

Methodology for Collection and Analysis of Simulator Data for HRA Applications

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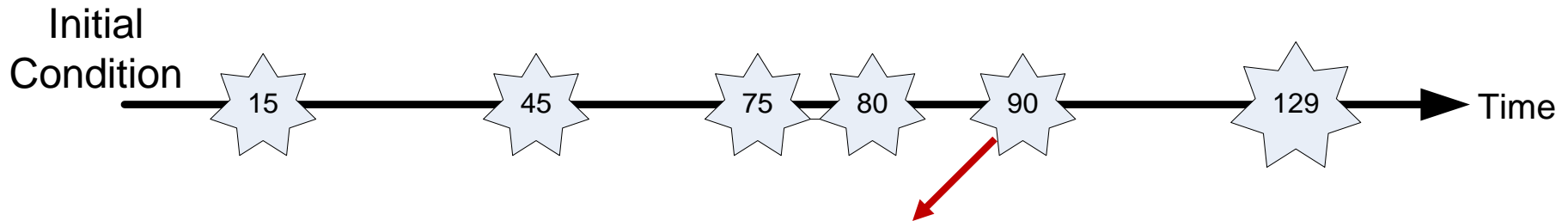
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Outline

- Licensed operator simulator training data structure
- Concept for generating data-driven human error probabilities (HEPs) for human reliability analysis (HRA)
- Overview of the SACADA database
 - Scenario Authoring, Characterization and Debriefing Analysis
- Conclusions

Training Scenario Data Structure

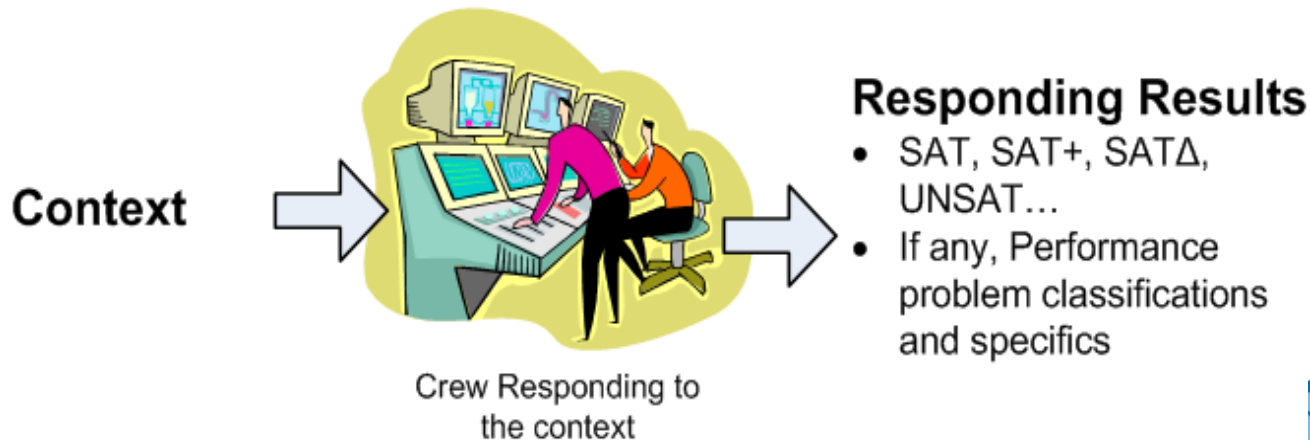


Response Opportunities

Loss of ECW 1A	
POSITION	EXPECTED RESPONSE
CREW	Recognize loss of EW flow to A train.
Crew	Secure ECW pump 1A
SM	Manually trip Diesel Generator prior to any of the following occurring: Diesel Generator tripping
Crew	Ensure CCP 1A is in service
Crew	Verifies Natural Circulation
SM	Determines need to cooldown
ED	Declare an Alert HA1/EAL2 due to damage to EW structure or notify ED that escalation is appropriate.

