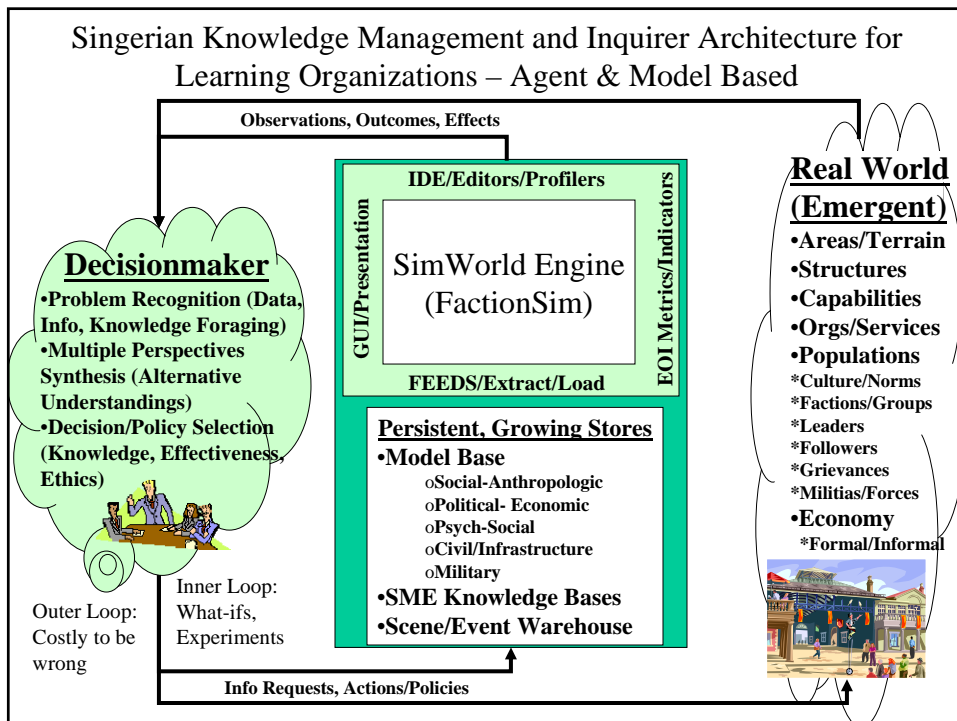


ACASA

for Advancement of the Systems Approach

Simulators of Complex Systems: Micro-Decision Making, Macro-Behavior Emergence

Barry G. Silverman, Director of ACASA
 Postdocs: Gnana Bharathy, Kevin Knight, Jeff Kim
 PhD Students: Ben Nye, Deepthi Chandasakeran, David Pietrocola, Jay Eksin
 Staff: Mark Roddy, Mjumbe Poe, Nathan Weyer
 University of Pennsylvania
 Electrical & Systems Engineering Dept.
 Hayden Hall, Rm 120
 Philadelphia, PA 19104-6316
 basil@seas.upenn.edu



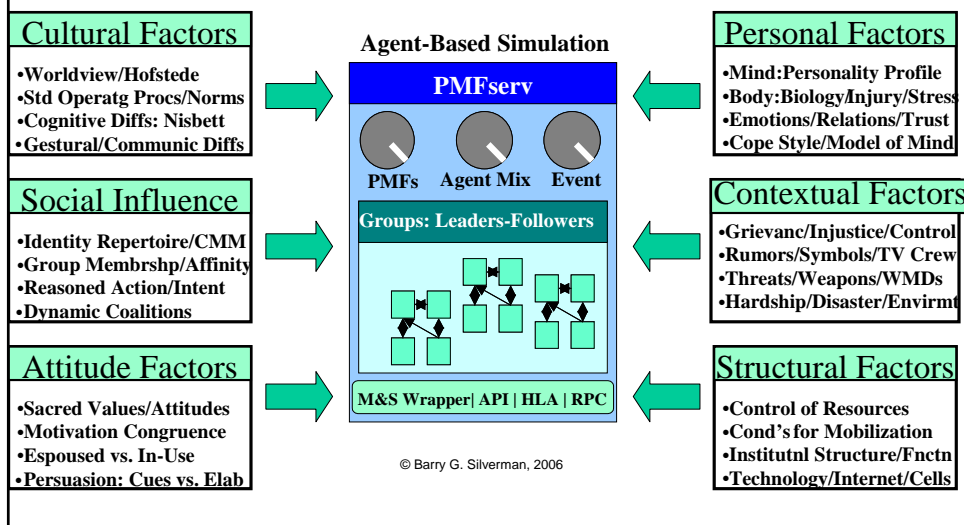
Singerian Inquirer Guidelines (Churchman, 1971)

