

# Model-based Framework for Characterizing Contextual Factors for HRA Applications

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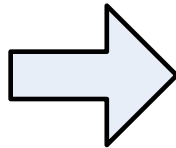
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# Need to Represent Context in HRA

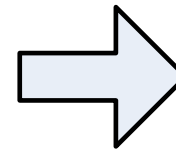
- Growing consensus that human performance can not be analyzed as isolated tasks
  - e.g., closing a valve
- Need to capture the **broader contextual factors** that impact individual and team performance
  - For example:
    - *Factors that complicate diagnosis*: might not believe the valve needs to be closed
    - *Factors that complicate decision-making*: might be reluctant to ‘close the valve’ because of negative side effects.

# Contextual Factors Influence Performance

Situation  
(Characterized by the  
situational factors)



Operating Crew  
Cognitive and psychological  
responses to the situation



Crew physical  
responses  
(Characterized by the  
unsafe acts)

- **Missing radiation alarm**

- **Fail to isolate ruptured SG**

- **Fail to diagnose SG tube rupture**

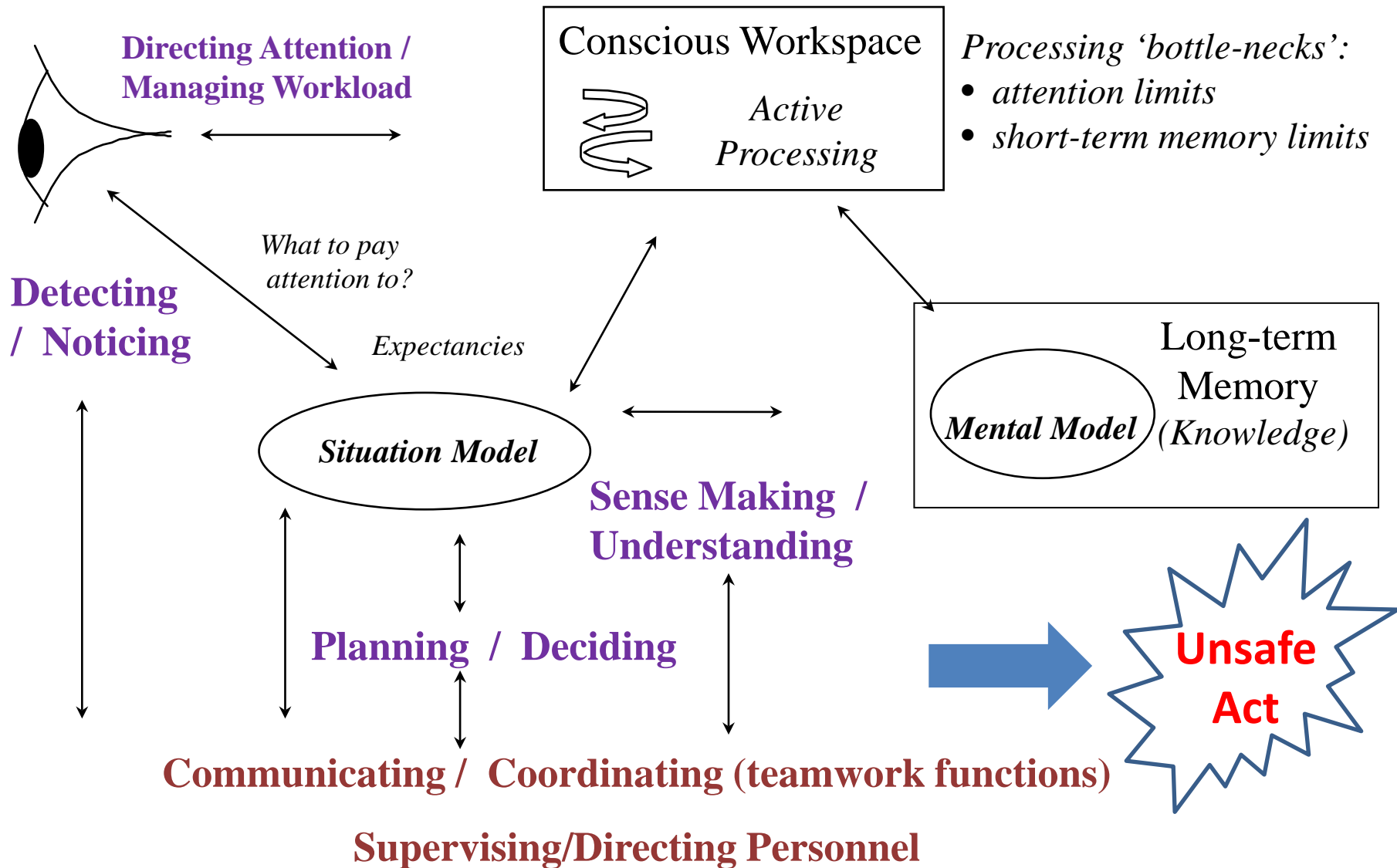
# Model-Based Framework for Characterizing Context

- U. S. NRC is developing a data collection methodology to capture contextual factors
- Part of larger program to collect and analyze licensed operator simulator training data.
  - To generate context-based HEPs for use in HRA
  - To provide qualitative insights on types of human error and causes in specified contexts.

