Results From A Pilot Benchmarking Study Of HRA Methods –

A Comparison of Method Predictions Against the Outcomes Observed in the Simulator Study

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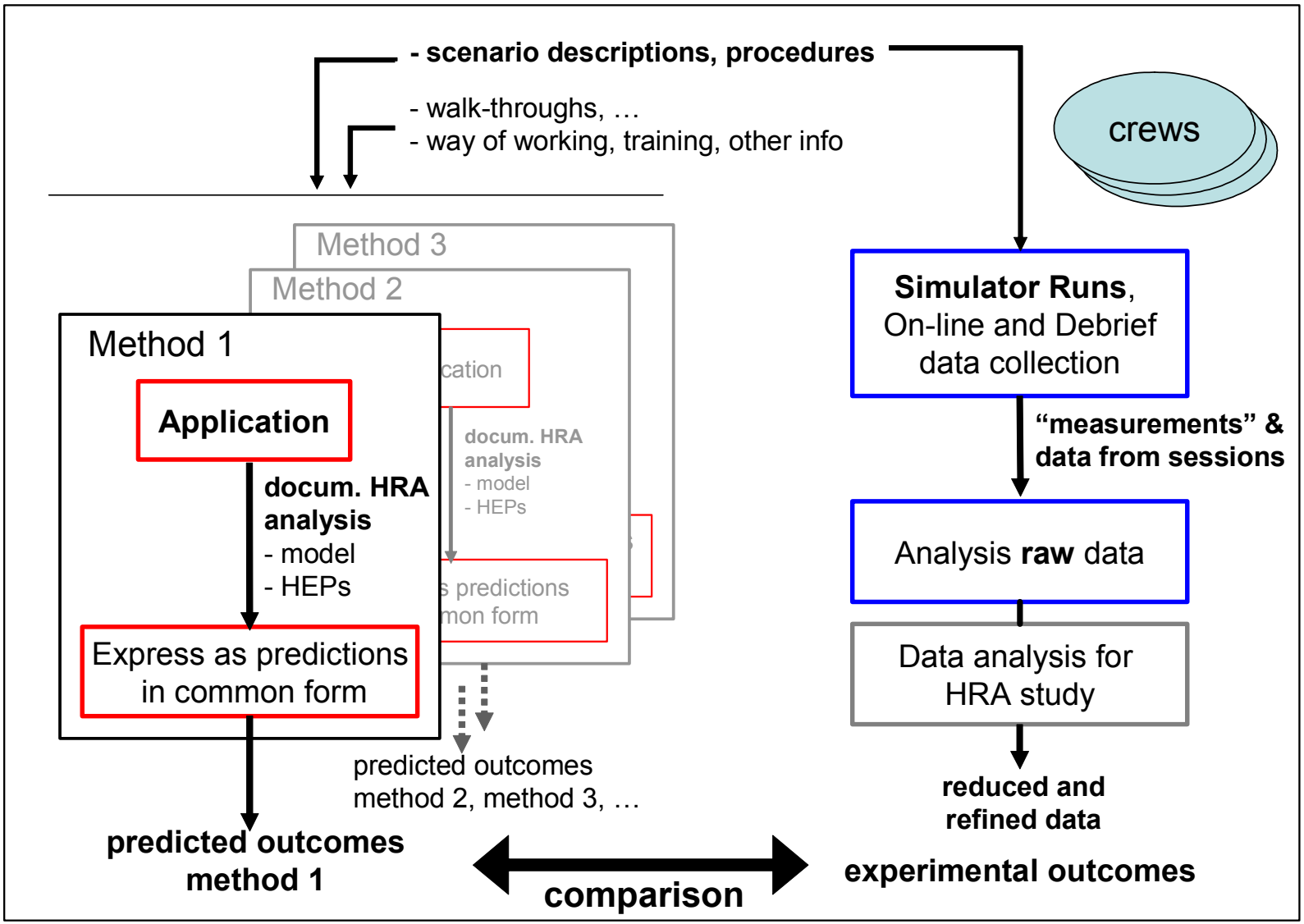
Results From A Pilot Benchmarking Study Of HRA Methods

- Driving factors identified for the 2 HFEs used in first pilot phase
  - short review of analysis
  - result
- Example comparisons
  - driving factors
  - operational description (ease or difficulties)
- Some challenges for scoring
- Conclusions

The views expressed are those of the authors and do not necessarily represent the views of the U.S. NRC and other organizations mentioned.


