JENSEN HUGHES

Advancing the Science of Safety

Overview of PSAM HRA Workshop on Collecting HRA Data

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PRESENTATION TOPICS

1. **HRA Society Overview**
2. **PSAM Workshop Set-Up**
3. **Results from the PSAM Workshop Breakout Group Discussion**
4. **Going Forward**

1-HRA SOCIETY OVERVIEW

A young professional society to promote the sharing of research, methods and data.

Members are regulator, research labs, consultants & utility staff.

Short history:

- Initial meeting in Seattle at PSAM'11 conference (2010)
- Follow-up meeting in Honolulu at PSAM'12 (2012)
- HRA Master Class in Paris last year, (2015)
  - Largest meeting, ~50 participants from 8 countries
  - Surveyed recent activities
  - Voted on new leadership
- *HRA Special Session at PSAM'13 (Seoul, 2016)*
- *PSAM HRA Topical Meeting (Munich, 2017)*
- *PSAM HRA Workshop (Los Angeles, 2018)*

1-HRA SOCIETY VISION

- **3 Elements:**
  1. Error Identification, after understanding interactions humans have with a plant or facility.
  2. Error Assessment (qualitative and quantitative)
  3. Error Reduction
- **Each element has Research, Modeling, & Applications**
  - Human Reliability Analysis as part of PRA for Decision-Making
  - Human Factors
  - Human Error reduction programs
- **Improve Technical Bases**
  - Relationship between HF and HRA
  - HRA methods, models, data & guidance
  - HRA for Digital Control systems
  - HRA for increased PRA Scope such as External Hazards; Level 2 & 3
- **Support Expansion & Growth**
  - Support advancing technologies (beyond digital)
  - Support for emerging countries – Regulators & Utilities
  - Looking to expand with “regional” chapters such as USA, EU & Asia
  - Open to new members

1-HRA SOCIETY BOARD MEMBERS

Name	Organization	Country
Cilla Andersson	Ringhals AB	Sweden
Andreas Bye	IFE-OECD Halden Reactor Project	Norway
Ronald Boring	Idaho National Laboratory	USA
Vinh N. Dang	Paul Scherrer Institute	Switzerland
Xuhong He	Lloyds Register Consulting	Sweden
Stacey Hendrickson	Sandia National Laboratories	USA
Jeff Julius	JENSEN HUGHES, supporting EPRI	USA
Michael Montecalvo	U.S Nuclear Regulatory Commission	USA
Ali Mosleh	University of California, Los Angeles	USA
Jinkyun Park	Korea Atomic Energy Research Institute	Republic of Korea
Luca Podofillini	Paul Scherrer Institute	Switzerland
Andrew Wright	Corporate Risk Associates	United Kingdom

COLLECTING HRA DATA

- **Address the "Elephant in the Room"**
  - **Which has been there for years.**

2-PSAM14 WORKSHOP

COLLECTING HRA DATA

- **Theme**

  What are the lessons learned from recent HRA data collection projects that can be used to support future HRA data development?

- **Building off (or onto) HRA meetings**
  - PSAM HRA Topical Meeting, June 2017
  - IAEA HRA workshop, November 2017
  - SACADA workshop, March 2018
  - Potential future meetings:
    - PSAM14 workshop, UCLA, September 2018
    - ANS PSA'2019, April 28 – May 3rd, 2019
    - Others like ESREL or ASRAM?

- **Promoting the idea of improved data sharing**
  - What is needed to succeed?
  - What are the barriers to success?
  - Next steps?

2-HRA WORKSHOP AGENDA

Introductions – 35 participants from 11 countries

Workshop Concept / Overview

Selected Presentations

- ***SACADA Data Program***, James Chang
- ***Characteristics of the HuREX Framework as a Tool for HRA Data***, Yochan Kim
- ***MicroTasks and MicroWorld***, Andreas Bye and Ron Boring
- ***EPRI FLEX and MCR Abandonment***, Mary Presley & Kaydee Gunter

Discussion – Breakout Groups

- Group 1 - Data Collection
- Group 2 - Data Analysis
- Group 3 - Application of HRA Data in Decision-Making

Breakout Session Results

Closing

2-HRA WORKSHOP BACKGROUND

Issues considered during pre-meeting discussion

- **Started with Data Collection**
  - But "Data" can be different types & different sources:
    - Data can be on tasks, PSFs and also on Context
    - Data from simulators, e.g. Human Error Probability measurement
    - Data from Expert Elicitation
    - Data impacting the Qualitative Analysis
      - Performance shaping factors
      - Timeline
    - Research on the different types of failure
  - Data sources: simulator, microtasks, operating experience (incident reports), design basis
- **Data, once collected requires Analysis**
- **Last, Application of the HRA data**
  - Applicability for sharing between countries or disciplines
  - Meeting end-user needs

3-WORKSHOP BREAKOUT (GROUP 1)

Group 1 - Data Collection – How can we improve or facilitate data sharing?