# Focus on Situational Factors

- Situational Factors (SFs) – factors specific to a particular event or situation -- such as:
  - Missing or misleading indicator
  - Multiple interacting malfunctions that challenge diagnosis; create goal conflicts; or complicate use of procedures
- Contrast with more traditional performance influencing factors such as organizational factors (e.g., safety culture) or person-specific factors (e.g., risk-taking) that remain relatively fixed across events.

# SF Organized Around Model of Macrocognition



# Iterative Refinement of Framework

- The context capture data collection framework is being iteratively exercised and refined based on:
  - Use in pilot training simulator data collection
  - Feedback from NPP training instructors and crews

# Data Collection Framework

- Performance Problem Types:
  - Core :
    - Monitoring/Detection
    - Diagnosis/Understanding
    - Procedure/Decision Making
  - ‘Assist’:
    - Supervision
    - Teamwork
    - Communication
- Performance Problem Causes:
  - Situational Factors
  - Person/Team Specific Factors
- Performance Problem Consequences:
  - End Result from the perspective of what the plant needs



# Example of Performance Problem Sub-types

## Diagnosis/Understanding: Performance Problem Sub-Type

### Sub-Type

- Misinterpreted:** Critical data misinterpreted. ⓘ
- Discredited:** Critical data dismissed, discredited or discounted.
- Incorrect/Incomplete:** Failure to form a correct understanding or to revise initial false concept. ⓘ
- Awareness:** Lack of awareness of plant conditions.
- Slow:** Slow interpretation of plant parameters.
- Other:** Explain.

# Examples of Performance Problem Causes: Situational and Person-Specific Factors

SAT Δ - Element: Manually initiates Rx Trip & SI when directed or when Pzr level decreases to < 8%.

## Diagnosis/Understanding: Performance Problem Cause

### Alarm Issues

- Unspecific Alarms:** Individual Alarms are not specific enough pointing to the system problem.
- Unfamiliar/Unrecognizable alarm pattern:** Alarms did not show recognizable pattern in pointing to the system problem.
- Spurious:** For example, sensor failure triggered the alarm.
- Failed:** key alarm failed dark.

### Indicator Issues

- Misleading Indications:** Subset of indicators gave misleading or conflicting information. ⓘ
- Missing Indications:** The primary cue was missing. ⓘ

### Other Situational Issues

- Ambiguous/Unreliable:** Ambiguous/subtle cues.
- Masked:** Masked cue. ⓘ
- Pre-disposed (Fake-out):** Initial symptoms capture thinking leading to misdiagnosis. ⓘ
- Distributed:** Relevant information distributed over time/space. ⓘ
- Mismatch:** Plant response mismatched prior training/experience. ⓘ
- Other:** Explain.

### Overarching Issues/Person Specific

- ▼ Overarching Issues:** Situational issues that apply across problem types. These concern factors present due to the way events unfold during the scenario.
  - Multiple Demands/Distractions:** Multiple attention demands.
  - Tempo:** High tempo tasks. ⓘ
  - Memory:** Demands on memory.
  - Stressors:** Psychological/physical stressors. ⓘ
  - Habit Intrusion:** Highly practiced response interfered with desired response.
  - Personnel Shortage:** Shortage of personnel. ⓘ
- ▼ Person Specific**
  - Knowledge Gap:** Lack of knowledge or experience/skill. ⓘ
  - Slow:** Thinking slow, moving slow, monitoring slow, communicating slow.
  - Lack of Questioning Attitude:** or lack of discussion of concerns. ⓘ
  - STAR:** Failure to STAR. ⓘ
  - Rushing:** Responding to real or perceived time pressure.
  - Attention Distracted**
  - No Obvious Cause:** Mental lapse, loss of focus. ⓘ

# Example of Performance Problem Consequences

SAT A - Element: Manually initiates Rx Trip & SI when directed or when Pzr level decreases to < 8%.

## End Result

### End Result From Perspective of What Plant Needs

- None:** Error may have affected crew performance but did not impact control of the plant.
- Required Action Not Taken:** Failed to take required action (did not attempt action).
- ▼ Incorrect Timing**
- ▼ Process Control Complication**
- ▼ Executed undesired action:** Incorrect action from perspective of what plant needs or requires.
  - Misaligned:** Misaligned component/system
  - Defeated:** Prevented an automatic or safety function from initiation. ⓘ
  - Stopped:** Stopped or turned off a needed function. ⓘ
  - Unnecessary Initiation:** Unnecessary initiation of a function. ⓘ
  - Other:** Explain.

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## Comments

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# Anticipated Benefits of Approach

- Allows performance problems and causes to be characterized at a more abstract, psychological, level of description
- Enables generalization across events that appear dissimilar on the surface but share common performance problem types and causes
  - Actual events
  - Simulator events
- Provides the basis for context-based reference HEP estimates

# Current Status

- The data collection methodology is continuing to be exercised and refined
- Initial feedback has been positive
- Further development and evaluation cycles are planned.