Organizational Factors in PRA: Twisting Knobs and Beyond

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ANS International Topical Meeting on
Probabilistic Safety Assessment and Analysis (PSA 2019)
Charleston, SC; April 28 – May 3, 2019

Outline

- Background

- Observations

- Challenges

- Concluding Remarks

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Background

- SECY-19-0060: increased use of risk information => desirable to reduce completeness uncertainties
- Organizational factors long-recognized as a gap ("completeness uncertainty")
  - Operational experience
  - NRC program (1990s)
  - Continuing R&D
  - Recent calls for attention
- Problem seems amenable to technical solution; cost/benefit (in RIDM environment) unknown
- NRC/RES considering whether to pursue (as part of HRA)

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Observations

- In principle, many impacts can be modeled with changes to PRA basic events ("twisting knobs")
  - Human and hardware (including CCF)
  - Qualitative and quantitative
- Discussion of influences has transitioned from "organizational factors" to "safety culture" framework
- Effect (positive or negative) of changes in factors/traits can be complex
- Plant-to-plant variability in estimates suggests avenues of investigation
  - Potential overall effect on PRA model parameters
  - Possible correlations across parameters

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Transition to Safety Culture Framework

Organizational Factors (1999)

- Culture
  - Organizational culture
  - Ownership
  - Safety culture
  - Time urgency
- Communications
  - External
  - Interdepartmental
  - Intradepartmental
- Decisionmaking
  - Centralization
  - Goal setting
  - Organizational learning
  - Problem identification
  - Resource allocation
- Administrative Knowledge
  - Coordination of work
  - Formalization
  - Organizational knowledge
  - Roles/responsibilities
- Human Resource Administration
  - Performance evaluation
 - Personnel selection
  - Technical knowledge
  - Training

Safety Culture Traits (2014)

- Leadership
- Safety values and actions
- Problem identification and resolution
- Personal accountability
- Work processes
- Continuous learning
- Environment for raising concerns
- Effective safety communication
- Respectful work environment
- Questioning attitude
- Decisionmaking

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Complex Effect of Changes - Examples

- Positive safety culture traits can have uncertain public risk impacts
  - Turkey Point (1992): worker safety => stay indoors
  - Point Beach (2000): worker safety => rx trip
  - Blayais (1999): Y2K caution => non-standard shutdown
- Training
  - Scenario-specific practice vs. general practices (e.g., use of diverse and redundant indicators when monitoring)
  - "Worst case" vs. more likely/less severe
- Multivariate effects (confluence of factors)
- Potentially wide scope of effects

