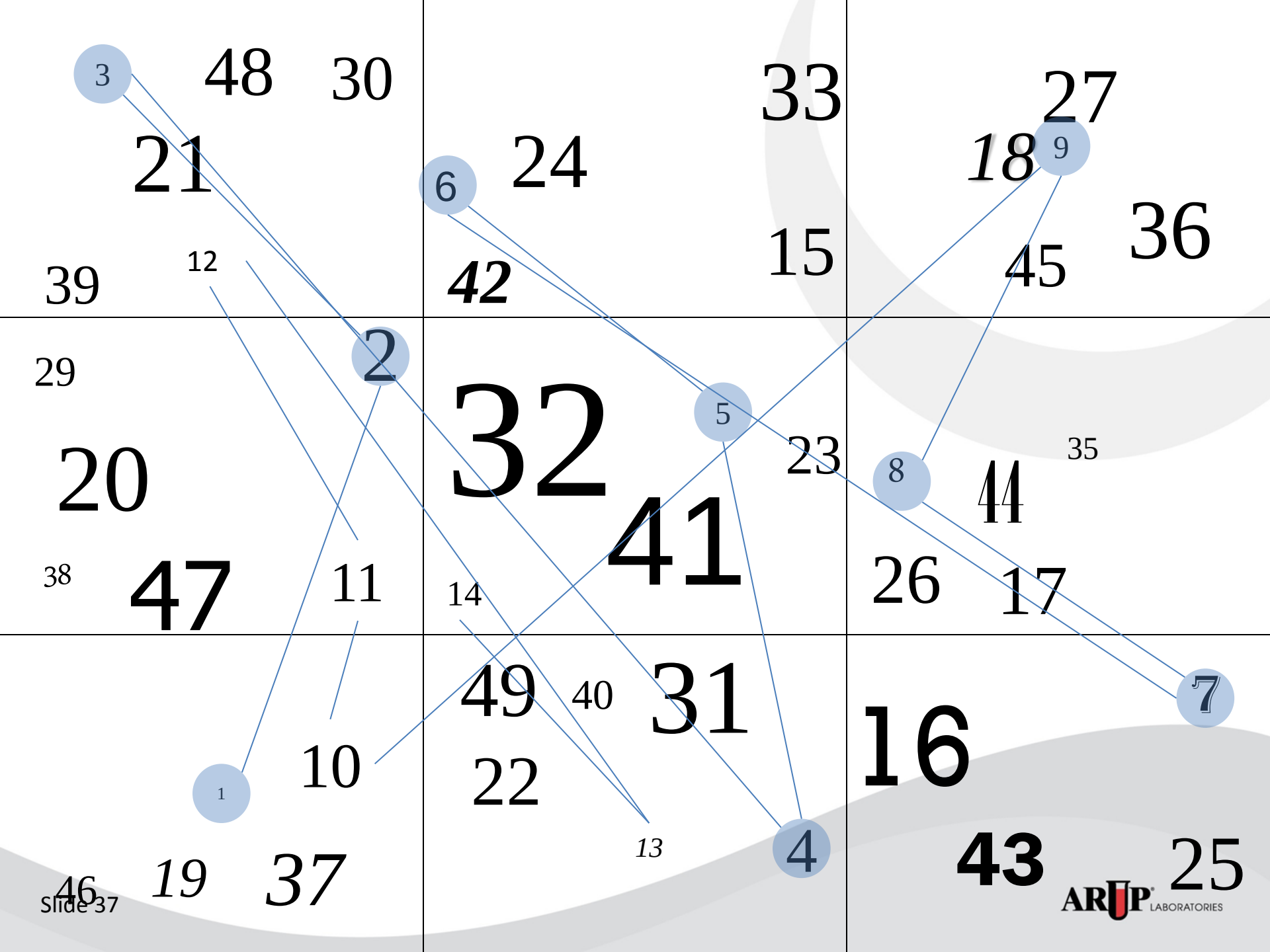


ARUP LABORATORIES

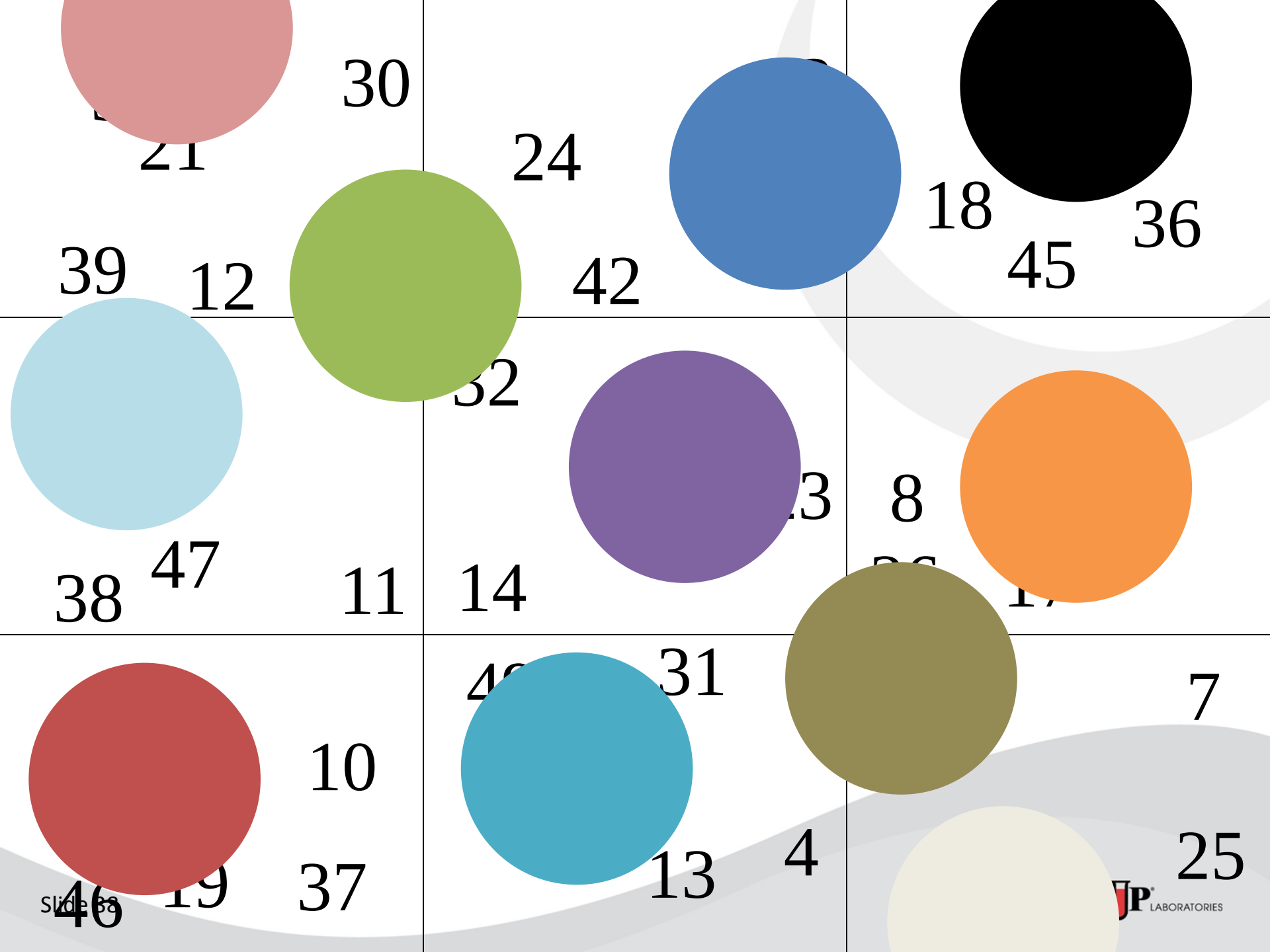




ARUP LABORATORIES



ARUP LABORATORIES



Numbers from 1 to 49

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27		29	30
31	32	33		35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	

Importance of Design

Every system is perfectly designed to achieve exactly
the results it gets.

-Paul Batalden

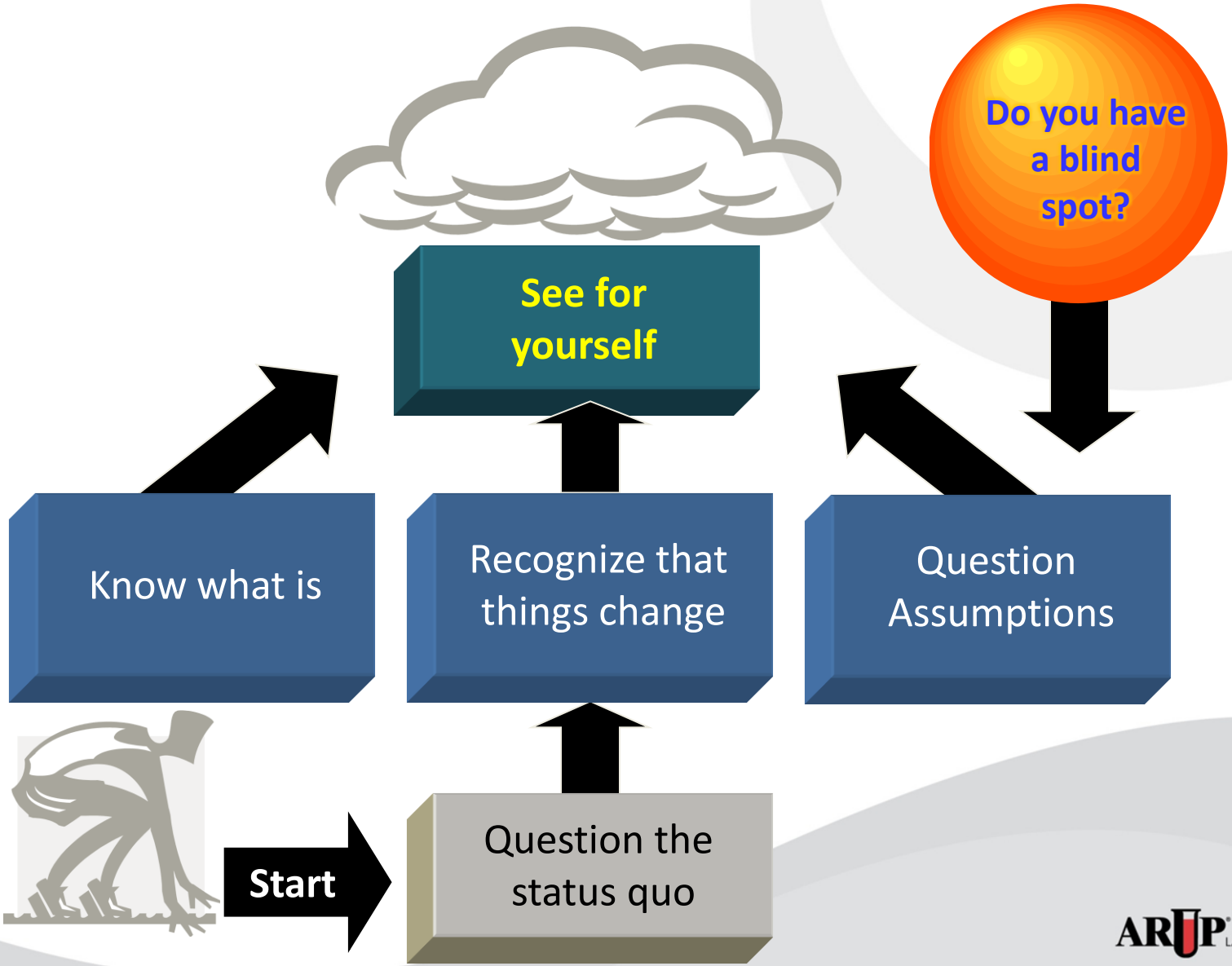
http://www.swapmeetdave.com/Humor/Fun4.htm

If your operation can't tolerate error you should remove the opportunities for error

