Roadmaps Tuned to Strategic Guidance of January, 2012

- **President**
  - ... focus on ... Asia Pacific ... deepening partnerships
  - ... military is agile, flexible, and ready for the full range of contingencies

- **DepSecDef**
  - ... Joint Force of the future that will be smaller and leaner, but will be agile, flexible, ready, and technologically advanced.
  - ... led by the highest quality, battle-tested professionals

- **Primary Missions**
  - Counter Terrorism and Irregular Warfare
  - Deter and Defeat Aggression
  - Provide a Stabilizing Presence
  - Conduct Stability and Counterinsurgency Operations
  - Conduct Humanitarian, Disaster Relief, and Other Operations

- **Joint Force**
  - ... resist the temptation to sacrifice readiness
  - ... limited resources may better tuned to their requirements
  - ... encourage innovation in concepts of operation
Summary – Human Systems

• Big Ideas
  – Enable Engineering and Assessment for Joint Mission Effectiveness
    – Baseline Effectiveness Using Realistic Mission Training Scenarios
    – Extend Mission Training Scenarios to Joint Missions
    – Provide Synthetic Environments for Collaboration with Industry, Others
  – Natural interfaces to manage multiple scale multiple role systems
    – Develop common representation schemes for system/data interaction
    – Develop natural language and gestural system interaction
    – Develop operator state monitoring technology
Human Systems Interface for Effectiveness

Problem: Current system operation is rigidly data-centric vice flexibly information-centric

- Modern technologies exacerbate critical manning and talent pool deficiencies by ignoring role of Mission, Task & Context – Moving & presenting data vice information
- Current adaptive planning tools do not allow rapid “course of action” analysis and generation
- Information displays typically non-interactive, adapting little to changing needs
- Data quantity will continue to increase non-linearly

Virtual lab

Actual lab
1. Task-centric interfaces for increased speed and accuracy of decisions
   - Model context and decision space
   - Situation sensitive adaptive interface

2. Mission-centric automated information analyses (e.g., prioritized COA recommendations)
   - Operator state driven tailored information

3. Context sensitivity to Commander’s intent
   - Common control station for UxS
   - Tactically believable agents

4. Natural language dialogue
   - Influence operator state

5. Social Cognitive Architectures for synthetic teammate development

6. Hybrid force demonstration for multiple UxVs via natural man-machine interactions
Human Systems Interface Technical Challenges

Challenge 1: Human-Machine Teaming
- Developing representation and inference frameworks that capture and reason over the beliefs, goals, intentions and obligations of the human user
- Integrating low-level operator state modeling with representations of human user’s estimated mental states (see below)

Challenge 2: Intelligent, Adaptive Aiding
- Measuring, assessing, and modifying operator’s mental and physical state
- Adapting estimates of user’s mental states via successful and unsuccessful interactions
- Iteratively learning user model via natural, multi-modal interfaces (E.g. gesture, natural language dialogue)

Challenge 3: Intuitive Interaction
- Natural, anticipatory interaction
- Trust
# Interface Challenges

**#1 – Human-Machine Teaming**

*Gaps*
- Non-verbal cue understanding between the interface and the operator
- Natural interfaces to manage multiple scale (one to many), multiple role systems

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**#2 – Intelligent, Adaptive Aiding**

*Gaps*
- Metrics (systematic, scalable, relevant) for free form interactions
- Interfaces which adapt to the user’s mental state
- Heuristics to determine relevant information to be exchanged during operations

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**#3 – Intuitive Interaction**

*Gaps*
- Human-centric parameters for management of autonomous systems
- Goal-oriented interfaces for simultaneous multiple domain operations
Human Systems
Training for Readiness

Problem: Complex Evolving Threats Outpace Readiness Training

- Warriors train for tomorrow’s fight using yesterday’s technology, methods, and strategies
- Current training scenarios not matched to evolving mission complexity and dynamics
- Warfighters are trained to doctrine -- fight strategically and dynamically to meet new threats
- Training is costly
  - Live systems deplete inventory, consume fuel, require maintenance & wear out
  - Ranges & role players are expensive – lack fast responsiveness to changing scenarios
  - Training ranges not designed for flexible scenarios and throughput is inadequate
Training Technology End States

- Seamless Virtual/Constructive training
- C2 with tactical players
- Quantified human system performance with mission effectiveness metrics
- Safe, live virtual constructive training
- Individual adaptive team training
- Increased Complexity
- Increased players

- Timely and effective training reflecting dynamic operational insights/challenges
- Personalized, adaptable, point of need training
- Integrated regional ally mission preparation
- Credible synthetic players: persistent, generative, robust
- Continuous, real time, high fidelity training with LVC multinational partnering – when and where needed

Mission Effectiveness (% Current)

Years

0

Speed to Train for Full Mission Effectiveness

0

100

Number of years away

Distribution A: Approved for Public Release
Human Systems
Training Technical Challenges