- scenario descriptions, procedures
- walk-throughs, …
- way of working, training, other info
crews
Method 3
Method 2
Method 1
Application
docum. HRA analysis
- model
- HEPs
Express as predictions in common form
predicted outcomes method 1
docum. HRA analysis
- model
- HEPs
predictions
mon form
predicted outcomes
method 2, method 3, …
Simulator Runs, On-line and Debrief data collection
"measurements" & data from sessions
Analysis raw data
Data analysis for HRA study
reduced and refined data
experimental outcomes
comparison

Starting point
Identification of driving factors

Crew summaries representing performers from both ends of the performance spectrum

- In this case, primarily by time to isolate, which correlates with steam generator level at time of isolations
- Generally aimed for 3 at each end (among fastest, among slowest), in practice 1-3

Structure of the summary of the performance of a single crew

HFE:
Narrative (Identification phase) • time line of key crew behaviors, communications, operator actions • short free-form description of salient aspects of crew performance
Narrative (Isolation phase) *[as for identification phase]*
Summary of **most influencing factors** affecting performance (individual crew)
Summary of the (a) **observed difficulties (or ease)** of various tasks within performance and (b) why the task was easy or difficult

Factors used in comparison (driving factors)

- Adequacy of time
- Time pressure
- Stress
- Scenario complexity
- Indications of conditions

- Human-machine interface
- Procedural guidance
- Execution complexity
- Training
- Experience

- Work processes (work practices)
- Communication
- Team dynamics

- set of factors is not a model of performance
  - superset of dimensions frequently considered, not PSFs for some ideal method
- some double-counting
- interactions

Influencing factor matrix

- base case

HFE 1A	2 fast crews (H, M)	1 slow crew (N)
positive	**Procedural guidance**. Good match of the procedures to the scenario (all) **Scenario complexity / indications of conditions**. Low complexity, indications are clear. (all) **Work processes** - good RO-ARO coord and communication, good procedure work (H) **Team dynamics**. SS decisive (H) SS keeps good overview of process and crew's work progress (M) **Training**. Crew easily identified tube rupture based on their training. Crew easily works ahead of the procedures (high degree of familiarity with the procedure, which means training is good) (H, M)	**Procedural guidance**. (as for fast crews) Good match of the procedures to the scenario (all) **Scenario complexity / indications of conditions**. As for fast crews). Low complexity, indications are clear. (all) **Training**. Indications were detected early. No specific difficulty with the diagnosis or isolation was observed. (N)
negative	**No direct negative influences. No "negative factor present" identified** (no negatively rated factor without observable impact). (H, M)	**Training**. ARO did not use the large overhead screen efficiently and used time to navigate to the appropriate screen at the workstations. SS does not focus on overfilling the SG. SS did not focus on speeding up the work (unaware of scenario dynamics). SS interrupts sometimes with less important things. (N) **Work processes**. Crew follows good practices (meeting at procedure transfer, thorough checks and verifications) "whole crew were clearly updated and coordinated on the situation and chosen strategy" but thoroughness and unwarranted attention to detail slows them down in this scenario. (N) **Team dynamics**. RO waits for ARO and does not work independently (also slows down crew). (N)

Driving factors – base case

Table 19. Summary of PSF Drivers – identified for HFE 1A (SGTR base case)

	Base case (HFE 1A)
Positive Driving Factors	HMI and indications of conditions – very good Training and experience – good to very good Adequacy of time – good Procedural guidance – good [*–]
Negative Driving Factors	Execution complexity – somewhat high

[*–] While overall effect is positive, this PSF had a secondary negative influence

Driving factors – complex case

Table 20. Summary of PSF Drivers – identified for HFE 1B (SGTR complex case)

