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Evolutionary and Bio-Inspired Computation: Theory and Applications III

Teresa H. O'Donnell
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Kevin L. Priddy
Editors

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Introduction

The “Evolutionary and Bio-Inspired Computation: Theory and Applications” conference was back by popular demand, settling into its third year at the Defense, Security, and Sensing 2009 symposium. Several interesting presentations were made by some of the brightest luminaries in the computational intelligence and defense communities, covering such topics as knowledge discovery and understanding, advanced approaches for image and audio processing, space situational awareness, and design and optimization of systems and components. We were especially happy to announce the merger of Kevin Priddy’s conference on Advanced Sensors and Sensing Systems to our own. In addition, this year’s conference had two engaging keynote discussions, one by Dr. Leonid Perlovsky, titled “Modeling evolution of the mind and cultures,” and another by Matthew B. Caffrey on “Intelligent computing: the key to meeting the most important challenge to defense and service campaign-level wargaming.”

As always, any conference is only as good as the planners, authors, presenters and attendees make it. In that respect, we have yet to see a better mix of all the ingredients. For those of you who attended, we hope you came away a little more enlightened than when you arrived. We sincerely hope you appreciate the papers that follow, and that they serve to foster further research into, and application of, evolutionary and bio-inspired computation. We look forward to seeing you next year at “Evolutionary and Bio-Inspired Computation: Theory and Applications IV,” to be held at the SPIE Defense, Security, and Sensing Symposium from 5-9 April, 2010 in Orlando (Kissimmee), Florida.

Teresa H. O’Donnell
Misty Blowers
Kevin L. Priddy
Disclaimer

The views expressed in this briefing are those of the speaker and do not necessarily represent those of the Air Force Research Laboratory or the United States Air Force.

Why Listen to Me

- DoD Civil Servant – previous positions
  - Professor of Wargaming & Campaign Planning, Air Command and Staff College
  - Research Associate, School of Advanced Airpower Studies
- Col USAFR (ret.) - USAFR Assignments
  - Senior Reservist, AF Research Lab's Info Directorate
  - Chief Wargaming, HAF/XDOC (Checkmate)
- Author/Speaker
  - Co-author Gulf War Fact Book
  - Many articles, chapters, hundreds of talks

Eisenhower’s Strategic Dilemma

“We can lose the Cold War in an afternoon, but we can only win it over decades. Hence we must spend enough on defense to avoid losing it in an afternoon yet little enough so we will win in the long term.”

Today’s Strategic Dilemma

We must spend enough on our current wars to prevent our enemies from gaining safe havens from which to mount a new attack on the US, yet we must spend little enough that our economy and the world economy will recover - making it more difficult for terrorists to recruit.
To understand why wargames are so helpful it is necessary to understand OODA Loops.

Boyd predicted, and experience confirms, with experience OODA Loops get tighter and decisions get more effective. Does this give us an advantage in war?

Not necessarily. As we go through our OODA Loop…

…Our Adversaries go through their OODA Loop, their OODA Loops get tighter and decisions get more effective just as ours do.

Wargames allow their users to improve their decisions and their decision makers without a similar improvement taking place in the enemy.
Why Wargames Work

OODA Loops of both the Blue and Red players get tighter and decisions get more effective, but Blue’s real adversary is unaffected. So...

When we do engage our adversary our OODA Loop is shorter and more effective – theirs is unchanged.

The Effectiveness of Wargaming Has Been Confirmed By History

No

• Need: Warfare is evolving, wargaming needs to evolve to remain effective
• Opportunity: Advances in computing can enable that evolution and more

The Evolution of Warfare & Wargaming

First Generation of War
• Dawn of civ through medieval
• Unlimited – people vs. people

First Generation of Wargame
• Abstract
• Develop Strategists
• Down board thinking

Second Generation of War
• Post 30 Years War –
• Limited – State vs. State

Second Generation of Wargame
• 1811/1824
• Professional Development
• Decision Support
The Evolution of Warfare & Wargaming

3rd Generation of War
- World Wars -
  - Economy vs. Economy

3rd Generation of Wargame
- Work in progress
  - Need to:
    - Adjudicate effects
    - Look deep into campaign

4th Generation of War
- Post-9/11 -
  - Will vs. Will

4th Generation of Wargame
- Work in progress
  - Need to:
    - Adjudicate "will"
    - Look deep into campaign

5th Generation of War
- Full Spectrum Warfare
  - DIME+ vs. DIME+

5th Generation of Wargame
- Work needed
  - Need to:
    - Adjudicate all effects
    - Look deep into decades

Why Full Spectrum Warfare

"Grant will move to the North Anna because that is his best move and Grant will make his best move."