Challenge 1: First Principles for Training Design
- **Validated tools to optimize** training outcomes across individuals and teams
- Characterizing and exploiting the “science of learning” and developing performance measures for effectiveness prediction
- Techniques to automatically capture operationally relevant measures of performance

Challenge 2: Realistic, Adaptive and Interactive Scenario Based Training
- Persistent integration of real world events and content into scenarios and syllabi
- Demonstrated and validated for the full range of warfighter capabilities reflecting recent lessons learned
- Training that adapts to warfighters’ individual needs in near real-time

Challenge 3: Persistent, Affordable, Integrated Training
- Mission-focused training simulations that enhance individual and collective training
- **Seamless, secure** integration of training systems across services and coalition partners
# Training Challenges

<table>
<thead>
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<th>#1 – First Principles for Training Design</th>
<th>#2 – Realistic, Adaptive, and Interactive Scenario Based Training</th>
<th>#3 – Persistent, Affordable, Integrated Training</th>
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<tr>
<td><strong>Gaps</strong></td>
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<tr>
<td>- Estimated operational effectiveness via training scenarios</td>
<td>- Automated, adaptive, and individualized tutors</td>
<td>- Training systems which adapt to individual needs</td>
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<td>- Verification &amp; Validation of advanced training models</td>
<td>- Automated knowledge elicitation to develop responsive instructional content</td>
<td>- Standardized data protocols for operation in multi-level classified environments</td>
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<td>- Measures and assessment of long term (life long) performance</td>
<td>- “On the fly” assessment in dynamic environments</td>
<td>- Scalability across increasingly complex domains</td>
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Training Roadmap – First Principles for Training Design

End States:
- ITSSs for Intell Analysts & STEM
- Scalable Agents for Teams
- Agent-driven Aiding & Trng for C2
- Persistent Models & Environments

Military Capability:
- Integrated Live, Virtual, Constructive (LVC) Environments With Real Time Assessment For Joint and Coalition Individuals, and Teams

Technical Capability:
- Discovery engines to model individual expert behaviors
- Generalized Intelligent Framework for Tutoring
- Higher fidelity behavior models (individual and teams)
- Training authoring tools
- High resolution, validated metrics for performance measurement
- Computational models of human cognitive performance

R&D Programs:
- Automated Knowledge Elicitation / Engineering
- Mechanisms of Cognitive Processing
- Cognitive Model and Scale Integration
- Integrated LVC Training and Assessment (F-18, F22, JSF, UAS)

Shading Legend:
Dark: Funded
Light: Not/partially funded

2013 - 2023
Training Roadmap – Realistic, Adaptive and Interactive Scenario Based Training

End States

Military Capability States

Individual 

- LMS Exemplar for Distributed Training
- Integrated Live, Virtual, Constructive (LVC) Environments With Real Time Assessment For Individuals, and Teams
- Comfortable ergonomics (portable)
- Virtual Human Integration
- Persistent Readiness Assessment Tracking, Prediction
- “Invisible HMD”
- Higher fidelity behavior models (individual and teams)
- Automated Authoring for Seamless LVC Scenario Generation
- Teams & ‘Teams of Teams’ training techniques
- Agent-Based Training Enterprise Management
- Persistent, Generative Models and Agents
- Integrated Family of Complimentary Trainers
- Persistent Globally Distributed Knowledge Bases

R&D Programs

- Augmented Immersive Training
- Perceptual Training Systems
- Small Unit (Leader & Individual) Adaptive Tutoring Research
- Neuroadaptive Training
- Integrated LVC Training and Assessment (F-18, F22, JSF, UAS)
- Adaptive Training for C2ISR (Pervasive)

2013 2016 2018 2020 2023

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Training Roadmap – Persistent, Affordable, Integrated Training

End States
- Language-Enabled SynTeammate/Coach
- Reduced tutor development time/cost

Military Capability
- Integrated Live, Virtual, Constructive (LVC) Environments With Real Time Assessment For Individuals, and Teams
- Personalized, adaptive, persistent, scalable training
- Persistent Readiness Assessment, Tracking, Prediction

Technical Capability
- Virtual Human Integration
- Higher fidelity behavior models (individual and teams)
- Common Instructional Strategies across Domains
- Persistent, Generative Models and Agents
- Robust Functional Synthetic Teammates
- Persistent Globally Distributed Knowledge Bases
- Agent-Based Training Enterprise Management

R&D Programs
- Augmented Immersive Training for Infantry
- Perceptual Training Systems and Tools
- Everyday (not stressful) Environments 24/7/365 training
- Virtual World for Post Deployment Soldier Support
- Small Unit (Leader & Individual) Adaptive Tutoring Research
- Pervasive Learning with Personalized Training

Shading Legend
- Dark: Funded
- Light: Not/partially funded

2013  2016  2018  2020  2023

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Summary

- Engineering and Assessment for Joint Mission Effectiveness
- Natural interfaces to manage multiple scale multiple role systems