

DEFENSE ANALYSIS CHALLENGES FOR MODELING AND SIMULATION

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LISTEN TO THE EVOLVING LANGUAGE OF THE DEFENSE DEBATE

-“ASYMMETRIC” THREATS.

-“UNCERTAINTY” AND “CHANGE”.

-EFFECTS BASED WARFARE.

-PRECISION ENGAGEMENT.

•“UNINTENDED CONSEQUENCES”.

-SYNCHRONIZING ALL INSTRUMENTS OF NATIONAL POWER TO
ACHIEVE A DESIRED END STATE.

•VARIETIES OF MOTIVATIONS & CAPABILITIES.

-ADAPTIVE THREATS.

- INFORMATION BASED WARFARE.

-EMERGENT BEHAVIOR.

THE LANGUAGE OF “OPEN SYSTEMS”.

THE LANGUAGE OF COMPLEXITY SCIENCE.

BEHAVIORS, SYSTEMS, STRUCTURES EMERGE FROM
INTERACTIONS AMONG INGREDIENTS; THEY ARE
“CONSEQUENCE” MORE THAN “CAUSE”.

OPEN SYSTEMS

- **THERMODYNAMICALLY, ENERGY CROSSES THE SYSTEM BOUNDARY.**
 - “ENERGY” INCLUDES MENTAL ENERGY:
 - INFORMATION, CREATIVITY, PERCEPTION, MOTIVATION.
- **STRUCTURE & BEHAVIOR “EMERGES” - ATTRACTORS**
 - WHAT WE SEE AS “SYSTEMS” APPEAR AND ENDURE AND CAN CHANGE THEMSELVES TO SATISFY MOTIVATIONS ABILITIES AND OF THEIR INGREDIENTS. .
- **CHARACTERIZED BY STATE CHANGES: LIKE WATER**
 - **FIXED** (SOLID) - “LOCKED” STRUCTURE.
 - TRADITIONAL, NEWTONIAN, ANALYSIS METHODS APPLY.
 - **BOUNDARY** (LIQUID) - EMERGENT BEHAVIOR “WHIRLPOOLS”
 - COMPLEXITY SCIENCE.& OPEN SYSTEMS ANALYSIS METHODS.
 - ADAPTATION, EVOLUTION, CHANGE.
 - STRUCTURES EXHIBIT, HOMEOSTASIS, RESILIENCE.
 - **CHAOS** (GAS) - “EXTREME SENSITIVITY” TO INITIAL CONDITIONS.
 - FLAPPING BUTTERFLY WINGS → TORNADOES

WARFARE

A COMBINATION OF “OPEN & CLOSED” PARADIGMS

- **COMMAND AND CONTROL & COMMUNICATIONS.**
- **“FOCUSED LOGISTICS” & TPFDD AND DEPOT BASED LOGISTICS.**
- **FORCE PLANNING FOR “ADAPTIVE” THREATS.**
 - **“THREAT” vs “CAPABILITY” BASED FORCE DESIGN.**
 - **“SCENARIOS” vs CO-EVOLVING FITNESS LANDSCAPES.**
- **BUDGET PLANNING.**
 - **“KNAPSACK” PROBLEM vs. SURVIVAL & ADAPTATION ON AN EVOLVING FITNESS LANDSCAPE.**

STATE OF DEFENSE ANALYSIS METHODOLOGY

- DOMINATED BY LEGACY OF THE **“CLOSED SYSTEM”** PARADIGM.
 - **“NEWTONIANISM”** DETERMINISTIC CAUSE & EFFECT.
 - **“REDUCTIONISM”** DISASSEMBLE THE WHOLE, UNDERSTAND THE PIECES, REASSEMBLE TO UNDERSTAND THE **“WHOLE”**.
- USE OF **“REALISM PAINT”** TO MAKE A **“CLOSED”** MODEL LOOK MORE **“REALISTIC”**.
 - **STOCHASTICS** TO FUZZ THE BEHAVIOR
 - **MORE DETAIL**; THE ENDLESS QUEST.
- INCREASED USE OF **GAMING** AND **FACILITATED SEMINARING** IN COMBINATION WITH CLOSED PARADIGM M&S.
 - CAPTURE EMERGENT BEHAVIORS & UNINTENDED CONSEQUENCES
 - M&S USED HERE FOR **“ACCOUNTING”** AND **“KINEMATICS”**.
- BEGINNINGS OF A MILITARY **COMPLEXITY SCIENCE**.
 - **AGENT BASED SIMULATION**- PROJECT ALBERT, USMC.

EXAMPLE

CLOSED vs OPEN SYSTEM

ANALYSIS

WWII SUBMARINE SEARCH:

THE “SYSTEM” = GERMAN ATLANTIC SUBMARINE OPERATIONS.

REAL WORLD SUBMARINE PRESENCE PERCEIVED WITH:

- RADIO REPORTS ATTRIBUTABLE TO SPECIFIC SUBMARINES.**
- UNATTRIBUTABLE RADIO TRAFFIC FROM SUBS.**
- TORPEDO HITS ON CONVOYS.**
- RECCE & INTEL FROM SUB BASES .**
- PHYSICS OF SUBMARINE PERFORMANCE.**
- INTEL AND EXPERTISE ON SUBMARINE ORGANIZATION, OPS, ROE.**
- GOOD KNOWLEDGE OF MY OWN SENSING CAPABILITIES.**

LOTS OF ENERGY FLOWING FROM THE SYSTEM: **OPEN**

SYSTEM HAS GOALS & MOTIVATIONS; STRUCTURE, IT BEHAVES & EVOLVES.

