

Conclusions on Human Reliability Analysis (HRA) Methods from the International HRA Empirical Study

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Motivation

- Human performance is an important contributor to risk
- Many different HRA methods in use today
- Diverse underlying models, producing different results
- Reliable estimates are needed for risk-informed decisions
- Lack of data, particularly on cognitive and collaborative aspects of crew performance

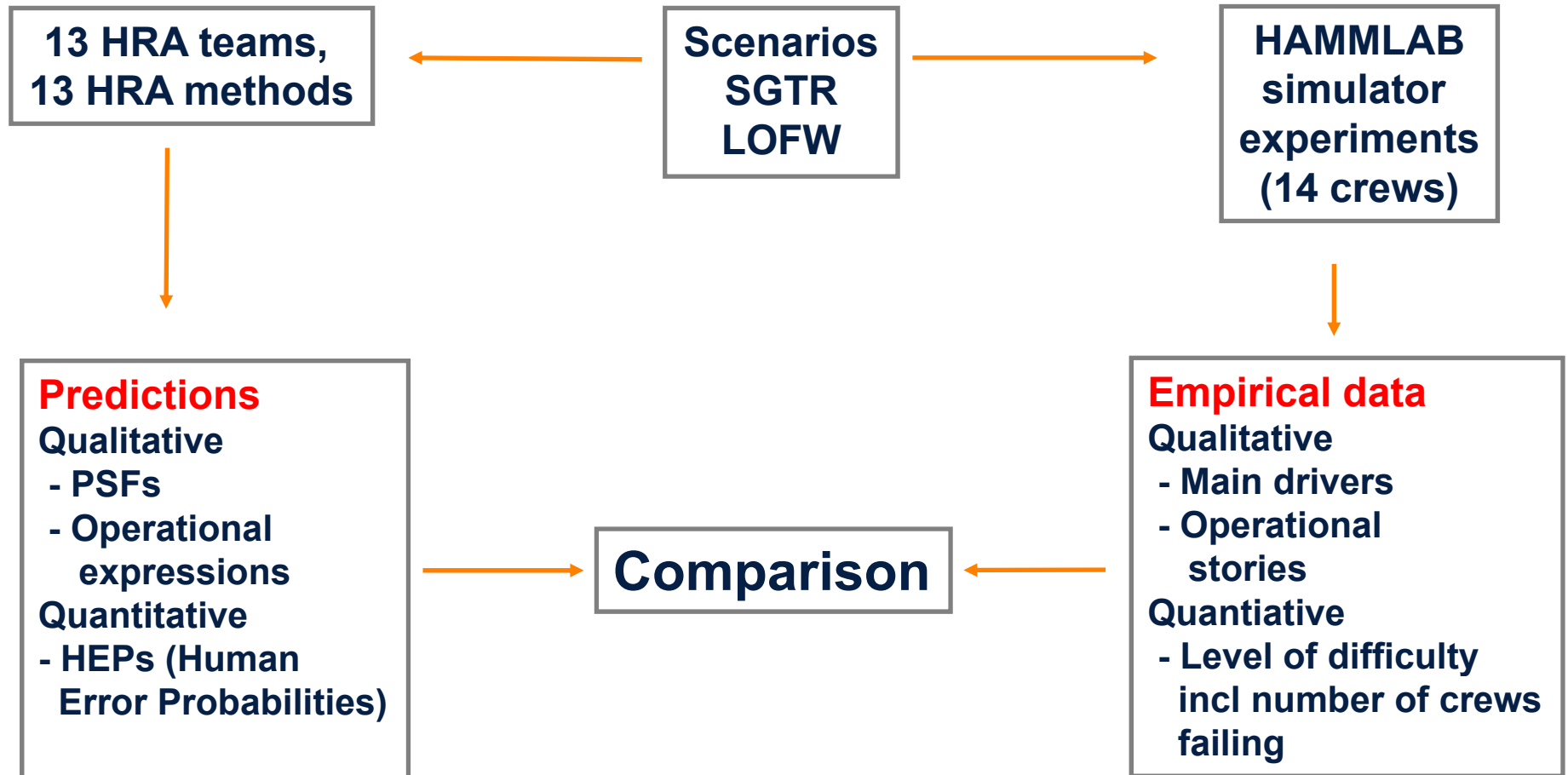


Objectives of International HRA Empirical Study

- Use simulator data to assess strengths and weaknesses of HRA methods
- Identify any limitations in predictive capability of the methods
- Improve the robustness of HRA methods and practices