1. What kind of framework did you initially start with for the following:
   - Tasks – is this the lowest level of data collection?
   - Performance shaping factors – positive and negative
   - Objective vs. Subjective evidence – what measurements are taken
   - How does data collection identify and distinguish the Context?

1. What issues did you need to address, beyond those listed above and beyond IP/Privacy/Confidentiality? And how did you solve these?

What is the scope and intention of your data collection?

- Halden
  - Collecting data for realistic scenarios with their procedures (CE, Westinghouse), but digital I&C (also at plant's simulator). PWR and BWR
    - More challenging than regular training scenarios (outside the basis of PRA?)
    - 3-4 hrs max
    - Working on SBO scenarios (2 crews)
    - Data stored at report, but working on moving them into a database (Katrina has loaded some into SACADA)
  - Micro-tasks
- KAERI
  - Advanced (fully digitalized) MCR; Only PWRs, full scope simulations
  - Data is database and 3 information gathering templates (plant scenario, time analysis, context information/PSFs).
  - OPERA database is operational experience data
  - Scenarios decided based on discussion with trainers and use PRA to help pick scenario (training data)
  - 50min-1hr
- NRC
  - SACADA training data (not exam data or e-plan scenarios)
    - 1-2hrs; conventional MCR
  - IDHEAS -> cognitive literature
  - Expert elicitation for FLEX
- CREIPI
  - HRA data collection is not yet in Japan
  - Human Factors Root Cause database for maintenance failures mostly
  - PWR and BWR training center has video recording and stuff, but not HRA data….not sure how they use that data
- INL
  - HERA – incident reports…no further work being done in that area
    - Can we use SACADA to collect incident reports
  - Validation studies for digital control upgrades
  - timing data based on operator logs (SBO to support dynamic HRA)
  - MicroWorlds to answer specific questions
  - Using data to bound human performance (distributions)…"what if"
- NASA
  - Space --- JSC Human and Performance Lab
    - Probability of operators hitting the launch abort button
    - Decision making when bad stuff happens in space
    - Data from shuttle, Apollo and ISS
    - Common matrix for the data
    - To support design decisions for Mars mission
  - Oil & Gas
    - Well incident report (like LARs)

What kind of framework did you start with?

- Tasks
- PSFs
- Objective v. Subjective evidence
- How is context captured

Hurdles and Lessons Learned

- Exam security and E-plan (security)
- The more challenging scenario that you run the more trained the crew has to be
- Extra workload to training department needs to show big benefit to adopt
  - How do we communicate benefit to the plants so they adopt the data collection?
  - Putting the information into the software helps distill the training findings and common issues the various trainers see and make them visible
  - Linking to utility need (regulator and/or risk drivers)
- HUREX 1x month workshop key to keep data collection consistent and learnings passed on.
- Training very different from country to country
- How can we share data? Particularly with other industry (e.g., NASA, oil/gas)
  - 3rd party clearing house

3-WORKSHOP BREAKOUT (GROUP 2)

Group 2 - Data Analysis

1. Did you need to revise an underlying taxonomy that is used to categorize, parse and understand the data?
2. How is the data analyzed?
   - Direct HEP
   - Factors that impact the HEP
   - Bayesian-belief network
   - New causes of error?

Main takeaways (1): Do you need to use an underlying taxonomy to categorize, parse and understand the data (i.e., beyond that in a data source)?

- **"YES. This is essential."**
  - To enable consistent interpretation of the data
  - To map across different data collection activities
  - To map data across industries
  - To enable using multiple data sources (similar data types or different)
  - To capture causes and effects beyond a single data source;
  - To incorporate qualitative information
  - To enable text mining & automated data extraction
- **"YES but.."**
  - These is a tradeoff between comprehensiveness of the taxonomy and data quantity.
  - We need multiple taxonomies: PSFs, task types, error types, database types – "HRA data" is uniquely multifaceted.
  - This requires a serious investment

Main takeaways (2) How is the data analyzed (why did you choose this approach)?