1. Find
2. Clarify
3. Discover

Shigeo Shingo

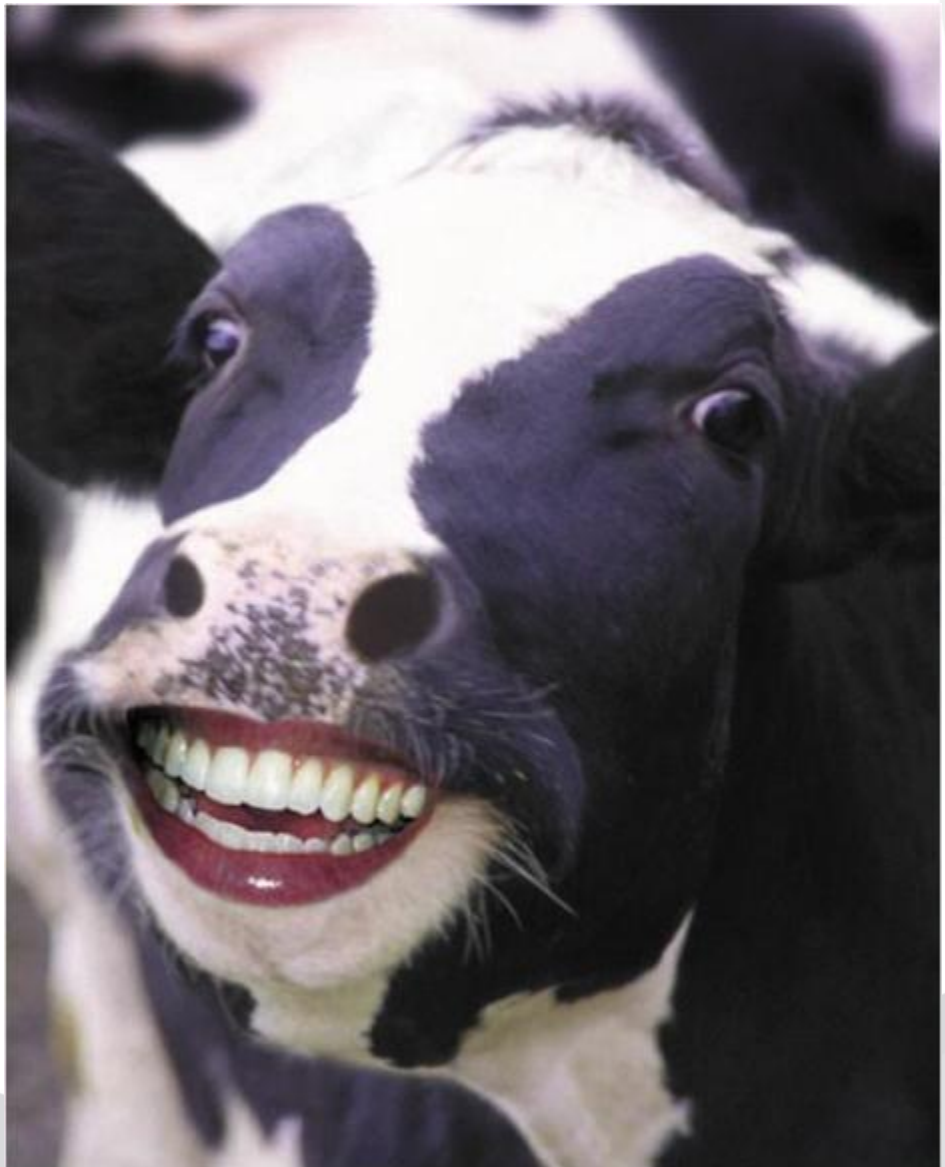
1. Find the problem!



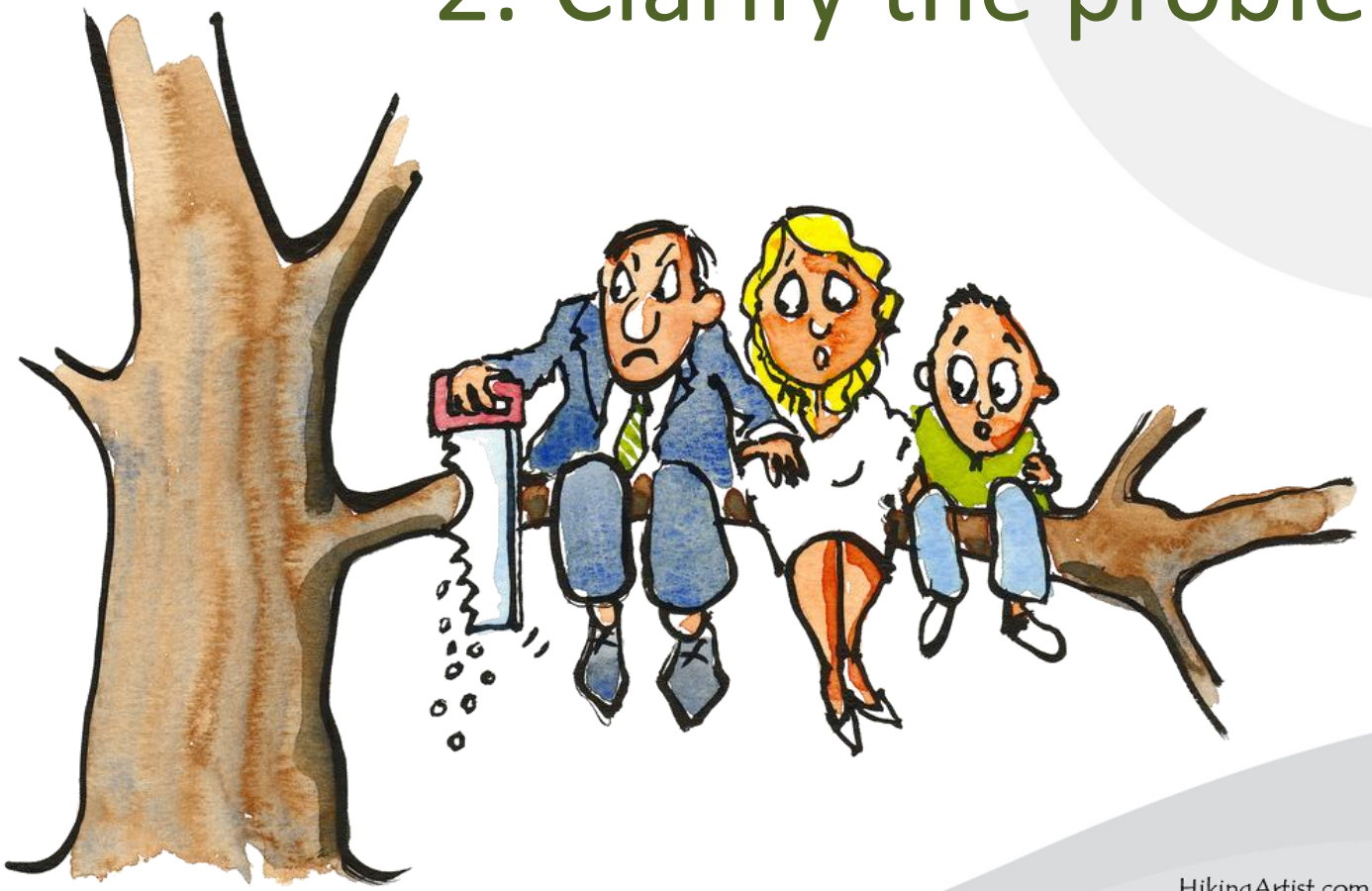
ARUP LABORATORIES

Never Assume

Never Assume



2. Clarify the problem



3. Discover the cause

It's not always about finding a simple solution to a complex problem, occasionally it's about simplifying the problem.

-Adam Bosworth

Design Modification

Best rate	Method of ensuring accuracy	Example
1 in 1,000	• Clear process documents • Reliance on vigilance, memos, training, warnings • Audits	Hand washing
1 in 10,000	All of the above plus… • Processes designed for human behaviors • Reminders, checklists, clear communication • Re-training, competency testing	Sub-optimal specimens Order errors
1 in 100,000	All the above plus… • Systems for identifying and preventing error (error-proofing) • Standardization • Elimination of distractions, interruptions and fatigue	Mislabeled specimens Corrected reports
1 in 1,000,000	All the above plus… • Automation, software enhancements • Advanced process design (remove steps that require memory or knowledge)	Lost specimens Interfaced result entry

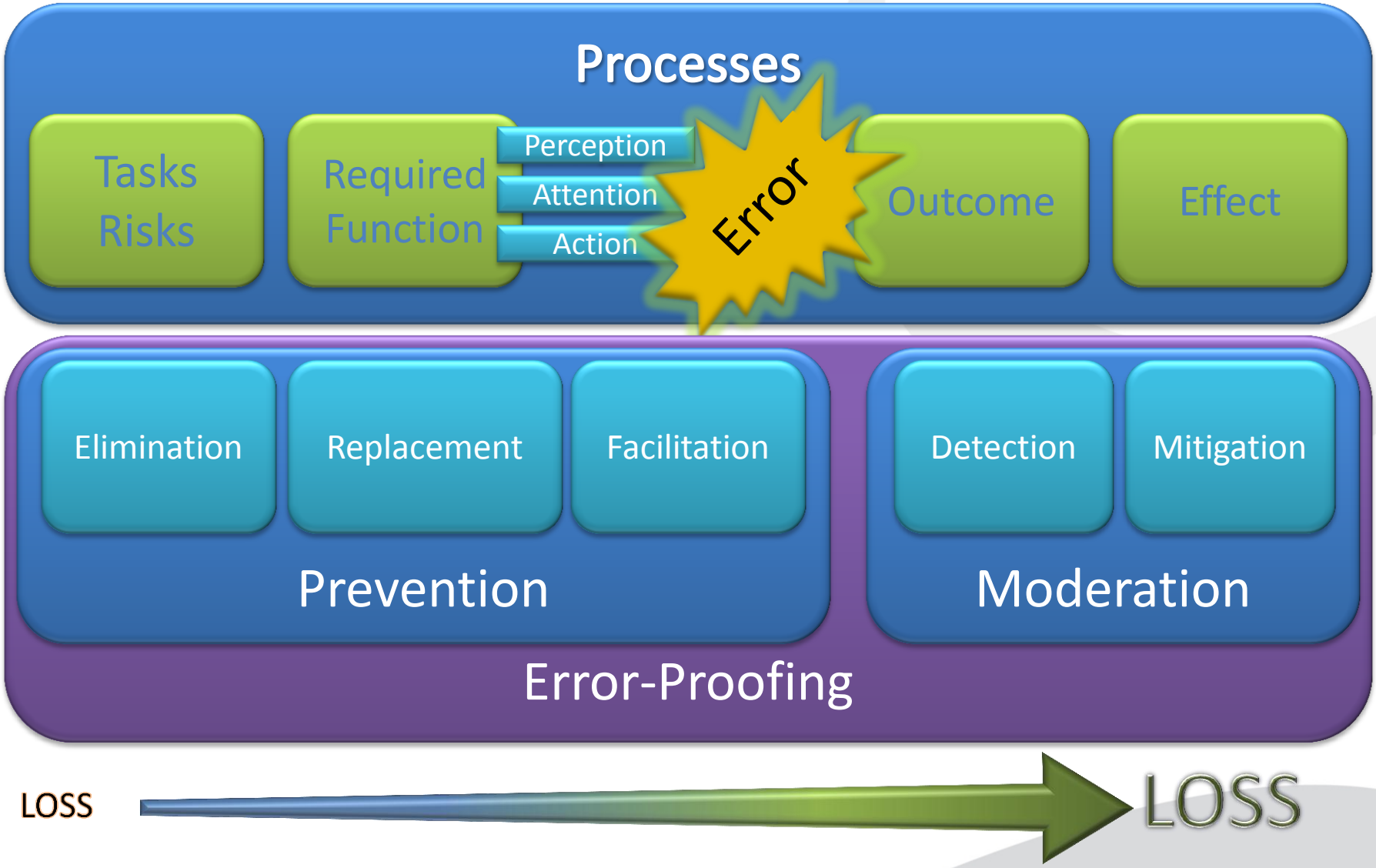
(With thanks to Dr. Michael Astion)

Error-proofing Engineering

- Microwave will not work if the door is open (a prevention device)

- Car beeps if keys are left in the ignition (a detection device)

- Spelling errors corrected in MS Word™ as you type (a reversing device)



(Godfrey, *ASQ, 2005*)

ARUP LABORATORIES

Assessment

Processes and instructions

- Designed for humans
- Clear directives

Training

- Accounting for attentional deficits

Resources, materials and equipment

- Right resource
- Right time

Environment

- Matched to the task

Work

- Manageable workload

Slips & Lapses vs. Mistakes

Slips & Lapses	Mistakes
Execution failure	Cognitive failure
More frequent	Less frequent
False negative	False positive
Difficult to eradicate	Easier to eradicate
Main cause of liability	Main cause of disciplinary action