Study overview



Achievements

- The first major effort to establish an empirical basis for HRA
 - Actual comparisons of predictions to observations (HAMMLAB)
 - All methods on the same playing field
 - Evidence of how people apply methods
 - Demonstrated the dynamic nature of crew-system interactions
 - Needed to be considered in HRA
- Established the use and usefulness of simulator experiments for HRA
 - Developed experimental design focusing on HRA
 - Developed method-to-data comparison methodology
- International and interdisciplinary study team
 - Buy-in from all 13 HRA teams
 - Acceptance of results and motivation for improving HRA methods and practices
- Addressed qualitative predictive power of HRA
 - capability to predict failures and underlying drivers



Key insights on HRA methods, 1

- Addressing diagnosis and related activities
 - Several methods allow analysts to model execution of procedures as purely task oriented (little diagnosis involved)
 - Cognitive demands are considerable for crews executing emergency procedures in complicated scenarios
 - E.g., interpretation of cues and procedural criteria in a dynamic environment
 - Failure in considering crews' cognitive activities while working with procedures may lead to lack of identification of important influencing factors and in underestimation of HEPs
 - Examples: SPAR-H and ASEP need to include diagnosis, CBBDT+THERP needs to include use of DTs



Key insights on HRA methods, 2

- Identification of failure mechanisms and contextual factors
 - Methods that focus on this (the way crews could fail a task) produced richer content in the qualitative analysis
 - Examples: ATHEANA, MERMOS, CESA
 - than PSF-based methods
 - SPAR-H, ASEP, THERP, PANAME, HEART
 - More detailed prediction of what could occur
 - More reliable results (better justification)
 - However, not necessarily more accurate HEPs

Key insights on HRA methods, 3

- Judging the degree of influence of PSFs and choosing the right PSFs is difficult
 - Variability in the PSF based methods
 - 1) different degrees of qualitative understanding of the details of the scenario
 - Lack of guidance as to what level of detail to address, e.g., in procedure execution
 - 2) differences in the interpretation of the scope of the PSFs and in the ratings
 - For a given issue or performance condition
 - Improved guidance required, e.g., complexity and HSI in SPAR-H
 - Overlap of PSFs



Key insights on HRA methods, 4

- Range of PSFs covered not always adequate
 - Some methods lack adequate PSFs for the observed phenomena
 - Some methods focus on evaluation of available time, then a few PSFs to adjust
 - May produce reasonable HEPs
 - However, may be for the wrong reason, a lucky shot



Main conclusion

- The qualitative scenario analysis performed to support HRA quantification is an important contributor to the adequacy of HRA predictions
 - Otherwise, no basis to address the range of conditions possible in PRA scenarios
 - The use of HRA is not only the number for PRA, but also insights for error reduction, which depends on a detailed understanding of the difficulties for the crews



Summary and Outlook

- The HRA Empirical Study produced a large set of diverse findings on the different HRA methods and their use
- Method assessments based on reference data from simulator studies useful to establish agreement among experts
- Qualitative and quantitative HRA issues can be explored from a manageable number of scenarios and crews
- Additional simulator studies desirable to better substantiate the results and address generalizability of the findings
 - A USA “domestic empirical study” is underway exploring intra-analyst variability -- supported by Halden
- Improving HRA (accuracy as well as reliability) requires enhancements to both the qualitative and quantitative analysis
- The NRC and EPRI are collaborating on developing a hybrid method improve the robustness of HRA