- Social System is Teleologic (purposeful, macro-behavior emerges from micro-decisions, edge of chaos, non-ergodic, ...)
- Assembling Exoteric Knowledge is its main purpose – each new SI is an experiment in social policy, in social science, and systems science
- Components are not SS Disciplines, but themselves Teleologic Subsystems (orgs, factions, leaders, followers, etc.)
- System is indivisible (open exchange of info will lead to serendipitous learning and adaptation) – improve the description/models & society
- Boundaries – Client is society and humanity, multiple perspectives being swept in is raison d'être (social equality, transformation)
- Measures of Performance Improvement – Emancipation for all clients/perspectives, freedom of individuals, self-sustainment
- Validity/Guarantors – Knowledge/models built should “do no harm”. Must try to use all approaches and must treat the SI as an experiment in doing it better
- Ideal (shared interests): Designer = Decision maker = Client

***Issue:** All definitions appear imprecise and unsatisfying.*

“Realism” of a Behavior & Social Game Engine:

Wicked or Ill-Structured” Problems – Each is evolving and unique.
Keep It Descriptive, Stupid (KIDS) - There are always more factors to add when fitting models to a dataset. Don't force the model onto the data. Need to validate.



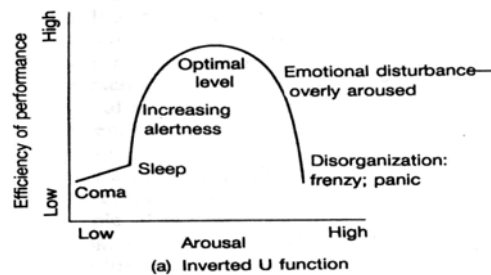
Systems Science, Synthesis, Wholisms

(Singer, Ackoff, Churchman, Jackson, Silverman)

- Synthetic or Systems Thinking (Synergies)
 - Seek to Visualize/Study the Whole & Its Dynamics
 - Focus on inter-relations between parts
 - **All parts are purposeful systems too (Micro-Decisions lead to Macro-Behavior, Unscripted Emergence of Equilibria, Phase Shifts) – Teleologic Parts**
- Not Just Integrating Up to Wholes
 - Encapsulate Components and Replace/Modify/Reuse
 - Interchange Specs (semantics, math, terms, units, .)
 - Accuracy, not precision (1st order, linear approximations)
- Knowledge Synthesis (**Esoteric, Exoteric**, Complex, Descriptive)
 - Domain Knowledge (1st Principles, **Best-of-Breed PMFs**)
 - Testing and Validating (Training Datasets, Out-of-Sample Testing)

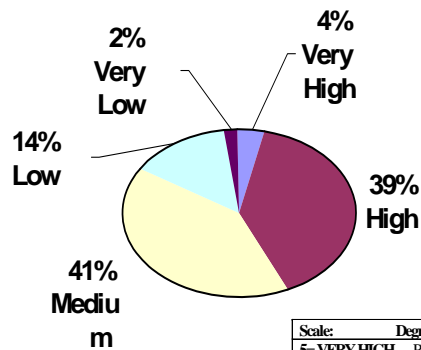
© Barry G. Silverman, 2006

Best-of-Breed PMFs may be to Socio-Cognitive Processes,
what 1st Principles are to Physical Sciences



- | | |
|--|--|
| <ul style="list-style-type: none"> • External Stress <ul style="list-style-type: none"> – Fatigue – Heat – Noise – Vibration – Time Pressure – Sleep Loss – Workload – Drug, Alcohol | <ul style="list-style-type: none"> • Internal Stress <ul style="list-style-type: none"> – Anxiety & Emotion – Stamina – Morale & Motivation – Experience – Way of thinking/Ideology (Positive/Negative) – Uncertainty – Personality (Big 5) |
|--|--|

Percent of Human Behavior Literature in Each Validity Category
(based on a sample of 48 abstracts in booklet -- 461 PMFs)



