

MODELING PERFORMANCE IN C4ISR SUSTAINED OPERATIONS: A MULTI- LEVEL APPROACH



Lt Christopher Barnes
Air Force Research Laboratory
Biodynamics & Protection Division
Warfighter Fatigue Countermeasures

christopher.barnes@brooks.af.mil



Credits



- **Dr. James C. Miller: Air Force Research Laboratory Warfighter Fatigue Countermeasures R&D Program**
- **Dr. Linda Elliott: Veridian Engineering**
- **Dr. Michael Coover: University of South Florida**
- **21ST Century Systems, Inc., providing the Agent Enabled Decision Group Environment (AEDGE) software**



Issues



- **Modeling**
 - **Agent-based Software Architecture**
- **Assessment**
 - **Scenario Design**
 - **Construct Validity / Measures**
 - **Multi-level Modeling of Interrelationships**
- **Application**
 - **Criterion Performance (Training)**
 - **Fatigue Models**



Software Architecture



- **AEDGE- Agent-Enabled Decision Group Environment**
 - **Federation of IA agents**
 - **Heterogenous / Distributed / Autonomous / Concurrent**
 - **Component-based Architecture**
 - **Hierarchical Collective Agents Network (HCAN)**
 - **4 Modules**
 - * **Data Management**
 - * **Reasoning**
 - * **Control and Adaptation**
 - * **User Interface/Visualization**



