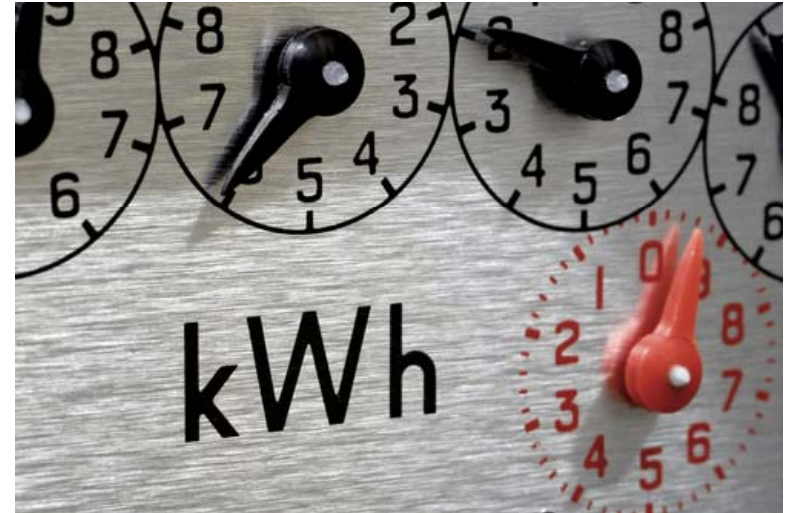**Analytics for Reliability Enhancement**

Human & Organizational Perspectives on Organizational Assessment

NERC
March 26, 2013

Utility Analytics

business transformation, data analysis, outage management and call center operations, predictive maintenance, credit & collections, demand forecasting, customer engagement, grid optimization
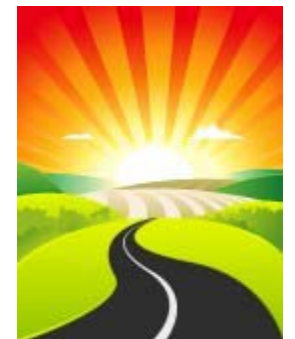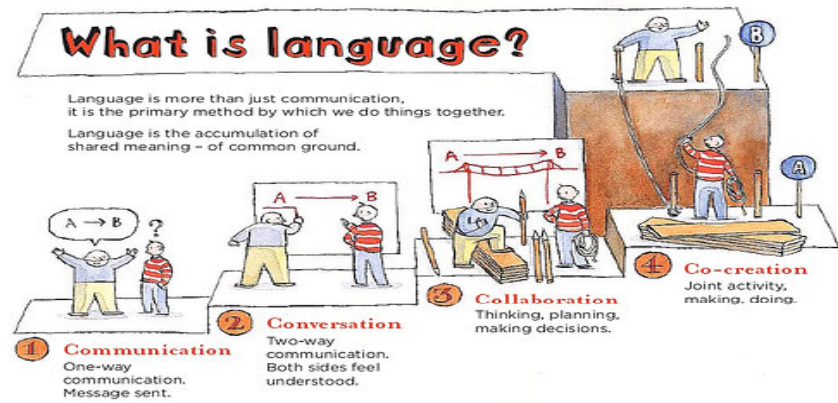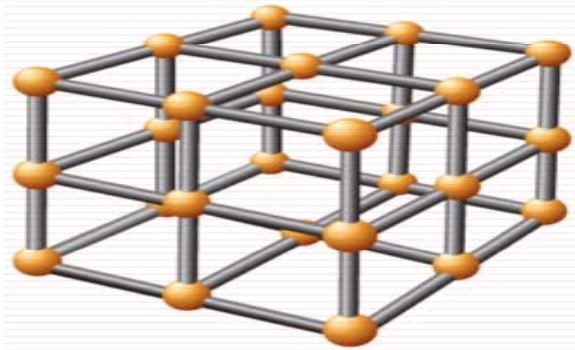
What's missing?

•Organizations as complex socio-technical systems
•Assessment of both technical & social components
•Putting it all together to identify evidence based improvements

Sustaining Reliability:
A short course for long journey

- What is the purpose of organizational assessment?
- How do you make sense of the assessments you conduct?
- Is there a theoretical basis for assessments that aligns with your purpose?
- What methods do you use to assess?
- Are the methods aligned with your purpose?
- If you plot the conclusions and recommendations from all assessments are they aligned with the purpose?
- Can you see a trajectory of change in conclusions/recommendations overtime?
- Are your assessments making an impact? How do you know?

What is language?

Language is more than just communication, it is the primary method by which we do things together.

Language is the accumulation of shared meaning – of common ground.

1. **Communication**
One-way communication. Message sent.

2. **Conversation**
Two-way communication. Both sides feel understood.

3. **Collaboration**
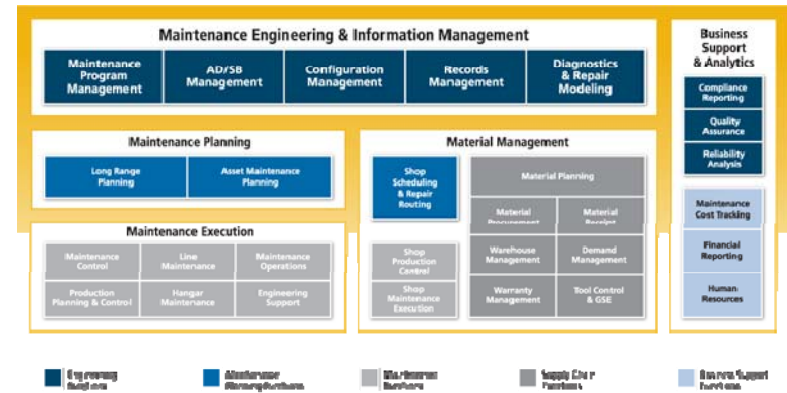Thinking, planning, making decisions.

4. **Co-creation**
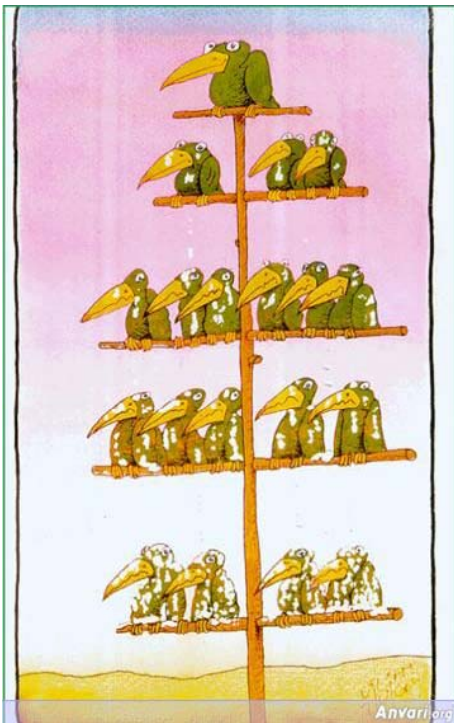Joint activity, making, doing.

…a

Organizations: many perspectives -

What is a socio-technical system?
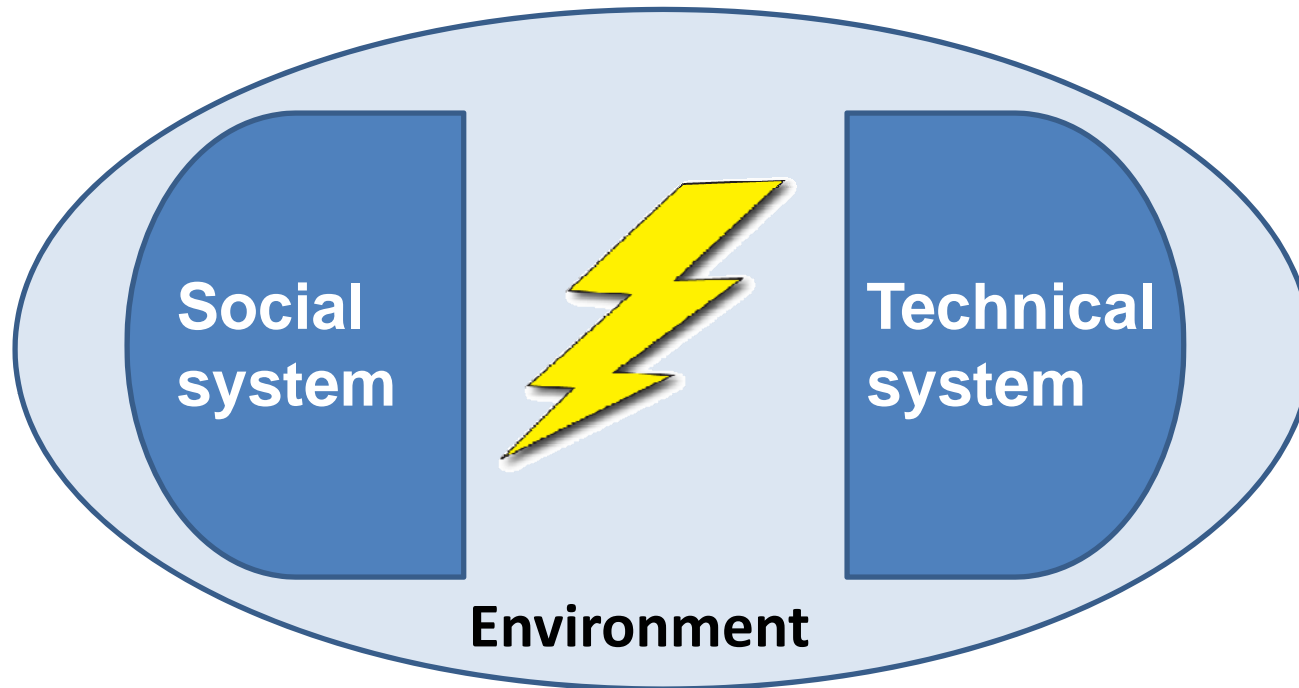
- ➢ Jointly designed & optimized
- ➢ Human focused approach

What is a System?

- A perceived whole whose elements 'hang together' because they continually affect each other over time and operate toward a common purpose
  - Senge et. al.

SOCIAL SYSTEMS

1) INDIVIDUAL   2) GROUP   3) SYSTEM
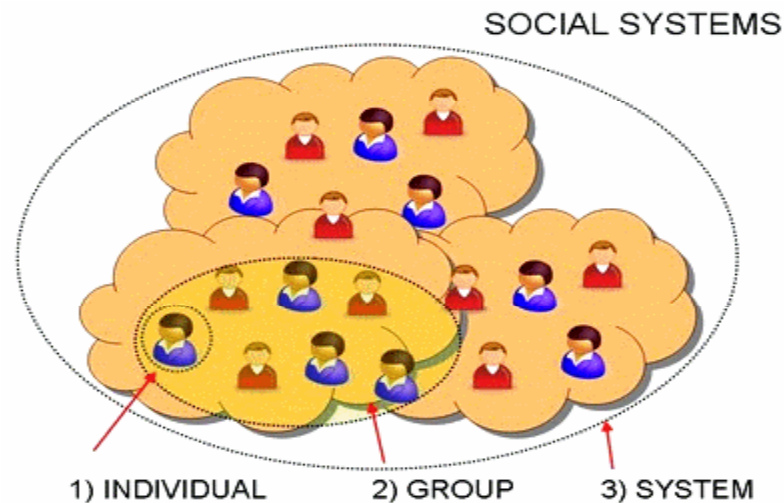
Systems Theory

- Synergy
- Interdependence
- Interconnections
  - within the organization
  - between the organization and the environment
- Organization as CAS ecology
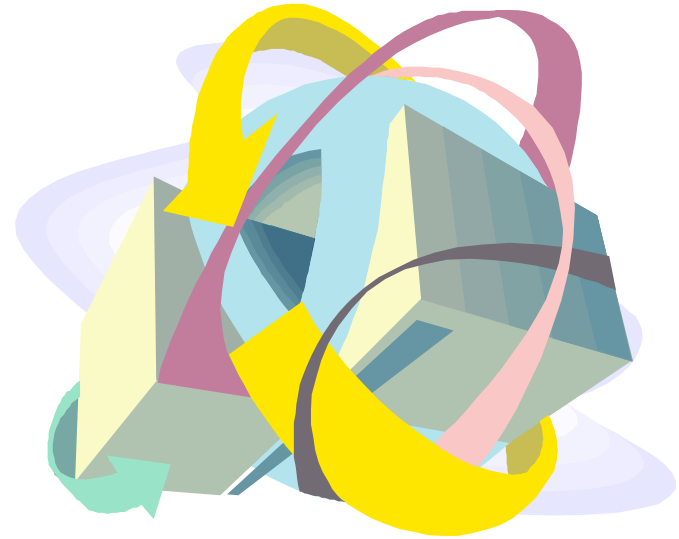
Systems Framework

- NOT a theory of management - new way of conceptualizing and studying organizations
- Four Strengths
  - Designed to deal with complexity
  - Attempts to do so with precision
  - Takes a holistic view
  - It is a theory of emergence -

Characteristics - Organizations as Systems

➢ **Role of Communication**
  - Communication mechanisms to **exchange relevant information with environment**
  - **Flow of information** among the subsystems
  - **Energy that sustains social systems**

➢ **Systems, Subsystems, and Supersystems**
  - Interrelated parts process inputs into outputs
  - Subsystems do the processing
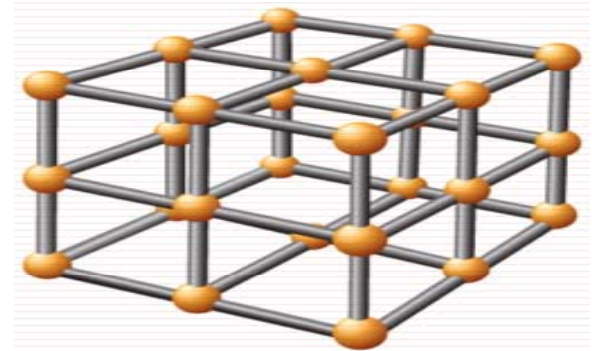 - Supersystems - other systems in environment on which the survival of the focal system is dependent