Average Validity: 3.5

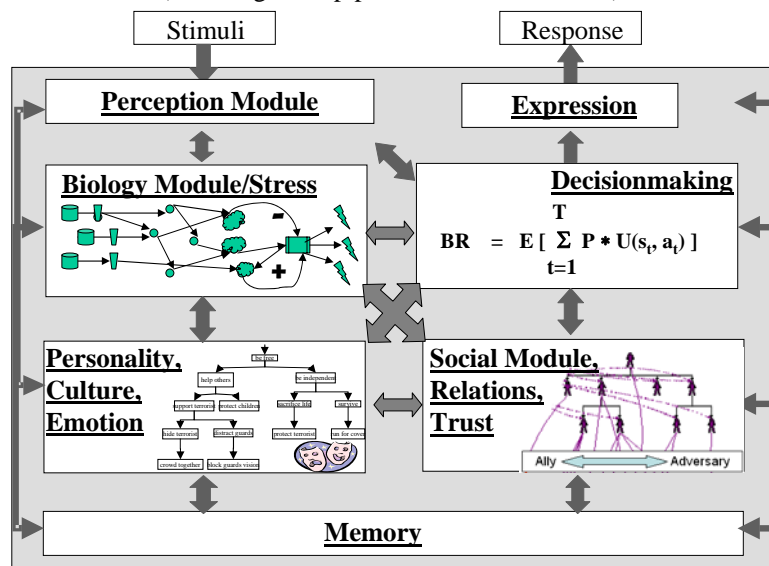
Scale:	Degree of Value of Literature Item for Constructing PMFs
5= VERY HIGH	PMFs provided with backup data sets
4= HIGH	Could make PMFs directly from the data in this study
3= MEDIUM	Some preliminary data for initial PMF construction, but more data needed
2= LOW	Theoretical model suggested from which an ungrounded PMF could be derived.
1= VERY LOW	No valid data in this report for PMF construction
0= NONE	Irrelevant to the PMF construction process.

www.seas.upenn.edu/~barryg/PMFset.zip

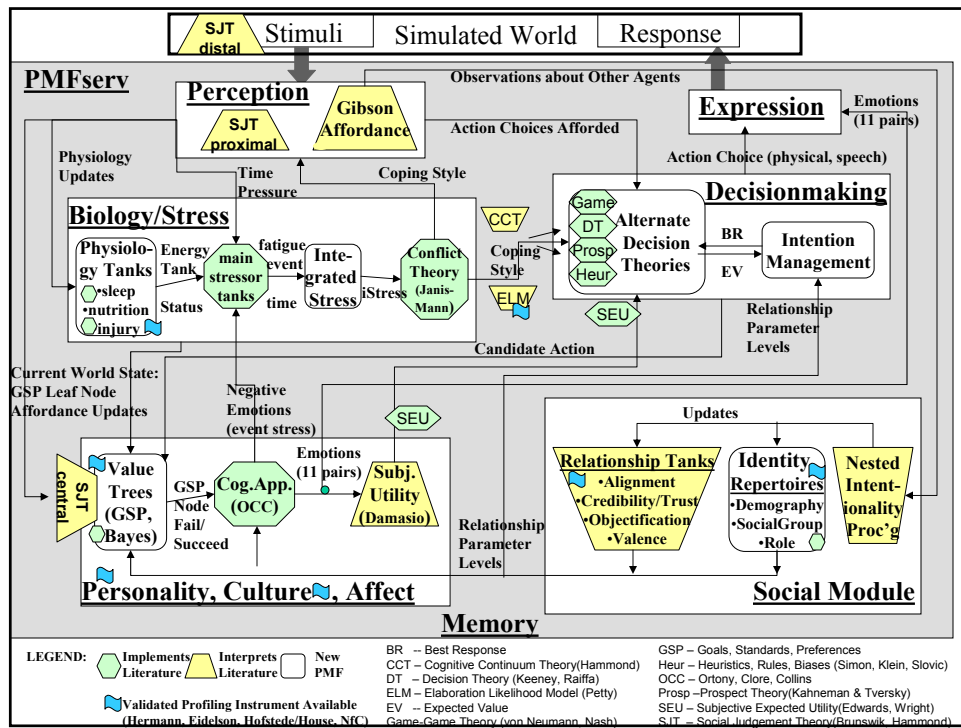
www.seas.upenn.edu/~barryg/PMF_Addendum1.doc