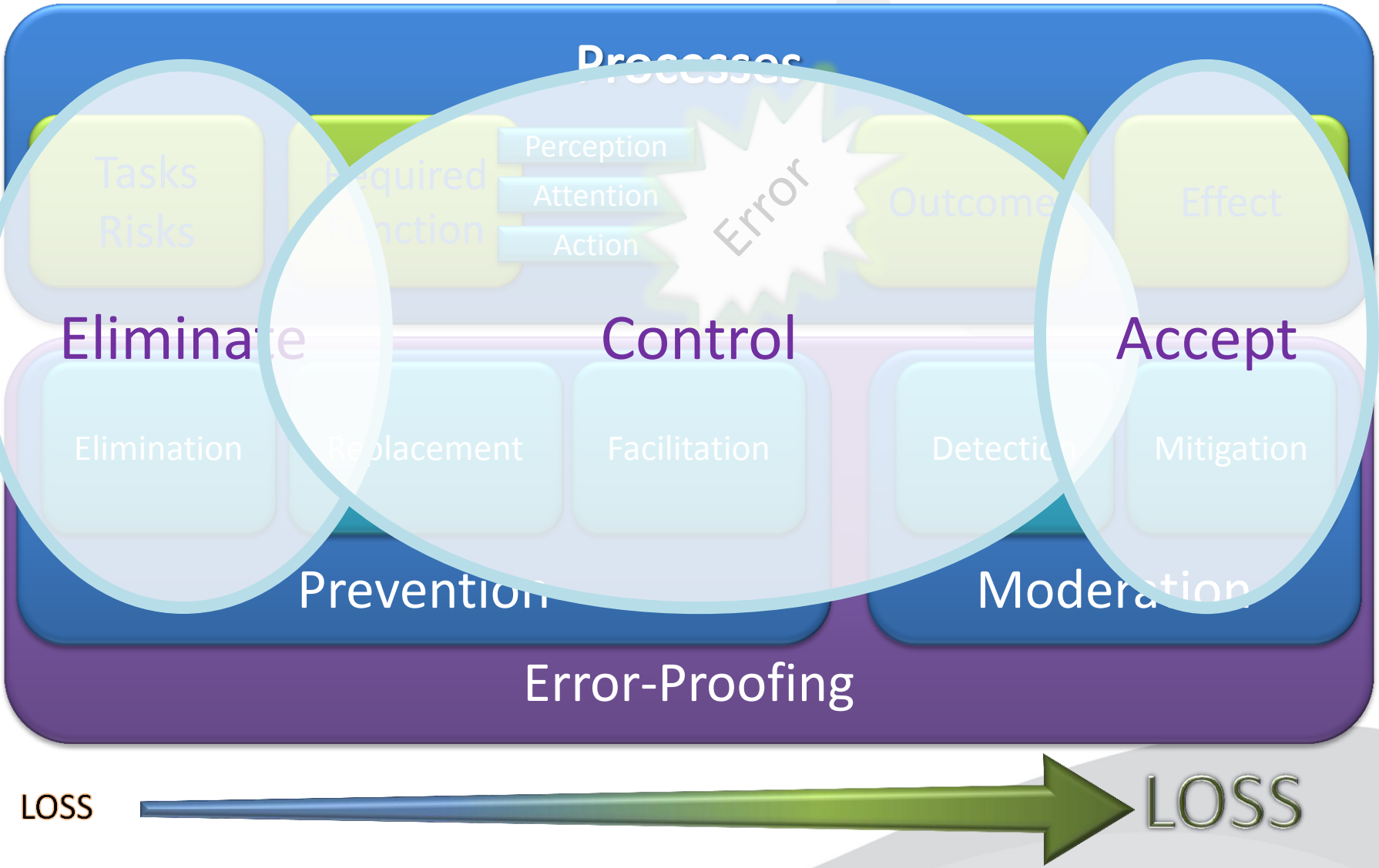
Slips and Lapses

Attentional deficits,

execution error:

Most difficult to eradicate

FMEA



LOSS → LOSS

ARUP LABORATORIES

Five Error-proofing Principles

- Eliminate → Task or Risk
- Replace → Function or Process
- Facilitate → Human behaviors
- Detect → Defects or Dissatisfaction
- Mitigate → Effects

(Godfrey, *ASQ, 2005)*

Eleven Solution Directions

- Trimming
- Self-elimination
- Standardization
- Unique Shape
- Copying
- Prior Action
- Flexible Films or Thin Membranes
- Color
- Combining
- Counting
- Automation

(Godfrey, *ASQ, 2005)*

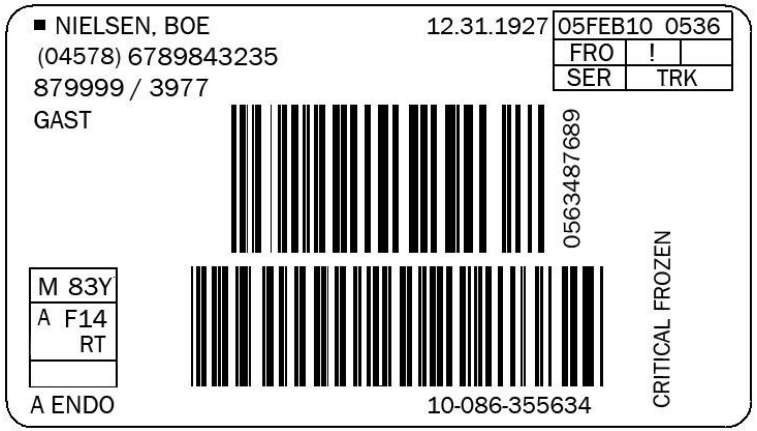
Principle First, Then Solution

Problem:
Mislabeled Specimen
Illegible Handwriting
Transcription Error

Principle First, Then Solution

Elimination:

Standardization



ARUP LABORATORIES

Principle First, Then Solution

Problem:
Handling Error
Spilled Sample
Misracked Tube

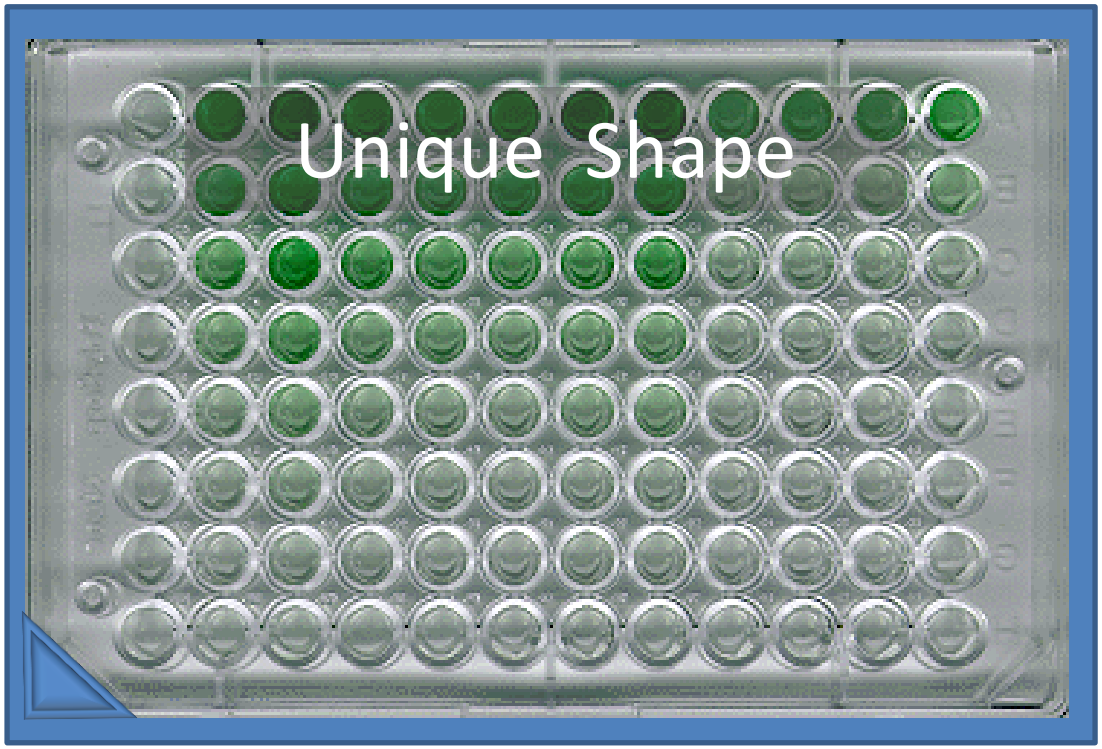
Replacement: Automation

Principle First, Then Solution

Problem:
Plate position error

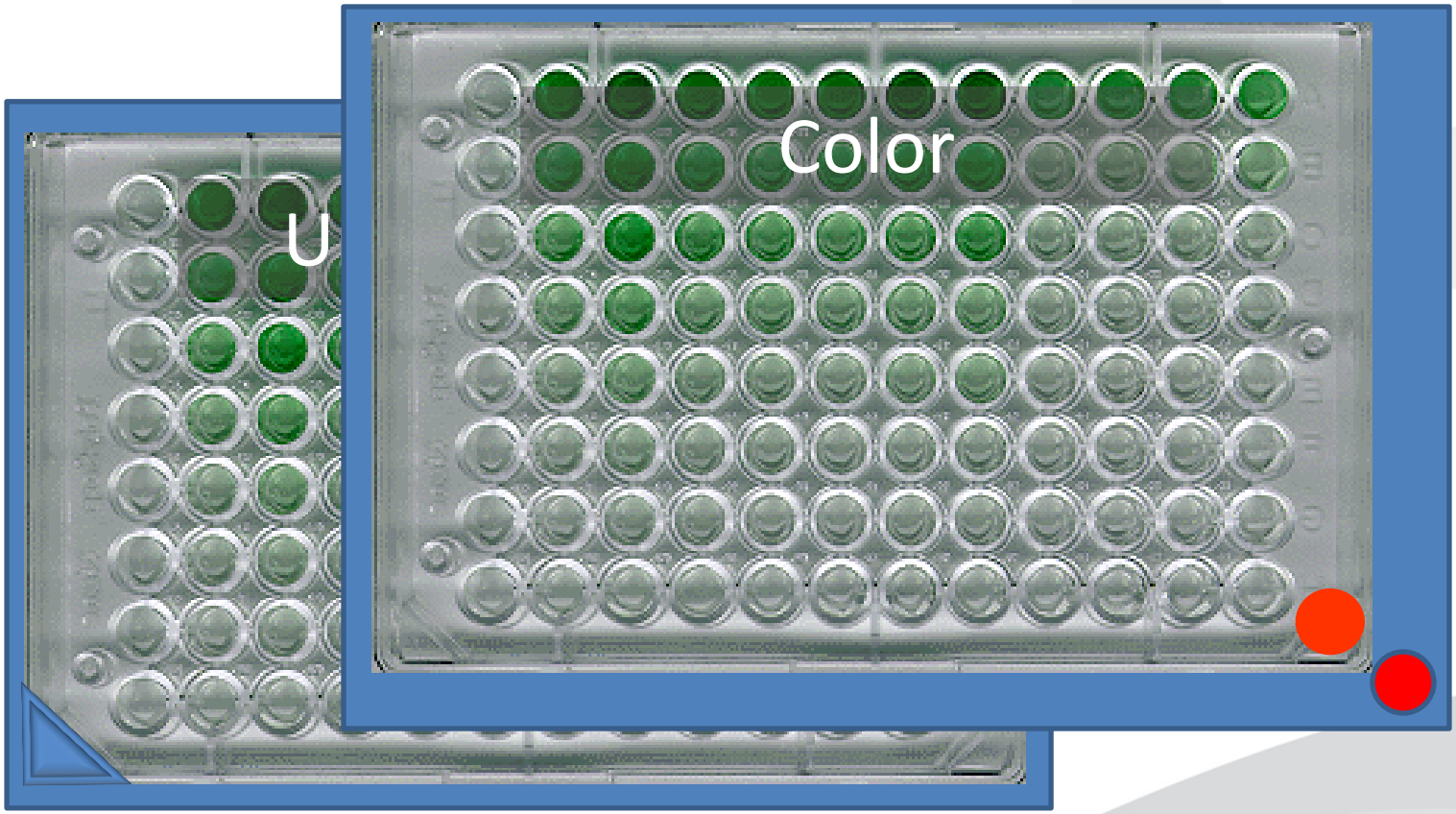
Principle First, Then Solution

Facilitation:



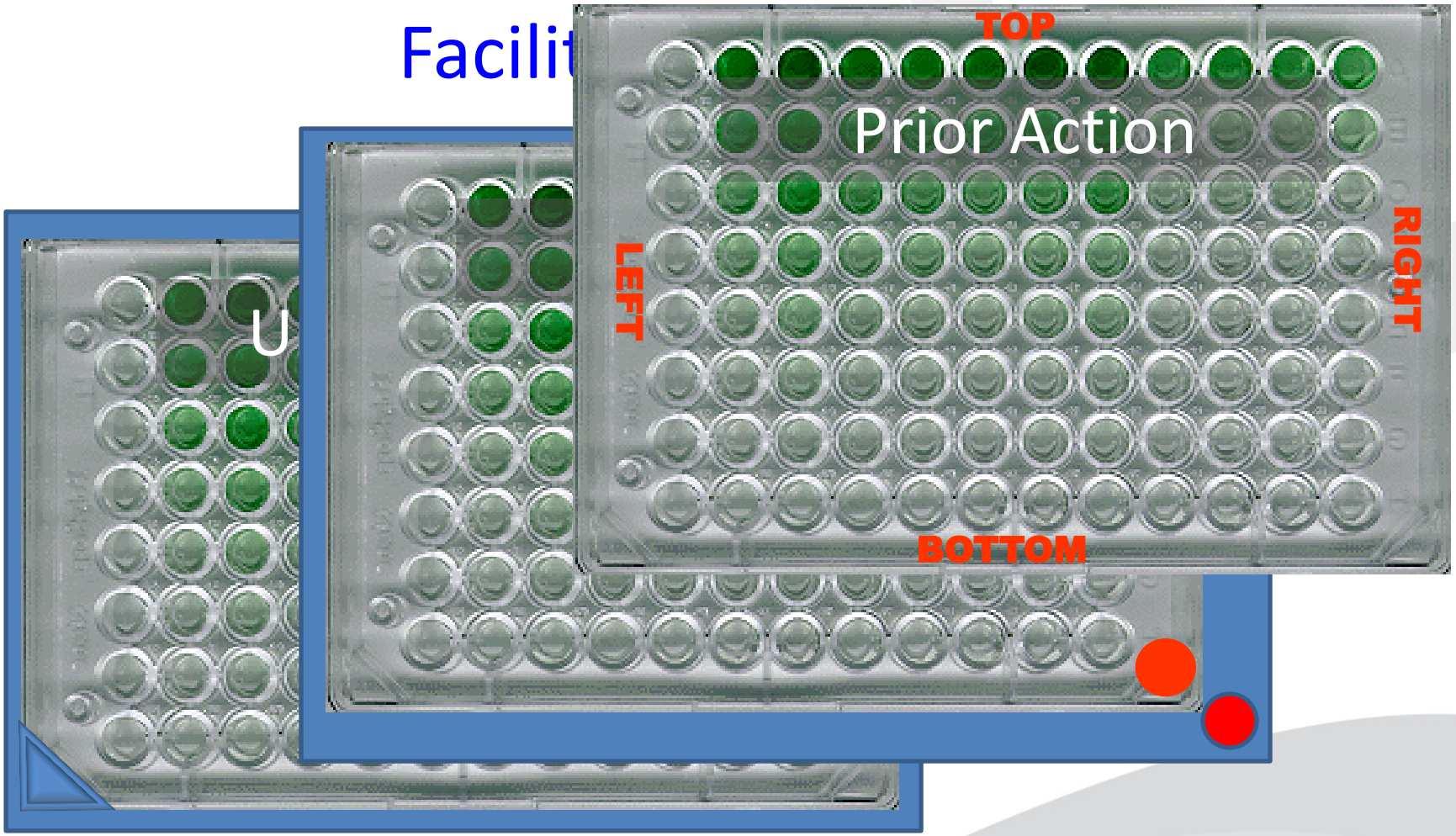
Principle First, Then Solution

Facilitation:



ARUP LABORATORIES

Principle First, Then Solution



ARUP LABORATORIES

Principle First, Then Solution

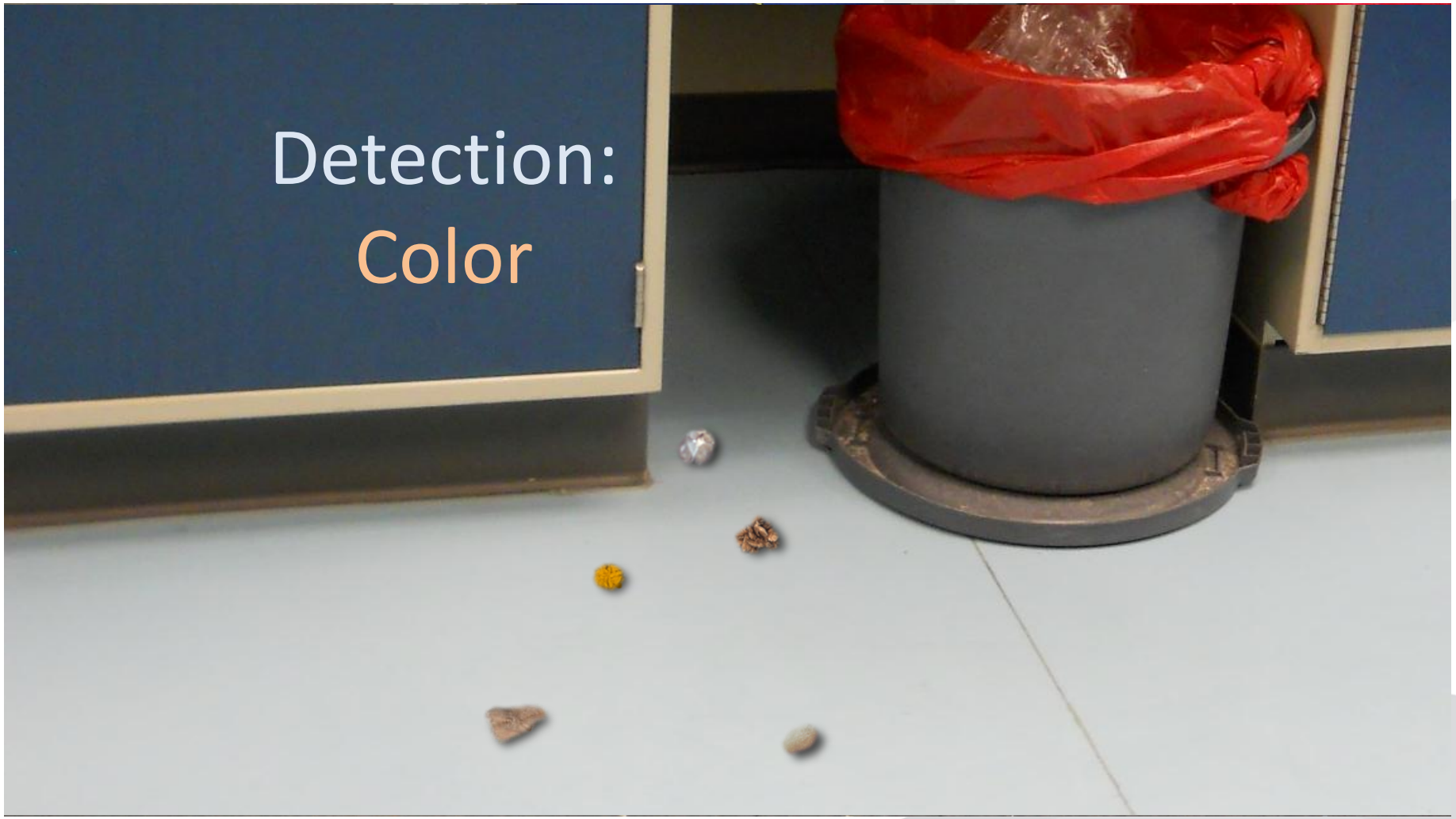
Problem:
Lost Calculi Stones

Principle First, Then Solution

Principle First, Then Solution

ARUP LABORATORIES

Principle First, Then Solution



ARUP LABORATORIES

Principle First, Then Solution

Problem:
Potential for Harm

Principle First, Then Solution

Mitigation:

Copying

Mistakes

Cognitive deficits;

contextual misalignment:

Information processing

6 Core Questions

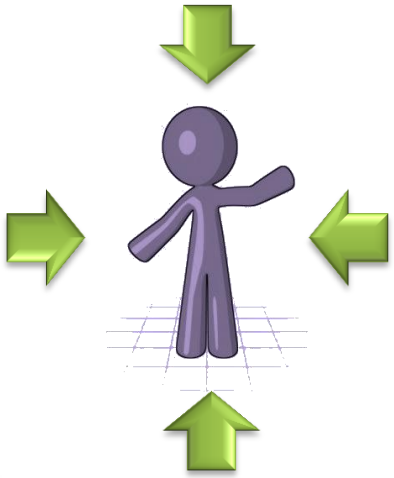
- Who?
- What?
- When?
- Where?
- How?
- How much?

(Galsworth, *Visual Workplace, Visual Thinking*, 2005)

I-Driven Visuality

Translates information into behavior

- What do I need to know that I don't know in order to do my job or in order to do it better?
- What do I know that others need to know (that I need to share) in order for them to do their work better, faster or at less cost?



(Galsworth, *Visual Workplace, Visual Thinking*, 2005)

I-Driven Visuality

Traditional method of influencing behavior

1. Classes
2. OJT
3. Manuals
4. Procedures
5. Online information
6. Meetings
7. Questions

Visual method of ensuring behavior

1. Visual Devices

(Galsworth, *Visual Workplace, Visual Thinking*, 2005)

ARUP LABORATORIES

Who?

Tags are easier
than a check out log

http://www.leanmarketplace.com/5s-tool-kit

ARUP LABORATORIES

Who?

http://www.leanmarketplace.com/5s-tool-kit

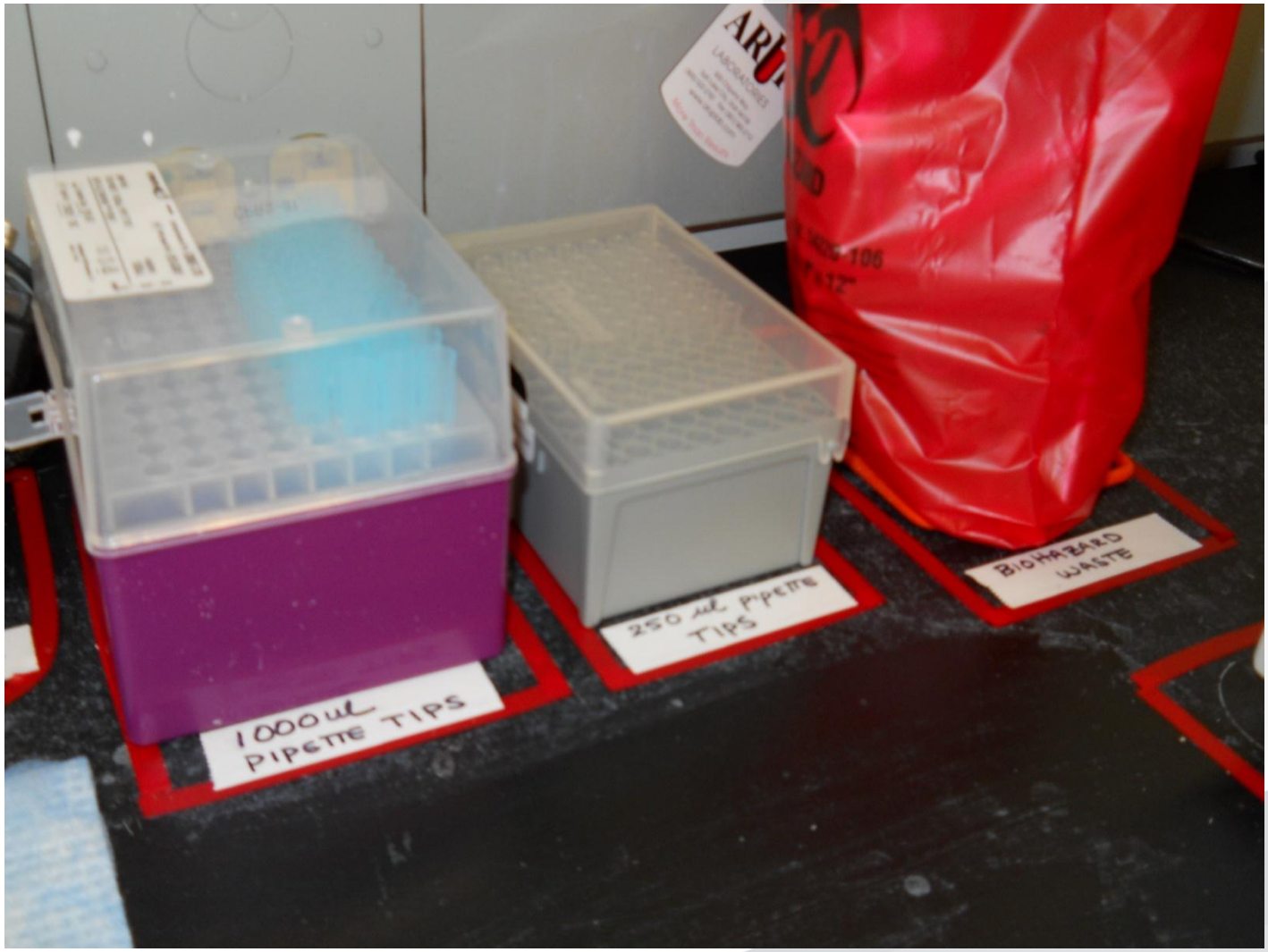
ARUP LABORATORIES

What?