➢ **Five Main Types of Subsystems**
  - Production (technical) - concerned with throughputs
  - Supportive - ensure production inputs are available
  - Maintenance - social relations in the system-HR, training
  - Adaptive - monitor the environment & generate responses
  - Managerial - coordinate, adjust, control, & direct subsystems

Bottom Line

The same misunderstandings & problems that continue to occur will eventually cause fatal damage to the system.
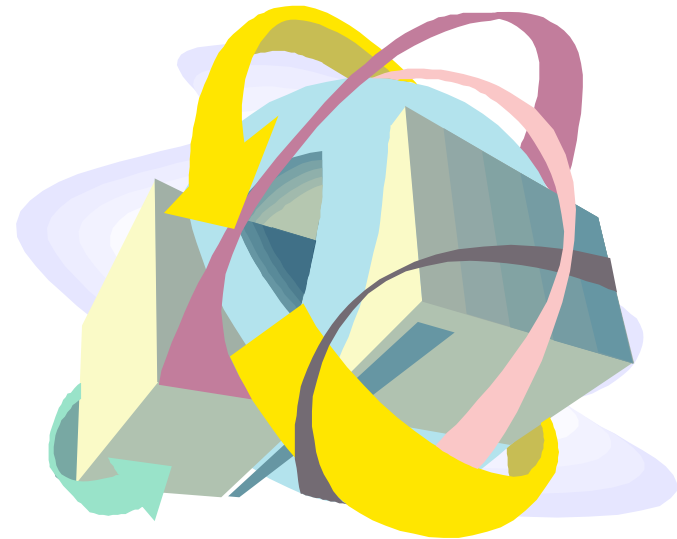
Practical Application of Systems Theory

The Learning Organization

– Continually expanding capacity to *create its future*

– Occurs under two conditions

- 1) Design of organizational action aligns with the intended purpose
- 2) Mismatches between intentions & results corrected with no unintended adverse outcomes

– *Increased adaptability*

– Evolves to generative learning

Peter Senge's *The Fifth Discipline: The Art and Practice of the Learning Organization (1990)*

The Learning Organization

- Through communication, teams are able to learn more than individuals operating alone.

- Leadership is key element in creating & sustaining a learning organization.

- Leaders responsible for promoting atmosphere conducive to learning

- CREATIVE TENSION
  - Difference between the "vision" of where the organization could be & reality of current organizational situation.

Our reach should exceed our grasp

Impediments to Learning Organization

- **Complexity of the Environment**
  - Difficult to determine cause & effect
  - Multiple contributing elements in complex environments
- **Internal Conflicts**
  - Individuals, teams, departments, & subcultures often at odds
  - Energy is drained by conflict

  ➢ Organization members must be trained in communication & conflict-negotiation skills

Systems Approach Summarized

- Systems Theory is NOT a prescriptive management theory
- Attempts to widen lens through which we examine and understand organizational behavior
- The Learning Organization
  - Synergy
  - Whole greater than sum of parts
  - Interdependence
  - No single solution, new problems and solutions emerge
  - Requisite Variety
  - Emphasizes COMMUNICATION in the Learning Process
- Organizations cannot separate from their environment
- Organizational teams or subsystems cannot operate in isolation

"…the system by which companies are directed & controlled"

…the framework by which various stakeholder interests are balanced; or,

…"the relationships among the management, Board of Directors, controlling shareholders, minority shareholders & other stakeholders".

What does good governance look like?

Functions of Governance

➢ **Governance creates & aligns**
- organizational structures & policies,
- roles, responsibilities, & accountability
- processes,
- programs,
- procedures,
- standards

➔**to guide** operation, maintenance, & support of technical operations.

➢ Corporate governance considers relationships among stakeholders & organization's goals.
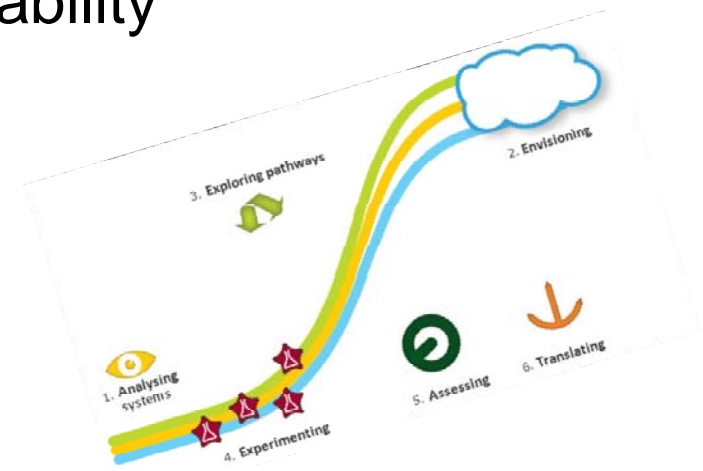
Management Control Systems

➢ ....tools for steering an organization toward goals & strategic objectives

➢ gather & use information to evaluate performance of different organizational resources (human, physical, financial) & and organization as a whole

Levels of Control

➡️ **Four [4] levels of control include:**
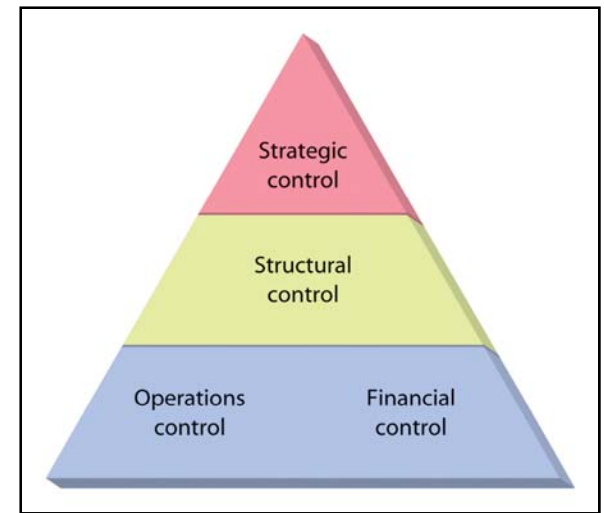
➡️ **Operations Control** – focuses on the processes the organization uses to transform resources into products or services.

➡️ **Financial Control** – concerned with the organization's financial resources.

➡️ **Structural Control** – concerned with how the elements of the organization's structure are serving their intended purpose.

➡️ **Strategic Control** – focuses on how effectively the organization's strategies are succeeding in helping the organization meet its goals.

OVERSIGHT

…verification that the standards, expectations, and goals established through governance of the organization are met.

Principles for Strong Governance and Oversight of Nuclear Power Organizations, INPO (Preliminary), 2011

What is the Purpose of Assessment & Analysis?
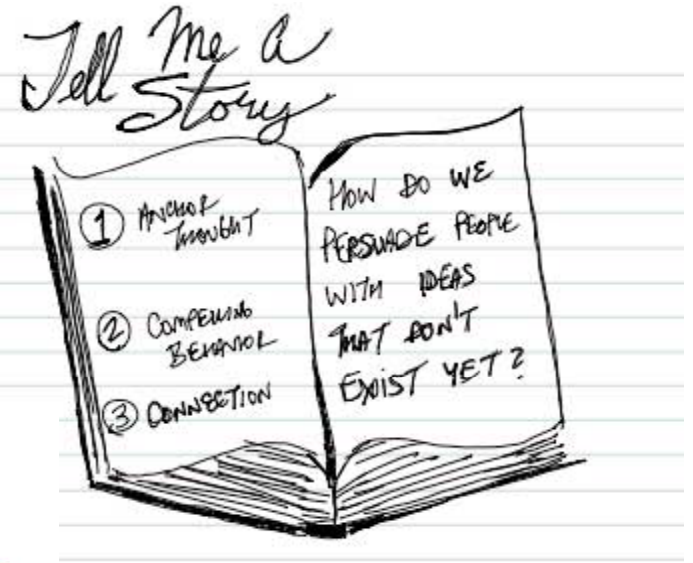
The real voyage of discovery consists not in seeking new landscapes, but in having new eyes.

Marcel Proust

What's the story?

Children running
from explosion
in Baghdad Iraq

Children playing
at school in
Atlanta

Students from
Sandy Hook
Elementary School
after their
Superbowl
performance

Data alone has no meaning; it takes context to make sense

"Well, your structure looks good, but I'm afraid your vision is weak."
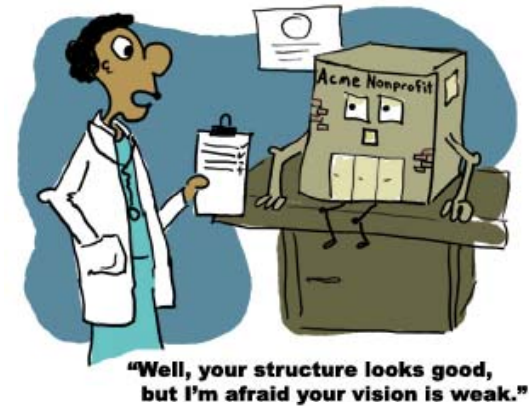
www.FieldstoneAlliance.org

"The purpose of an organizational evaluation is not usually to explain what has happened but to judge whether an organization is capable of managing risks and creating sufficient safety in its activities. *The focus of an organizational safety evaluation is on the future* – to assess the organization's potential for safe performance."

"A Guidebook for Evaluating Organizations in the Nuclear Industry – an example of safety culture evaluation" VTT 2011

Our Knowledge is Imprecise; Tools Help

"One aim of the physical sciences has been to give an exact picture of the material world. One achievement of physics in the twentieth century has been to prove that that aim is unattainable.
"There is no absolute knowledge… All information is imperfect. We have to treat it with humility."
[Bronowski, 1973]

From earliest times, humans had tools like hammers that extended our physical self. Today's technology extends our mental self. It's changing the way we experience the world.
—Amber Case, Cyborg Anthropologist

Evidence based – collecting data

- Self-assessments
- Post-job reviews
- Problem reporting
- Observations
- Performance indicators & trending
- Operating experience
- Benchmarking
- Management oversight & involvement
- Causal analysis
- Interviews
- Focus groups

Causal Analysis

- Usually assumes linear causation

    Why?
    Why?
    Why?
    Why?

- Systems thinking assumes interconnectedness and loops – every influence is both cause & effect
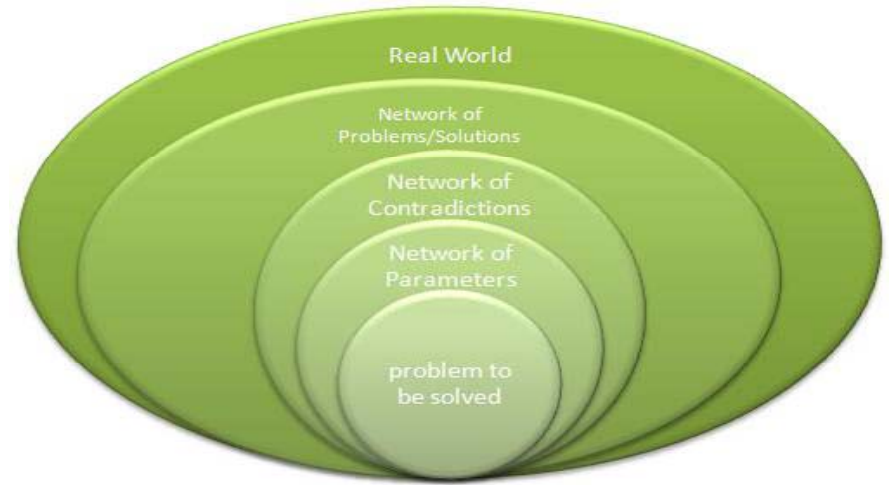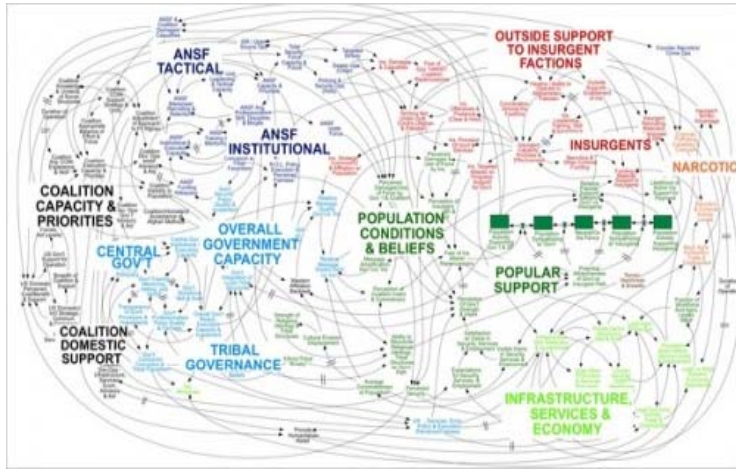
In complex systems analysis *reduces* complexity
to a certain extent, so the components
are *more* amenable to scientific and causal
theorizing than the whole…

Analysis is modeling the problem -
Analysis patterns are as important as
design patterns.