	Complex case (HFE 1B)
Positive Driving Factors	(none)
Negative Driving Factors	Scenario complexity – high Indications of plant conditions – somewhat poor to poor [*+] Procedural guidance – poor Training – somewhat poor [*+] Execution complexity – somewhat high Adequacy of time – somewhat poor Work processes – high [requirements]

[*+] While overall effect is negative, this PSF had a secondary positive influence

Comparison of negative influences (example)

Negative factors predicted in HEART submission	Negative driving PSFs observed in the empirical data (HFE1B)
Selection of Generic Task Category for "complex task requiring high level of comprehension and skill"	Corresponds to driving factors "Complexity (scenario complexity) – somewhat high to high and "Execution complexity" – somewhat high
EPC "Unfamiliarity.. infrequent, novel situation" – poor, high impact on HEP	Corresponds to driving factor "Training" – somewhat poor
EPC "Shortage of time for error detection and correction" – poor, high impact on HEP	Not supported by the empirical data as such.
EPC "poor system feedback" – somewhat negative, low impact on HEP	Corresponds to driving factor "Indications of plant conditions" – somewhat poor to poor
EPC "stress" – very negative, relatively low impact on HEP	Not supported by the empirical data.

Assessment of operational description (example)

Summary of operational description provided in the HEART analysis (HFE1B)

Operational expression: Due to the masking effect, the crew may have **difficulties identifying the SGTR** – this relates to perceiving the relevant indications. In addition, they **may address the steam line break and not continue to verify for additional faults** (at least not immediately, which may cause problems in meeting the time criterion defined for the HFE).

Assessment of operational description (HFE 1B)

The operational expressions predicted in the HEART submission **do not correspond to the observed performances** at all. In the observed performances, the **difficulty to use the procedural guidance was central** and interacted with a number of PSFs. The HEART submission does not address the procedural guidance at all, which tended to impede or delay success. A number of the crews appeared to have diagnosed the SGTR and struggled to find an appropriate transfer to the E-3 procedure. The predicted possible (secondary) scenario with crew fixation on the steam line break was not observed.

Method-to-method

Scoring by matches of driving factor "matches" alone can mislead

Table 6. Trial score-card at level of driving factors (selected methods, HFE 1B) *

Negative driving factors	**Number predicted**	**Correct predictions** (predicted and observed)	**Incorrect Prediction** (not observed)	**Observed but not predicted** (failed to predict)
ASEP	6	5	1	1
SPAR-H	3	2	1	4
ATHEANA	5	4	1	2
MERMOS	3	3	0	3
Positive driving factors				
ASEP	2	0	2	0
SPAR-H	2	0	2	0
ATHEANA	1	0	1	0
MERMOS	1	0	1	0

- HEP driven by positive PSFs
- HEPdecision misses negative driving factors
- PSFs wrong on the details (at operational level)
- difficulty predicted to be low

- time recognized to be an issue but not reflected in HEP
- difficulty correctly predicted to be high

difficulty correctly predicted to be high

many other factors identified but scenarios have low weight

Conclusions 1.

- Very preliminary results
  - pilot of the comparison methodology
  - only 2 HFEs (same action in 2 scenarios) have been used in assessment to date
- More conclusive results would need a set of HFEs representative of the HFEs in a typical PSA
- Some strengths and shortcomings of the methods for these specific HFEs have been identified.

Conclusions 2.

- Method-to-data comparison has been emphasized over method-to-method
- Scoring the methods involves a number of issues

- Operational expressions are the most straightforward to compare.
- The concept of reporting operational expressions is also fairly novel for HRA teams
  - Can be expected to do better, now that they have seen different types of difficulties and performance issues that can be identified.

- Lack of guidance for rating PSFs is common to many methods.

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HWR-844

OECD HALDEN REACTOR PROJECT

INTERNATIONAL HRA EMPIRICAL STUDY -
PILOT PHASE REPORT

DESCRIPTION OF OVERALL APPROACH AND FIRST PILOT RESULTS FROM COMPARING HRA METHODS TO SIMULATOR DATA

by

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