http://www.mistakeproofing.com/example7.html

ARUP LABORATORIES

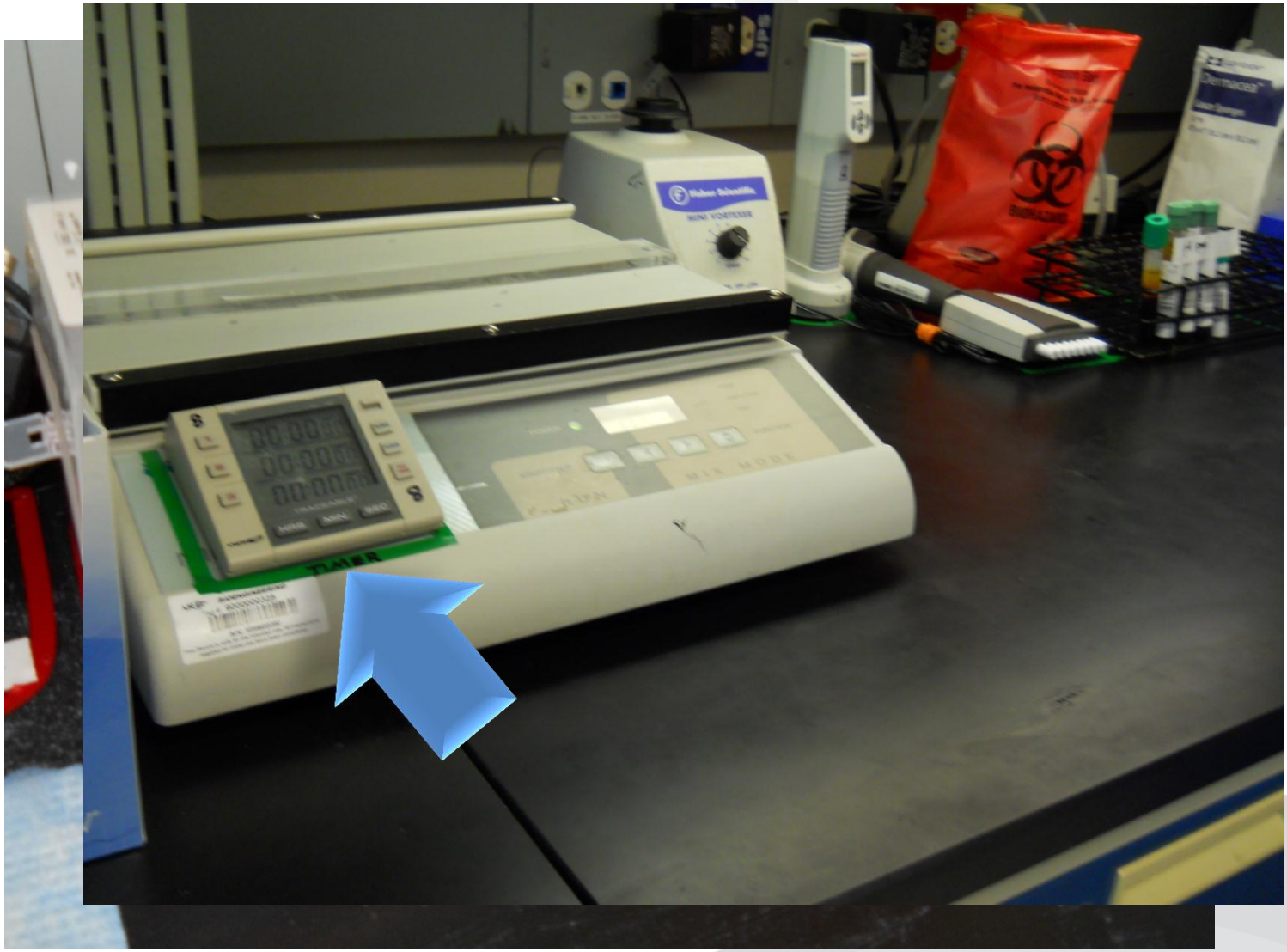
What?



http://www.mistakeproofing.com/example7.html

ARUP LABORATORIES

What?



http://www.mistakeproofing.com/example7.html

ARUP LABORATORIES

When?

"Reorder at 500 sheets"

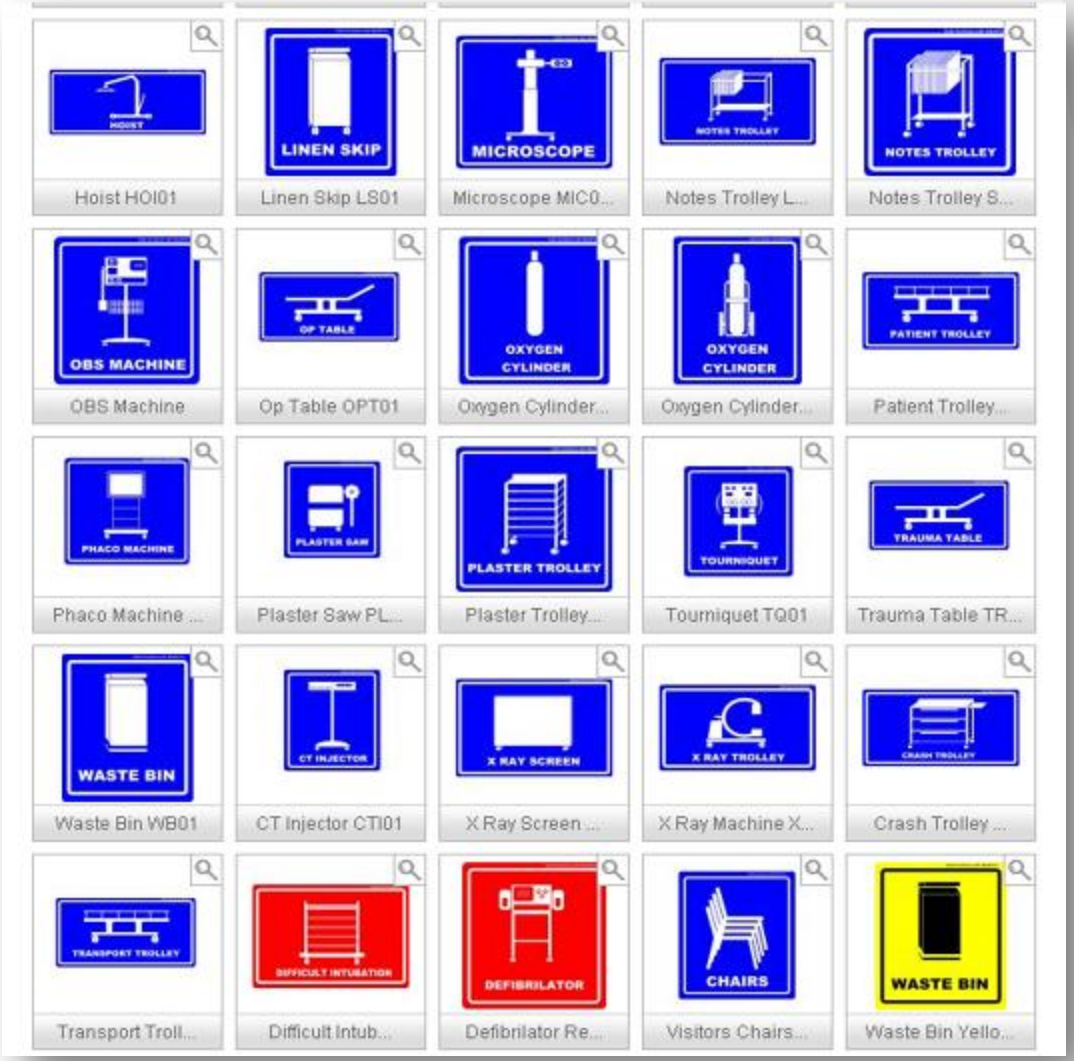
"Reorder at 750 sheets"

"Reorder at 1,000 sheets"

(Galsworth, *Visual Workplace, Visual Thinking*, 2005)

ARUP LABORATORIES

Where?



http://www.gembapantarei.com/2009/04/visual_management_resource_for_lean_hospitals_1.html

ARUP LABORATORIES

Where?

http://www.gembapantarei.com/2009/04/visual_management_resource_for_lean_hospitals_1.html

ARUP LABORATORIES

Where?

spitals_1.html

ARUP LABORATORIES

How?

http://www.myspace.com/vantilden/blog/495869074

How Much?

Broselow Pediatric Resuscitation System

http://www.armstrongmedical.com/index.cfm/go/product.detail/sec/3/ssec/14/fam/150

Information Deficits

By HikingArtist.com

"Like holes in a torn fishing net, something of value escapes with every missing answer."

At first, only the small fish are lost, but as time passes, the holes are enlarged and more and more value escapes, never to be captured.

(Galsworth, *Visual Workplace, Visual Thinking*, 2005)