"The soul...never thinks without a picture."
Tips/Suggestions   Aristotle
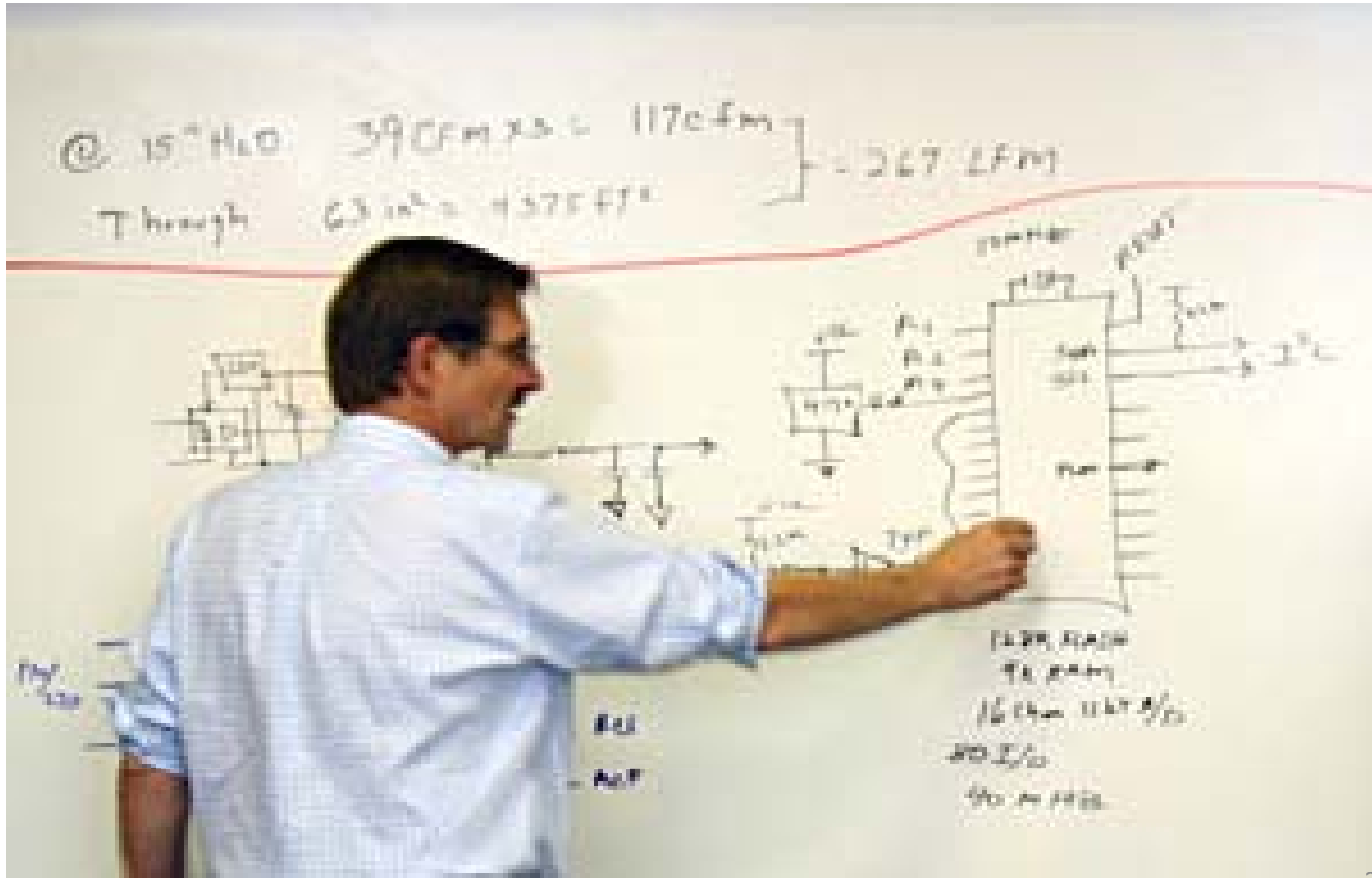
Models
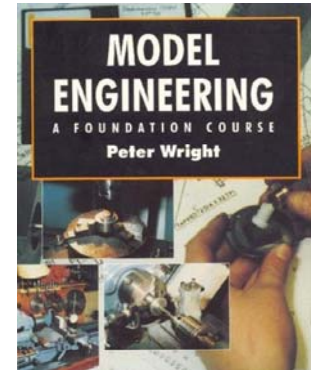
- **Why teach models?**
  - If you want to teach people a new way of thinking, don't bother trying to teach them. Instead, give them a tool, the use of which will lead to new ways of thinking.
    - (Buckminster Fuller)
- **What are they?**
  - A representation of how something works – the important variables and how they relate to each other
  - A list of important considerations

Models

- Models provide multiples "lenses"
- They are frameworks, not 'how to' books
  - Show where to look, give 'threads to pull'
  - But not the 'right' answer
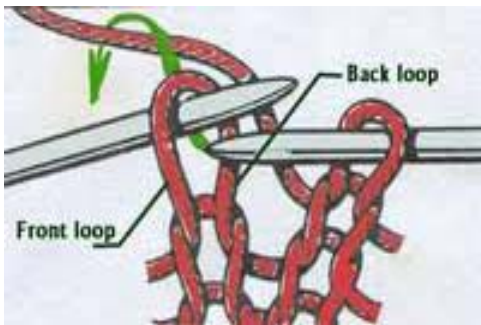
- Tools & their use evolve & improve with experience

Data first, diagnose second, _then_ act

Models help you make sense of data –

What?
So what?
What now?

Why Use a Particular Method?

➢ Because none of us can think of all the questions relevant to complex systems on our own

➢ Because we each bring our own personal and professional knowledge and biases to the table

➢ Why reinvent the wheel every time?

Modeling Tools for Assessment & Analysis

Brainstorming
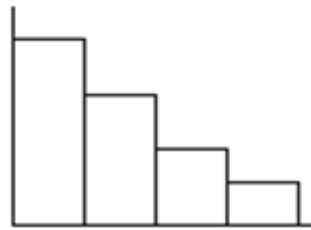
Pareto Chart

Fishbone Diagram
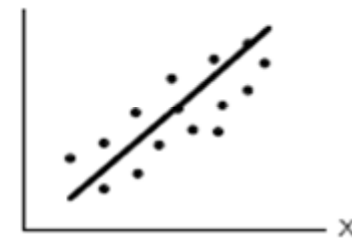
Scatter Diagram
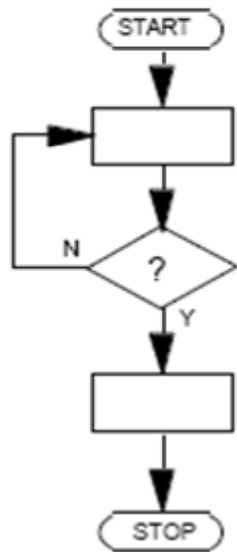
Flowchart
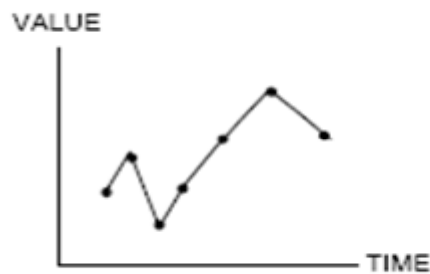
Run Chart
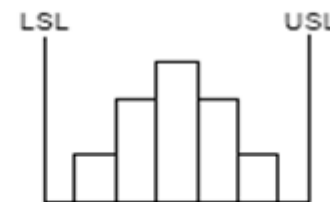
Histogram
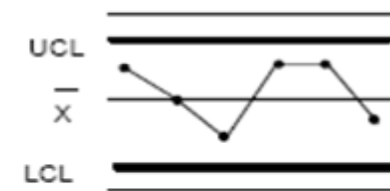
Control Charts
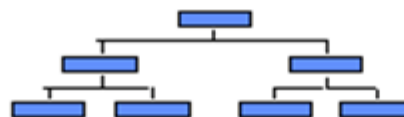
Tree Diagram
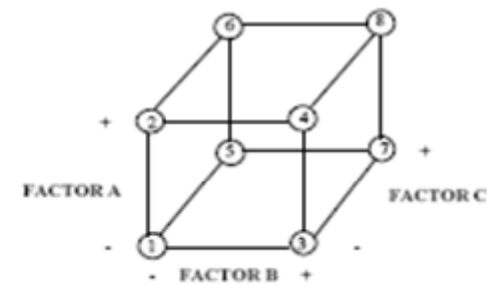
Design of Experiments
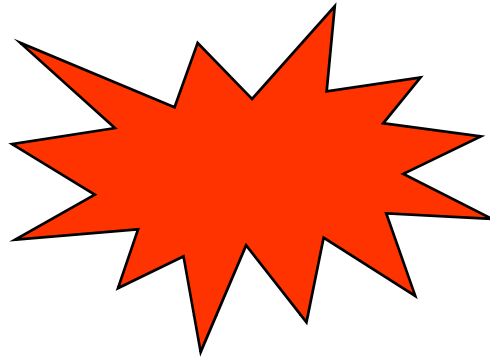
Technical subsystem tools

Event and Causal Factor Charting

CF = Causal Factor
* = Item of Note
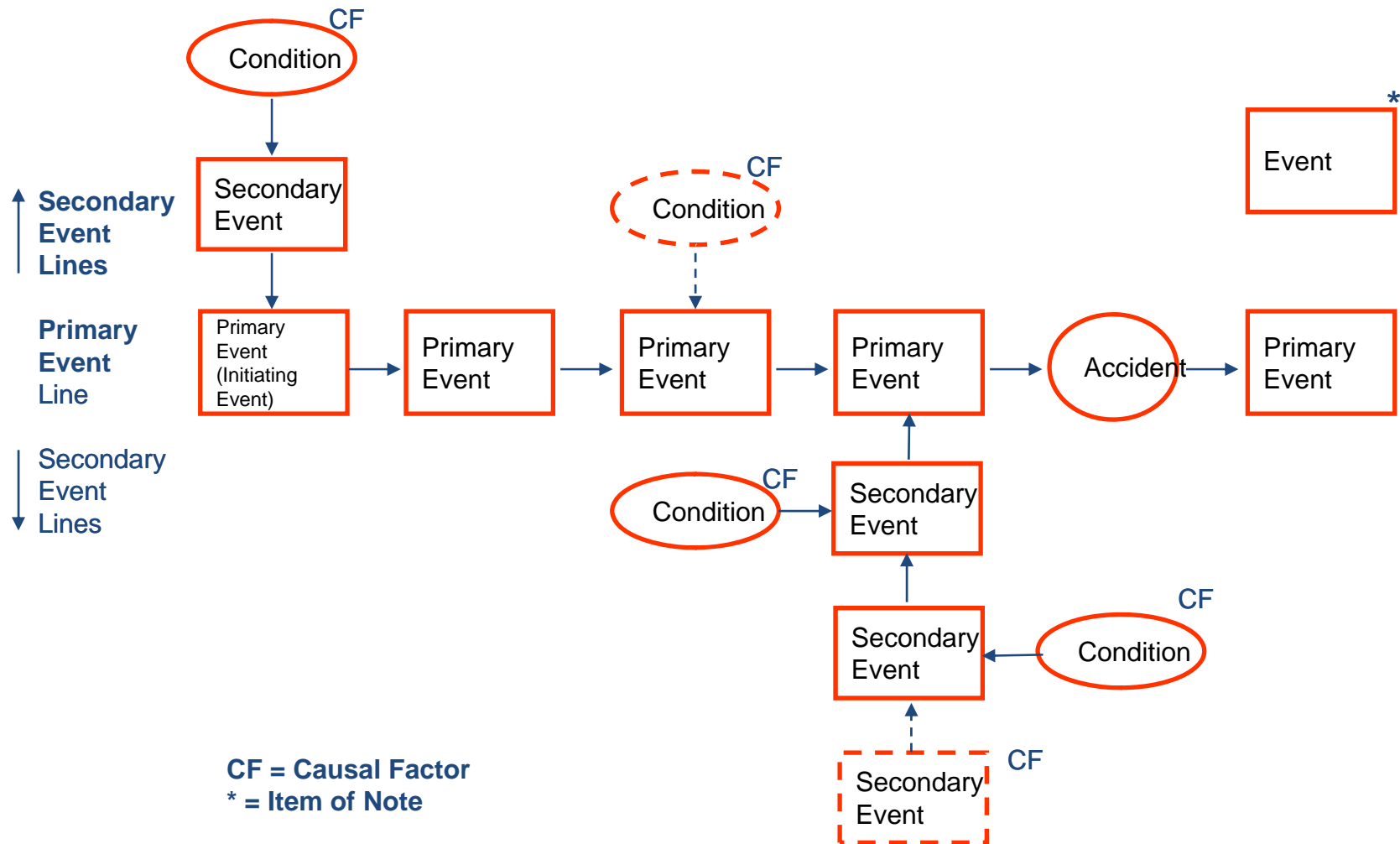
Barrier Analysis

Sequence of events:

System Tagout — Tag Hung — Electricians Given Assignment — Electricians Follow Procedure — Reactor Trip

Barriers Analysis

Start	Tagout Process Step 1	Tagout Process Step 2	Communications Process Interface	Procedure	Occurrence
Barrier Holds	Barrier Holds	Barrier Holds	Barrier Fails	Barrier Fails	Barrier Fails

Change Analysis

1 Occurrence with undesirable consequence

3 Compare

2 Comparable activity without undesired result

4 Identify differences

5 Analyze differences for effect on undesired consequences

6 Integrate information relevant to the causes of undesired consequence

Task Analysis

```
┌─────────────┐     ┌─────────────┐     ┌─────────────┐     ┌─────────────┐
│   Obtain    │     │   Select    │     │   Obtain    │     │  Prepare a  │
│ Preliminary │ ──▶ │  Task(s) of │ ──▶ │  Detailed   │ ──▶ │    Task     │
│ Information │     │  Interest   │     │ Information  │     │ Performance │
│             │     │             │     │             │     │    Guide    │
└─────────────┘     └─────────────┘     └─────────────┘     └─────────────┘
                                                                   │
                                                                   ▼
```

Reenact Task Performance (Preferred Method)

Interview Personnel (Alternate Method)

