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Original title on 712 A/B: Analyzing Irregular Warfare (IW) using a Narrative Approach and Agent-based Modeling

If the title was revised please list the original title above and the revised title here:
Analyzing Irregular Warfare (IW) with Agent-based Modeling

PRESENTED IN:

- WORKING GROUP: 10
- COMPOSITE GROUP:
- SPECIAL SESSION 1:
- SPECIAL SESSION 2:
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**Analyzing Irregular Warfare (IW) with Agent-Based Modeling**

Analyzing Irregular Warfare (IW) with Agent-Based Modeling

LT Robin Marling, USN
Dr. Bob Sheldon
Mr. Cortez (Steve) Stephens

Operations Analysis Division (OAD)
Marine Corps Combat Development Command (MCCDC)

75th MORSS
WG-16
Purpose

• Set forth results to date of the U.S. Marine Corps Irregular Warfare (IW) study

• IW study problem
  – Given
    • Joint, Combined, Inter-Agency, Counterinsurgency (COIN) Environment
    • Marine Air-Ground Task Force (MAGTF) Area of Operations COIN mission
  – Provide
    • Plausible range of resultant civilian population behaviors
Agenda

- IW Study Quad Chart
- IW Modeling Challenge
- Insurgency Behavior Model
- Pythagoras Counterinsurgency Application
- Critical Issues for Analyzing IW
Irregular Warfare (IW) Study

• **Background**
  The Joint community has called for analyses in IW, yet very little has been done in the detailed development of irregular scenarios, and even less in the analysis of them.

• **Study Question**
  What is a *good methodology* for analyzing Marine Corps *IW* problems *in-house*?

• **Findings**
  - Rich counterinsurgency literature
  - Interagency aspect is a challenge
  - *Civilian population is key*
  - Population security is critical
  - Irregular wars last years, not months
  - Two promising methodologies
    - Population Dynamics
    - *Agent-Based Models*
The IW Modeling Challenge

**Military OR Analyst Comfort Zone**

- Weapon Pk
- Armor Thickness
- Vehicle Speed

**Combat Model**

- Lethality
- Survivability
- Killer-Victim Adjudication

**IW Domain**

- Influence
- Susceptibility
- Information Ops

**IW Model**

- Population Response
- Attitude
- Behavior

**The Challenge:** Different data, different algorithms, different MOEs
IW Modeling: Expectation Management

“Soft Sciences” typically have much lower statistical correlation than “Hard Sciences”

– As a practical matter, for typical data found in the social sciences, values of $r^2$ as low as .25 are often considered useful. For data in the physical and medical sciences, $r^2$ values of .60 or greater are often found; in fact, in some cases, $r^2$ values greater than .90 can be found.*

Modeling human behavior involves a higher level of uncertainty than modeling traditional force-on-force combat

* Statistics for Business and Economics by Anderson, Sweeney, and Williams
Civilian Population

Population Segments

Insurgency Behavior Sectors

Insurgent

Pro-Insurgent

Apathetic

Anti-Insurgent

Counter-Insurgent

Civilian Population

Segments
Insurgency Behavior Model
Fictitious “Troubled Country”

**Developmental Scenario**

Troubled Country’s government is stressed and has turned to the United Nations for assistance combating the insurgency. A combined task force consisting of U.S. and British ground forces (including a MAGTF) has entered the country.

**Fictional Scenario: “Operation Pacific Breeze”**

- Humanitarian assistance / disaster relief
- Deploy a Marine Expeditionary Unit (MEU) and a Marine Expeditionary Brigade (MEB)

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*Pythagoras*

**Counterinsurgency Application**

*Akela Province*  
*Colombia*
Pythagoras Input

- Population segments & sectors
- Population segment demographics
- Scenario event list
- Population segment behaviors, interrelations, vulnerabilities, & influences
Pythagoras Input, cont.

- Data required
  - Prevalence of current behavior patterns
  - Susceptibility from unfulfilled perceived needs
  - Influence effect of events
  - Interactive influence effect of others
  - Attractiveness of others
- Probabilities, percentages, and ordinal numbers (quantitative, but non-empirical)
- Data sources
  - Culture-ware SMEs

“It’s the data, Stupid!” Dr. Akst
Output

- Change in population segment behaviors over time
  - Experimental design
  - Independent variable: MAGTF COA
    - COA example: Minimize footprint ashore vs. Establish base camp

Notional Output
Critical Issues for Analyzing IW

- Credibility
- Analytical rigor
- Time
- Distance
- Resolution
- Scalability
- Population shifts
Questions?

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Backup Slides
Agent-Based Simulation VV&A

- 1-2 May 2007 ABS VV&A Workshop Goal: Develop general, institutionally acceptable processes and criteria for assessing the validity of agent-based simulations used as part of DoD analyses
- Workshop summary
  - Elements of validation: results, referent, bounding principle
  - ABS validation
  - Validation techniques: data validation, SME validation
  - Data validation
  - Requirements for declaring an ABS valid for an application
**Insurgency System Dynamics Model**

Mathematical Model

\[
\begin{align*}
\frac{dP}{dt} &= \frac{dS}{dt} + \frac{dD}{dt} + \frac{dI}{dt} \\
\frac{dS}{dt} &= \alpha - \delta \\
\frac{dD}{dt} &= \delta - \lambda - \alpha \\
\frac{dI}{dt} &= \lambda - \mu
\end{align*}
\]