Data Fusion and Decision Support

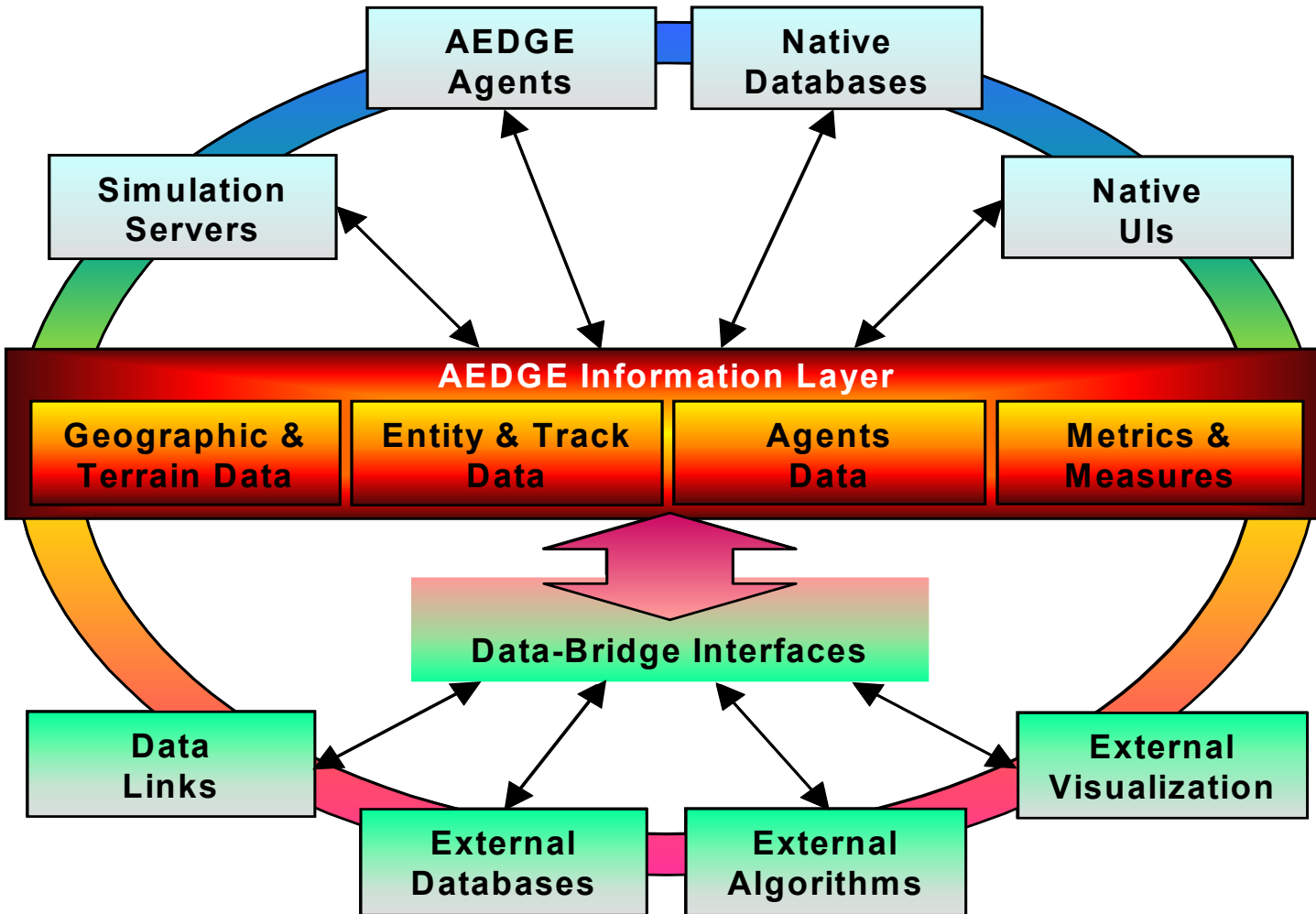


Figure 1. 21CSI's AEDGE™ Product

New Open Save Connect

Restart Pause Play FastFwd

login mission values priorities markers layers

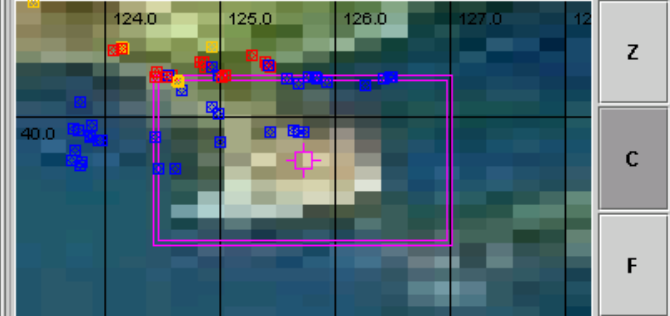
Allocate Modes Auto-Accept Help Accept

Navigation icons: Home, Search, Refresh, Undo, Redo, Stop



Comm Nav Scores Orders

Navigation



Coordinates

	Center	Extent
Curr.Lat	36.435763888888886	5.614583333333336
Curr.Lon	128.2079443247495	4.994152046783611
New Lat	36.435763888888886	5.614583333333336
New Lon	128.2079443247495	4.994152046783611

Aspect Lock Apply

Previous Home Next

Global View





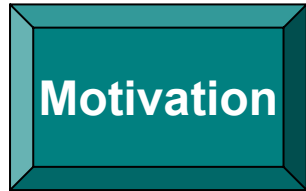
Scenario Design



- **Operational Relevance**
 - **C4ISR assets / roles**
- **Construct Validity:**
 - Need to ELICIT**
 - **Individual Decision-making**
 - Type / Timing of Decision Errors
 - **Team Planning**
 - **Team Communication**
 - **Team Coordination**
 - **Team Adaptive Decision-making**



Current Research Goal Modeling of:



MOTIVATION

Measured by:

Team Efficacy survey

Communication data

**-Encouragements to
each other**

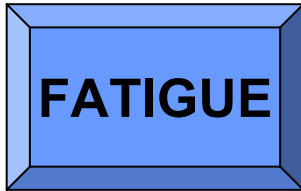
**-Conscientiousness
(Neo PI)**



Current Research Goal Modeling of:



FATIGUE



Measured by:

Stanford Sleepiness Scale

Profile of Mood States

Time



Current Research Goal Modeling of:



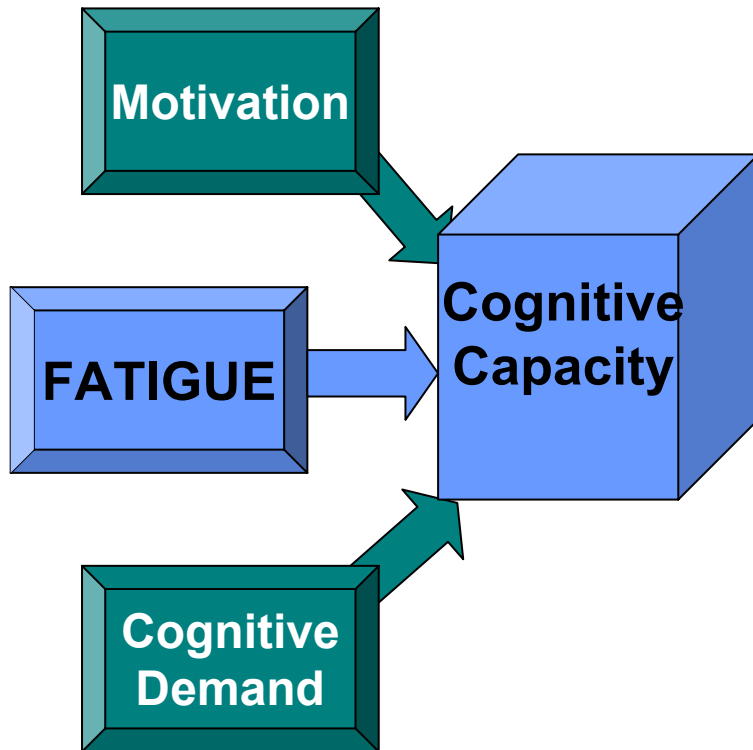
COGNITIVE DEMAND

Determined by complexity
of scenario





Current Research Goal Modeling of:



COGNITIVE CAPACITY

In part measured by
experience:

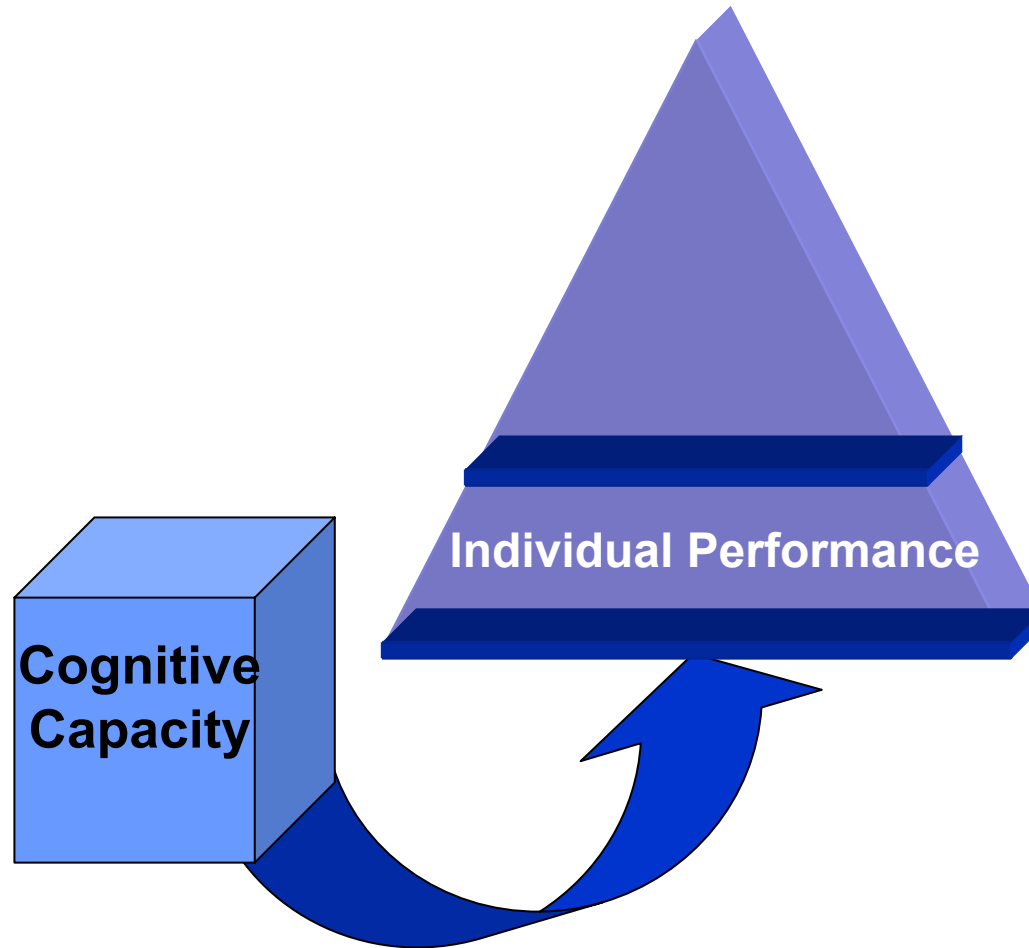
ABC Course

1 week AEDGE training

Biographical data



Current Research Goal Modeling of:





Current Research Goal Modeling of:



Individual Performance and Decision-Making

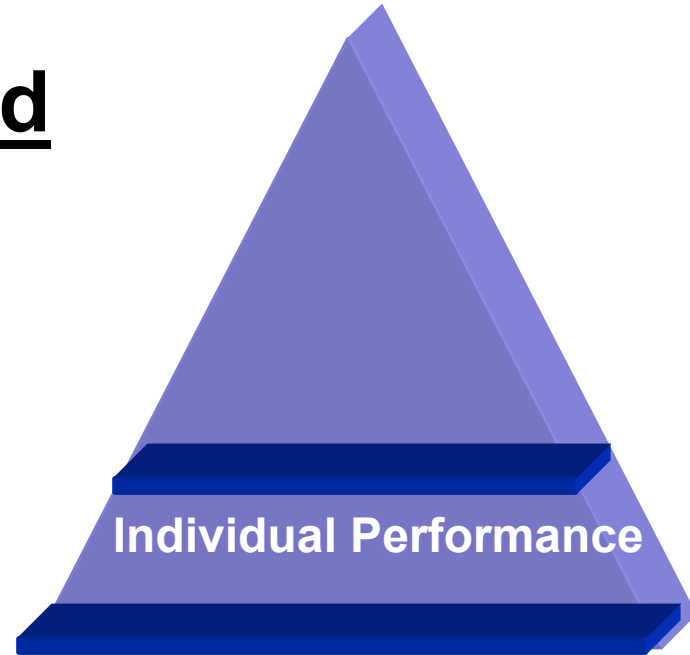
Measured by:

Fuel management

Asset ownership

Latency

ANAM battery: reaction time,
short term memory, multitasking





Current Research Goal Modeling of:



Team

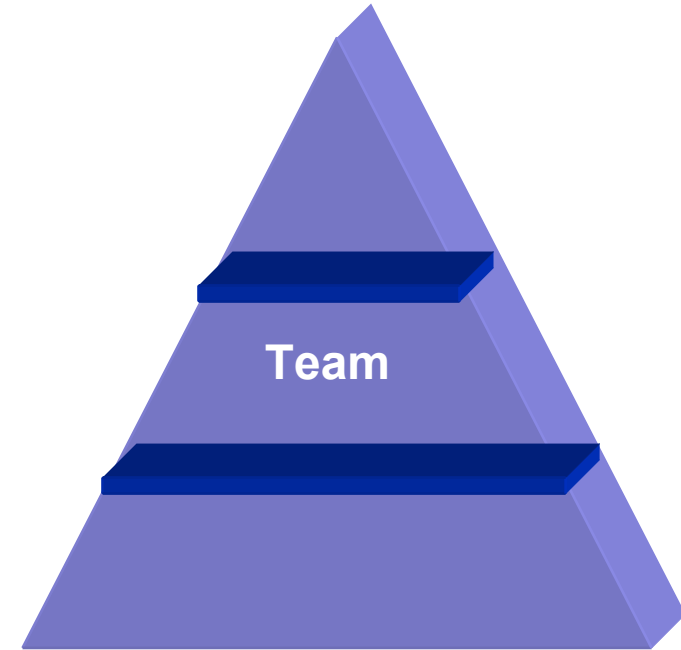
Measured by:

Communications

-Strategy

-Sequencing of assets and
targets

Handovers





Current Research Goal Modeling of:



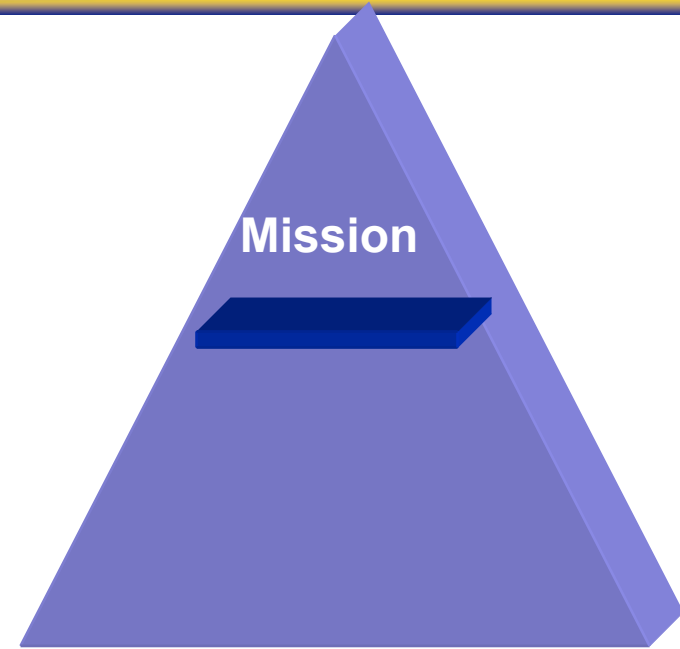
Mission

Measured by outcomes:

Assets lost

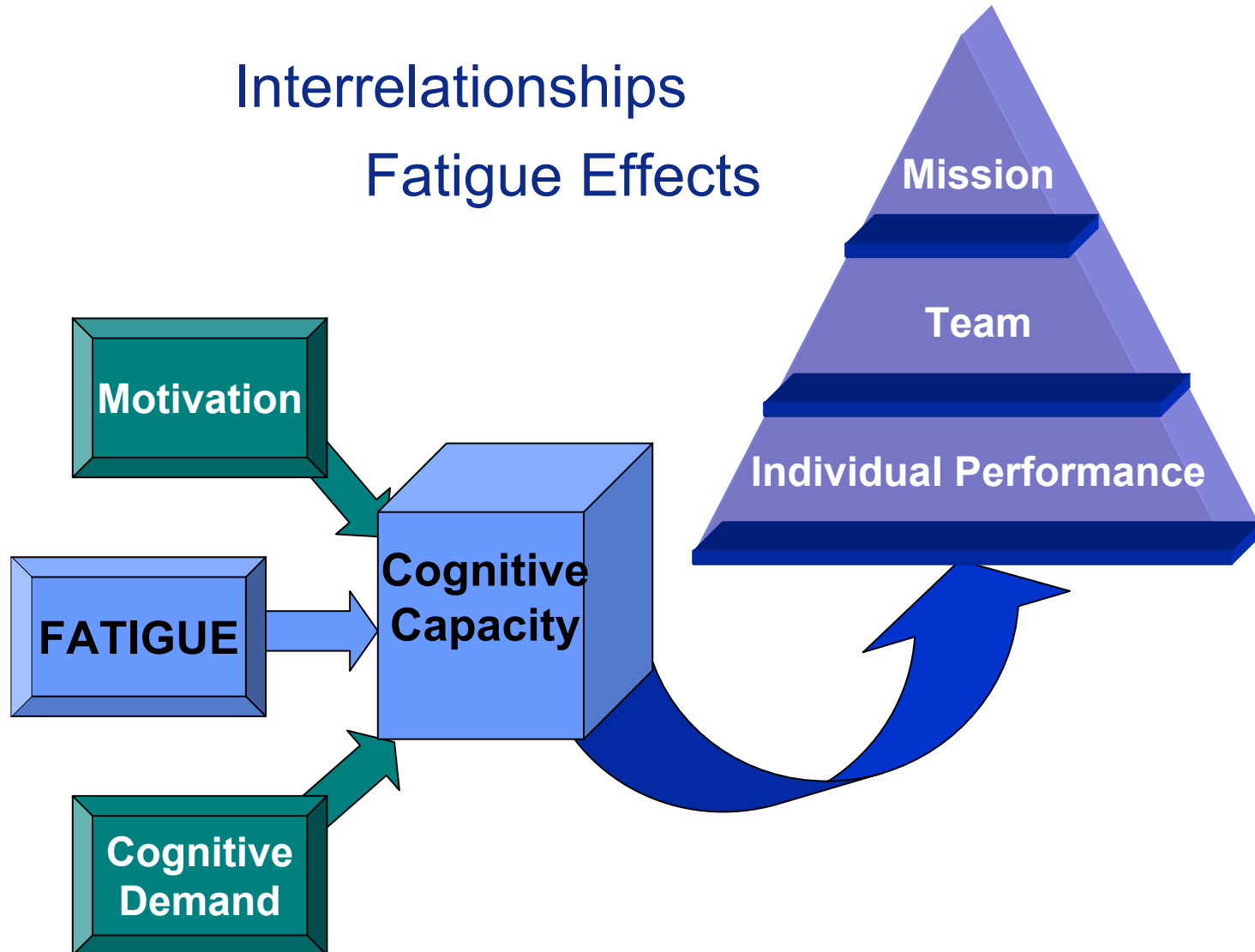
Enemies destroyed

Objectives fulfilled





Current Research Goal Modeling of:





Multi-Level Modeling of Data



- **Multiple Measures at different levels & across time**
 - Individual Differences
 - Individual performance
 - Team performance
 - Team Outcomes
- **MLWin**
 - <http://multilevel.ioe.ac.uk/features/index.html>
 - **The Third Edition of Multilevel Statistical Models is to be published early in 2003. For details and a preview visit http://www.ioe.ac.uk/hgpersonal/multmodels-edition3/multilevel_statistical_models-third_edition.htm**
- **Consultant: Michael Coovert, USF**



Contact Information



Lt Christopher Barnes

Warfighter Fatigue Countermeasures

Air Force Research Laboratory

Brooks AFB, TX

(210) 536-2177

Christopher.barnes@brooks.af.mil

Dr. Linda R. Elliott

Veridian Engineering

Brooks AFB, TX

(210) 536-8090

linda.elliott@brooks.af.mil

Dr. James C. Miller

Chronobiology and Sleep Laboratory

Air Force Research Laboratory

Brooks AFB, TX

(210) 536-3596

jcmiller@brooks.af.mil

Dr. Michael D. Covert

Department of Psychology

University of South Florida

813-974-0482

coovert@luna.cas.usf.edu