Evaluate & Integrate Findings

Select Personnel

Get Familiar With Your Guide

Technical system

→ **social system**

tools

Objective

Strategy

Goals

Initiative Drivers

Enablers

Elements

Results
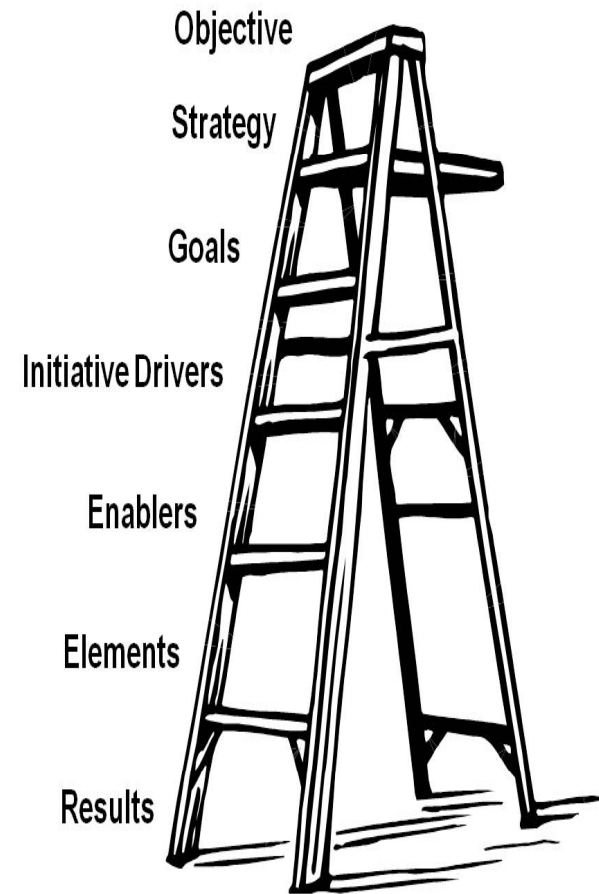
Basic Systems Event Model

ΔW

Work-as imagined

Flawed Defenses ← Manage Defenses

Work-as-done

Vision, Beliefs, & Values

2

Md

Closer Vision, Beliefs, & Values

Mission Goals Policies Processes Programs

No Event

3

Identify & Fix Latent Organizational Weaknesses

Re

4

Minimize Initiating Action

1

Human Errors ← Reduce Errors Frequency
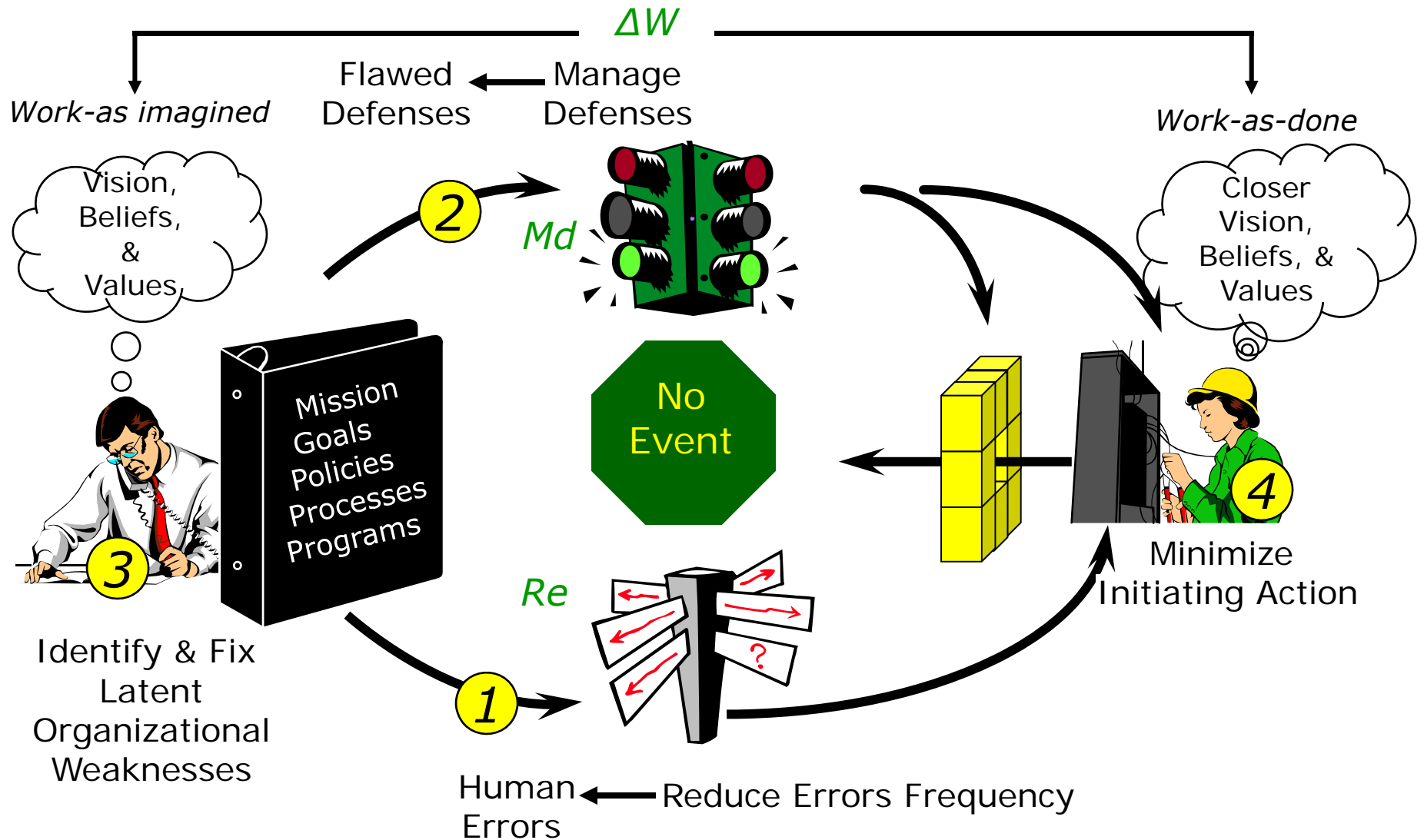
Precursors: What factors shape performance?

Task Demands	Individual Capabilities
▪ Time pressure (in a hurry)	▪ Unfamiliarity w/ task / First time
▪ High Workload (memory requirements)	▪ Lack of knowledge (mental model)
▪ Simultaneous, multiple tasks	▪ New technique not used before
▪ Repetitive actions, monotonous	▪ Imprecise communication habits
▪ Irrecoverable acts	▪ Lack of proficiency / Inexperience
▪ Interpretation requirements	▪ Indistinct problem-solving skills
▪ Unclear goals, roles, & responsibilities	▪ "Hazardous" attitude for critical task
▪ Lack of or unclear standards	▪ Illness / Fatigue
Work Environment	**Human Nature**
▪ Distractions / Interruptions	▪ Stress (limits attention)
▪ Changes / Departures from routine	▪ Habit patterns
▪ Confusing displays or controls	▪ Assumptions (inaccurate mental picture)
▪ Workarounds / OOS instruments	▪ Complacency / Overconfidence
▪ Hidden system response	▪ Mindset ("tuned" to see)
▪ Unexpected equipment conditions	▪ Inaccurate risk perception (Pollyanna)
▪ Lack of alternative indication	▪ Mental shortcuts (biases)
▪ Personality conflicts	▪ Limited short-term memory

JOB-SITE CONDITIONS

- Equipment Ergonomics & Human Factors
- Environmental Conditions
- Work-arounds & Inconveniences
- Fitness-for-Duty
- Worker Knowledge, Skill, & Proficiency
- Procedure / Work Package Quality
- Equipment Labeling & Equipment Condition
- Personal Motives
- Morale
- Lockout / Tagout
- Tool Quality & Availability
- Intolerance for Error Traps
- Foreign Material Exclusion
- Values & Beliefs
- RWPs
- Uneasy Attitude
- Roles & Responsibilities

WORKER BEHAVIOR

- Flagging
- Housekeeping
- Questioning Attitude
- Critical Parameters
- Effective Communication
- Procedure Use & Adherence
- Conservative Decision-Making
- Management Monitoring
- Rigor
- Self-Checking
- Place-Keeping
- Problem-solving Methodology
- Concurrent Verification
- Supervision
- Peer-Checking
- Job-site Review
- Recognizing Error Traps
- Team Skills
- Stop When Unsure

(center cluster between Job-Site Conditions and Worker Behavior)
- Turnover
- Clearance Walkdown
- Prejob Briefing
- Just-in-time Operating Experience
- Task Preview

ORGANIZATIONAL FACTORS

- Handoffs
- Training
- Procedure Revisions
- Rewards & Reinforcement
- Meetings
- Compatible Goals & Priorities
- Reviews & Approvals
- Role Models
- Safety Culture
- Strategic HU Plans
- Design & Configuration Control
- Staffing
- Op Ex
- Work Mgmt
- Simple / Effective Processes
- Problem-Solving
- Task Allocation
- Clear Expectations
- Self-Assessment
- Accountability
- Scheduling / Sequencing
- Change Mgmt.
- Benchmarking
- Socialization
- Labor Relations
- Corrective Action Program
- Communication Practices & Plan
- Management Oversight
- Trend Analysis

PLANT RESULTS

- Reactor Protection Systems
- Equipment Reliability
- Safeguards Equipment
- Containment

(cluster between Organizational Factors and Plant Results)
- Postjob Review
- Causal Analysis
- Problem Reporting
- Independent Oversight
- Performance Indicators

(left cluster)
- Walkdowns
- HP Surveys
- Task Qualification
- Task Assignment
- Performance Feedback

(right cluster)
- QC Hold Points
- Independent Verification
- Forcing Functions
- Interlocks
- Personal Protective Equipment
- Foreign Material Exclusions
- Alarms

Leadership

- Situation Awareness
- Coaching
- Respect for Others
- High Standards
- Reinforcement
- Motivation
- Courage & Integrity
- Healthy Relationships
- Proper Reactions
- Compelling Vision
- Sets Example
- Open & Honest Communication

45

Organization Focused Tools

Organizational Core Task

ANTICIPATING the state of the plant and the needed recourses, and acting accordingly

Co-ordination within maintenance and between maintenance, technical support and operations

Disseminating the knowledge concerning new phenomena, definition of responsibilities

FLEXIBILITY according to the situational state of the plant

LEARNING from incidents and operational experience also in other groups

Prioritisation of work tasks, co-operation between different technical fields

Technical competence and constant attention

Information management, uncertainty recognition, expert analyses

REACTING to sudden and unexpected incidents, and expected breakdowns

METHODICALNESS, ability to explain the actions taken and the methods used

MONITORING the state of the machinery and REFLECTING on the effects of actions

Adhering to work permit procedures, verification of the operability

Transparency of actions and documentation of work

MORT - Management Oversight and Risk Tree

Provisional Assumed Risks

Appendix A – Cause Code Quick Reference

NERC CCAP
Cause Code Quick Reference

nerc.lessonslearned@nerc.net   www.nerc.com

Start Here

A1 Design/ Engineering Problem	A2 Equipment/ Material Problem	A3 Individual Human Performance LTA	A4 Management Problem	A5 Communication LTA	A6 Training Deficiency	A7 Other Problem	A8 (Open)
B1 DESIGN INPUT LTA	B1 CALIBRATION FOR INSTRUMENTS LTA	B1 SKILL BASED ERROR	B1 MANAGEMENT METHODS LTA	B1 WRITTEN COMMUNICATIONS METHOD OF PRESENTATION LTA	B1 NO TRAINING PROVIDED	B1 EXTERNAL PHENOMENA	
B2 DESIGN OUTPUT LTA	B2 PERIODIC/ CORRECTIVE MAINTENANCE LTA	B2 RULE BASED ERROR	B2 RESOURCE MANAGEMENT LTA		B2 TRAINING METHODS LTA	B2 RADIOLOGICAL/ HAZARDOUS MATERIAL PROBLEM	**AX Overall Configuration Issue**
B3 DESIGN/ DOCUMENTATION LTA	B3 INSPECTION/ TESTING LTA	B3 KNOWLEDGE BASED ERROR	B3 WORK ORGANIZATION & PLANNING LTA	B2 WRITTEN COMMUNICATION CONTENT LTA	B3 TRAINING MATERIAL LTA		B1 INSTALLATION/ DESIGN CONFIGURATION LTA
B4 DESIGN/ INSTALLATION VERIFICATION LTA	B4 MATERIAL CONTROL LTA	B4 WORK PRACTICES LTA	B4 SUPERVISORY METHODS LTA	B3 WRITTEN COMMUNICATION NOT USED			B2 MAINTENANCE/ MODIFICATION CONFIGURATION LTA
B5 OPERABILITY OF DESIGN/ ENVIRONMENT LTA	B5 PROCUREMENT CONTROL LTA		B5 CHANGE MANAGEMENT LTA	B4 VERBAL COMMUNICATION LTA			
	B6 DEFECTIVE, FAILED, OR CONTAMINATED						

AN – <u>No causes found</u>

AZ – <u>Information to determine cause LTA</u>

NERC REGIONS

Level A nodes are underlined   Level C nodes are in "sentence case"
Level B nodes are in ALL CAPS   LTA = Less Than Adequate

Cause Code Binning example

806 = Individual behavior (32%)

