

Model-based Framework for Characterizing Contextual Factors for HRA Applications

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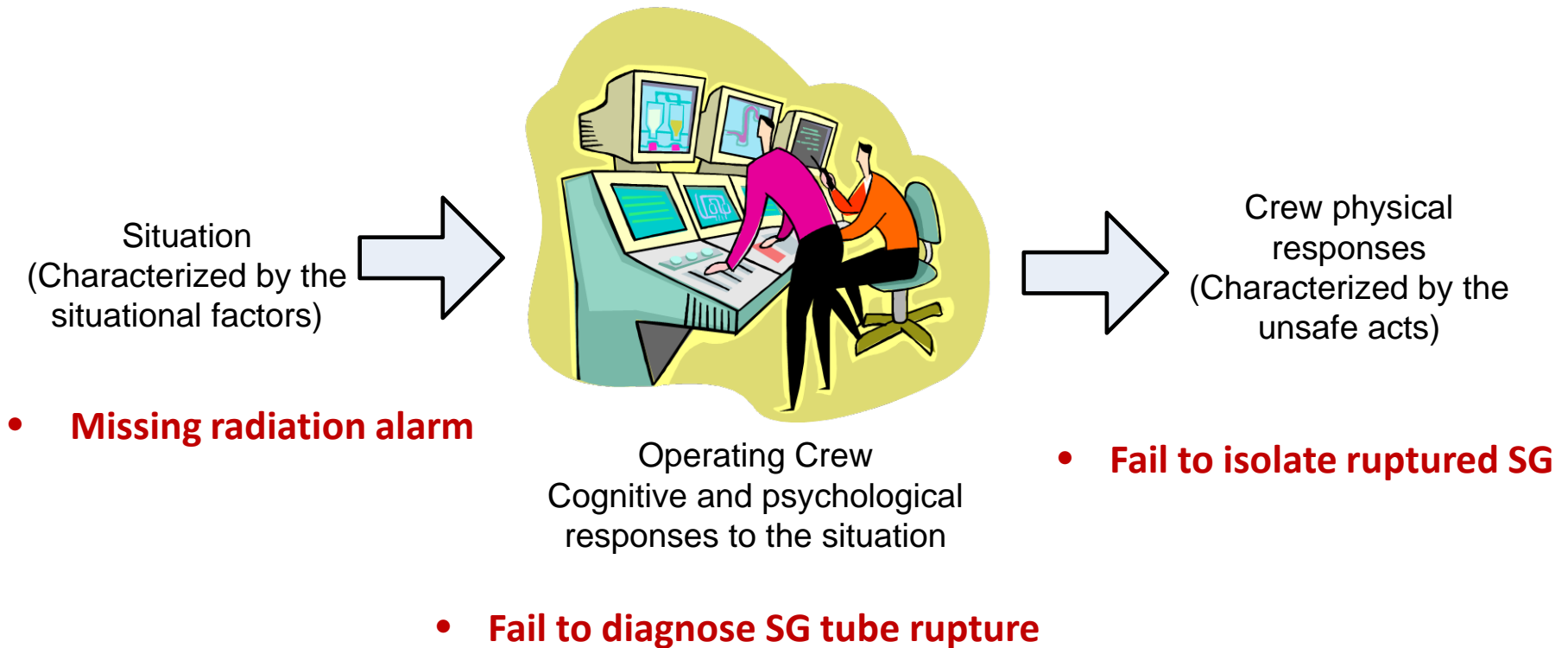
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Need to Represent Context in HRA

- 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



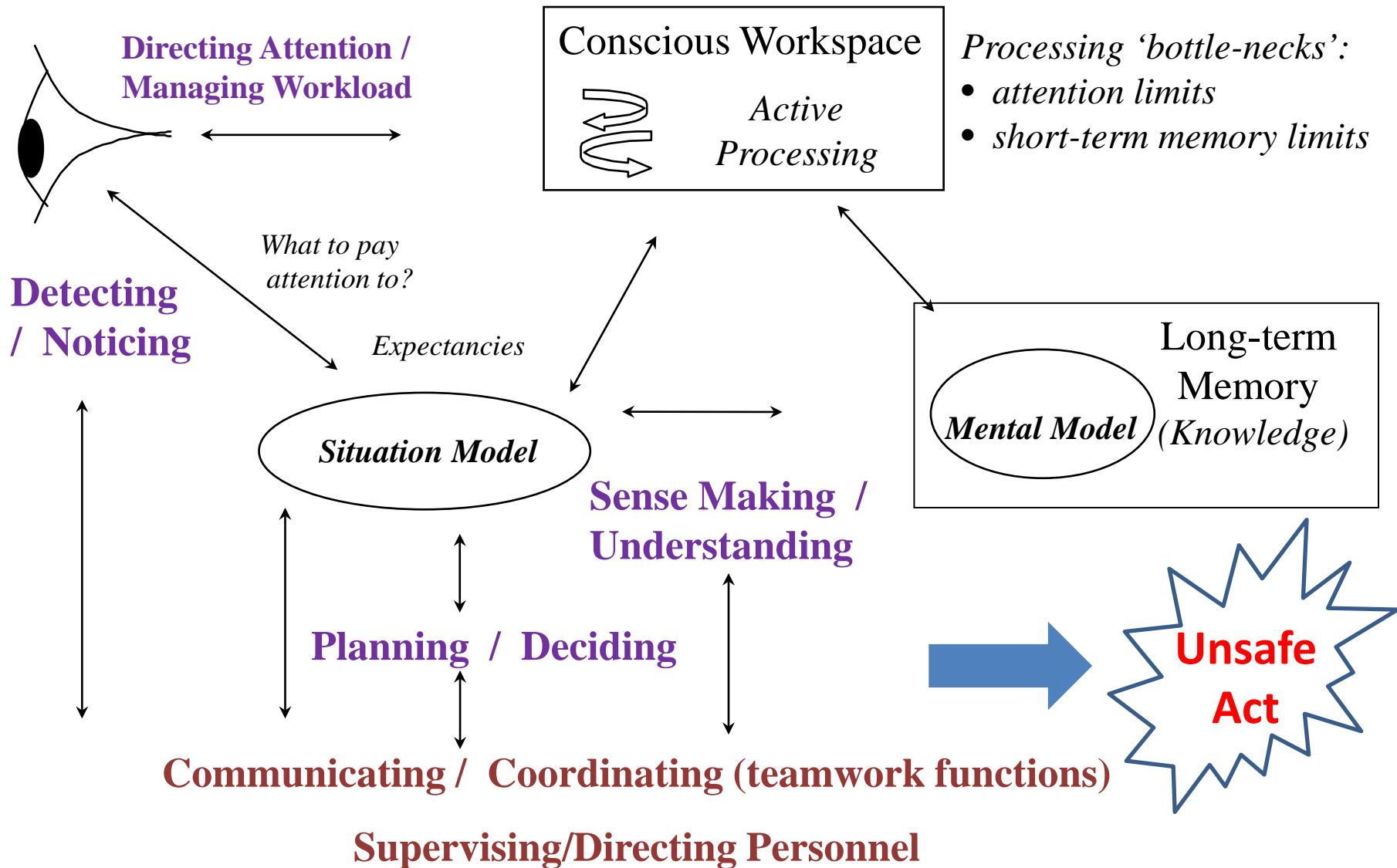
Model-Based Framework for Characterizing Context

- 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 Δ - 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

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.