Can’t Rather Than Don’t

-Henry Ford’s Safety Principle

Intermediate

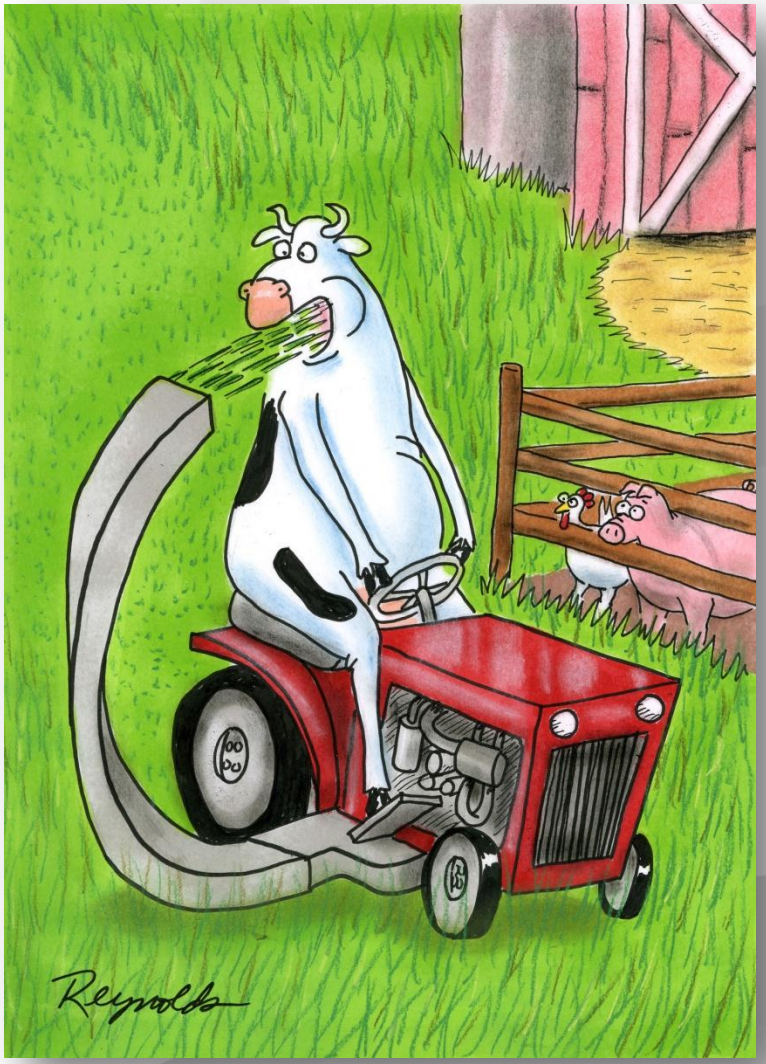
Repairs aimed at changing processes

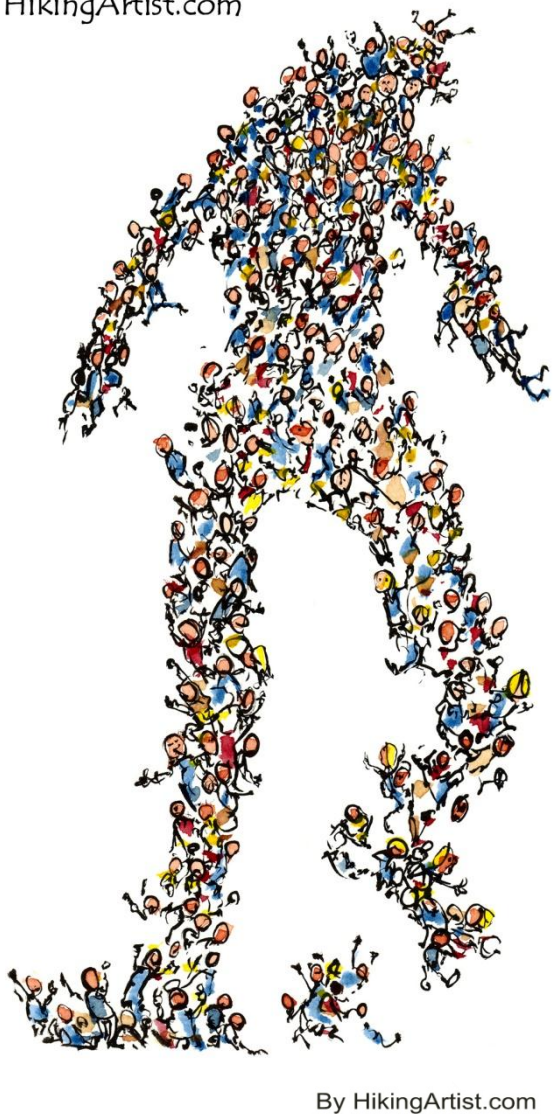
- Checklists
- Read-back/Repeat-back policy
- Eliminate look-alike/sound-alike
- Eliminate or reduce distractions
- Minor software enhancements; benign failures

(Gosbee, *Laboratory Errors and Patient Safety*, May-June 2005)

The Rest of the Story

Optimizing a function does not mean optimizing the system





Systems Thinking

ARUP LABORATORIES

Complex Adaptive System

- collection of individual agents
- free to act
- not always predictable
- actions are interconnected
- actions change the context for other agents

(IOM, *Crossing the Quality Chasm*, 2001)

Complex Adaptive Systems

- Complex
  - Diverse
- Adaptive
  - Capable of change
- System
  - A set of interconnected things

The Systems Thinking approach to quality creates the conditions under which a good outcome

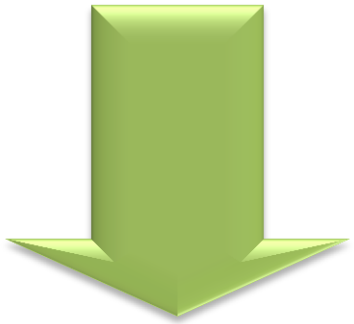
is not only

possible,

but probable.

(IOM, *Crossing the Quality Chasm*, 2001)

Relatively simple rules



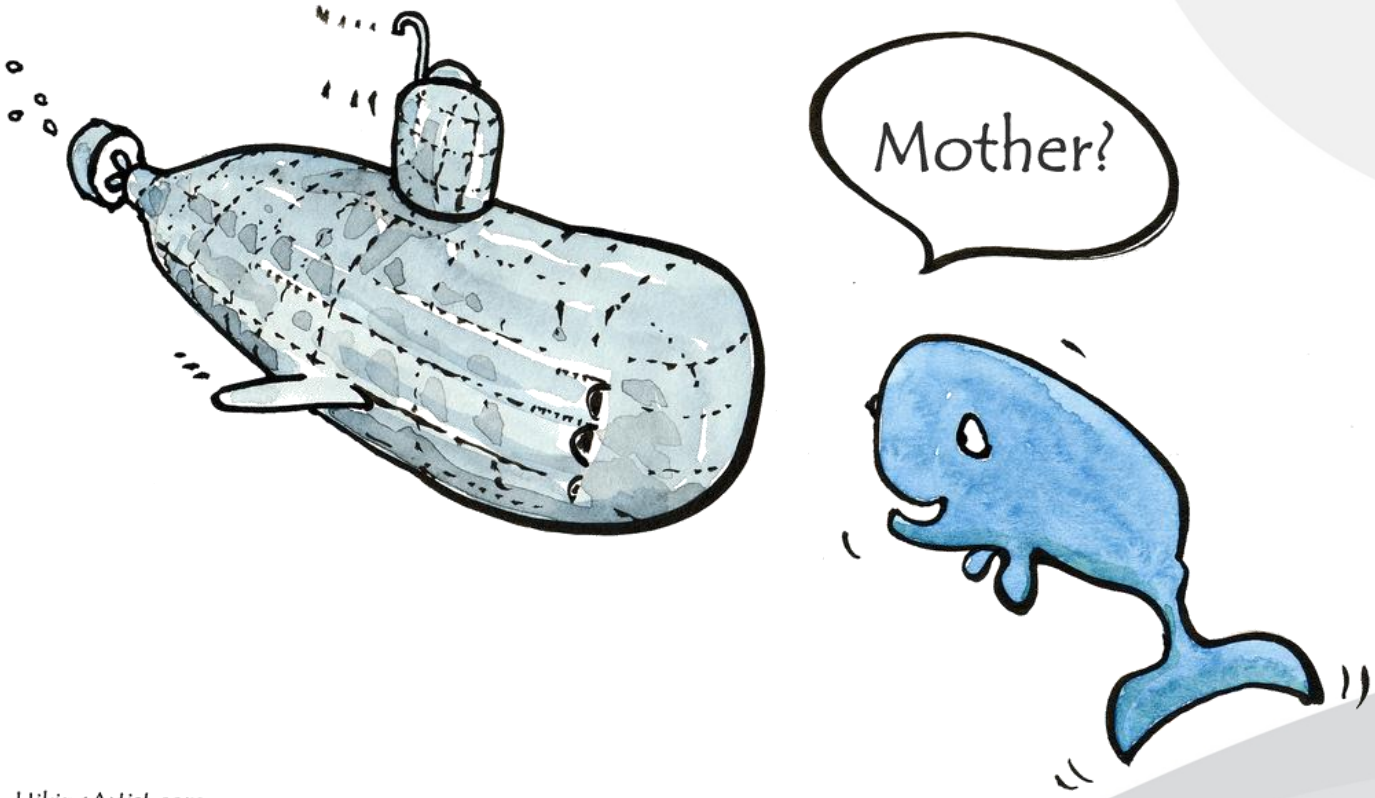
complex, emergent, innovative

system behavior

(IOM, *Crossing the Quality Chasm*, 2001)

Culture Modification

All systems are unique and different



Assessment

Employees

- Consciousness
- Dexterity
- Cognition
- Synthesis

Employers

- Well-designed processes and clear instructions
- Training
- Resources, materials and equipment
- Environment
- Manageable workload

Culture

- Basic principles
- Collegiality
- Organizational learning
- Holistic quality
- Empowered Teams

Assessment

Basic principles

- Simple rules; cultural norms
- Management as role models

Holistic quality

- Embracing who we are
- Planning for who we will be

Collegial relationships

- Patients, practitioners, suppliers and the community as partners

Organizational learning

- Mistakes as opportunities
- Workforce open to growth

Empowered Teams

- Characterized by accountability
- Driven by front line champions

Strong

Reforms intended to improve systems

- Major software enhancements
- Removing unnecessary steps
- Standardizing
- Process/ equipment design changes
- Leadership/ culture changes
- Redesign of work area

(Gosbee, *Laboratory Errors and Patient Safety*, May-June 2005)

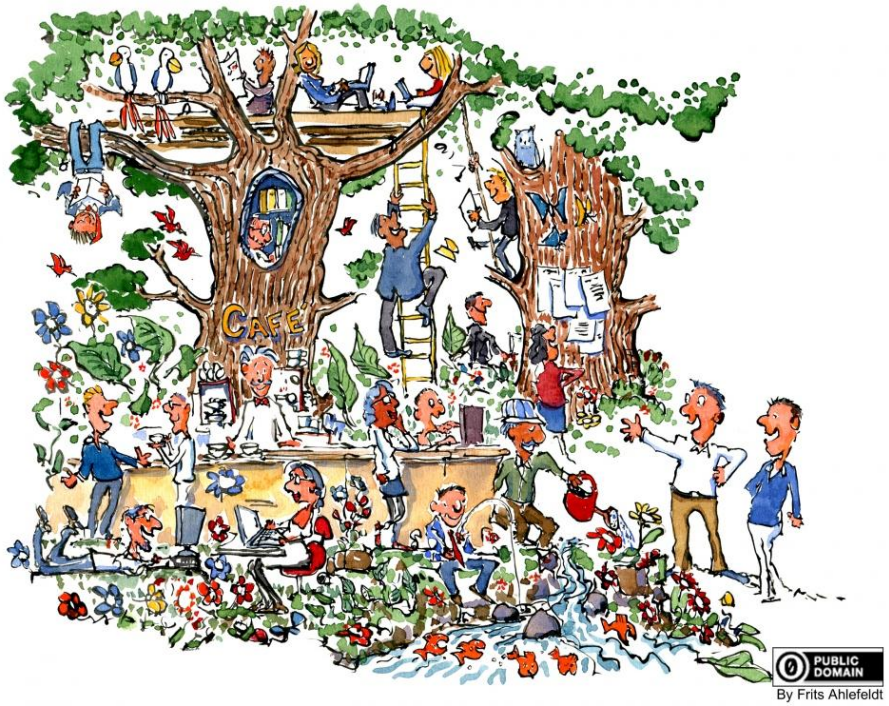
Systems Thinking Fundamentals

The organization that embraces chaos

- focuses on information-seeking over stability,
- allows new ideas with disruptive potential, and
- is open to growth.

Chaos is a place of instability, a philosophy of embracing the unknown. As such, for many, it is a frightening place to be.

Systems Thinking Fundamentals



Usually improvement cannot be accomplished or sustained without giving the messy business of social interactions, communication, power and organizational context its due.

(Carr, *Patient Safety & Quality Healthcare*, Sept/Oct 2008)

Systems Characteristics

- Simple Rules
- Non-Linearity
- Unpredictability
- Inherent Order
- Adaptable Elements
- Emergent Behavior
- Context and Embeddedness
- Co-evolution

(IOM, *Crossing the Quality Chasm*, 2001)

Simple rules

Simple rules can produce complex results

CAS Properties

Simple rules

Aversion

move away from very nearby neighbors

Alignment

adopt the same direction as those that are close

Attraction

avoid becoming isolated

Systems Thinking Application

- What are you trying to do? (alignment rule)
- What should you always do? (attraction rule)
- What should you never do? (aversion rule)
- What is your sphere of influence? (accountability rule)

Practically Speaking…

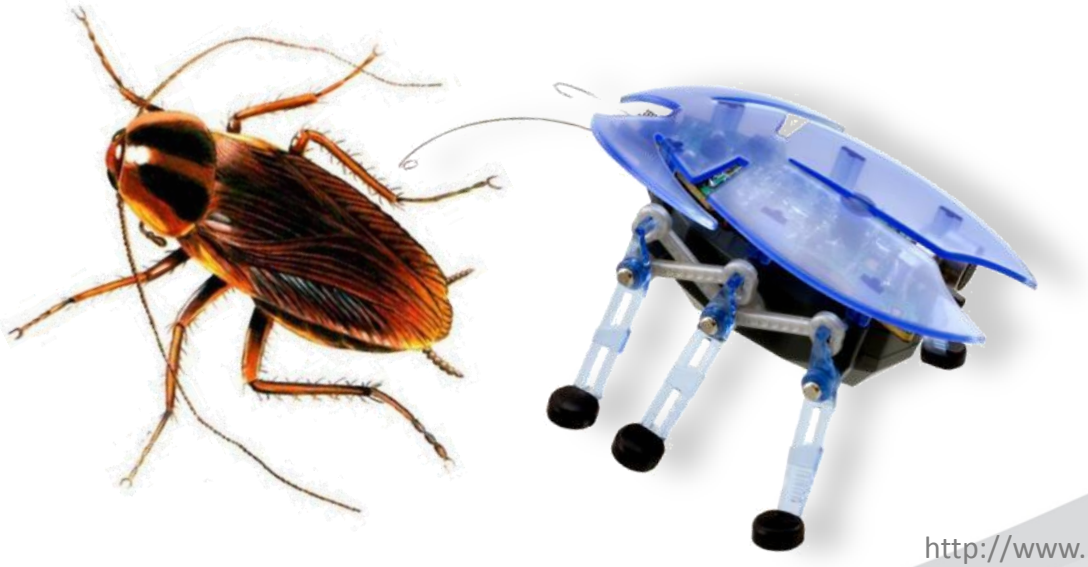
Don’t fight the system. Change the rules and the system will change itself.