1,676 = Org behavior (68%)
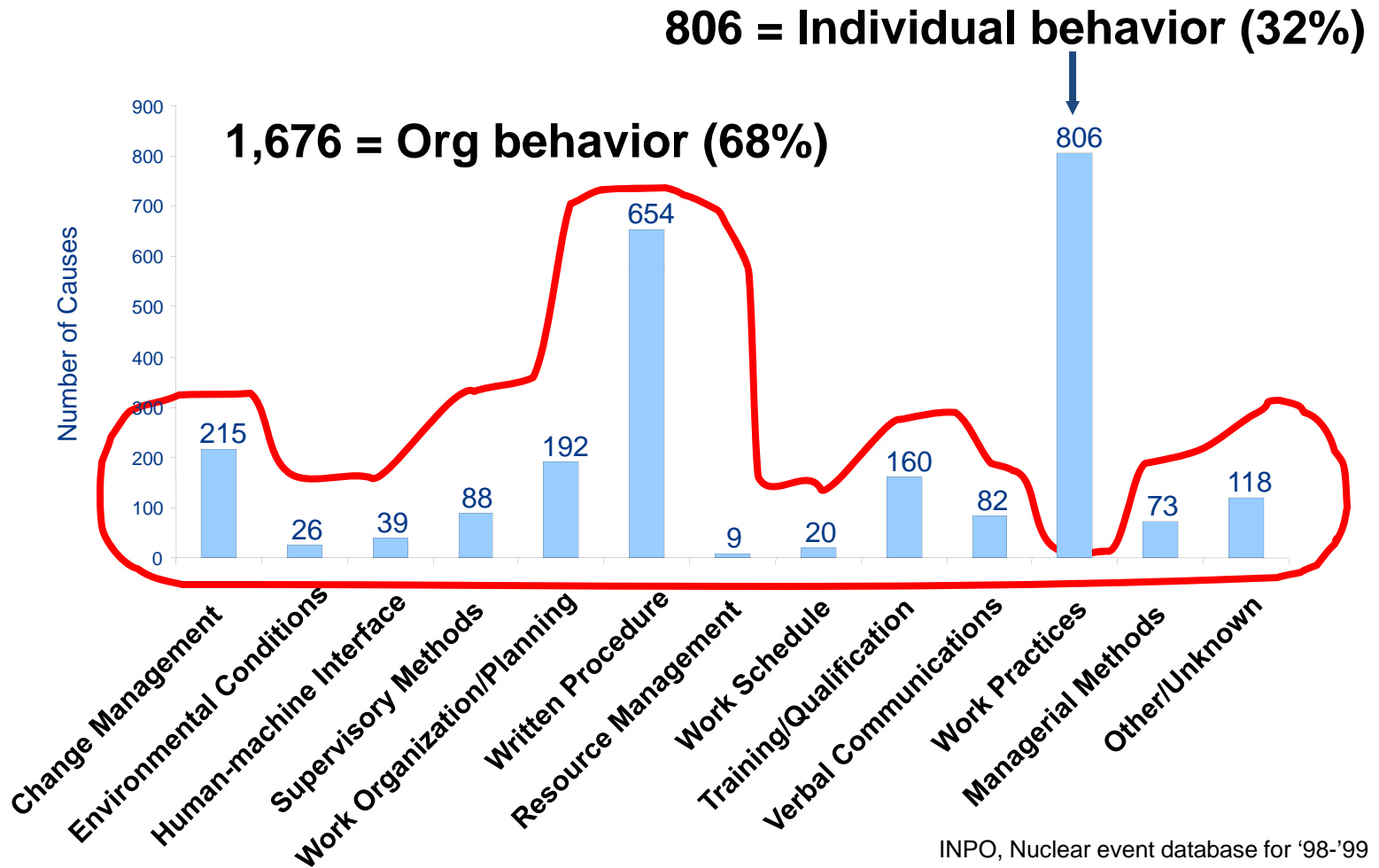
INPO, Nuclear event database for '98-'99

REGULATORY FRAMEWORK

NRC's Overall Safety Mission

PUBLIC HEALTH AND SAFETY AS A RESULT OF CIVILIAN NUCLEAR REACTOR OPERATION

Strategic Performance Areas

REACTOR SAFETY

RADIATION SAFETY

SAFEGUARDS

Cornerstones

INITIATING EVENTS → MITIGATING SYSTEMS → BARRIER INTEGRITY

EMERGENCY PREPAREDNESS

PUBLIC RADIATION SAFETY

OCCUPATIONAL RADIATION SAFETY

PHYSICAL PROTECTION

-------- HUMAN ---------------- SAFETY CONSCIOUS WORK ----------------- PROBLEM --------------
PERFORMANCE   ENVIRONMENT   IDENTIFICATION AND
                                                                                      RESOLUTION

Cross-Cutting Areas

51

Organizational Assessment Criteria Model

SECTION I – FUNCTIONAL AREAS

FUNDAMENTALS

1. Operations
2. Maintenance
3. Engineering
4. Chemistry
5. Radiological Protection
6. Training

SECTION II - CROSS-FUNCTIONAL AREAS

ORGANIZATIONAL EFFECTIVENESS

1. Foundation for Nuclear Safety
2. Leadership and Management
3. Human Performance
4. Management and Leadership Development
5. Independent Monitoring and Assessment
6. Industrial Safety

EQUIPMENT RELIABILITY

1. Equipment Performance
2. Prevention of Equipment Failures
3. Long-Term Equipment Reliability
4. Work Management

CONFIGURATION MANAGEMENT

1. Maintaining Margins Consistent with Design Requirements
2. Operational Configuration Control
3. Design Change Processes
4. Reactor Engineering and Fuel Management