- **Multiple types of HRA data & multiple goals for data analysis - lends itself to a variety of analytical approaches.**
  - Several groups directly quantify HEP and/or PSF->HEP effect using statistical techniques on the data
  - Several groups use BNs (either with or without causal maps)
- **Considerations that led to the choices of modeling framework:**
  - Need to capture data/information beyond what exists in a single source
  - Need to combine data from different sources & accommodate data together with industry-specific expert judgment;
  - Need to combine both data and scientific process models; enables consistent use of multiple types of data; enables handling differences with simulator
  - Cannot alter aspects of the data (whether that be the simulator environment or the observed accident data); so we can't fully decouple HEP effect from the context.
  - Can't directly assess a "nominal" HEP without considering the context (i.e., a large set of PSFs which need to be mapped onto HEP)
  - Treatment of PSF interdependencies -- potential combinatorial explosion of PSF states dependencies.
  - Potential for controlled PSF->HEP experiments
  - Secondary benefits beyond HRA – i.e., influence training

3-WORKSHOP BREAKOUT (GROUP 3)

Group 3 - Application of HRA Data in Decision-Making

1. How do you ensure your data collection and/or analysis supports the end-user needs?

2. How does your data provide insights and support to decision-making?

Group 3, #1: How do you ensure your data collection and/or analysis supports the end-user needs?

- Data development teams carry out case studies by comparing collected data to existing HRA methods such as CREAM.
  - Question applicability of another country's data
- UK – not collecting enough data to support end users.
  - Lots of opportunity but need to define the studies.
- From applications side - need to review key qualitative factors and compare to insights from the existing data sets.
- Start with feasibility and identify qualitative insights of applications align with data insights.
- Availability of data is a tough issue
  - Use of expert judgement
- Adapted THERP to have plant specific factors.

Group 3, #2 - How does your data provide insights and support to decision-making?

- Different levels of applications require different scope of data
- To answer this question we need to first list what the applications are.
  - Applications can include
    - HRA model and methods development.
    - Human error mitigations
      - Procedure updates – Formatting and content
      - Training
      - Control room design
        - New digital I&C
    - Plant design changes
    - Organizational changes

3-HRA WORKSHOP CONCLUSION

The workshop concluded with:

- **Presentation of Breakout Group results**

- **Short discussion of the Next Steps**
  - **Send out Breakout Group slides**
  - **Dialogue continues with PSAM14 HRA Data Analysis sessions on Tuesday**

  - **Continued the discussions during PSA'2019**
    - **"What's next for HRA Data Analysis? Panel**
    - **Future of HRA panel**

4-GOING FORWARD (1 OF 2)

- **Data Collection**
  - Trending up. Data collected in several countries from a variety of sources, and different levels
    - Simulator data at the task level (Korea) and the training objective level (USA); both more than 20,000 data points
    - MicroTasks and MicroWorlds
    - End-user, plant data such as FLEX and MCRA
  - Did not discuss Operating Experience as a data source
    - EPRI Pre-Initiator
    - ICDE CCF Data is 30-50% HRA
- **Data Analysis**
  - Needs a theoretical framework
  - Link to Context or de-couple?
  - Ability to correlate PSF?
  - Finding new failure modes

4-GOING FORWARD (2 OF 2)

- **Application of Data**
  - Identify gaps, are they being filled?
  - Consider:
    - Changes in plant design beyond Digital Controls (e.g. SMR multiple cores)
    - Changes in Hazards (e.g. new information such as consequential or combination hazards like seismic-fire)
    - Changes in models (PRA, HRA, HF)
- **Next Steps**
  - Need a taxonomy and guidelines that relates the different types of data and different levels
  - Need champions/sponsors
- **Next Meetings**
  - ANS PSA'2019, April 28 – May 3rd, 2019
  - Fall 2019 - ESREL and ASRAM

QUESTIONS?