Concept For Generating Data-Driven HEPs

$$\text{HEP (Context)} = \frac{\text{\# of Failures (Context)}}{\text{\# of Response Opportunities (Context)}}$$

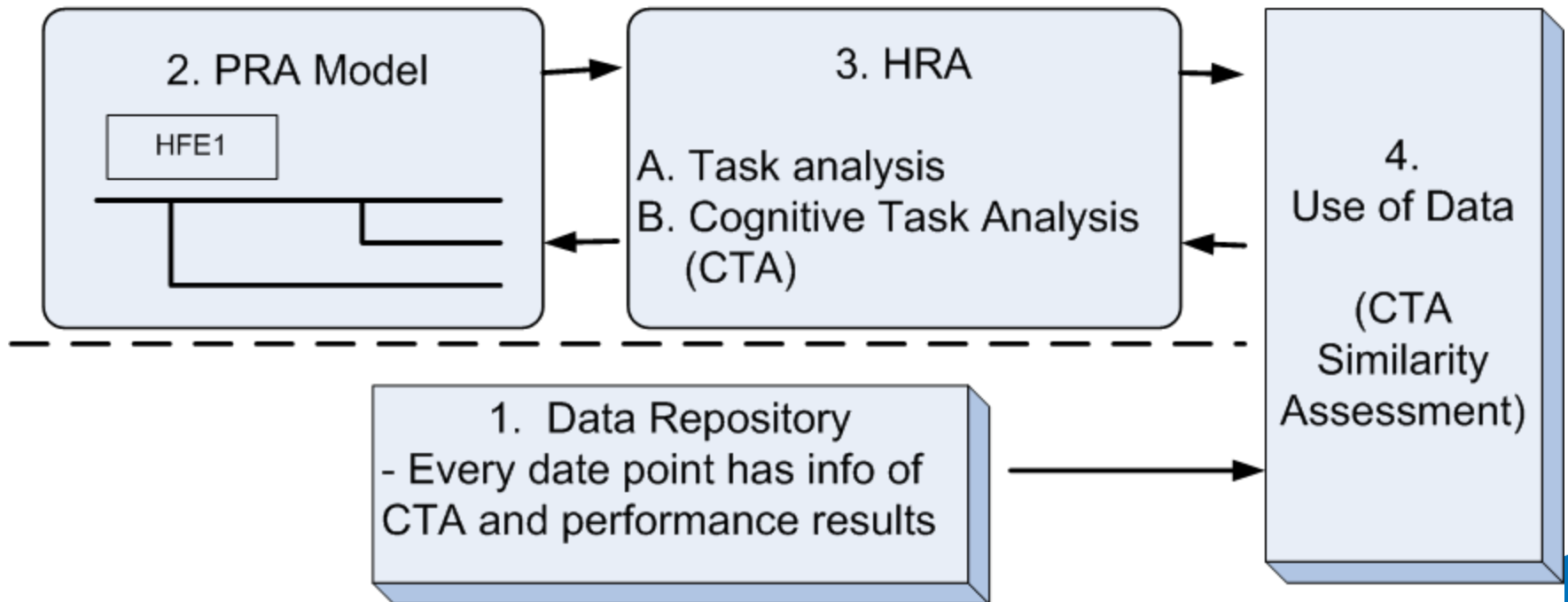


Context (Draft)

- Cognitive task analysis on six functions
 - Detecting, understanding, deciding, action, communication/teamwork, and supervision
 - Each function is characterized by a set of contextual factors
- E.g., Contextual factor for Detecting
 - ☐ Large number of simultaneous alarms
 - ☐ Missing/Degraded information
 - ☐ Misleading information
 - ☐ Unfamiliar/unrecognizable alarm pattern
 - ☐ Small or gradual change
 - ☐ Status of automatic control system/automatic control actions not clearly indicated (e.g., complex interlocks)
 - ☐ No reason to check
 - ☐ Others