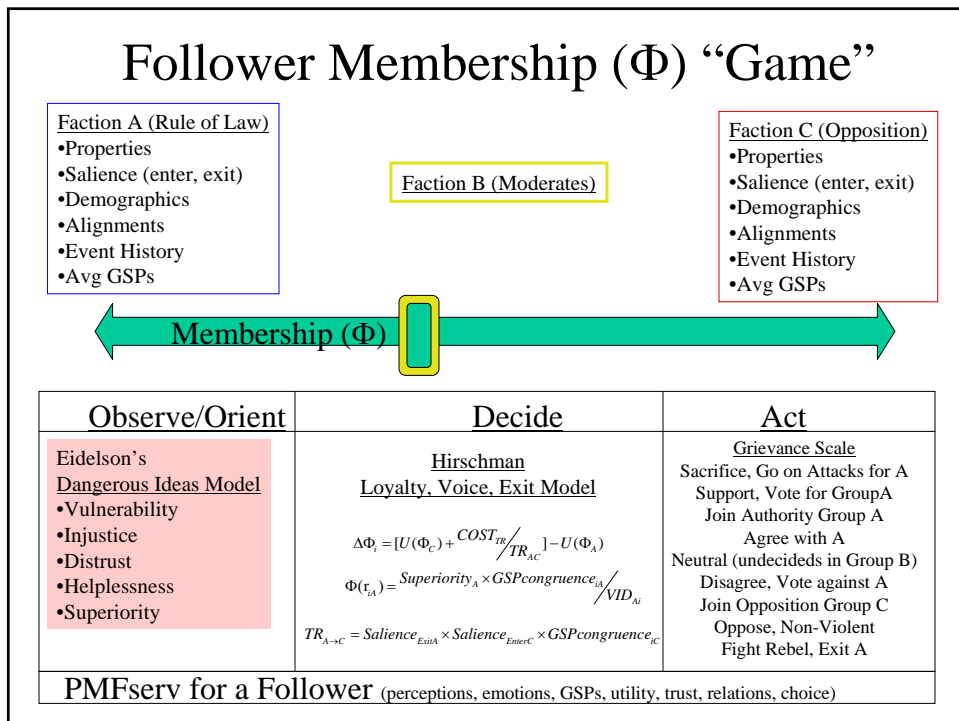
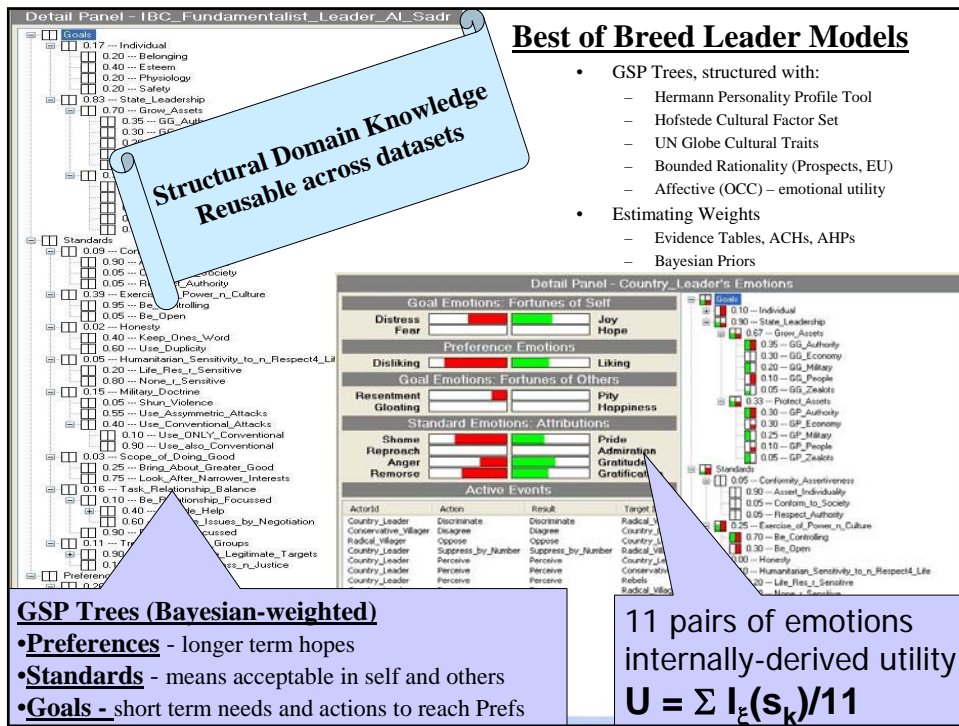
PMFserv's Unified Architecture for Cognition

