Applying RE to Practice

Christopher Nemeth, PhD

September 13, 2020

Key Points

- To be effective, socio-technical systems (e.g., ATC) must reflect intense attention to behavior (operators, users, maintainers)
- Resilience Engineering (RE) creates systems that can anticipate and sustain when confronted by unforeseen threats in high stakes sectors

  Able to adapt in the face of complexity
  Able to reveal interdependencies
  Distinguish work as done from work as imagined
  Enable operators to fulfill ability to ensure resilient performance

- ATC and NAS design, technology procurement, operation and maintenance roles are well-suited to benefit from RE.

Burn Intensive Care Unit

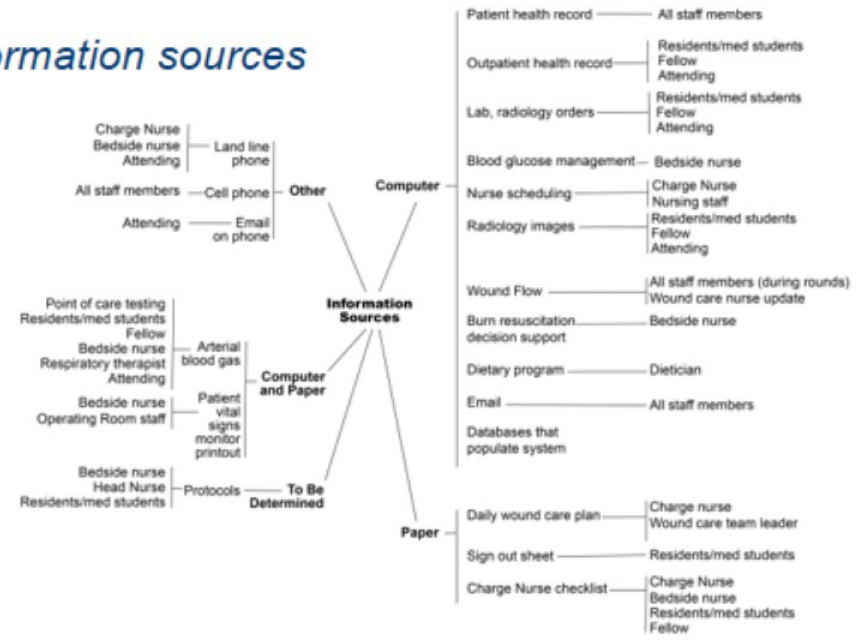
Real-Time Decision Support (Dept. of Defense)

USNS Comfort, Persian Gulf, 2003

Burn ICU

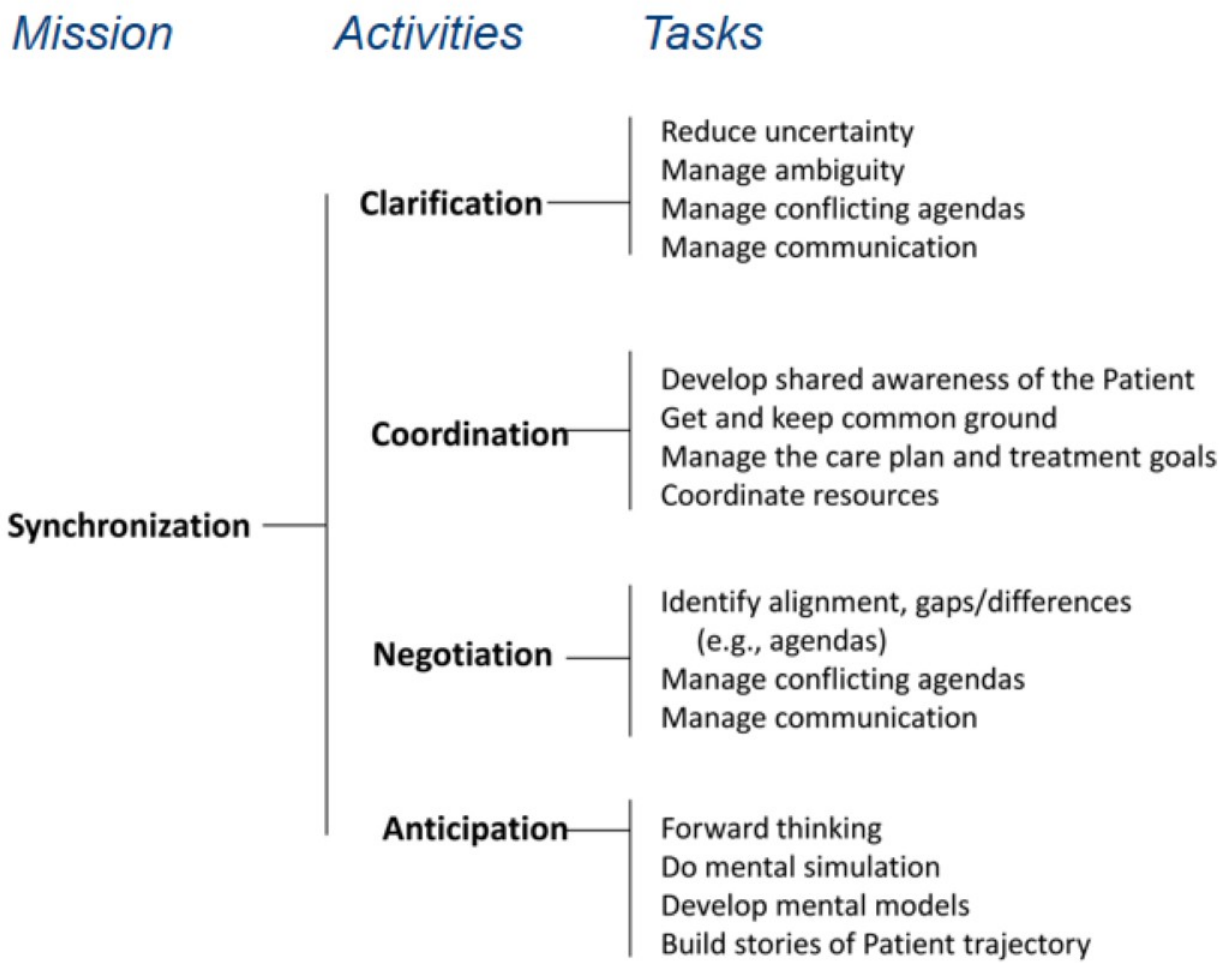
- Complex system that requires numerous care providers, support persons, and information systems working together to deliver effective patient care
- Cognitive work here is poorly understood
- Research methods revealed initiatives that workers create and maintain in order to accomplish shared goals

