

Methodology for Collection and Analysis of Simulator Data for HRA Applications

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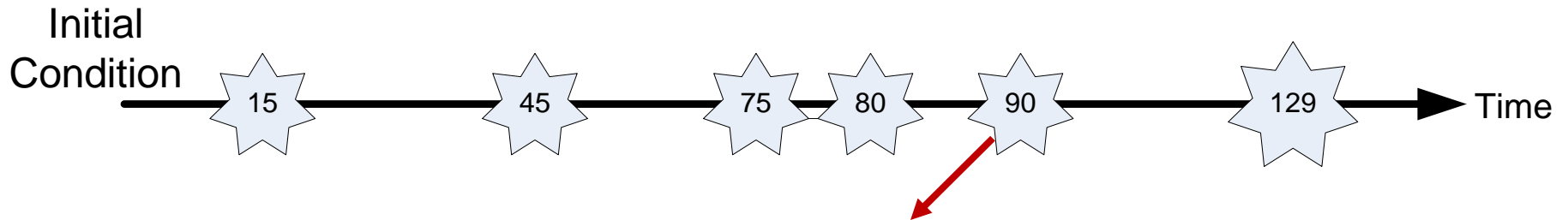
Helsinki, Finland

June 25 - 29, 2012

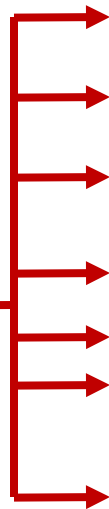
Outline

- 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



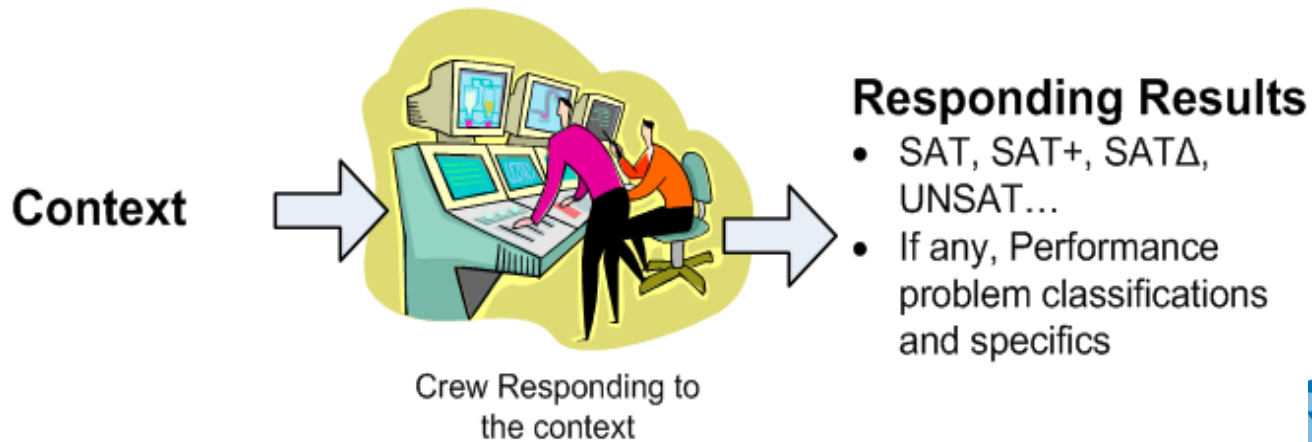
Response Opportunities



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

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

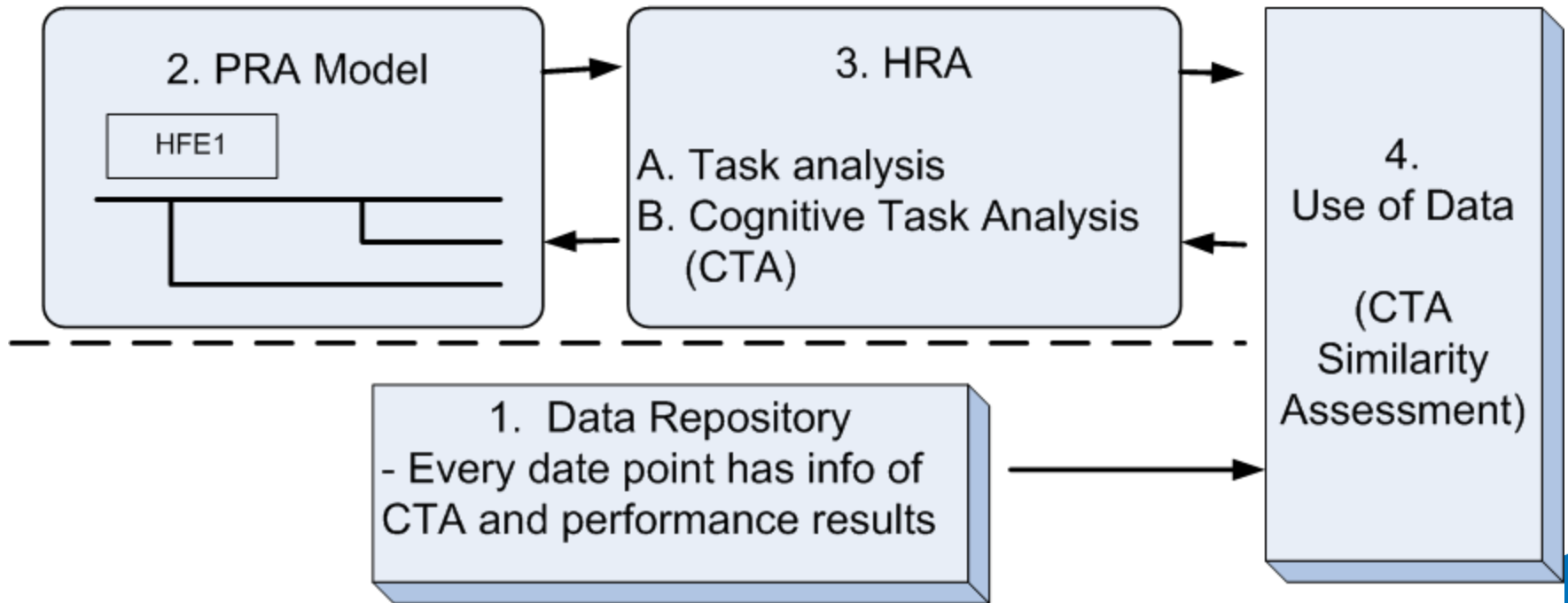


Context (Draft)

- 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

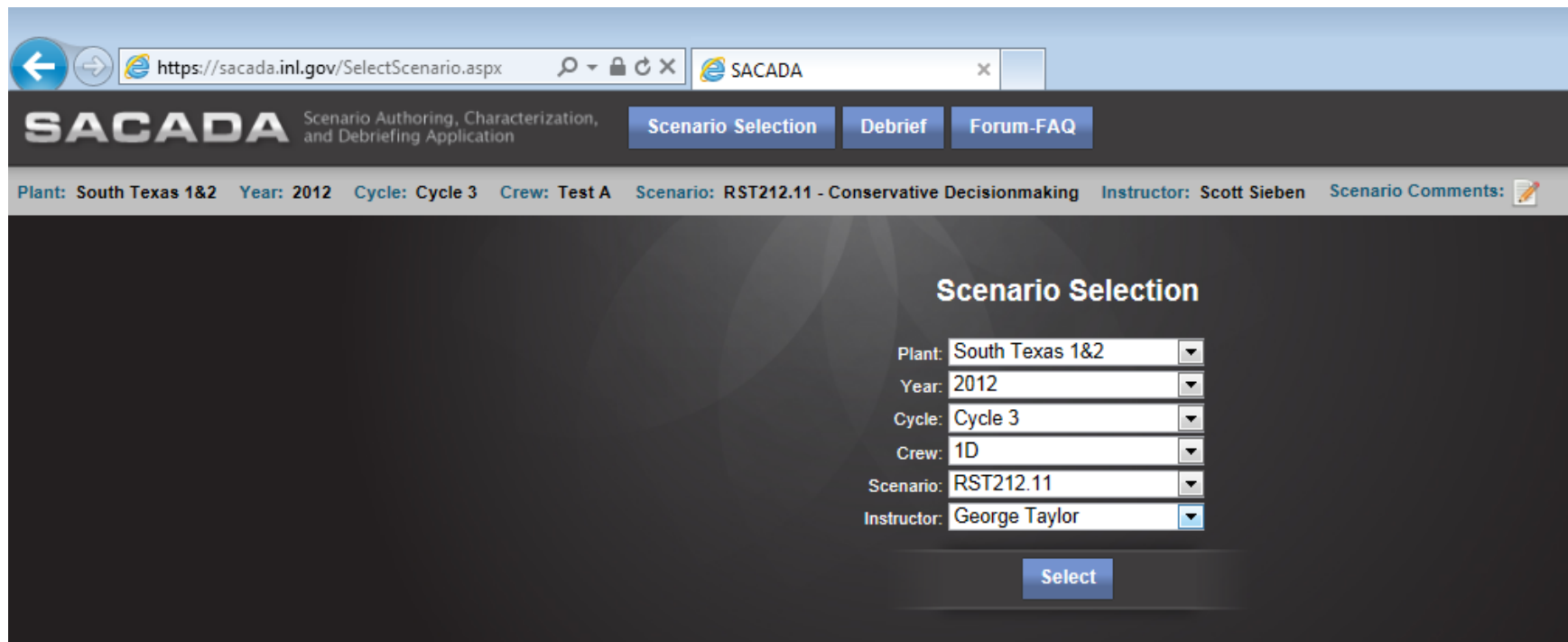
Generating Data-Driven HEPs

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 title is "SACADA Scenario Authoring, Characterization, and Debriefing Application". The navigation menu includes "Scenario Selection", "Debrief", and "Forum-FAQ". The breadcrumb trail shows: "Plant: South Texas 1&2", "Year: 2012", "Cycle: Cycle 3", "Crew: Test A", "Scenario: RST212.11 - Conservative Decisionmaking", "Instructor: Scott Sieben", and "Scenario Comments: [edit icon]".

Scenario Selection

Plant:

Year:

Cycle:

Crew:

Scenario:

Instructor:

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: [edit]

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]

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 A - Element: Implement POP04-CW-0001.

Diagnosis/Understanding: Performance Problem Sub-Type

Sub-Type

- Misinterpreted:** Critical data misinterpreted. i
 - 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

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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 A - 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?