CLOSED SYSTEM ANALYSIS APPROACH

QUESTION: HOW MANY SUBS ARE DEPLOYED?

APPROACH: DEFINE A **CLOSED SYSTEM AND PREDICT
ITS CHARACTERISTICS.**

-CLOSED SYSTEM:

**- USE ONLY THE RADIO REPORTS ATTRIBUTABLE TO
SPECIFIC BOATS.**

**-IGNORE THE REST OF THE ENERGY PASSING THROUGH
THE SYSTEM, (THE SIGNATURES OF THE REAL SUBMARINE
OPERATING STRUCTURE)**

-ASSUME A POISSON DISTRIBUTION. (UNIFORMITY ASSUMED)

5 SUBS REPORTED 1 TIMES.

3 SUBS REPORTED 2 TIMES

2 SUBS REPORTED 3 TIME.

PREDICTIONS: THERE ARE 2 SUBS NEVER HEARD/ 12 SUBS TOTAL.

NEXT QUESTION:HOW DO WE BEST FIGHT THESE SUBS??

**-HEART & SOUL OF **EFFECTS BASED WARFARE
ANALYSIS.****

OPEN SYSTEM ANALYSIS APPROACH

AGENT BASED SIMULATION.

- TREAT CONVOY SHIPS AS “AGENTS (SCRIPTED)**
- DEFINE SUB “AGENTS”. (TUNE DETAIL FOR REALIST BEHAVIOR)**
- USE GENETIC ALGORITHMS TO “BREED”SUBMARINE FORCES AND OPS CONCEPTS**
 - SUB CHARACTERISTICS (PRETTY GOOD BOUNDARIES)**
 - C2 STRUCTURE (REPORTING RULES)**
 - MOTIVATIONS (SINK SHIPS & DON/T GET SUNK)**
 - OPS CONCEPTS (CRUISE DURATION, REPLACEMENT SCHEMES ,OPS AREAS)**
- AS SUB OPERATING STRUCTURES EMERGE FROM SUB AGENT INTERACTIONS WITH CONVOYS,SEARCH EFFORTS, PHYSICS, ETC)**
- TEST THOSE EMERGENT SUBMARINE “STRUCTURES”.**
 - COMPARE ITS PERCEIVABLE “SIGNATURES” (RADIO TRAFFIC, TORPEDO HITS, PORT INTEL REPORTS, ETC) TO REAL EXPERIENCE.**
- OBSERVE “BEST FIT”OF AGENT MODEL TO REALITY**
- NOW SPECULATE ON: HOW MANY, HOW TO FIGHT.**

CLOSED vs OPEN SYSTEM COMPARISON

CLOSED SYSTEM APPROACH:

- DEFINED A STRUCTURE; ITS SHAPE & BEHAVIOR- OUR “MODEL”.
- CLOSED THE BOUNDARIES OF OUR INVESTIGATION.
 - WORKED WITH A FIXED SUBSET OF THE INFO AVAILABLE
 - IGNORED DATA THAT DID NOT FIT THE “MODEL”.
- LEARNED VERY LITTLE OF WHAT THERE WAS TO KNOW ABOUT GERMAN SUBMARINE BEHAVIOR.
- WE FIT THE WORLD TO OUR DESIGN; NOT ASKING WHAT MIGHT BEST EXPLAIN WHAT WE WERE SEEING; USING ALL OF WHAT WE WERE SEEING; NOT CONSIDERING HOW IT MIGHT RESPOND TO SOMETHING WE MIGHT DO

OPEN SYSTEM APPROACH:

- LET A STRUCTURE “EMERGE” FROM THE POSSIBLE INTERACTIONS.
 - “SELF ORGANIZATION”- IT DEFINES ITS “BEST” SELF.
- USE ALL THE INFORMATION AVAILABLE TO TEST EMERGENT STRUCTURE.
 - HAVE A TOOL FOR UNDERSTANDING THE “WHOLE” OF THE ENEMY OPS AND WHAT MIGHT HAPPEN NEXT--EXPLORE ADAPTIVE BEHAVIOR.
- HAVE A METHODOLOGY FOR **EFFECTS BASED WARFARE** ANALYSIS.

CHALLENGES

•WHAT IS THE **VALUE** OF ANALYSIS OF “OPEN SYSTEM” ISSUES PERFORMED WITH CLASSIC “CLOSED SYSTEM” METHODOLOGY?

HOW DO WE **RECOGNIZE, DESCRIBE& ANALYZE** “OPEN SYSTEM” ISSUES?

•WHAT IS IMPORTANT TO **KNOW** ABOUT “OPEN” MILITARY SYSTEMS BEHAVIOR?

•WHAT CAN WE REASONABLY **TELL** DECISION MAKERS ABOUT “OPEN” PROCESSES AND THEIR CONSEQUENCES?

•WHAT CAN WE LEARN FROM **COMMERCIAL USES** OF COMPLEXITY SCIENCE & OPEN SYSTEM ANALYSIS?

•WHAT IS THE “**RIGHT WAY**” TO USE THE COMPUTER?

•AGENT BASED SIMULATION

•BREEDING & TESTING STRUCTURES vs DEFINING “THE SYSTEM”.