Human Performance Modeling
Presentation/Brief

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Human Performance Modeling

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AFRL/WS 05 - 2680
Introduction

- AFRL manages the Defense Modeling and Simulation Office (DMSO) Human Performance program
- Today I will provide an overview of:
  - Crowd modeling
  - Rules of engagement simulation
  - Non-lethal weapons modeling
  - Cultural modeling testbed
  - Recently transition projects

These are the topics I will be covering today:

Crowd modeling
Rules of engagement simulation
Non-lethal weapons modeling
Cultural modeling testbed
Recently transition projects
The Prime contractor is VMASC

The goal of the effort is to:

Develop and demonstrate a culturally variable crowd federate that can interoperate with existing military simulations

Specific Technology that is being developed includes

- Crowd conceptual models
- Crowd federate that interacts with JSAF and OneSAF
- Behavioral moderators for crowds

Users and Sponsors

- Air Force Research Lab
- Defense Modeling and Simulation Office
- Joint Forces Command
- Joint Non-Lethal Weapons Directorate
- Army Maneuver Support Battlelab
The Motivation of the effort was to:
Understand crowd behavior in military scenarios
Provide psychological basis for cognitive model

Methods that were employed include
Interviews and surveys
Behavior coding from crowd event video
Observe military crowd control training
Literature review

Status
Project specific information gained
More study needed to provide firm basis
A key product of the effort was a modular architecture that allows different models to be incorporated into a simulation.

The software was programmed in C++
Crowd Federate
Crowd Parameters

- Mood
- Size
- Propensity for violence
- Demographics
- Leadership structure
- Presence of Local Police Force
- Ability to negotiate
- Terrain

Some of the parameters that were modeled include:
- Mood
- Size
- Propensity for violence
- Demographics
- Leadership structure
- Presence of Local Police Force
- Ability to negotiate
- Terrain
The behavior is controlled through implementation tables, of which there are three:

3 Tables for configuration
   Crowd Parameter x Crowd Parameter
   Stimuli x Aggression Level
   Aggression Level x Behavior

Certain combinations of factors will result in an increase or decrease of the crowds aggression level

Configuration tables can be representative of differing cultures or population groups
Here is the first table.

<table>
<thead>
<tr>
<th>Terrain</th>
<th>CrowdSize</th>
<th>Mood</th>
<th>Mood</th>
<th>Mood</th>
<th>Mood</th>
<th>Mood</th>
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</thead>
<tbody>
<tr>
<td>Steep</td>
<td>Flat</td>
<td>Small</td>
<td>Med</td>
<td>Big</td>
<td>Neutral</td>
<td>Avoidance</td>
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</tbody>
</table>

**UNCLASSIFIED**

**Integrity - Service - Excellence**
### Crowd Federate

**Stimuli x Aggression Level**

<table>
<thead>
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<td>See Bystander</td>
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</tr>
</tbody>
</table>

Table two.
### Crowd Federate
#### Aggression Level x Behavior (1 of 2)