-Andrew Carey

ARUP LABORATORIES

Nonlinearity

The relationship of a change to its downstream effect may not be directly proportional



http://www.hexbug.com/original/original-hexbug-single.html

Change Types

	Incremental *Internally driven* *Strong work teams* *Continuous*	Transformational *Environmentally driven* *Strong leadership* *Episodic*
Anticipatory *Planned* *Greater chance of success* *Sticks*	**Tuning** Strongest over time; purposeful; based on consensus; least frightening for employees; sustainable	**Re-orientation** Likely to succeed; has the luxury of time to shape change, build coalitions, empower individuals; initiated in advance of change; based on strategic gamble
Reactive *Urgent* *Greater chance of failure* *Degrades*	**Adaptation** Most common type of change; triggered by adverse event(s); short-lived	**re-creation** risky; initiated under crisis; requires change to core values; individual resistance is high

(Schneier, *The Training Development Sourcebook*, 1994)

Change Types

	Incremental ***Internally driven*** ***Strong work teams*** ***Continuous***	**Transformational** ***Environmentally driven*** ***Strong leadership*** ***Episodic***
Anticipatory ***Planned*** ***Greater chance of success*** ***Sticks***	**Tuning** Strongest over time; purposeful; based on consensus; least frightening for employees; sustainable	**Re-orientation** Likely to succeed; has the luxury of time to shape change, build coalitions, empower individuals; initiated in advance of change; based on strategic gamble
Reactive ***Urgent*** ***Greater chance of failure*** ***Degrades***	**Adaptation** Most common type of change; triggered by adverse event(s); short-lived	**Re-creation** Risky; initiated under crisis; requires change to core values; individual resistance is high

(Schneier, *The Training Development Sourcebook*, 1994)

Change Types

	Incremental ***Internally driven*** ***Strong work teams*** ***Continuous***	**Transformational** ***Environmentally driven*** ***Strong leadership*** ***Episodic***
Anticipatory ***Planned*** ***Greater chance of success*** ***Sticks***	**Tuning** Strongest over time; purposeful; based on consensus; least frightening for employees; sustainable	**Re-orientation** Likely to succeed; has the luxury of time to shape change, build coalitions, empower individuals; initiated in advance of change; based on strategic gamble
Reactive ***Urgent*** ***Greater chance of failure*** ***Degrades***	**Adaptation** Most common type of change; triggered by adverse event(s); short-lived	**Re-creation** Risky; initiated under crisis; requires change to core values; individual resistance is high

(Schneier, *The Training Development Sourcebook*, 1994)

Practically Speaking…

Transformational Change	Incremental Change
• Radical	• Simple
• Top down	• Bottom up
• Change is disruptive	• Change is normal
• Improvement changes how work is done	• Improvement is part of daily work
• High risk	• Limited risk
• Revolution— throw out the baby with the bath water	• PDCA— make change, adjust; make change, adjust

CAS Properties

Emergent behavior, novelty

Innovation is the defining characteristic of the system

ARUP LABORATORIES

Innovation cannot survive in a blame culture

Practically Speaking…

- Human error

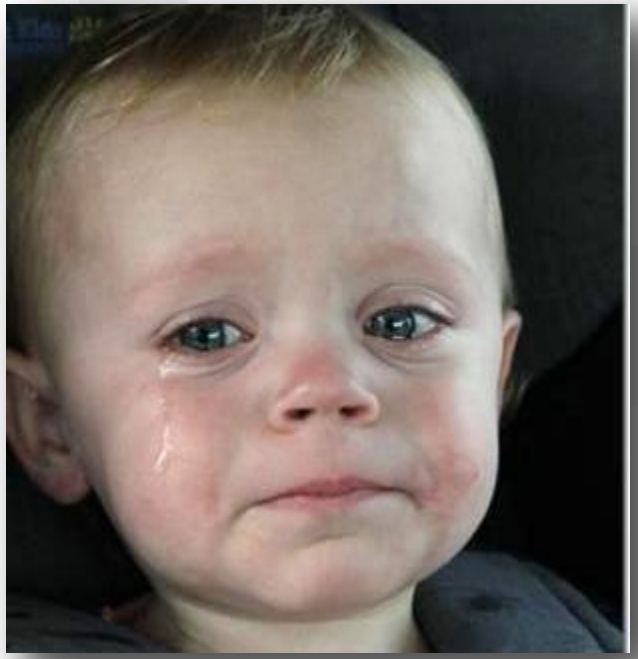
  To err is human

- At-risk behavior

  To drift is human

- Reckless behavior

  To cause harm is indefensible



(Outcome Engineering, *The Just Culture Algorithm*, 2007)

Practically Speaking…

- Human error

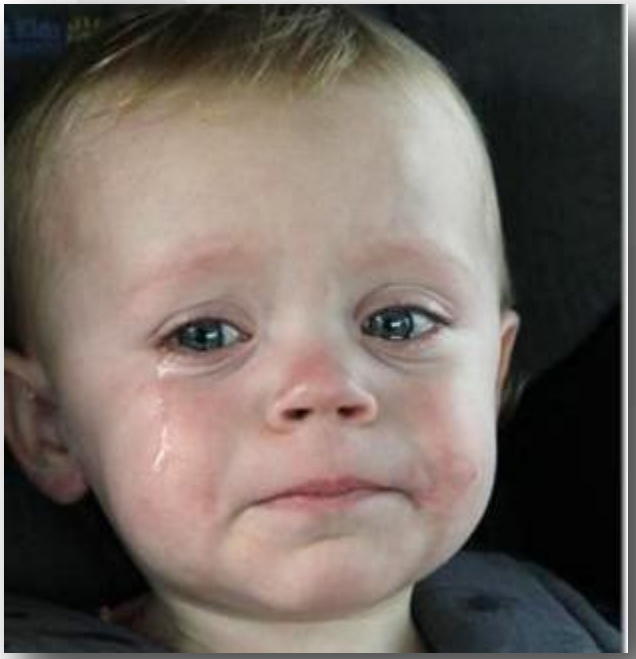
  Console

- At-risk behavior

  To drift is human

- Reckless behavior

  To cause harm is indefensible



(Outcome Engineering, *The Just Culture Algorithm*, 2007)

Practically Speaking…

- Human error

  Console

- At-risk behavior

  To drift is human

- Reckless behavior

  To cause harm is indefensible

(Outcome Engineering, *The Just Culture Algorithm*, 2007)

Practically Speaking…

- Human error
  - Console
- At-risk behavior
  - Coach
- Reckless behavior
  - To cause harm is indefensible

(Outcome Engineering, *The Just Culture Algorithm*, 2007)

Practically Speaking…

- Human error
  - Console
- At-risk behavior
  - Coach
- Reckless behavior
  - To cause harm is indefensible

(Outcome Engineering, *The Just Culture Algorithm*, 2007)

Practically Speaking…

- Human error
  - Console
- At-risk behavior
  - Coach
- Reckless behavior
  - Punish

(Outcome Engineering, *The Just Culture Algorithm*, 2007)

CAS Properties

The Challenge of extreme weather

Not predictable in detail

ARUP LABORATORIES

Systems Thinking Application

We are always in the middle of a continuum of causes and effects;

thus, there is no “wrong” place or time to start improving.

Practically Speaking…

The best way to predict the future is to invent it

-Alan Kay

Inherent order

Even without a command center, systems have order

By HikingArtist.com

Change Agent:

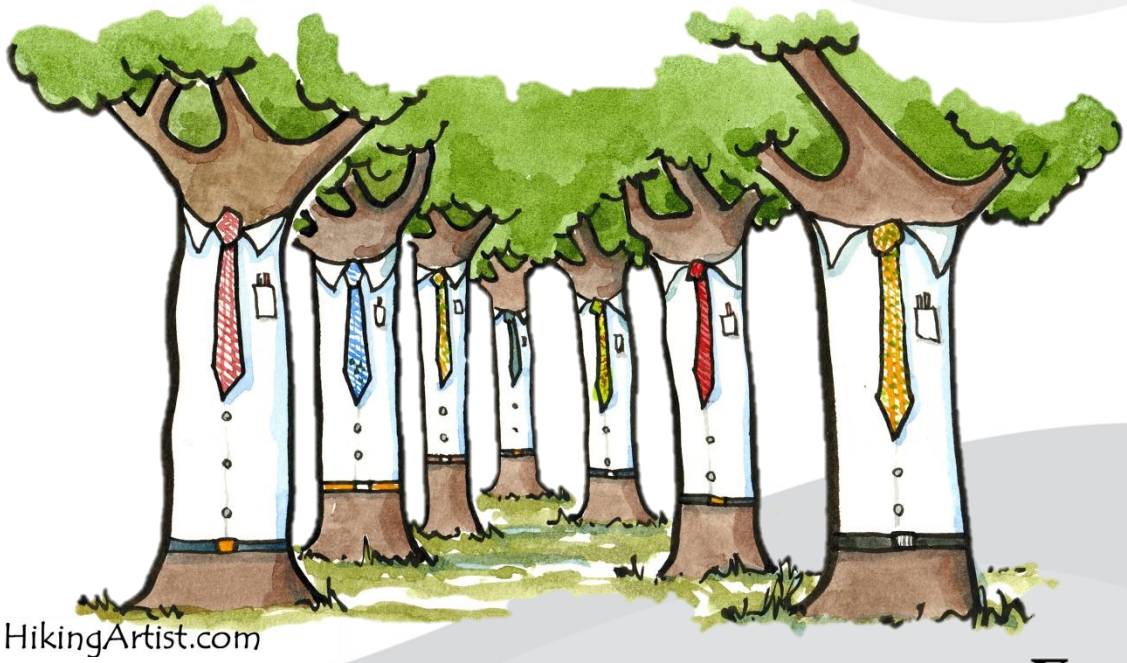
A person whose presence, or thought processes, cause a change from the traditional way of handling or thinking about a problem.

Practically Speaking…

It isn’t necessary to be in charge to lead a charge.

Adaptable elements

Components within the system are capable of changing themselves.



Systems Thinking Application

"Go to the *Gemba*."

ARUP LABORATORIES

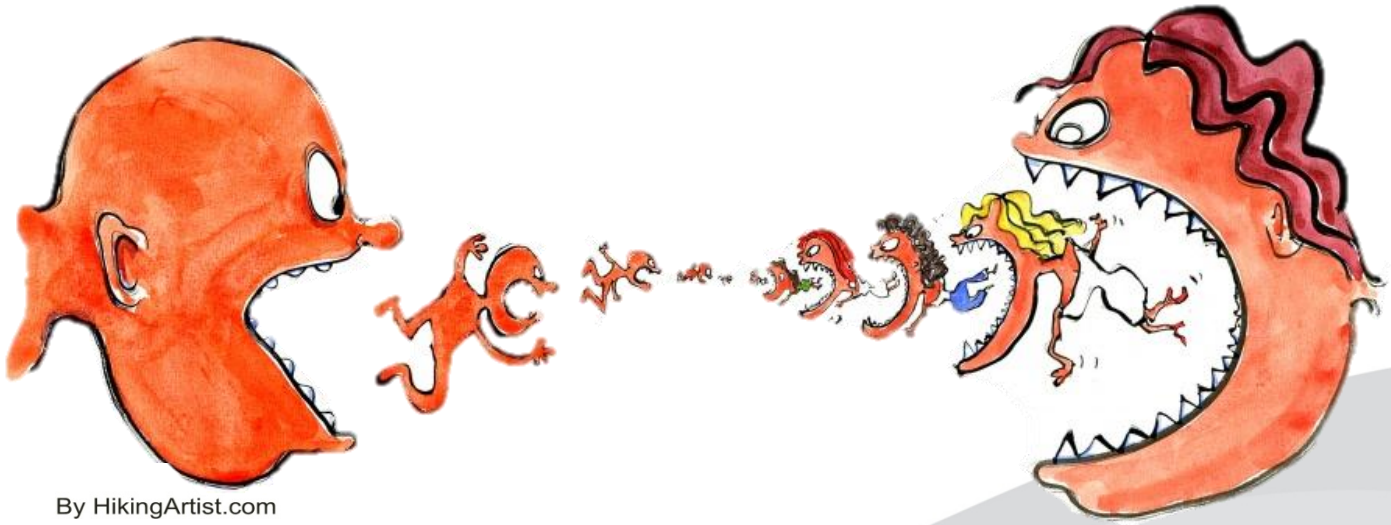
Practically Speaking…

	Manufacturing	Service
Major Focus	Control variability	Adapt to variability
Measures of Quality	Activity measures– time, cost, quantity	Value Demand and Failure Demand
Cost is in…	Rework, defects, scrap	Poor flow, non-value-added activities
Standardization	Controls cost	Angers customers
Improvement Method	Tools-based	Context-based
Focus	Efficiency	Efficacy
Processes	Clockware	Swarmware

http://www.newsystemsthinking.com/about_command_v_systems.asp

Embeddedness – Interconnectedness

All systems exist within larger or smaller patterns of systems



Patterns Within Patterns

Analytical Thinking

Breaks down into parts; studies each part and breaks down again.