Plant-to-Plant Variability
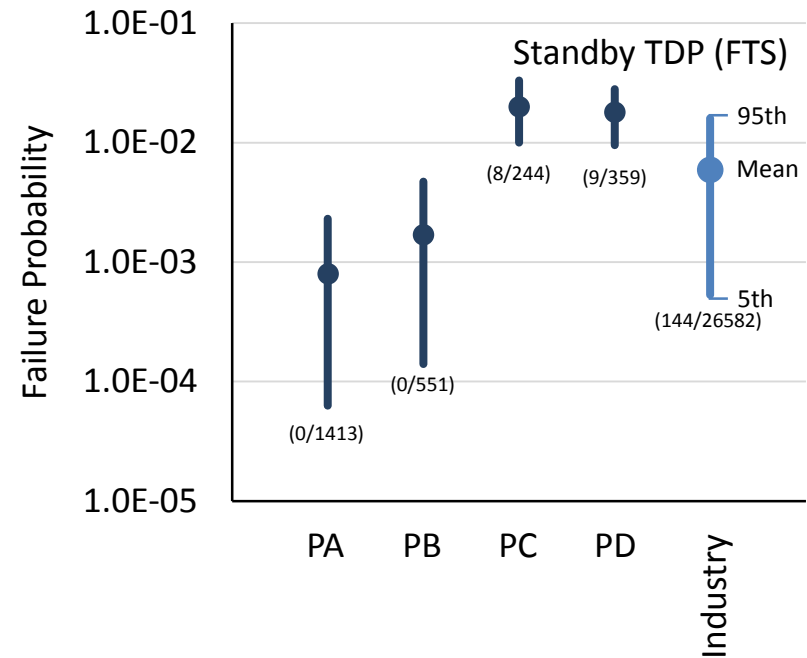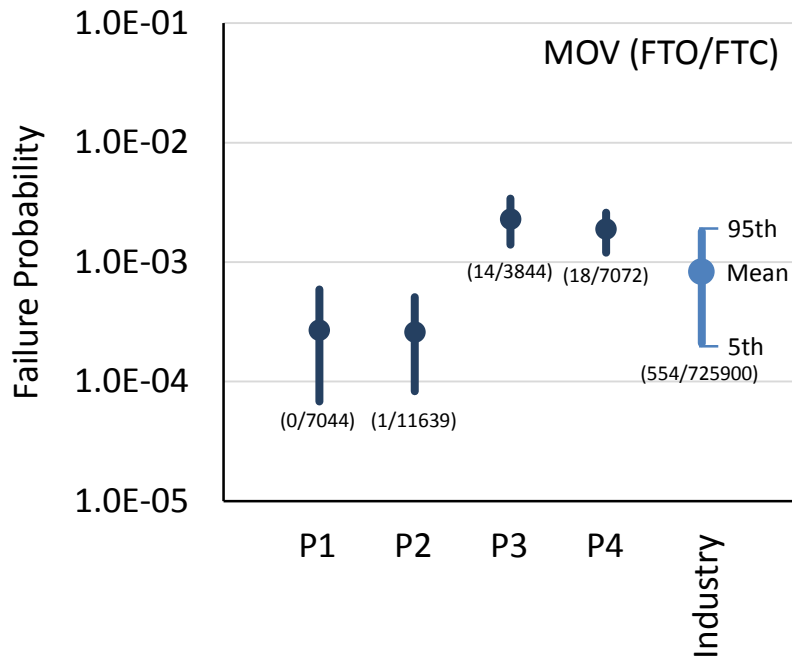
Notes:
1) Differences can be due to voluntary reporting practices as well as performance.
2) Prior distributions are generic.

Some Challenges

- Intended use and scope
- Interdisciplinary communication
  - Frameworks and terminology
  - Working methods
  - What's important
- Modeling
  - Multiple organizational science issues (see paper)
  - PRA end use perspective
    - Focus on "what's important" – credible? useful?
    - Identifying, characterizing, and quantifying dependencies
    - "New" scenarios?
- Data

"New" Scenarios?

- Accounting for organizational factors/safety culture traits: go beyond adjustment factors?
  - Level of causality explanation (intended use)?
  - Fundamentally different accident progressions?
- Possible aids
  - Top-down "search" (in addition to emergent results of system models)
  - Operational experience
    - TMI-2
    - Chernobyl 4
    - Fukushima Dai-ichi

Data

- Example: 2010 INPO safety culture survey
  - 63 sites, 2876 respondents (48% response rate), different occupational groups
  - 9 factors, reasonable alignment with NRC Safety Culture traits
  - Comparison with NRC performance metrics**
    - Moderate correlation with some 2010 metrics
    - Moderate correlation with some broad-based metrics for 2011
- Limitations and challenges
  - Correlation – not cause/effect
  - Single study – corroboration and longitudinal study would be useful
  - Need to connect with PRA basic events

Performance Metric	Corr. (2011)
Unplanned Scrams	-0.27*
Elevated Oversight in Action Matrix	-0.30*
Human Performance Cross-Cutting Area	-0.12
Problem Identification and Resolution Cross-Cutting Area	-0.27*

*Statistically significant ($p < 0.05$)

S.L. Morrow, G.K. Koves, and V.E. Barnes, "Exploring the relationship between safety culture and safety performance in U.S. nuclear power operations," *Safety Science*, **69, 37-47(2014).

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Closing Remarks

- PRA treatment of organizational factors/safety culture traits: a long-standing grand challenge

- Links to basic events can be hypothesized; theoretical and empirical basis needed

- Interdisciplinary challenges are important

- Multiple viewpoints and approaches may be useful