<table>
<thead>
<tr>
<th>Aggression Level</th>
<th>Behavior</th>
<th>Agitator</th>
<th>Protester</th>
<th>Casual</th>
<th>Bystander</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avoidance</td>
<td>Feeling from</td>
<td>20</td>
<td>20</td>
<td>25</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>Crowd retreating</td>
<td>20</td>
<td>17</td>
<td>20</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Hiding</td>
<td>10</td>
<td>25</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Scattering</td>
<td>30</td>
<td>25</td>
<td>20</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Dispersing</td>
<td>30</td>
<td>18</td>
<td>25</td>
<td>29</td>
</tr>
<tr>
<td>Neutral</td>
<td>Standing around individually</td>
<td>40</td>
<td>60</td>
<td>40</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Observers not participating</td>
<td>60</td>
<td>40</td>
<td>60</td>
<td>50</td>
</tr>
<tr>
<td>Curious</td>
<td>Hanging out watching</td>
<td>0</td>
<td>20</td>
<td>20</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>Climbing elevated structures</td>
<td>0</td>
<td>40</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Wandering</td>
<td>0</td>
<td>20</td>
<td>40</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Staring at</td>
<td>0</td>
<td>20</td>
<td>20</td>
<td>40</td>
</tr>
<tr>
<td>LowAggressive</td>
<td>Flag waving</td>
<td>20</td>
<td>30</td>
<td>40</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Standing on elevated structure</td>
<td>20</td>
<td>30</td>
<td>40</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Seeking to</td>
<td>40</td>
<td>30</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Carrying weapon on shoulder</td>
<td>20</td>
<td>10</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>MedAggressive</td>
<td>Chanting</td>
<td>25</td>
<td>30</td>
<td>36</td>
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</tr>
<tr>
<td></td>
<td>Waving signs and banners</td>
<td>18</td>
<td>17</td>
<td>23</td>
<td>0</td>
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<tr>
<td></td>
<td>Seeking to</td>
<td>13</td>
<td>12</td>
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<td>0</td>
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<tr>
<td></td>
<td>Overturning dumpsters</td>
<td>13</td>
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<tr>
<td></td>
<td>Carrying weapon in-hand</td>
<td>18</td>
<td>12</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Marching</td>
<td>13</td>
<td>17</td>
<td>17</td>
<td>0</td>
</tr>
</tbody>
</table>

Table three.
This table depicts some of the interactions between the various factors.
The crowd federate has been demonstrated at the Army Maneuver Support Battle Lab.
Crowd Federate
Joint Forces Command

- Multinational Experiment 4 (MNE 4)
  - Refine and assess processes, organizations and technology to support Coalition and NATO Response Force with regards to EBO
  - Participants: Australia, Canada, Finland, France, Germany, Sweden, United Kingdom, NATO
  - Execution: 20 Feb – 17 Mar 06

- Crowd Federate Participation
  - Selected to play complementary role to SEAS (Synthetic Environment for Analysis and Simulation)
    - SEAS will monitor and control overall population
    - Crowd Federate will control “temporal” crowds created by SEAS
  - Communications over HLA

There are plans to incorporate the crowd federate into a JFCOM exercise. In this exercise it will interact with another simulation.
Crowd Federate
Summary

• Successes
  – Movement from demonstration to participation
  – Initial transition underway
    • Additional support for the AMBSL planned with FY05 funds
    • JFCOM is bringing the Crowd Federate into the ATT
    • JFCOM will use the Crowd Federate in upcoming NATO experiment

• More work to be done
  – Crowd/group & Individual level parameter understanding & validation
  – Psychological model refinement

In summary...
Movement from demonstration to participation
Initial transition underway
  Additional support for the AMBSL planned with FY05 funds
  JFCOM is bringing the Crowd Federate into the ATT
  JFCOM will use the Crowd Federate in upcoming NATO experiment

More work to be done
  Crowd/group & Individual level parameter understanding & validation
  Psychological model refinement
Rules of Engagement Evaluation Environment (ROE3)

- Prime Contractor: Agent Oriented Software

- Project Definition
  - Create tools for investigating the employment and effects of Rules of Engagement (ROE)

- Specific Technology
  - Human behavior modeling environment for modeling ROEs
  - Framework and software tools for defining ROEs, tactics, behavior models and moderators
  - Cognitive architecture that incorporates behavior moderators

- Users and Sponsors
  - Air Force Research Lab
  - Defense Modeling and Simulation Office

Project Definition
Create tools for investigating the employment and effects of Rules of Engagement (ROE)

Specific Technology
Human behavior modeling environment for modeling ROEs
Framework and software tools for defining ROEs, tactics, behavior models and moderators
Cognitive architecture that incorporates behavior moderators

Users and Sponsors
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- Defense Modeling and Simulation Office
# Rules of Engagement Evaluation Environment (ROE3)