PERFORMANCE IMPROVEMENT

1. Self-Assessment and Benchmarking
2. Corrective Action
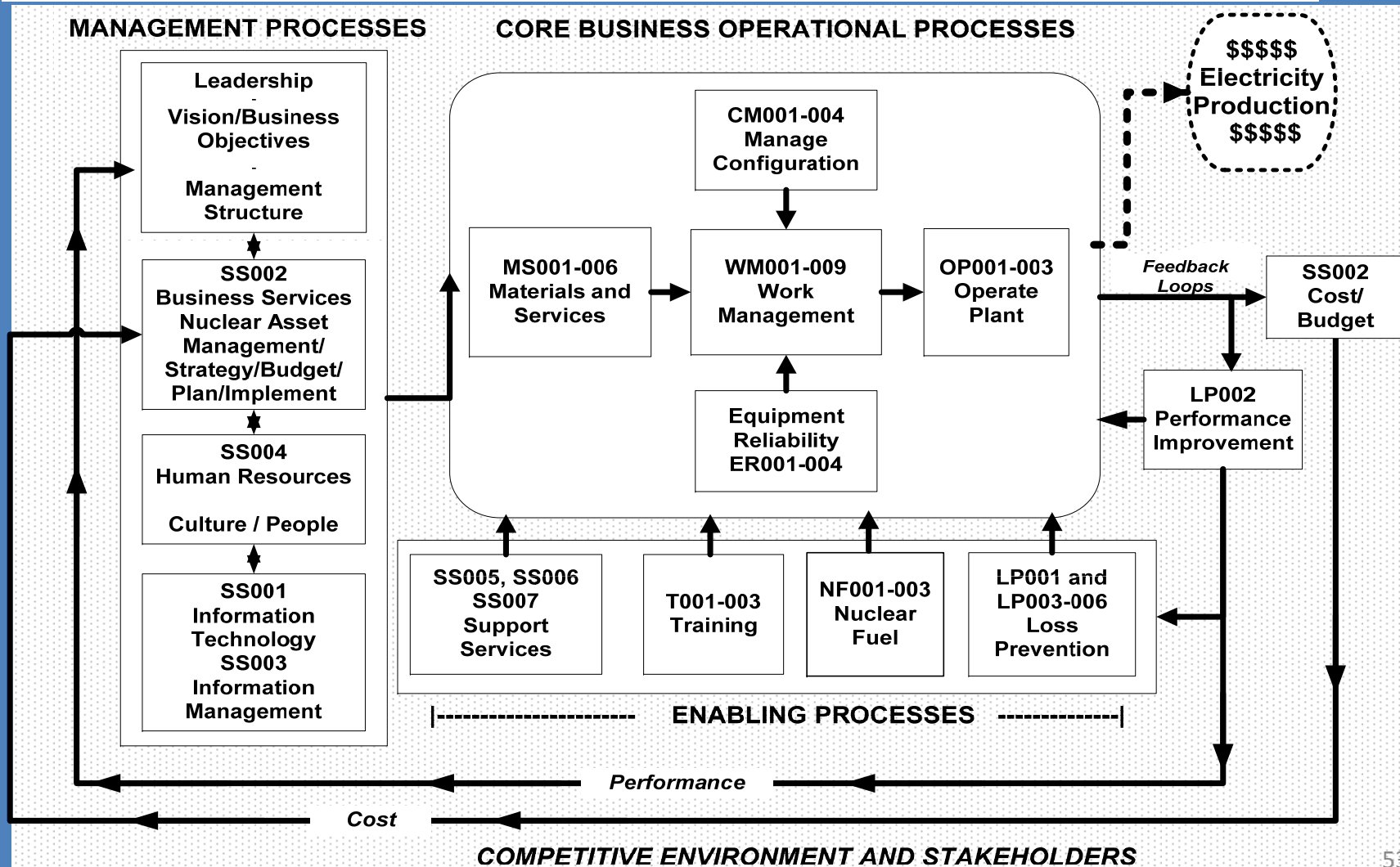3. Operating Experience

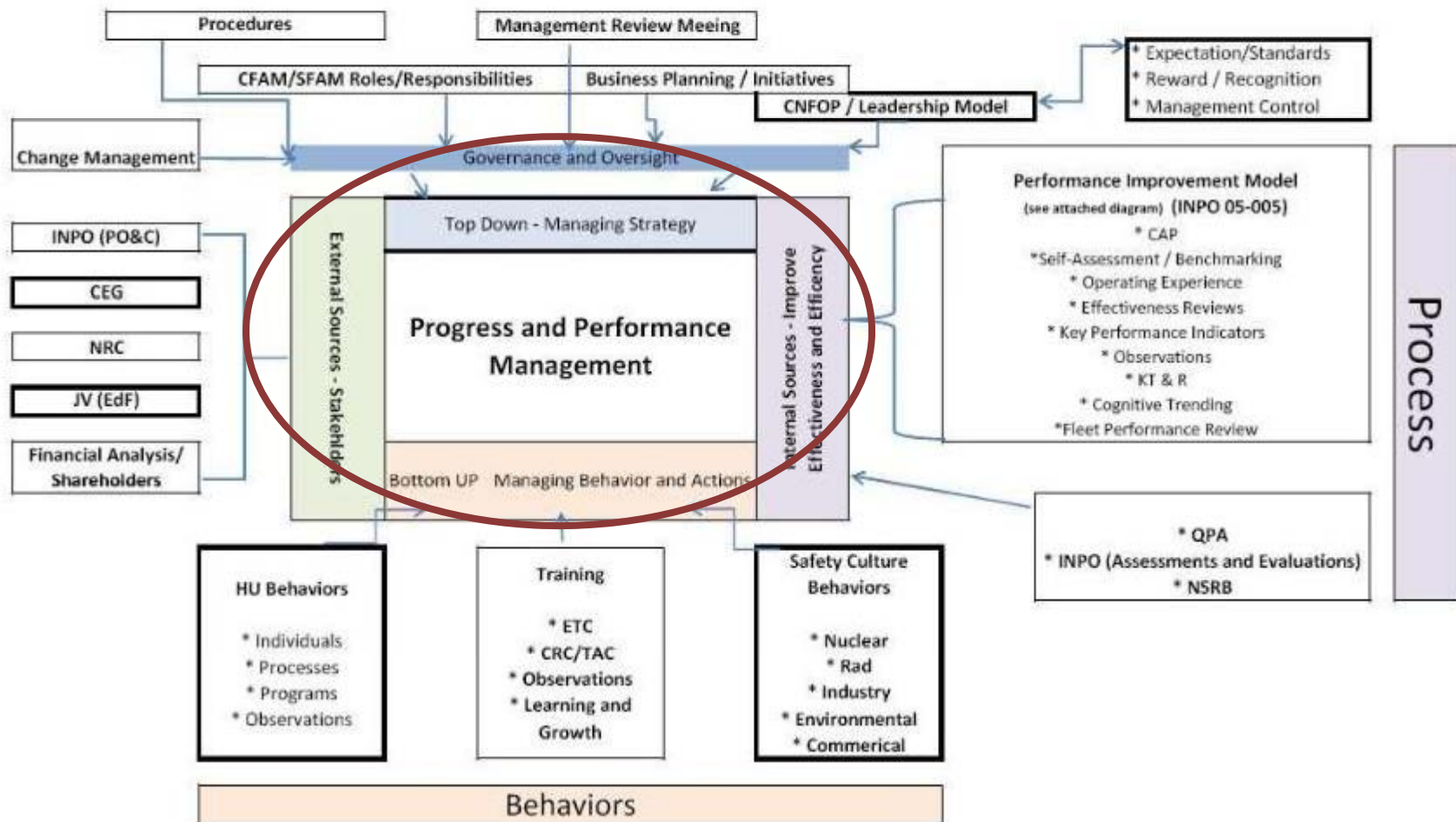**EMERGENCY PREPAREDNESS**

FIRE PROTECTION

SECTION III - CORPORATE AREAS

1. Corporate Leadership & Management
2. Corporate Oversight And Monitoring
3. Corporate Support
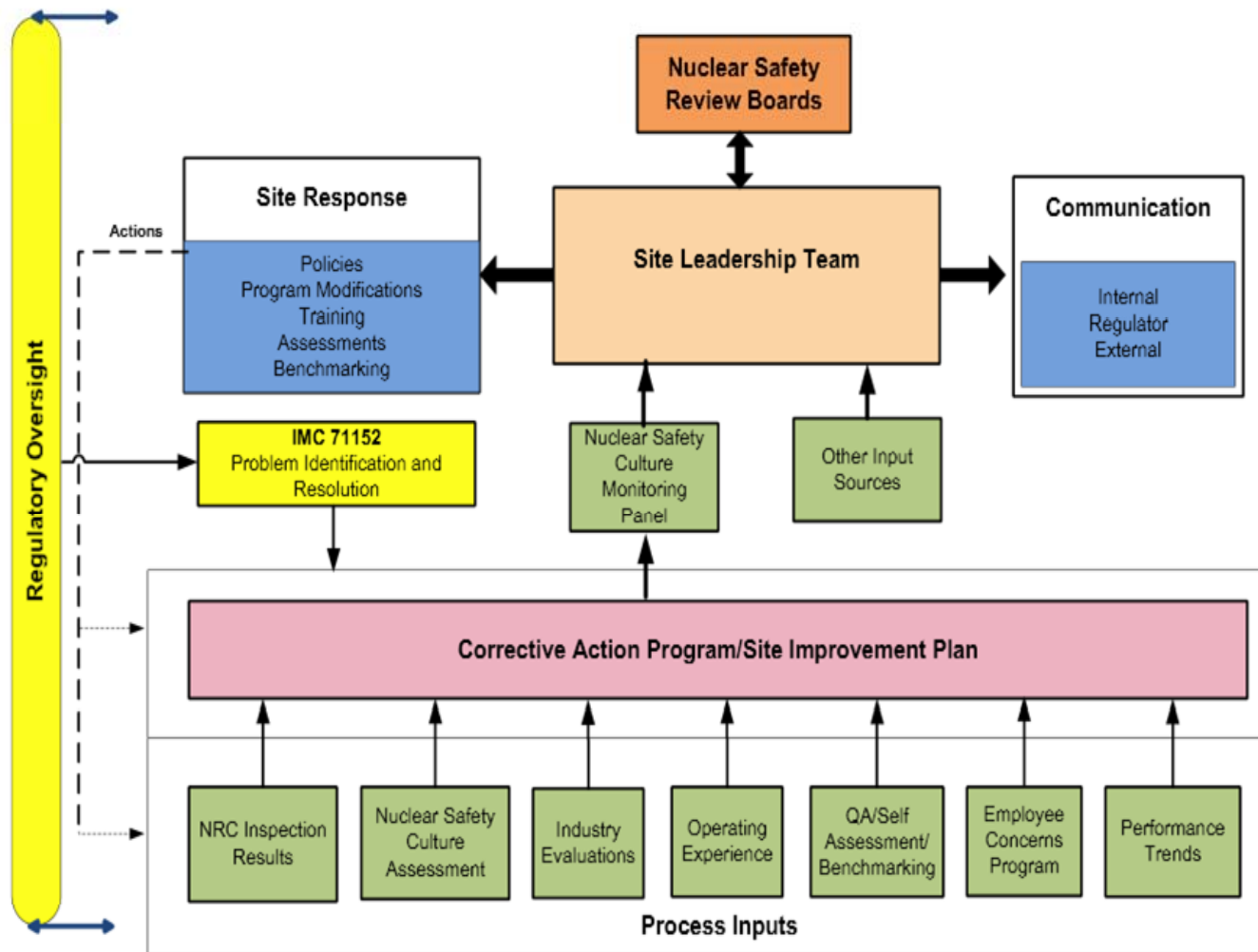4. Human Resources
5. Communications

Excerpt from INPO POCs

Organizational Process Model

STANDARD NUCLEAR PERFORMANCE MODEL (SNPM) - AN EXECUTIVE VIEW

MANAGEMENT PROCESSES

CORE BUSINESS OPERATIONAL PROCESSES

$$$$ Electricity Production $$$$

Leadership
-
Vision/Business Objectives
-
Management Structure

SS002
Business Services
Nuclear Asset Management/
Strategy/Budget/
Plan/Implement

SS004
Human Resources

Culture / People

SS001
Information Technology
SS003
Information Management

CM001-004
Manage Configuration

MS001-006
Materials and Services

WM001-009
Work Management

OP001-003
Operate Plant

Equipment Reliability
ER001-004

Feedback Loops

SS002
Cost/Budget

LP002
Performance Improvement

SS005, SS006 SS007
Support Services

T001-003
Training

NF001-003
Nuclear Fuel

LP001 and LP003-006
Loss Prevention

|----------------------- ENABLING PROCESSES --------------|

Performance

Cost

COMPETITIVE ENVIRONMENT AND STAKEHOLDERS

Organization Monitoring Model

Site Nuclear Safety Culture Process

Nuclear Safety Review Boards

Site Response

Policies
Program Modifications
Training
Assessments
Benchmarking

Actions

Site Leadership Team

Communication

Internal
Regulator
External

Regulatory Oversight

IMC 71152
Problem Identification and Resolution

Nuclear Safety Culture Monitoring Panel

Other Input Sources

Corrective Action Program/Site Improvement Plan

NRC Inspection Results

Nuclear Safety Culture Assessment

Industry Evaluations

Operating Experience

QA/Self Assessment/Benchmarking

Employee Concerns Program

Performance Trends

Process Inputs

Blueprint

for and effective HU programme

The Blueprint is made up of the following 7 key aspects:

Organisational Culture
- Safety Culture Surveys
- INPO HU/OR & SC AFI's

Leadership & Accountability
- Governance
- Oversight
- Support
- HU Strategy
- Roles and Responsibilities
- Management System

Engagement

Team
- Senior Managers
- Unions
- HU Factors
- Plant Touchers
- Knowledge Workers

Stakeholders
- Supply Chain
- INPO
- Regulators

Capability

Competence
- Nuclear Worker
- HU Coach
- HU Practitioner
- CFAM
- Contractor

HU Structure

Reporting, Learning & Measurement
- CAPS
- Benchmarking
- INPO Learning
- Metrics
- Sharing best practices

Managing Defences (latent error programme)

Point of Work Error Avoidance (active error programme)

The Blueprint is made up of the 7 key aspects required to implement an effective HU programme. The Blueprint is underpinned by a repository of information that includes all documented material to support the implementation of any effective human performance programme. The Blueprint shows all the ingredients required and your strategy is your method of baking the pie. The Blueprint also makes it easier to communicate to the plant based workforce who are used to this type of structure.

Draft 1.
Andrew George
CFAM, Sellafield Ltd

PEGASUS: Systems Thinking in Action
Boston – November 2010 – www.pegasus.com – graphics by Kelvy Bird of www.thevalueweb.org

System Tools
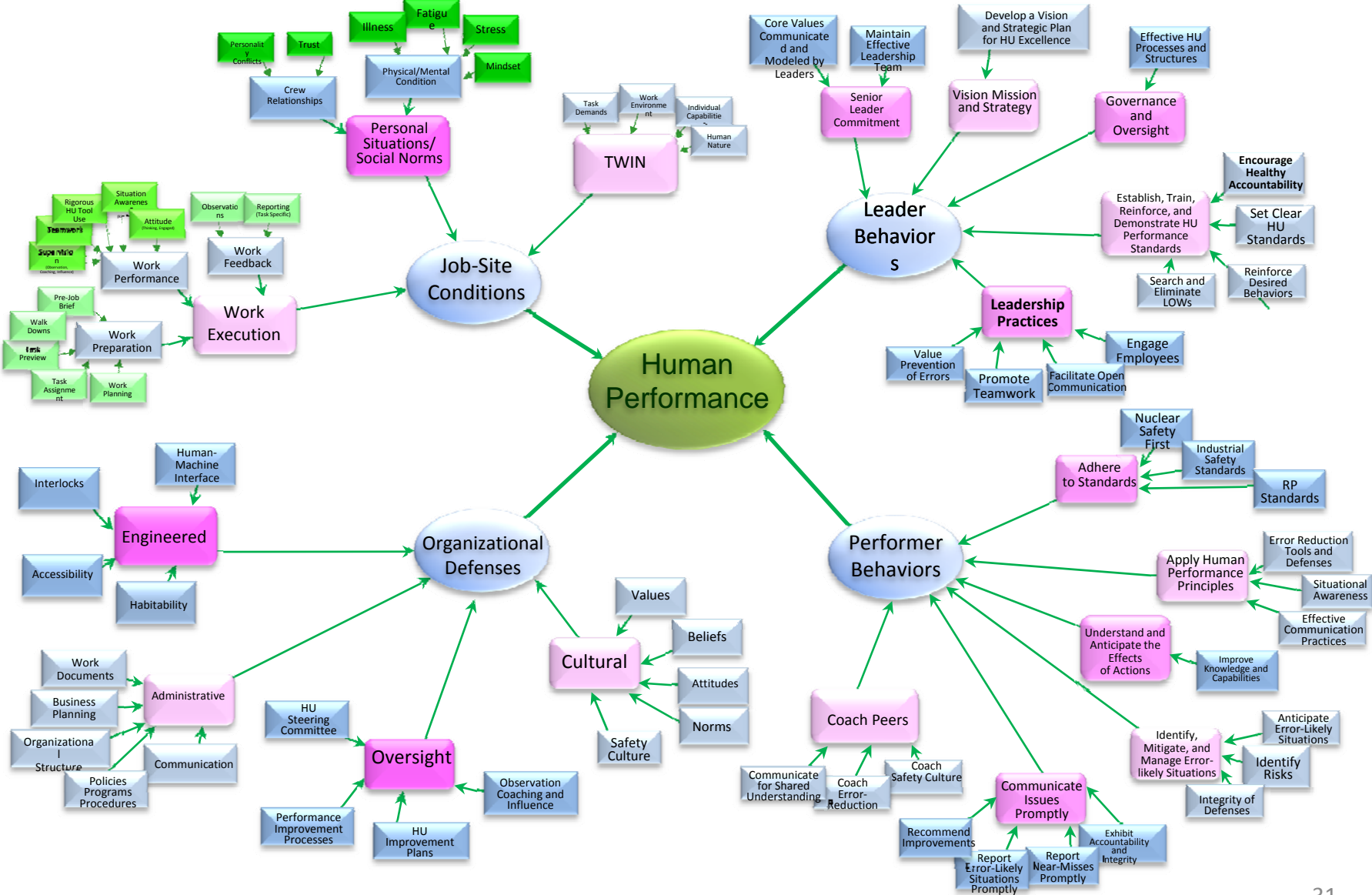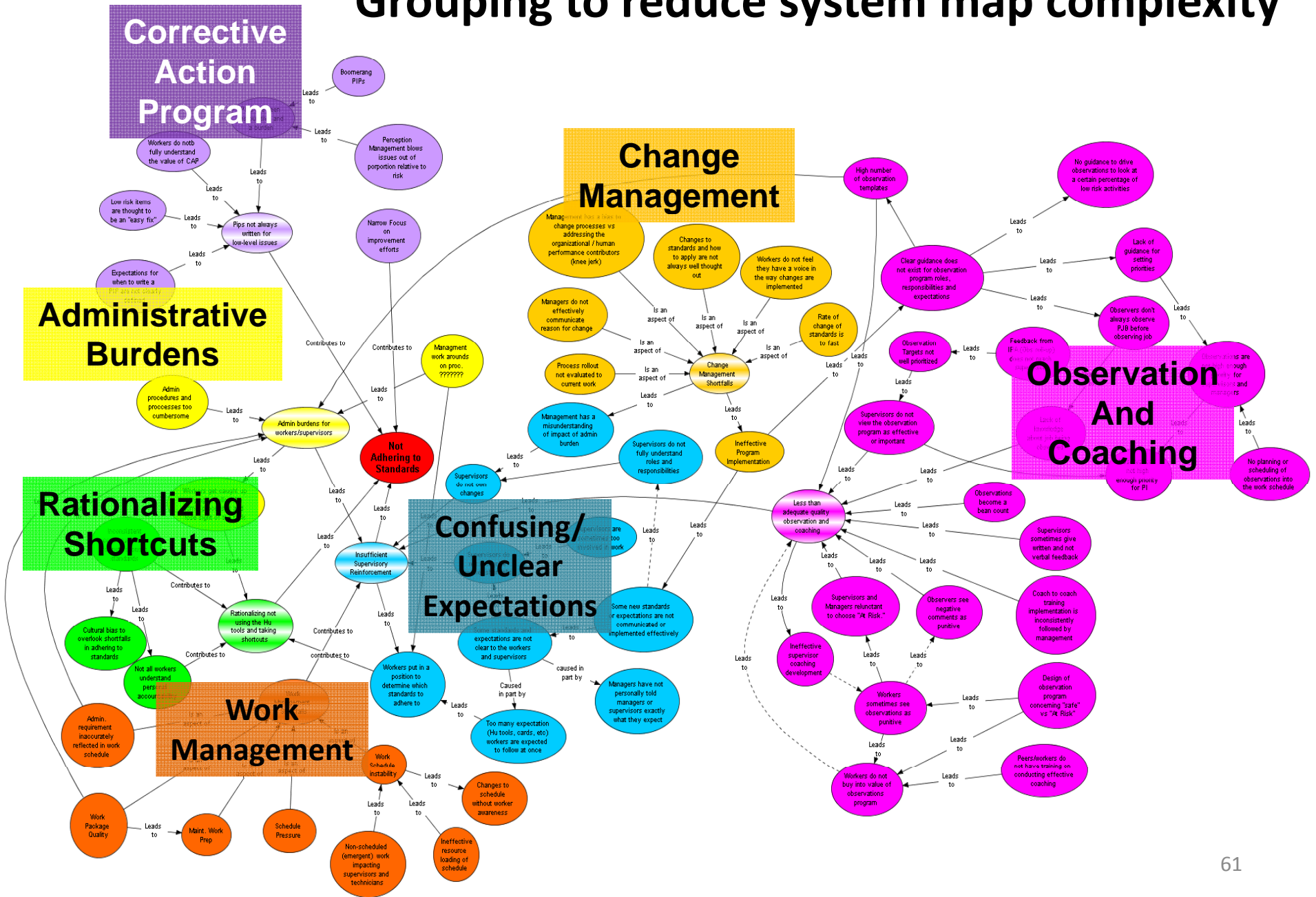
57