Information sources



Care provider team

Descriptive Model of Cognitive Work



Barriers to Cognitive Work

1. **No effective means to synchronize aspects of patient care**
2. Lack of awareness of activities/events that are tightly coupled
3. No efficient way to communicate patient status change across disciplines
4. **Updated information (e.g., cultures) is available, not accessible/visible**
5. Orders often late, missing, or overtaken/replaced by other orders
6. Reliance on verbal orders; no standardized way to share them
7. **Lack of coordination between shifts**
8. Documentation requires significant time from key members of the clinical
9. team, and:
   - IT issues and work process requirements frequently require redundant and/or repeated information capture and data entry
   - Compounds cognitive workload and attention management issues for clinical staff
10. Trend data identified as important; unavailable from Essentris or other IT.
11. Tracking patient indicators over time > 24 hours difficult
12. **Cognitive workload: clinicians must mentally integrate data**

Revealed Essential Aspects of BICU Work

Phenotype: *Clinicians talk among each other, spend a good deal of time writing at terminals*

Work-around

Genotype: *Disconnected databases*

Source of brittleness

→ ***Barrier:*** ***No effective means to synchronize*** *and adapt different aspects of patient care over the course of a shift, across caregiver team.*

Blocks synchronization

→ ***Requirement:*** *System shall provide access to a* ***plan of patient care,*** *visible to all care givers responsible for that patient*

Source of resilience

→ ***Features:***

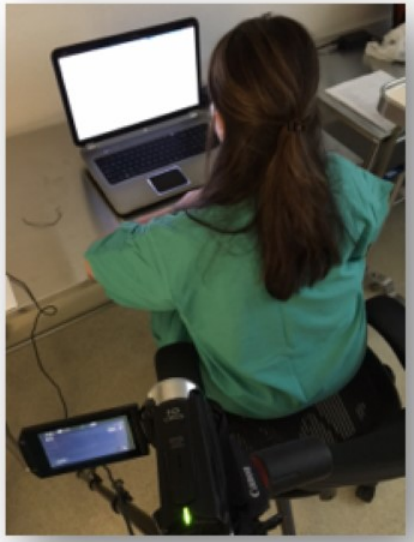
Current patient status *and top-level assessment*
Goals *and goal priorities*
Changes/updates*, such as indication that plan is being updated when one caregiver is working on it*
Schedule *of activities and any changes, timeline*
Orders *and their status*
Patient's ***care team*** *identity and contact information*

Facilitates synchronization

Solution, Evaluation

CCS Patient View

Individual Usability Assessment



Team Validation Assessment

Additional work to develop resilient performance

International Space Station (ISS)
Near-Fatal EVA Investigation (NASA)

Environmental/Ship Motion Forecasting
Office of Naval Research (USN)

Battlefield Medic/Field Hospital
Real Time Decision Support (DoD)

Next Generation C2 for NECC
Chief of Naval Operations (USN)

RE in Practice

- Intense attention to human cognitive work in system
- Reveals barriers to cognitive work, interdependencies
- Identifies opportunities to anticipate, monitor, respond, learn
- Collaborations with, rather than for, operators
- Solutions and evaluation clearly reflect requirements driven by empirical quantitative and qualitative data

Implications for FAA V&V

- Increasingly complex information-rich systems, operational domain require valid grasp of how operators create resilient performance
- Develop understanding of what goes well in ATC and NAS, and how to capitalize on that as an asset
- Accurately translate research into solutions
- Prove that decision making performance improves

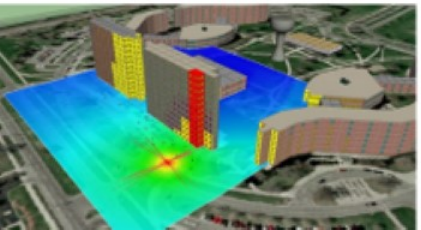
Your questions and comments are welcome

Christopher Nemeth, PhD
cnemeth@ara.com

September 14, 2020






ARA