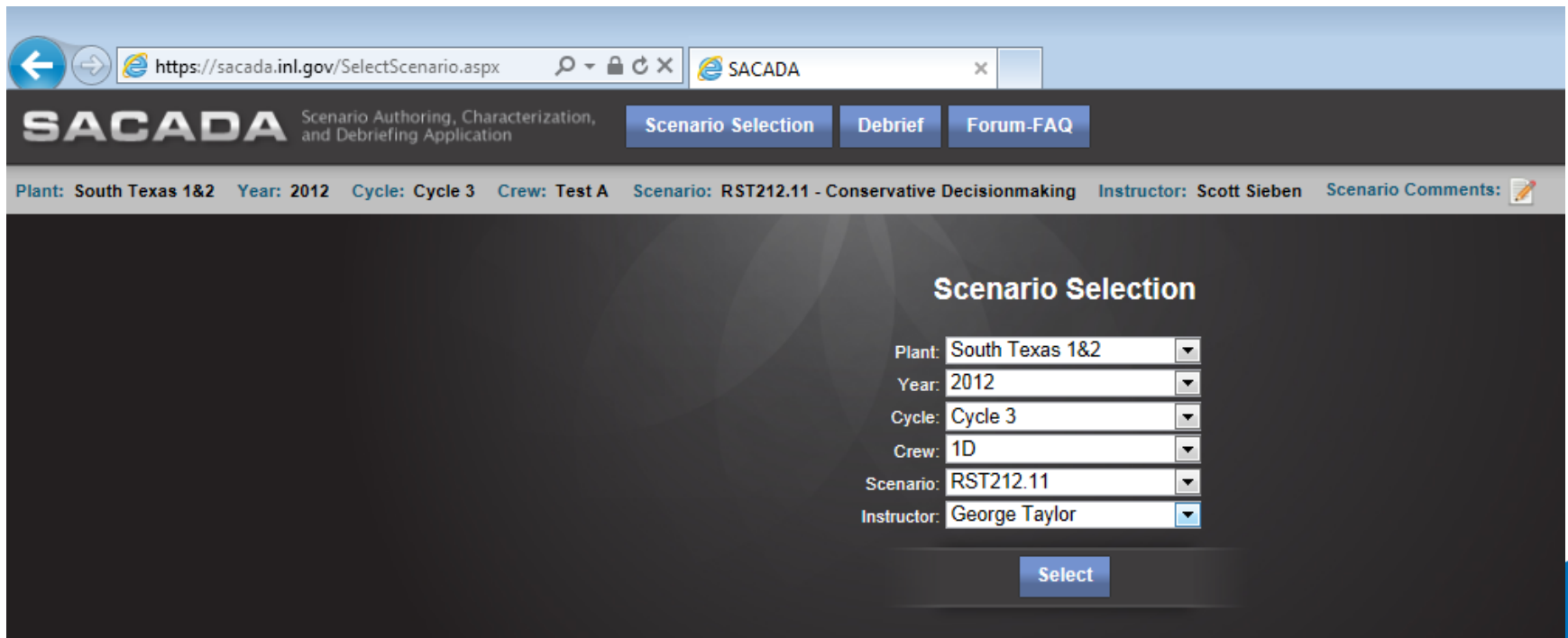
Generating Data-Driven HEPs

Applications



Data

SACADA: Scenario Authoring, Characterization and Debriefing



The screenshot shows a web browser window with the URL <https://sacada.inl.gov/SelectScenario.aspx>. The page header includes the SACADA logo and the text "Scenario Authoring, Characterization, and Debriefing Application". Navigation buttons for "Scenario Selection", "Debrief", and "Forum-FAQ" are present. A status bar at the top displays the following information: Plant: South Texas 1&2, Year: 2012, Cycle: Cycle 3, Crew: Test A, Scenario: RST212.11 - Conservative Decisionmaking, Instructor: Scott Sieben, and Scenario Comments: (with an edit icon).

The main content area is titled "Scenario Selection" and contains a form with the following fields:

- Plant: South Texas 1&2
- Year: 2012
- Cycle: Cycle 3
- Crew: 1D
- Scenario: RST212.11
- Instructor: George Taylor

A "Select" button is located at the bottom right of the form.

A Web Based Tool

Browser: <https://sacada.inl.gov/ScenarioDebrief.aspx> | SACADA

SACADA Scenario Authoring, Characterization, and Debriefing Application | [Scenario Selection](#) | [Debrief](#) | [Forum-FAQ](#) | [Account](#) | [Logout](#)

Plant: South Texas 1&2 | Year: 2012 | Cycle: Cycle 3 | Crew: 1C | Scenario: RST212.11 - Conservative Decisionmaking | Instructor: Sam Dugger | Scenario Comments:

Malfunctions: 3 Items | [Malfunction Comments](#) | [Edit](#)

Loss of Circ Water | [Edit](#)

Position	Expected Response	Sat?	Comments/Notes	Edit
SM	Implement OPOP04-CR-0001	SAT		Edit
RO	Determines the loss of vacuum is caused by reduced condenser cooling.	SAT		Edit
US	Implement POP04-CW-0001.	SAT		Edit
CREW	Dispatches operator to isolate 2 water boxes. (should not isolate 11 North or 13 South)	SAT		Edit
RO	Dispatches operator to close condenser isolation to CARS pump for water boxes that are isolated.	SAT		Edit
RO	Dispatches operator to start all available CARS pumps.	SAT		Edit

Loss of Open Loop | [Edit](#)