Robert E. Lee

Full Spectrum War Works
- Napoleon in Spain
- The US in Vietnam

Elements of 5th Generation Wargame Adjudication

- Retains the two sidedness of the 1st, the attrition of the 2nd and adds
  - Physical System Effects
  - Human Factors
  - Treatment of Time
**Physical System Effects Design Principle**

Real combatants function as systems made up of internal systems.

Models must depict all combatants as systems of systems.

---

**Col Caffrey’s Definitions**

- **Leadership**: The decision making element of the entity, the General, President or Board of Directors.
- **Transformation**: Capacity to transform one resource into another, crude oil into refined oil, students into graduates, flown aircraft into ready aircraft (maintenance teams).

---

**System Effects Implementation in 3G WG**

Inputs - Capital - Outputs

---

**Col Caffrey’s Definitions**

- **Transportation**: Capacity to move, speed, cube, weight, information, from one place to another, airlift, pipeline, fiber optic line.
- **Resources**: things; skilled workers, refined oil, spare parts.
- **Forces**: military capacity.

---

**System Effects Implementation in 3G WG**

Inputs on Hand - Capital Goods - Outputs on Hand - Defenses
Inputs on Hand | Capital Goods | Outputs on Hand | Defenses

System Effects Implementation in 3G WG

Inputs on Hand | Capital Goods | Outputs on Hand | AI Node | Defenses

Human Factors
Immediate & Cascading Design Principle

Real Human capability (training, experience) should influence effectiveness

Human decision criteria (doctrine, culture) should be reflected in AI

Modeling How They Think

AI Node

Inputs on Hand | Capital Goods | Outputs on Hand | Defenses

Modeling Who They Are

AI Node

Inputs on Hand | Capital Goods | Outputs on Hand | Defenses

Modeling The Impact of Comm/AI Reacting To Only What it Knows

All men may be created equal, but they don’t stay that way

Training Level | Cohesion | Health, Fatigue
Treatment of Time
Specifically the Explicit Modeling of Decision Loops at all Levels

Boyd’s Decision Loop

Col Boyd’s vision of how decisions work

Observe
Orient
Decide
Act

Nested Decision Loops

Nested Decision Loops Implementation in 5G WG

AI / Human Toggle
AI Control

Design Principle

Decision Cycle
Turn Cycle
Event Duration
Simulation Duration

Harmony between real and modeled time

Elements of 5th Generation Wargame Interface

- Much faster spin up
  - Built in instruction/tutorials
  - Intuitive interface
  - On-line help
- Much faster setup
  - Low resolution data on all Earth physical geography, infrastructure, and forces resident
  - Intuitive, powerful: map, scenario, platform, AI editor
- Faster to comprehend outputs
  - Output designed to speed comprehension
  - Detail of data adjustable for need
Elements of 5th Generation Wargame
Portability

- Expeditionary
  - Run on standard easy to deploy notebook computer
  - Built in reachback capability
- Distributed
  - Run on standard easy to deploy notebook computer
  - Built in multiplayer capability

How Hard Will it be to Create a 5th Generation Wargame?

- Many components already exist
- Integration may be biggest challenge

Armor in WWI May be a Good Analogy

- WWI Incredibly Hard on Allies
- Technology for the tank was not new
  - Hydraulic recoil on cannon – France 1870s
  - Internal combustion engine – Germany + 1880s
  - Caterpillar tread – USA 1880s
  - Armor plate – ancient
- Yet it took until late in the war for these technologies to start saving lives

Tank - More Integration Than Invention

- WWI Incredibly Hard on Allies
- Technology for the tank was not new
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5th Generation Wargame
As Much Integration as Invention

- More comprehensive adjudication
  - Physical effects – infrastructure analysis, Homeland Defense
  - Human factors – work done on insurgency/counter insurgency
  - Campaign/decade length runs – high speed computing/computer game AI - The power of Edison and Einstein working together -
- Faster insights –
  - Much faster spin up – computer game interfaces
  - Much faster setup – computer game mod trends
  - Faster to comprehend outputs computer gaming meets info science
- Expeditionary/Distributed
  - Deploy forward/reach back – increasingly powerful laptops, ever more robust internet

Conclusion

In part through 5th Generation Wargaming

- The wars we must fight will be faster with a lower cost in blood and treasure
- The peace we build will help turn former adversaries into willing allies, important trading partners and popular vacation destinations
- The future we build will be one in which government of the people, for the people and by the people shall inherit the earth.