Causal Loop diagram
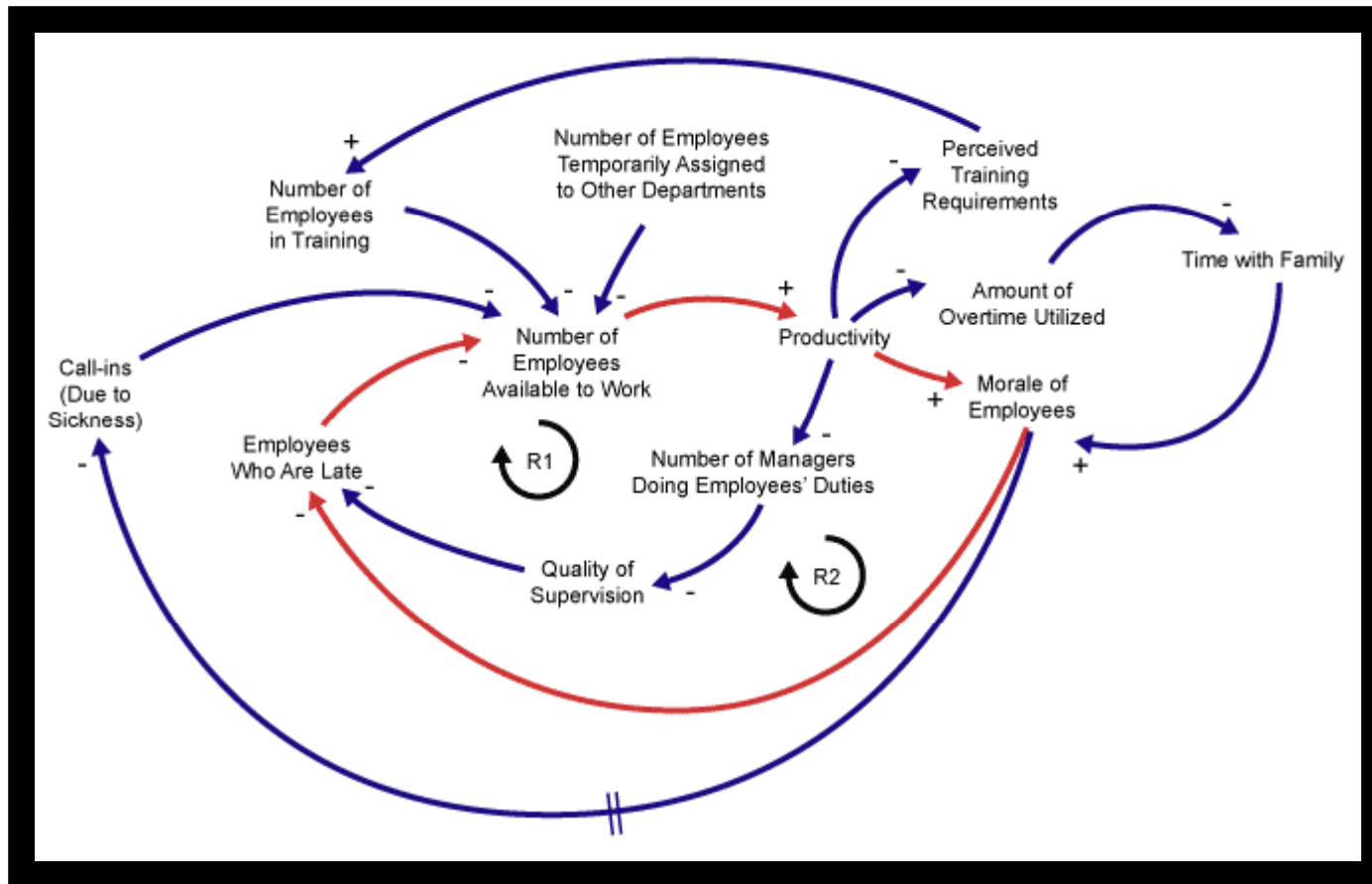
DOE Energy Systems Analysis

Performance

BUBBLE CHART

Grouping to reduce system map complexity

Streaming to map relationships

Right Picture

- Mission
- Organizational Structure
- Clear Direction

Processes

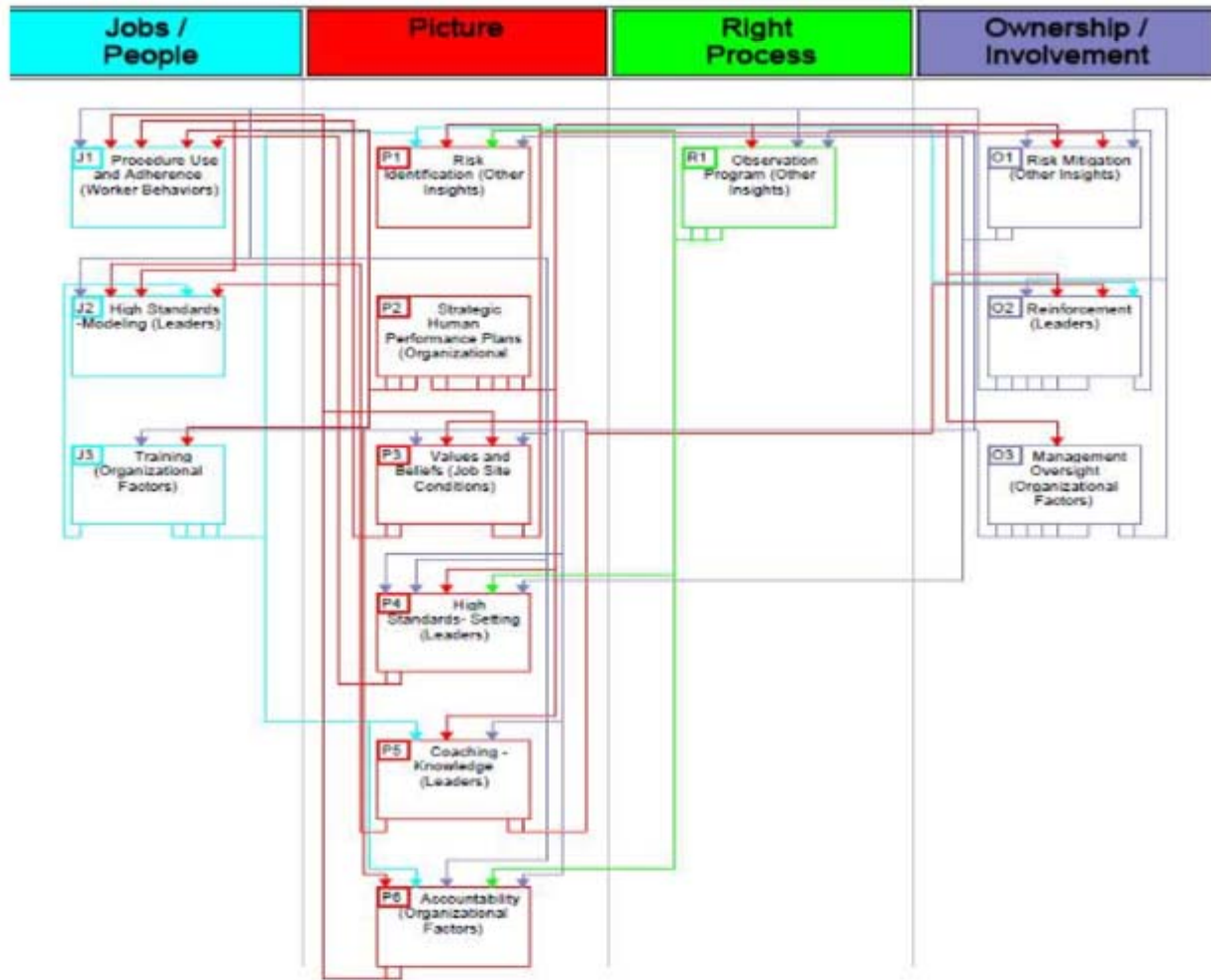- Work Management
- Administrative Controls
- Hazard Control
- Engineering
- Human Resources

Job Performance

- Knowledge & Skills
- Capacity and Readiness

Ownership

- Cultural Factors
- Open Communication
- Teamwork
- Coaching
- Values

Stream linking

Fundamental leverage points emerge from a mass of data

✓ Lack of strategic plan

✓ Inconsistent management oversight & reinforcement of standards

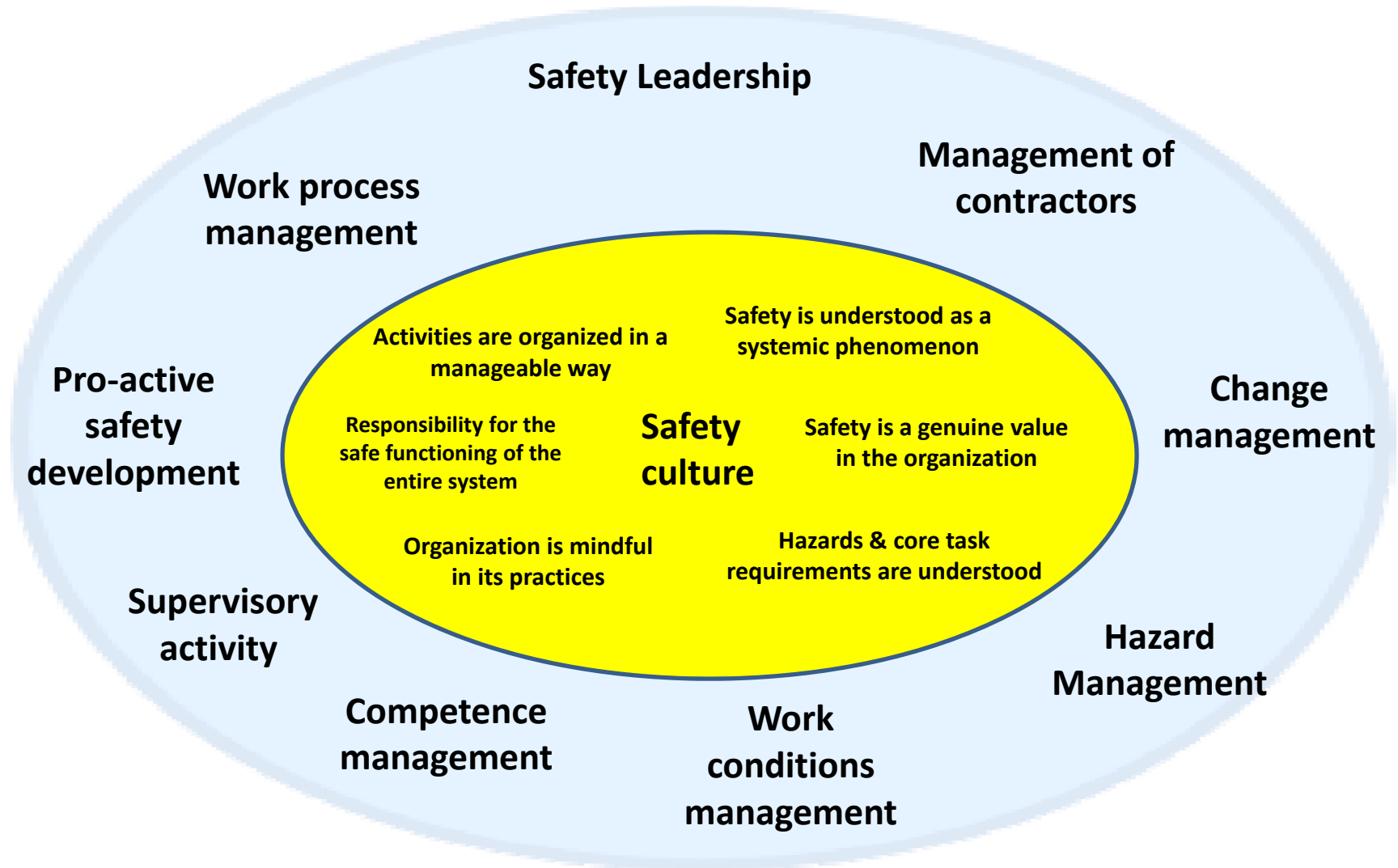✓ Inadequate Risk identification & mitigation processes & behaviors