Position	Expected Response	Sat?	Comments/Notes	Edit
RO	Check Open Loop Load temperatures	SAT		Edit
US	Enter POP04-OC-0001	SAT		Edit
RO	Direct the TGB watch to isolate RCB & MAB Chillers	Not Applicable		Edit
US	Dispatch Plant Operator verify discharge strainer DP, attempt a strainer swap	SAT		Edit
US	Direct securing of standby Open Loop pump	Not Applicable		Edit
US	Perform a Main Turbine load reduction	SAT		Edit
SM	Notify Co-Owners	SAT		Edit
		SAT		Edit

Browser: <https://sacada.inl.gov/ScenarioDebrief.aspx>

Taskbar: 8:39 PM 6/15/2012

SACADA Data

- Before simulation
 - Cognitive task analysis on key responses
 - Crew individual experience levels
 - Others (e.g., interacted safety systems and/or components)
- Post simulation
 - Final performance results
 - SAT+, SAT, SAT Δ , UNSAT, or N/A
 - If SAT Δ or UNSAT the tool also collects...



Performance Problem Types

SAT Δ - Element: Implement POP04-CW-0001.

Type Menu: Performance Problem Type

Instructions: Check all that apply. ⓘ

Core Tasks

- ☒ Monitoring/Detection ⓘ
- ☒ Diagnosis/Understanding ⓘ
- ☐ Procedure/Decision Making ⓘ
- ☐ Manipulation ⓘ

Assist Tasks

- ☐ Supervision ⓘ
- ☐ Teamwork ⓘ
- ☐ Communication ⓘ

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Comments



Performance Problem

Sub-Type: Diagnosis

SAT Δ - Element: Implement POP04-CW-0001.

Diagnosis/Understanding: Performance Problem Sub-Type

Sub-Type

- ☒ **Misinterpreted:** Critical data misinterpreted. 
 - ☐ **Discredited:** Critical data dismissed, discredited or
 - ☐ **Incorrect/Incomplete:** Failure to form a correct
 - ☐ **Awareness:** Lack of awareness of plant conditions.
 - ☐ **Slow:** Slow interpretation of plant parameters.
 - ☐ **Other:** Explain.
- e.g. lowering temperature due to Xenon-135 build up was misinterpreted as due to a steam leak pt. 

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Performance Problem Causes

SAT Δ - Element: Implement POP04-CW-0001.

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.
- ☐ ▼ **Person Specific**

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Recovery

SAT Δ - Element: Implement POP04-CW-0001.

Recovery

Recovery Status

- ☒ ▼ **Immediate Recovery:** Error was recovered with minimal impact on crew performance. 

How Recovered

- ☐ **Self Recovery:** Error was caught and recovered by individual who made the error.
- ☐ **Peer Check:** Intervention by peer checker prevented error.
- ☐ **Team Recovery:** Questioning attitude by team member realigned crew.
- ☐ **Supervision:** Intervention by supervisor identified or prevented error.
- ☐ **STAR:** Review of system response uncovered error.

- ☐ ▼ **Delayed Recovery:** Scenario objectives met but mistakes resulted in delay or confusion with noteworthy impact on crew performance. 
- ☐ **Unrecovered:** Error was never recovered. 

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End Results

SAT Δ - Element: Implement POP04-CW-0001.

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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Remediation

SAT Δ - Element: Implement POP04-CW-0001.

Remediation and/or Follow Through Items

Remediation (Data not shared with NRC)

☐ No Follow through/Remediation Required.

☒ Follow through/Remediation Required.

☐ Performance gap: Individual/Team performance gap that should be addressed.

☒ Simulator Deficiency: Fix needed to simulator equipment or code.

Responsible Individual: 

☒ Condition Report

☒ Procedure Revision: Problem(s) found with procedure(s).

Responsible Individual: 

Procedure:

☐ Teamwork/Supervisory Practices

☐ Policy Tune Up: Recommendation that plant policy be reviewed. 

☐ Organizational Lesson Learned 

☐ Other: Explain.

☐ Other: Explain.

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Comments

Conclusions

- **Potentially a large amount of quality data for statistical analysis**
 - Relation between Context and Err (or Err Types)
 - Relation between Err Types and Err Causes
 - HEPs
 - Need fidelity analysis on simulator data for HRA
 - Need long term data collection
- **For improving human performance**
 - Tracking and improving human performance
 - Improving scenario designs
- **Support**
 - SRM-090204B “Development of an HRA database”
 - Enhancing risk-informed methods/tools

Questions?