(Breaking Stovepipes Between Sub-Fields)



www.seas.upenn.edu/~barryg/HBMR





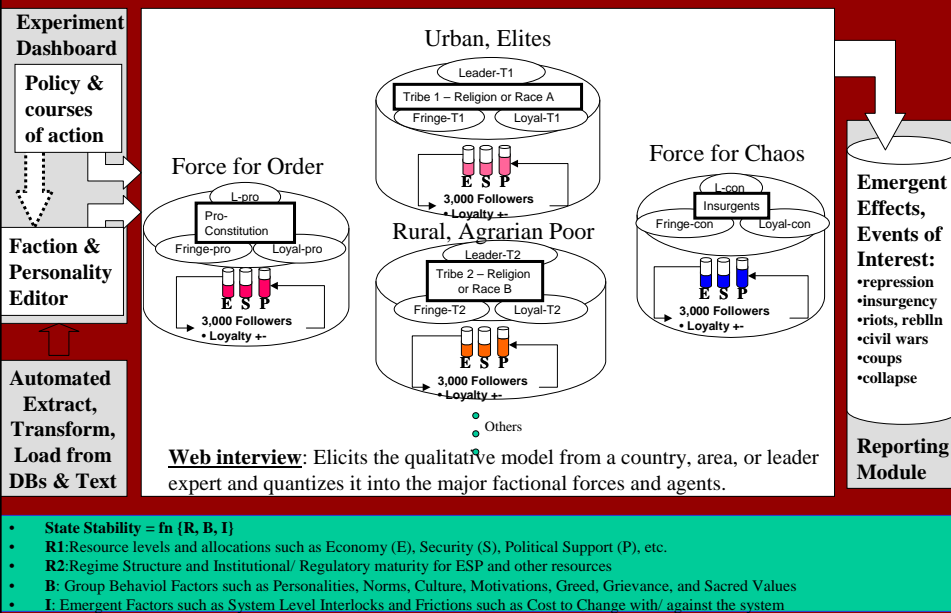
FactionSim Framework Permits Many Theories of Terrorism To Be Studied

- Ethnic Cleansing (One Faction Aims to Eliminate Another)
- Religious Extremism/Many Jihadists Modeled (Atran Absolutists)
- Isolationism, Separatism & Mobilization Movements
- Alienation/Politicized Religion (SageMan)
- Economic Deprivation Theory -- Lewis (and LRF) – 2 sectors (1979):
 - Small modern core – prohibitive to join, elitists
 - Large agrarian, tribal – poverty stricken, alienated
- Informal Economy Theory (non-declared income, crime, black market, insurgent econ, smuggling, etc.) -- Hart, then de Soto (1989)



- 3 Phases of Insurgency (Mao) -- COIN 'Doctrine',
- Overthrowing Authoritarians -- Haggard & Kaufman (Democratic Transitions)
- Preventing Terrorism – DIME/PMESII Studies, COIN, EBO

Modeling Socio-Technical Systems with FactionSim (Synthesizing Socio-Economic-Political Models and Resource Allocation Conflicts)