Acci-map
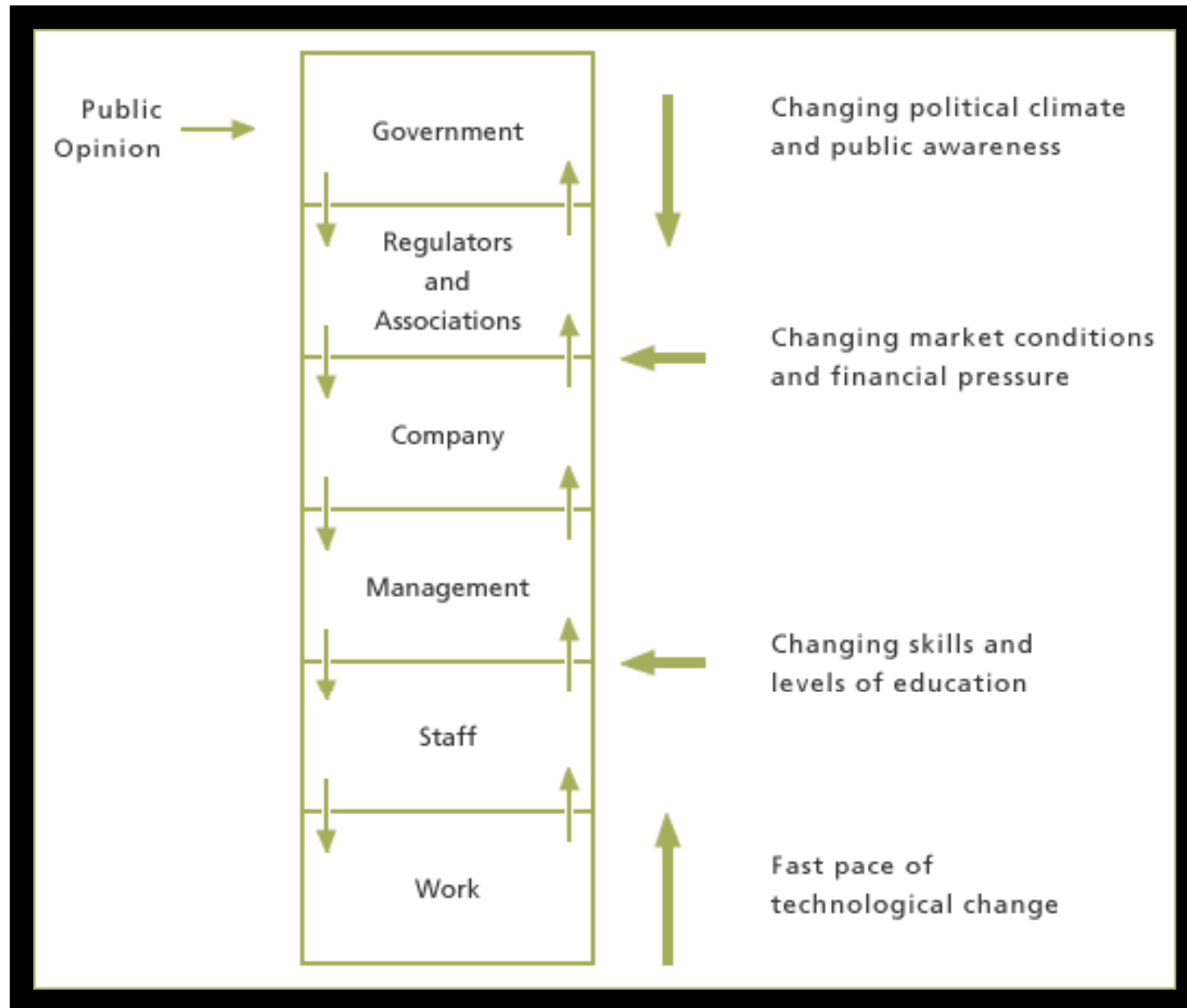
DISC Model – (Design for Integrated Safety Culture)

Safety Leadership

Work process management

Management of contractors

Pro-active safety development

Change management

Supervisory activity

Competence management

Work conditions management

Hazard Management

Activities are organized in a manageable way

Safety is understood as a systemic phenomenon

Responsibility for the safe functioning of the entire system

Safety culture

Safety is a genuine value in the organization

Organization is mindful in its practices

Hazards & core task requirements are understood

"A Guidebook for Evaluating Organizations in the Nuclear Industry", VTT 2011

Simplicity out of complexity – the future of analysis

Afghanistan Stability / COIN Dynamics
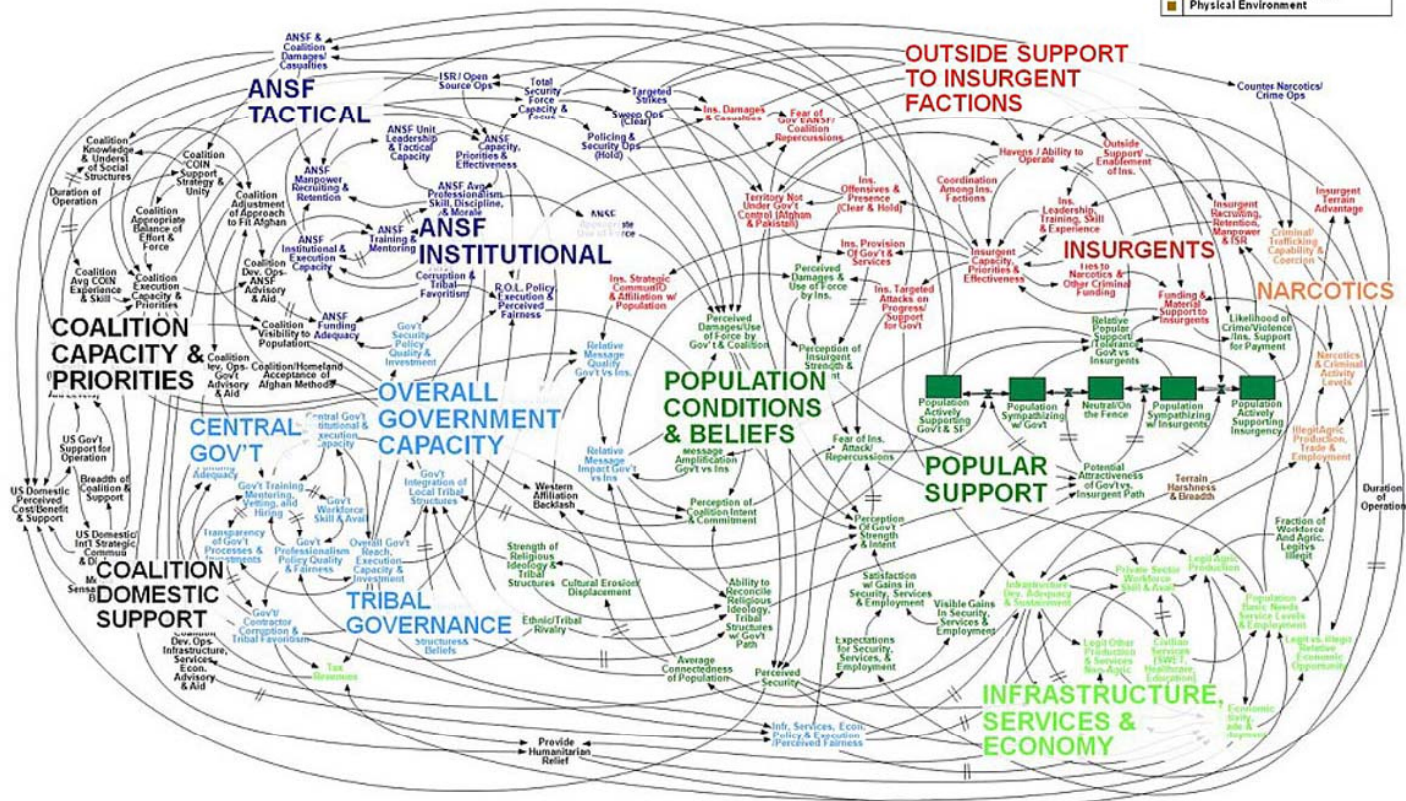
WORKING DRAFT – V3

How do you see the world?

What's in your tool kit?

OILs $\rightarrow$ **Ø**

- ➢ \e –
- ➢ . –
- ➢ Δ –
- ➢ r –
- ➢ . –
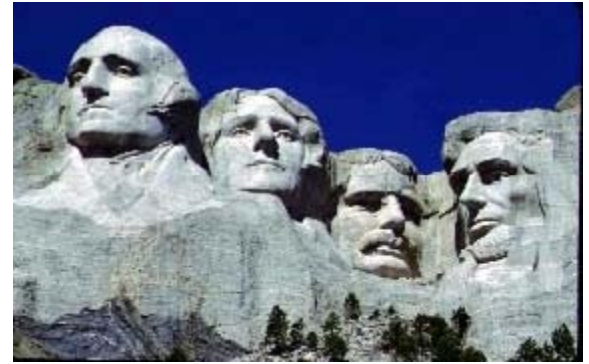- ➢ Ø –

the future

Triage Cards

VA National Center for Patient Safety
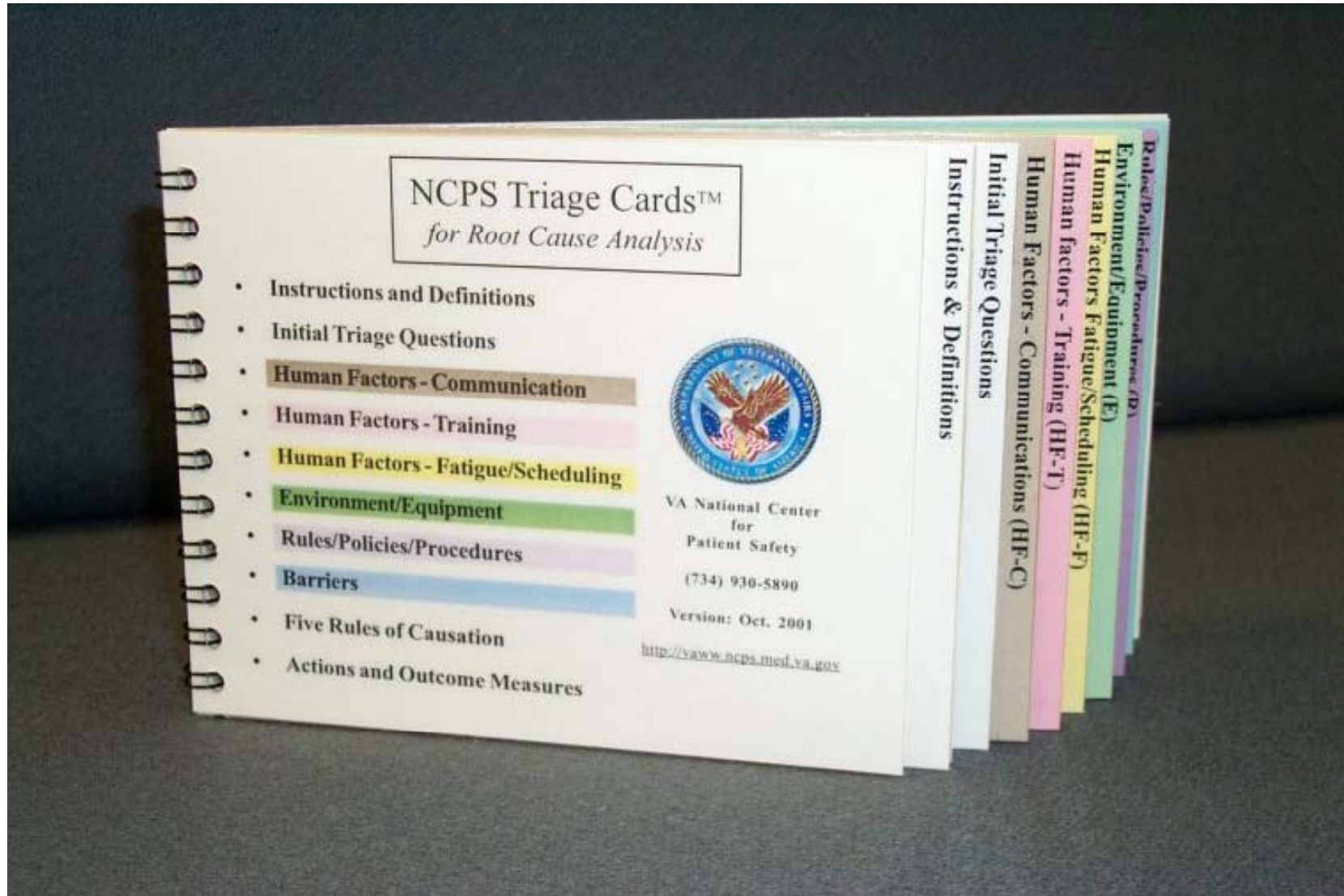
Begin with Six Simple Questions

I. What happened the way it **should have**?

II. What **didn't happen** as it was supposed to?

III. What **hazards did we miss**?

IV. Which **steps did we have to interpret**?

V. Where did we **detect and correct**?

VI. Where did we have to '**make do´ to get the job done**?

Leadership Questions –

- How does the organization react to ambiguous danger signals?

- Is the organization capable of building organizational redundancy?

- How does the organization handle conflicting objectives when safety is involved?

- How are safety critical tasks handled across organizational borders?
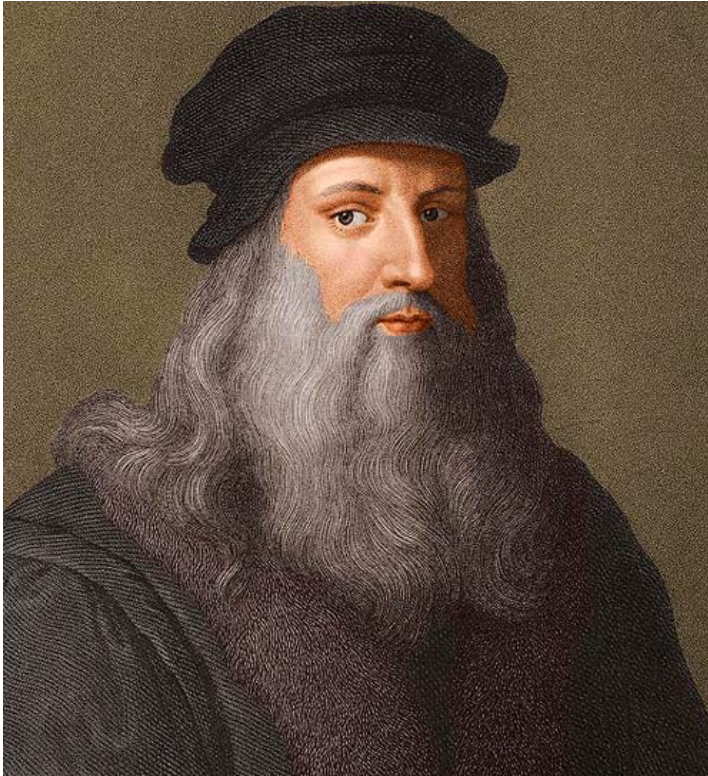
"Oh investigator, do not flatter yourself that you know the things nature performs for herself, but rejoice in knowing the purpose of those things designed by your own mind."

Leonardo da Vinci