<table>
<thead>
<tr>
<th>PRODUCT:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Human behavior modeling environment for modeling ROEs</td>
</tr>
<tr>
<td>• Framework and software tools for defining ROEs, tactics, behavior models and moderators</td>
</tr>
<tr>
<td>• Cognitive architecture that allows the invariant properties of human cognition to be configured across behavior models</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>IMPACT:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• ROEs can be systematically evaluated for effectiveness, clarity, unforeseen implications, and reliability</td>
</tr>
<tr>
<td>• Standardization of ROE formalization, thus reducing the cost and time to evaluate changes to ROEs</td>
</tr>
</tbody>
</table>

**PRODUCT:**
Human behavior modeling environment for modeling ROEs
Framework and software tools for defining ROEs, tactics, behavior models and moderators
Cognitive architecture that allows the invariant properties of human cognition to be configured across behavior models

**IMPACT:**
ROEs can be systematically evaluated for effectiveness, clarity, unforeseen implications, and reliability
Standardization of ROE formalization, thus reducing the cost and time to evaluate changes to ROEs
Accomplishments

OneSAF OTB2 selected and obtained for simulation environment
Convoy roadblock scenario with variations developed from SME and ROE Handbook
Specification Document submitted by contractors (AOS)
Initial integration between cognitive architecture (Co-Jack) and simulation environment (OneSAF) conducted

Summary: Solid technical groundwork established and core developmental work is underway
Potential future developments include:

Further define possible ROE3 uses:

- ROE framework for DARWARS Ambush! trainer
- ROE evaluation and demonstration tool for theater commanders
- ROE framework for Fixed-Site Facility Defense Testbed

Continue to coordinate with JFCOM and JNLWD to develop user needs and feedback

Proof of Concept demonstration goals (Q3 FY05)

- Show the feasibility of modeling ROE in a simulation environment
- Affect realistic/expected change in scenario resolution through the implementation of ROE
  - Secondary goal: demonstrate impact of behavior moderators on ROE and outcome
- Generate support for implementation effort
Possible implementation actions

Provide UI control to allow users to test, evaluate, and demonstrate different ROE under various circumstances

- ROE – Provide sets of ROE and a ROE construction tool
- Scenario – Select location and event
- Personnel – Friendly and opposition forces

Develop knowledge base and library of locations, ROE sets, and scenarios
Another completed effort addressed the development of models of non-lethal weapons. Specifically, model libraries were created for JSAF and OneSAF.
Non-Lethal Weapons Models

- Issues Dealt With
  - NLW related deficiencies in SAF
  - Data to support Control Force behaviors

- NLW Libraries
  - M203 (Grenade launcher)
  - Smoke (yellow, white, red)
  - Tear gas (CS)
  - Fragmentary grenade
  - Sponge round
  - Crowd dispersal cartridge
  - Rubber balls
  - M16, M4 (Rifle)
    - Metal bullets
    - Rubber bullets
    - Rubber balls encased
  - M9 (Pistol)
    - Metal bullets
  - ADS
    - Energy

Model libraries include:

M203 (Grenade launcher)

- Smoke (yellow, white, red)
- Tear gas (CS)
- Fragmentary grenade
- Sponge round
- Crowd dispersal cartridge
- Rubber balls
The Culture and Personality has completed the initial testbed.

Funding received for FY05 and FY06 to further refine the testbed and conduct experiments.

Initial BBN testing will compare Americans and Chinese (Boston area students)

The testbed is receiving a range of interest, test cases planned for NATO and Korea, also several graduate study programs are interested
The problem we are addressing is:

Problem: **Military operations are increasingly multinational involving partner nations with diverse cultures**

Wing Commander & Group Captain

Numbers, commas & decimals: 2.000 = ?

Military requires a better understanding of coalition partners for smoother operations

Wing Commander & Group Captain

Numbers, commas & decimals: 2.000 = ?
Our goal is to Develop a testbed for culture & personality research based on a commercial game.