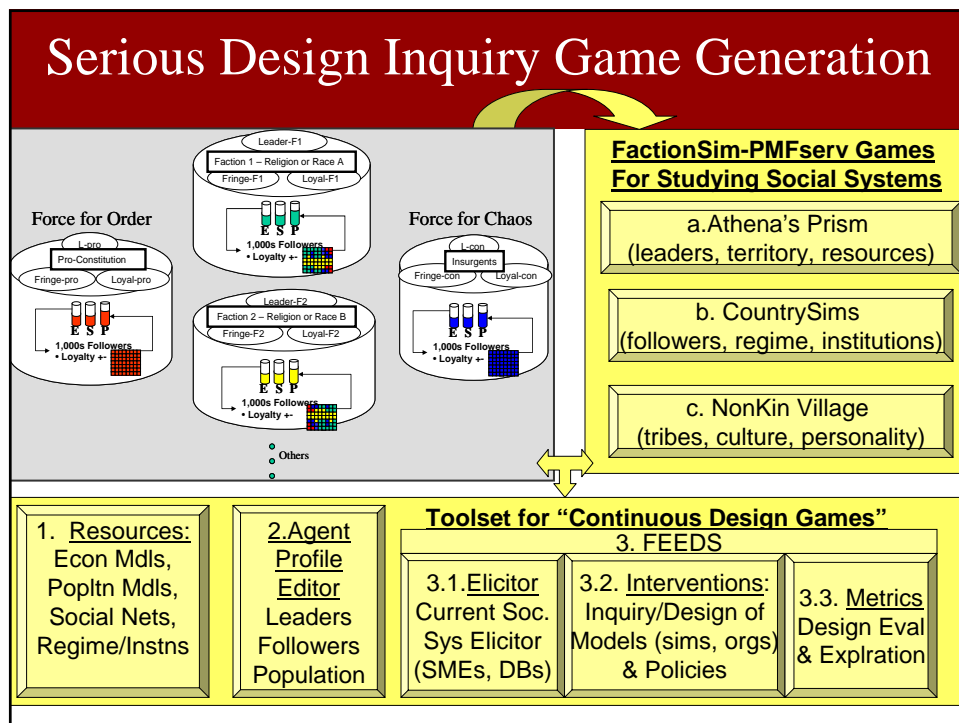
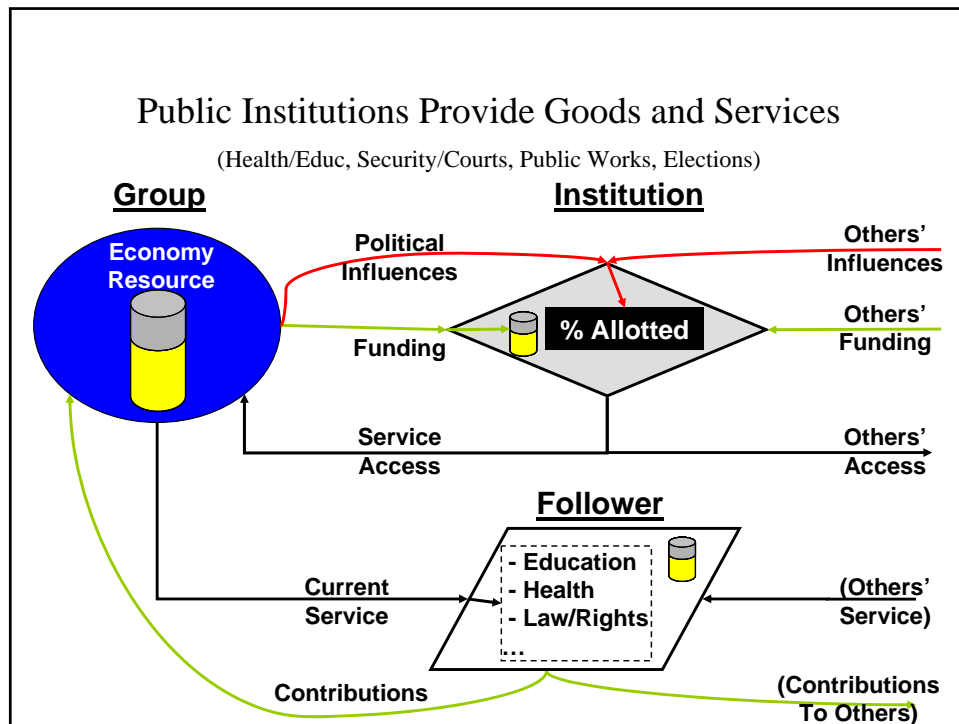


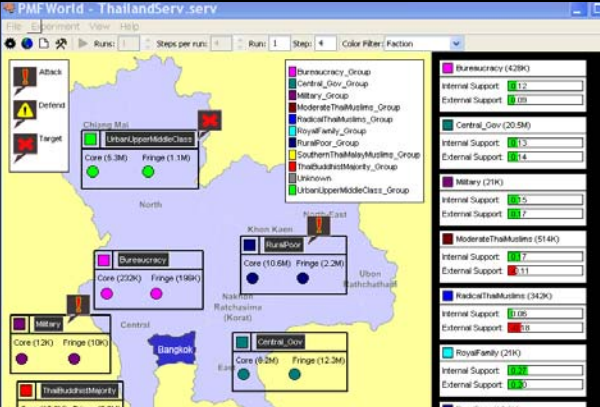


Table Top Game

Ackoff Collaboratory
for Advancement of the Systems Approach

Serious Game Design: Strategy Resources Game (Global Systems Thinking)