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BACK-UP SLIDES

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Fostering Collaboration Through a Communication Framework (PSAM HRA Topical Slide by Mary Presley, EPRI)

- **Need:** To *define*, *prioritize* and *track* status of HRA related research needs to:
  - Promote collaboration between research organizations
  - Reduce redundant efforts
  - Communicate advances in state of knowledge
  - Make systematic progress as an international community towards filling knowledge gaps
- **Proposal**: To create a common format to communicate state of HRA research gaps and ongoing efforts to address those gaps. Agree upon a forum which all organizations can provide their input (face-to-face meeting not necessary?)
- **Question**: In sharing data, how do we gauge applicability of data given the potential difference in plant operations between countries?

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Discussion

(PSAM HRA Topical Slide by Mary Presley, EPRI)

- Are the needs captured?
- Data Analytics – can we pool data?
- Thoughts on HRA Communication Framework
  - Can we use a structure like an HRA matrix regularly across organizations?
  - Are the categories correct?
  - Can we start filling it out now?
- Other collaboration opportunities?
  - HRA Researcher Wiki?
  - Additional topical conferences with broader audience?

		[Type of human action]
Driving PSFs	State of knowledge	<describe state of knowledge>
	Reducible gaps	<list reducible gaps>
	Ongoing research	
	Irreducible gaps	<list irreducible gaps>
Parameter Estimation	state of knowledge	
	reducible gaps	
	Ongoing research	
	irreducible gaps	
Quantification	state of knowledge	
	reducible gaps	
	Ongoing research	
	irreducible gaps	
Technology Transfer	state of knowledge	
	Ongoing research	

HRA Data Initiative

(Gunnar Johannsen after IAEA Technical Review meeting)

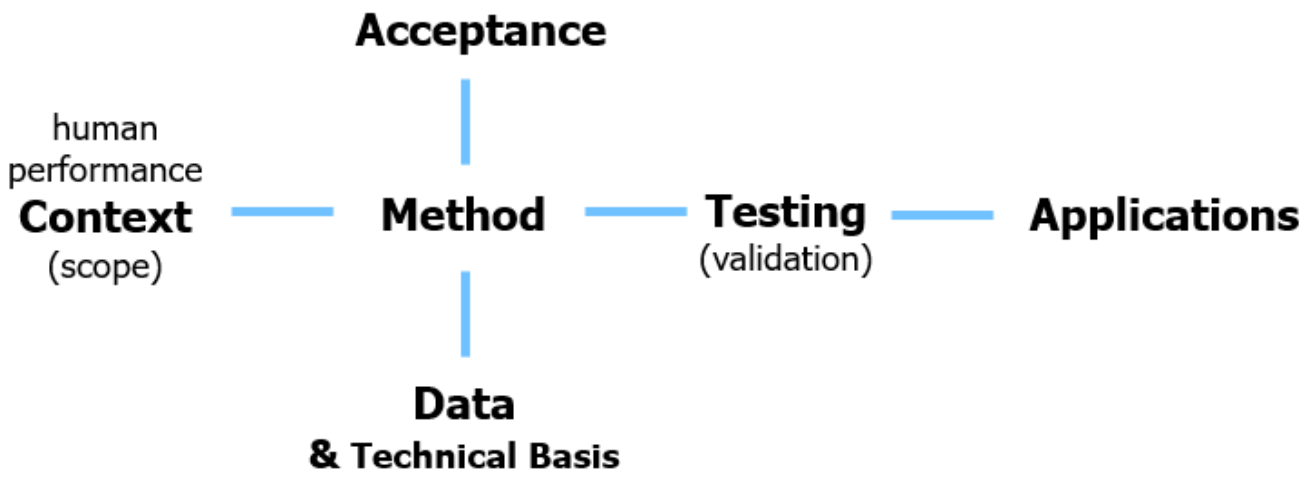
It is an open issue how joint (nuclear industry wide) data collection and analysis could be arranged in a meaningful way.

- Examples and Insight from ICDE
- Organization of data projects requires technical and administrative considerations
  - Example ICDE Operation - OECD/NEA
- Technical
  - Format and structure, coding guideline, workshop?
- Administrative
  - Proprietary rights
  - In kind contribution/Exchange
- How to start, Initiation work shop
  - Need agreement on technical framework
  - Need “champions” to push the issue
- Role of HRA Society

HRA STATUS AND RESEARCH ISSUES

PSAM13 (Seoul, 2016) – Organized by the HRA Society

- Survey of 4 countries and challenges in HRA; focus on Asia



... other challenges?