Good for:

- Process problems
- New problems; new processes
- Local outcomes
- Known factors and influences
- Clockware

Systems Thinking

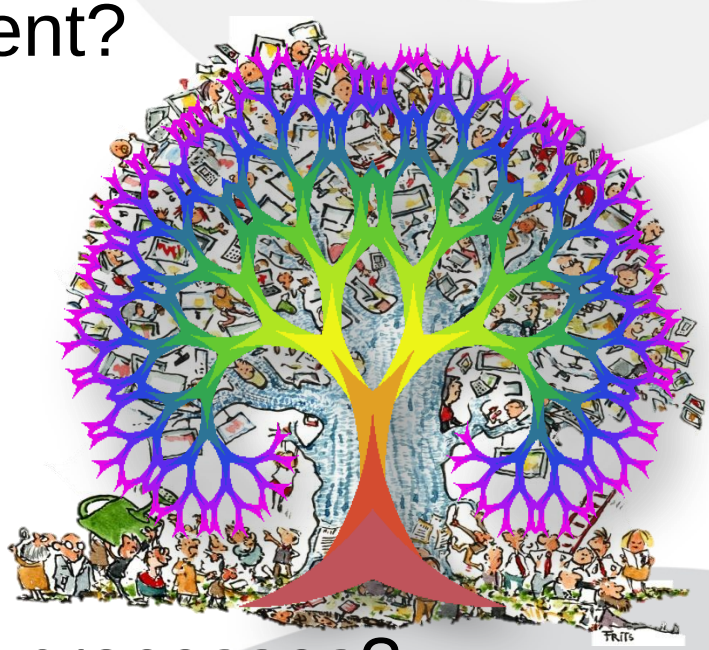
Expands to take into account more interactions.

Good for:

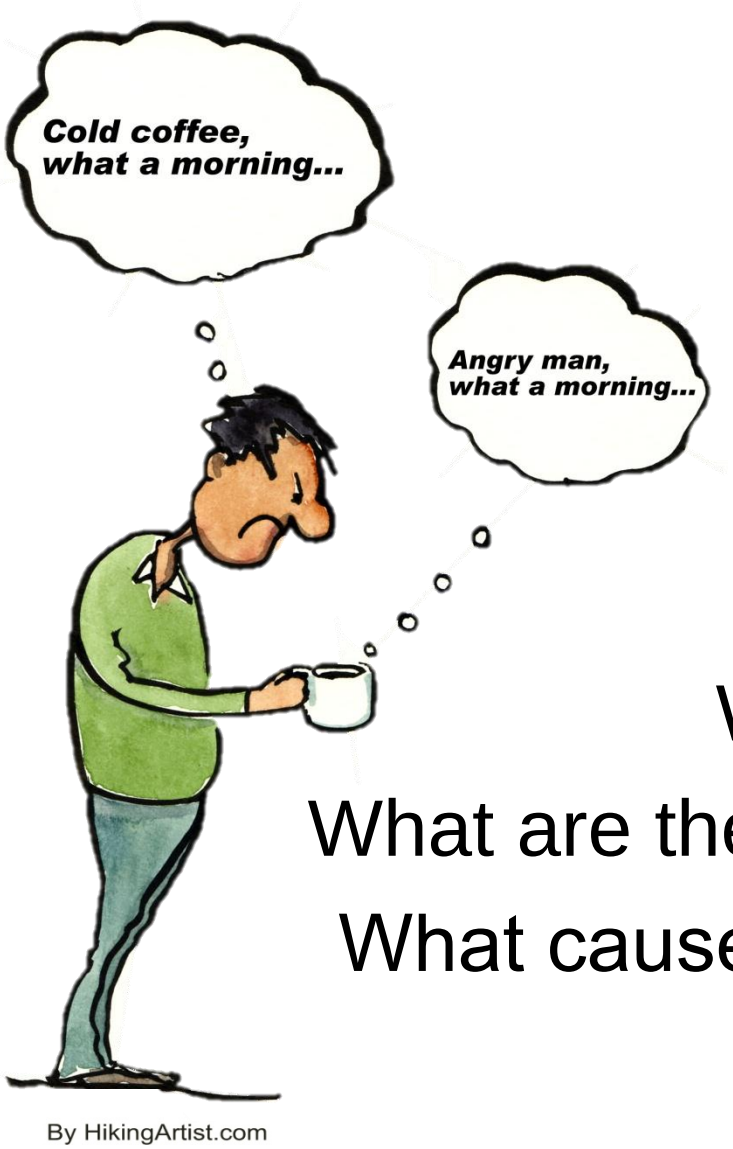
- Big picture problems
- Recurring problems
- Problems with global application
- No clear solution
- Swarmware

Look for recurring patterns

- Has this happened before? When?
- What was the same about the previous occurrence? What was different?
- Is this a common problem in the industry?
- Has anyone else solved it?
- How will my solution affect upstream processes?
- How will it affect downstream processes?



Practically Speaking…



Turn the lens around

Why is the problem unsolved?

What are the high performers doing right?

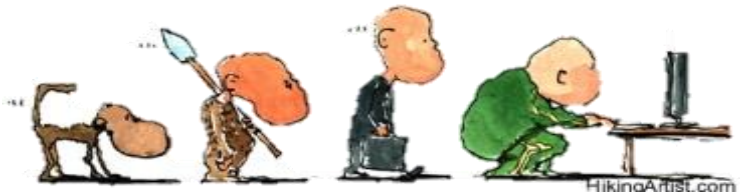
What caused the “right thing” to happen?

ARUP LABORATORIES

Co-evolution

A complex adaptive system is a pendulum, continually moving through states of balance and chaos.

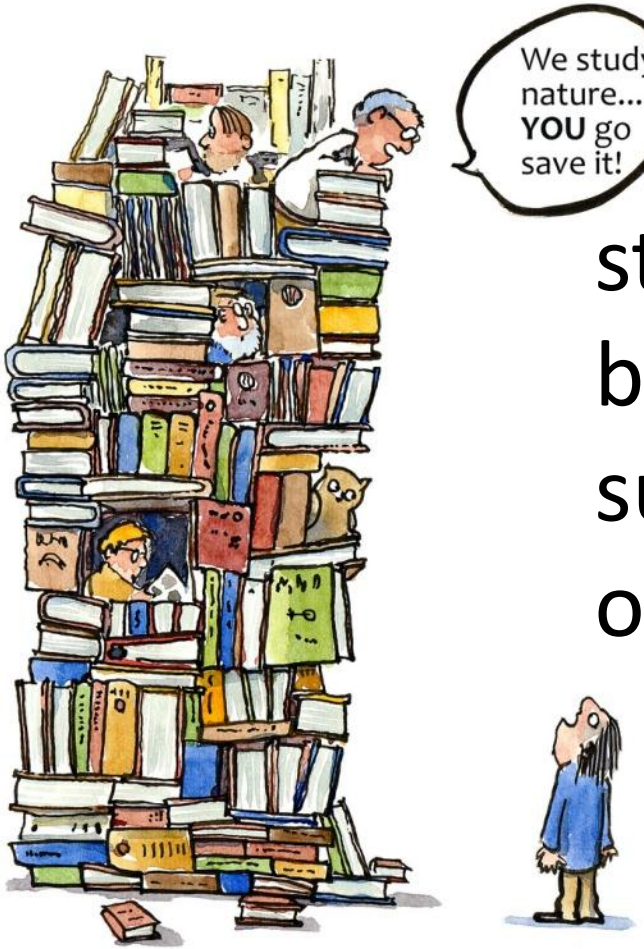
Changes made by one agent force an adaptive change in the next.



Practically Speaking…

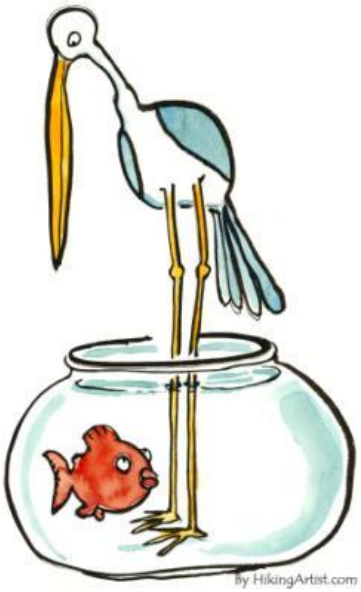
The first step in creating a culture of innovation requires overcoming paradigm paralysis

Importance of Context



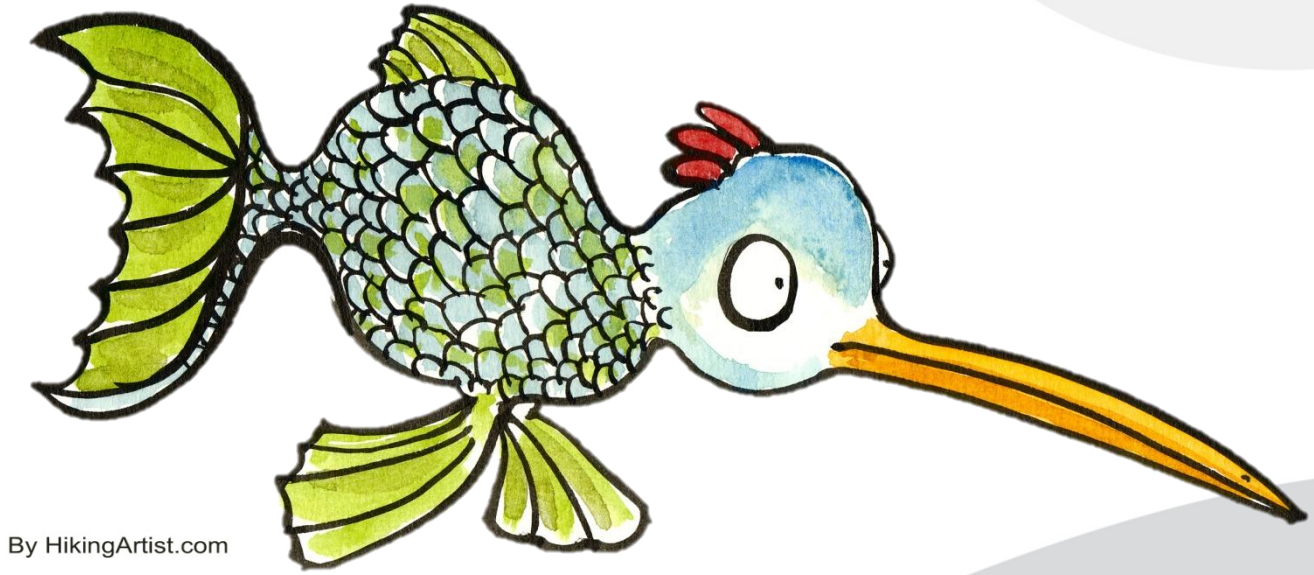
Any improvement strategy, no matter how brilliant, has little chance of success if it operates outside the context of our belief about ourselves and our work.

ARUP LABORATORIES



"Management systems that conform to a rigid and complex "quality" blueprint in the hope of rubber-stamping success will fail…

…The successful strategy is one that creates a unique culture of quality that has the ingenuity and intelligence to continually evolve.”



(Benson, *Journal for Healthcare Quality*, September/October 2005)

The Key to Error-Proofing

- Understanding human limitations
- Designing processes within the context of the current reality
- Establishing an open, learning, patient-centered culture

Questions?

ARUP® LABORATORIES | NATIONAL REFERENCE LABORATORY