Ackoff Collaboratory
for Advancement of the Systems Approach

DARPA Challenge: Modeling State Actors of Asia (CountrySim)

- Salient Factions (macro-groups, sub-state actors)
 - Key Leaders (named, known individuals)
 - Archetypal Followers (Core, Fringe) = Sub-Leaders
- Resources/Services (Economy, Utilities, Health/Educ, Law)
- Population Model (simple agents, identity repertoires, voting)
- Countries Modeled for DARPA and COCOMs
 - 2005 – Thailand
 - 2006 – Iraq
 - 2007 – Bangladesh
 - 2008 – 14 Countries of Pacific Rim (Multi-Country Crises)

Validity Assessment Levels

1. **Internal validity assessment.** For any given theory or model we try to implement, is it complete, clear, coherent, and robust? What are the situations it fails to address? What needs to be added to make it better?
2. **Ontological adequacy.** Do the combined set of theories and models implemented work well together? What are the gaps that need to be filled in? What further research and studies does this suggest?
3. **Analytical adequacy.** Can the collection of models assembled and implemented thus far satisfy various types of correspondence tests and historic recreation tests? What about SME sniff tests and Turing assessments?
4. **Mechanism assessment.** If we have gained some trust in the first three levels of testing, are the socio-cognitive agent collections able to explain the underlying mechanisms guiding situations? Can we use them going forward to explain anything? Are the possibility spaces that they enumerate worth knowing about?
5. **Cross-sample testing.** To avoid the problem of over-fitting to a single test sample, we always need to examine if the models work across samples. Here we propose to apply them to many States, Groups, People.

Collaborations Needed

- Behavioral Researchers – setup/test hypoths across DIME-PMESII life cycle – grow evidence base for training, DSS and M&S
 - Behavior/norms/patterns of cultures & groups (individual diffs)
 - Training & test data sets (population persuasion susceptibilities)
 - Campaign assessment studies/measurement (what succeeds/fails)
- Computational Researchers modeling human behavior and factions – synthesize & test the theories
 - Multi-resolution agent models – individuals, groups, social nets, societies
 - Validity Assessments (Analytic, Ontologic, Correspondent, Mechanism, Cross-Sample, etc.)
 - Composing new toolsets from reusable parts w/ interchange standards – Hard vs. Soft, Esoteric vs. Exoteric, Complex and Emancipatory/Transformative
- Decision Makers & Stakeholders – participate in conversations about real social systems they have inquiries about
 - Encourage discourse across stakeholders
 - Use of models to understand the system and its dynamics, precipitate questions
 - Wire up real world to collect results and promote adaptation & learning

Design Inquiry via Discourse in Role Playing Games

Design of Interventions via 'FARIST'

Faction-by faction Actors, Resources, Institutional services, Space, Time

Reduce suffering, chaos,
& agents of conflict

Increase welfare, coopera-
tion, & self- sustainment

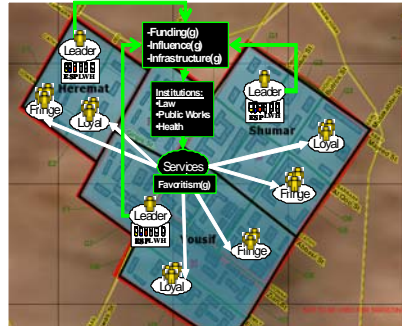
Play Games (RPGs)
Run Game Engine

Build Gameworld:
•System Model
(abstract)
•Physical Model
(concrete)

Ongoing data, info,
knowledge collection

Continual inquiry,
questions

**Real World Socio-
technical Reality**
(wicked, messy,
complex,
emergent)



Experiment & Evaluate

Measurement, drill
down, transparency

Test Intervention Design
•Purpose (what)
•Function (verbs), Form (How)
•Supra-system Factors
•Hazards, contingencies

Continual questioning, inquiry,
Ongoing data, info, knowledge collection

Note:
Planning
follows from
design