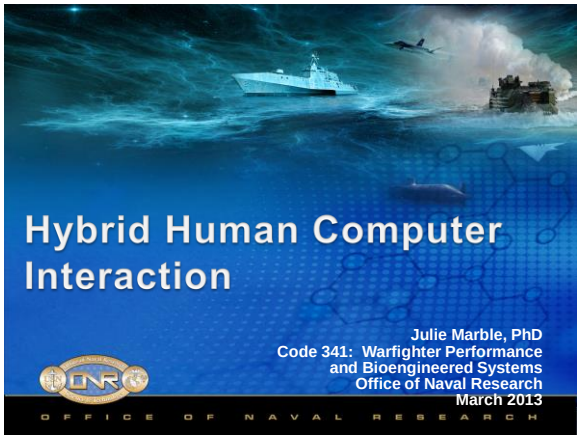


What do we do

- Look 5, 10, 20 years out to ask what will be Navy & Marine Corps needs
  - Roadmaps, STOs, POMs, FNCs, ECs, talking to groups.
- Basic and Applied Research
  - Focus on Transition of technologies
- Many potential application areas
  - Naval applications
  - Telemedicine,
  - Autonomous systems,
  - Decision making,
  - Cybersecurity, etc.

OFFICE OF NAVAL RESEARCH

Autonomy S&T PSC Roadmap (2012)

- Human/Autonomous system collaboration
  - Future R&D must further integrate Artificial intelligence & human cognitive models, advance human-agent feedback loops, optimize trust/transparency and advance sensor /data decision models.
- Scalable teaming of Autonomous Systems
  - Future R&D must provide secure communication between agents and their operators, decision making algorithms to enable operations, and adaptive guidance
- Machine Reasoning and Intelligence
  - Future R&D must advance data-driven analytics, contingency-based control strategies, decision making algorithms to enable operations, and adaptive guidance & control
- Test, Evaluation, Verification and Validation
  - DoD must strengthen its TEV&V … in live and simulated environments across all operational domains. Test beds must incorporate scenario-based testing. Joint testing may support future joint battle planning/execution

OFFICE OF NAVAL RESEARCH

Goals for Human Impact

- Assumption that human will always be 'in-the-loop'
- Support the human roles
  - Doing more, faster with fewer personnel
- Design of autonomous systems need to consider human role first
  - Not just how the task is done, but why do it that way
  - Reduce the cognitive load on the operators

OFFICE OF NAVAL RESEARCH

Management of Hybrid Heterogeneous Autonomous Systems

- How can two fallible collections of autonomous systems work together?
  - Humans and systems WILL fail
- Autonomy to increase operator control and situation awareness over collective, heterogeneous systems
  - Includes interface development, but not focus
  - One to Many →Many to many? When? How?
  - Increase coordination/reduce error

- Autonomy to help optimally allocate the human operators' limited cognitive resources to mission critical tasks
  - Need metrics of robust task effectiveness
    - How do we know when we've made an improvement?
  - Maintain awareness of higher order goals
    - Shift turnover

OFFICE OF NAVAL RESEARCH

Gap: Understanding the task

- Mission, interface, operator model coherence
  - CTA, FRA, FA necessary but not sufficient:
    - Must understand why task is performed that way
    - What happens to the process when you insert autonomy?
    - Which rules still apply? Why?
  - Misplaced faith in realistic displays (Naïve Realism, Smallman & St. John, 2005)
    - e.g., simulated toggle switches in simulators
    - Selection of data sources for fusion algorithms without analysis of task needs.
    - Faulty design assumptions wrt how the task can/should be performed

OFFICE OF NAVAL RESEARCH

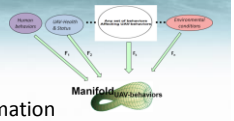
Gap: System Brittleness & Resilience

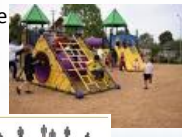
- Surprise is guaranteed
  - People fail & Machines fail
  - Failure in the face of surprise can yield catastrophic event
  - Changing technologies changes the source and form of risk
- Performance Shaping Factors
  - From HRA, factors assumed/known to influence the probability of human error
  - How much? How do they interact?
  - Current approach often 'Blame, shame, retrain'
  - Just remove the human from the system…

OFFICE OF NAVAL RESEARCH

Gap: Cooperation and behaviors

- Operator goals change
  - System needs to adapt
  - System should provide information to indicate when goal should change
- Off-normal occurrences
  - Operators must focus on details
  - Many to one breaks down
  - When to switch? How to cue?





OFFICE OF NAVAL RESEARCH

Gaps: Too much data

- Adoption of autonomous systems by DoD
  - Varying levels of autonomy
    - Variations in systems
  - Capabilities greater (and lesser) than operators can handle
  - Budgets for personnel are declining
    - Just-in-time staff replacement
- Sensors evolve, outstrip the human ability to process the data (D2D)
  - 'Data' is not 'information' until it has meaning (processing, context)
- The human is the source of all decisions and integrator of all data
  - Connectivity of distributed information

Everybody gets so much information all day long that they lose their common sense. –Gertrude Stein

OFFICE OF NAVAL RESEARCH

Gap: Variations in Solutions

- Different algorithms can yield the same outcome (e.g., anomaly detection or navigation)
  - But mission, task, context and operator goals determine which instantiation satisfies/optimizes the task
  - How does the system 'know' which to use? Why should the operator decide this?
    - Operator overload if human has to select
    - Designers choose different instantiations

OFFICE OF NAVAL RESEARCH

Research needs

- **Performance metrics**
  - Operator as well as kinematics/mechanical
  - Mission 'satisfaction'
  - System of systems; multiple scales
- **Allocating human and system resources**
  - Predicting and preventing errors
  - Building mental models to assist diagnosis
  - Situation awareness to anomalies
  - Ranges of teams and relationships
- **Accommodating changing goals and events**
  - Adjusting models to new information
  - Making the impact of new information apparent

OFFICE OF NAVAL RESEARCH

Current research

Recognizing interactions and gestures

Developing mental models for maintenance

Visual Analytics and Automation Schema
Interfaces for Future Unmanned Systems
Supervisory Control UAS

Performance Metrics for Autonomous Systems
Detection and Alerting Anomalous Behaviors

Focusing, Sustaining, and Switching Attention
Predicting & Preventing Errors in Procedural Tasks
Satisficing for Autonomous Decision Making
Visualization of Fused, Complex Data sets

OFFICE OF NAVAL RESEARCH