The advantages are:

- Action/behavior based rather than hypothetical situations or self-reports
  - New paradigm for culture research!
- Immersive environment:
  - True self can emerge
- Replicability
- Easier data collection
  - Decouple researcher & subject
  - Potentially larger subject pool available
### Culture and Personality Testbed

#### Testbed Features

- Multi-player format
- Reasonable military situation portrayal
- Versatility through authorable scenarios
- Hooks to facilitate entity control by Human Behavior Model's (HBMs)
- Teammates/opponents playable by humans & HBMs
- Automated data capture
- Multiple mechanisms for data collection:
  - In-game behaviors as well as out-of-game surveys

---

Key features include:
- Multi-player format
- Reasonable military situation portrayal
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- Teammates/opponents playable by humans & HBMs
- Automated data capture
- Multiple mechanisms for data collection:
  - In-game behaviors as well as out-of-game surveys
Culture and Personality Testbed
Methods for Data Collection

- In-game behaviors
- In-game probes (integrated into game narrative or gameplay)
  - questionnaires in guise of in-game conversations
  - write a memo
  - etc
- Out-of-game probes
  - occurs during the game, but not disguised as part of the game
- Pre- and post-game evaluation

Date we can collect include:
In-game behaviors
In-game probes (integrated into game narrative or gameplay)
  questionnaires in guise of in-game conversations
  write a memo
  etc
Out-of-game probes
  occurs during the game, but not disguised as part of the game
Pre- and post-game evaluation
The types of decisions the players have to make include:

- Shall I attack or negotiate?
- Which way will I go?
- Who should I talk to?
- Who do I believe?
- What equipment will I use?
- Should I expend a resource now or save it for later?
NwN has many recurring tactical situations which provide rich data potentially useful for measuring task effectiveness

Basic recurring tasks
- Combat
- Negotiation
- Trap avoidance
- Resource gathering
- Exploration

Other tasks could specifically be constructed for an experiment
- Efficiency in monitoring AI participants, team members
- Strategies chosen for team exploration
Culture and Personality Testbed
Time Pressure / Urgency

- Place explicit time limits on decisions
  - "No decision" becomes a decision after a certain point
- Impose time limits for goals to be achieved
- Write scenarios so that time urgency immerses from the scenario
  - E.g., the castle is falling apart so we need to leave soon
  - This may provoke more naturalistic reactions than artificial deadlines
  - This type of situation requires an immersive environment that works well in NwN, but not in a custom testbed solution

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The way to measure decision-making is to

Set up scenarios with options for

- Spending time gathering information
- Spend time planning
- Jumping directly into the situation

Monitor actions, individual & team

- Negotiation, exploration, combat,
- Resource gathering, etc.

Monitor communication

- How much, who, about, etc

Scenarios can be fairly linear or very open & parallel allowing extensive experimenter control of degree of flexibility given to participants.
Communication mechanisms provided in game

NwN virtual world constrains communication: only avatars in same virtual room can communicate

Communication difficulty can be manipulated using these constraints
### Culture and Personality Testbed

**How to Measure Situation Assessment**

- Can interrupt gameplay to assess participant's situation awareness
  - Goals, current actions, threats, beliefs, etc

- Can assess through nonplayer avatars
  - Which may provide a more ecologically valid method of assessment

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**Situation assessment can be measured by**

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  - Goals, current actions, threats, beliefs, etc

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  - Which may provide a more ecologically valid method of assessment
Sponsors include:
In FY04 we

Improved fidelity and accuracy of behavior models used in Joint Warfare Simulation (JWARS)

Commander Behavior Modeling for Command and Control (CBMC2) created more realistic decision models for three levels of command in JWARS (Incorporated into JWARS 1.6)
The Future

- DMSO Human Performance program is ending
- DMSO will focus on standards development
- Plan to transition existing programs to JFCOM and Service laboratories

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