



A Semantic Data Model for Simulating Information Flow in Edge Organizations

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Topics

- Computational Modeling of Organizations
- Modeling Edge Organizations
- The Virtual Design Team (VDT) Model
- The POW-ER Model
- Modeling a Command & Control System
- Discussion and Future Research
- Executable Documentation



Computational Modeling of Organizations

- Field research methods can be time consuming and costly, and lack experimental control
- Computational modeling & simulation of existing or hypothetical organizations is an alternative
 - ▶ Agent-based modeling and simulation
 - Embodies mature, validated models of micro-behaviors
 - Develops predictive, multi-level social science theory
 - Predictions may be validated against empirical data
 - ▶ Analog of structural analysis tools—predicts outcomes
 - Supports desktop “what if” experimentation
 - Complements laboratory and analytical methods



Modeling Edge Organizations

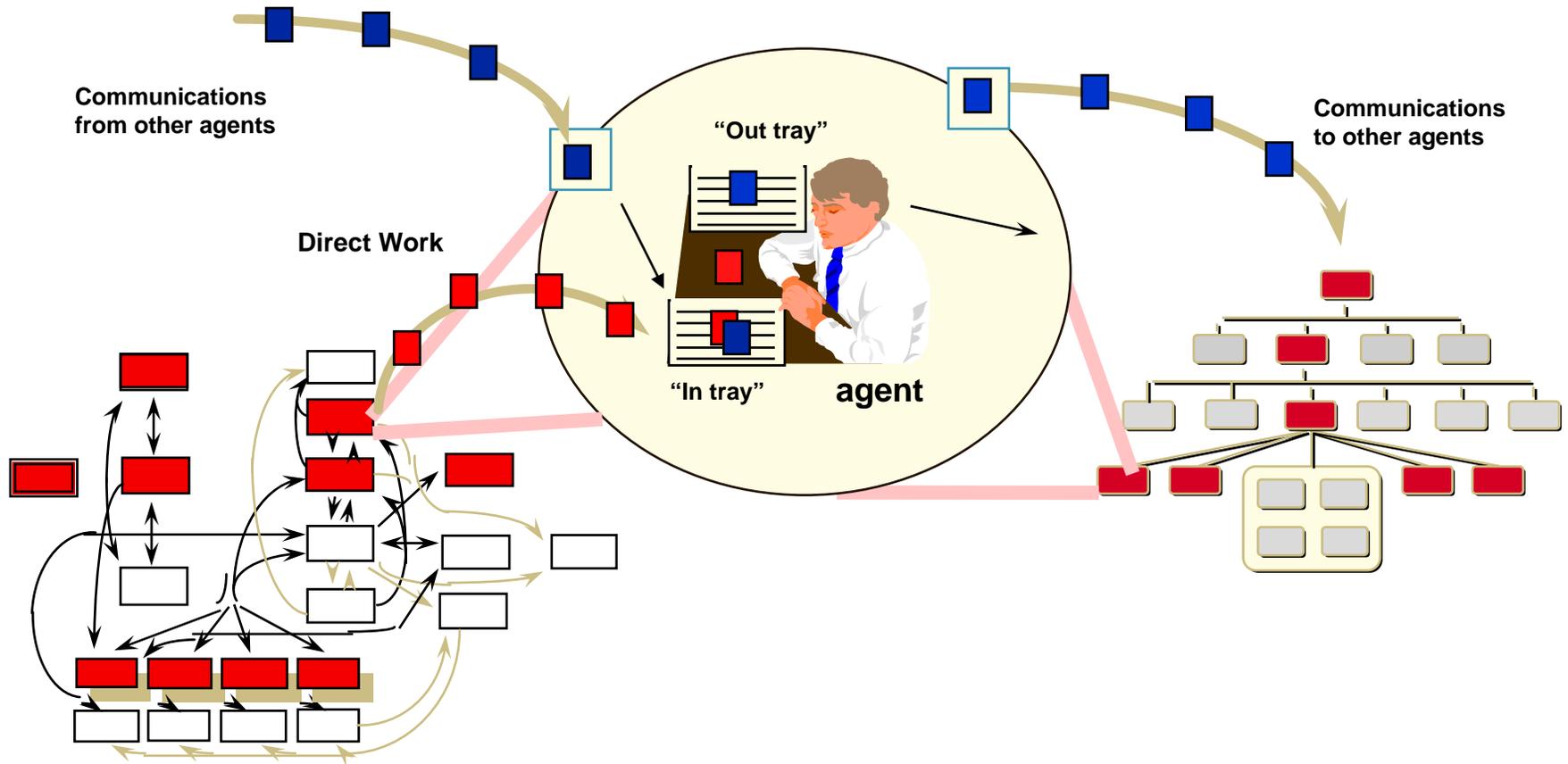
- Characteristics of Edge organizations
 - ▶ Rapid adaptation to changes in field environment
 - ▶ Dynamic task assignment and reporting hierarchies
 - ▶ Leadership may derive from competence and circumstances, not just position
- Features lacking in traditional project models
 - ▶ Task sequencing may be determined by situation
 - ▶ Demand-driven dynamic allocation of resources
 - ▶ Advanced communication and information systems



The Virtual Design Team (VDT) Model

- Ongoing research project at Stanford University
 - ▶ VDT → Commercial *SimVision*® software product
- Models traditional project-oriented organizations
 - ▶ Construction
 - ▶ Aerospace
 - ▶ Consumer product development
 - ▶ Healthcare
- Models pre-planned projects
 - ▶ Fixed organizational structure and task plan
- Validated through fieldwork in multiple domains.

VDT Model - agent Information Processing



The POW-ER Model

- **P**roject, **O**rganization, **W**ork for **E**dge **R**esearch
- Address VDT limitations in modeling dynamic, highly distributed organizations
- Modular framework consisting of:
 - ▶ Graphical model editor
 - ▶ Agent-based discrete event simulation engine
 - ▶ Chart and report generator
- Models and data stored in XML format files
 - ▶ Allows data interchange with third-party tools



POW-ER – Goals

- Model flow of information and knowledge
 - ▶ Advanced communication and information systems
 - ▶ Formal and ad-hoc peer-to-peer networks
- Tasks driven by operational considerations and availability of needed information and resources
 - ▶ Agents assigned to tasks dynamically based on availability, proximity, and applicable skills
- Measure effects on performance resulting from
 - ▶ Incorrect, incomplete, contradictory information
 - ▶ Alternative reporting and decision-making policies
 - ▶ Use of various tools and systems



POW-ER – Semantic Data Model

- Environment is a collection of objective *facts*
 - ▶ Facts are categorized by relevant skills, locations, etc.
 - ▶ Facts are observed by agents and systems
 - ▶ Facts can change over time
- Agents form *beliefs* about facts
 - ▶ Beliefs from observation, other agents and systems
 - ▶ Confidence levels determined by skills, trust in sources
- Agents execute tasks based on beliefs
 - ▶ Tasks have prerequisite facts
 - ▶ Tasks change existing facts and/or produce new ones
 - ▶ Quality of outcome determined by relevant beliefs

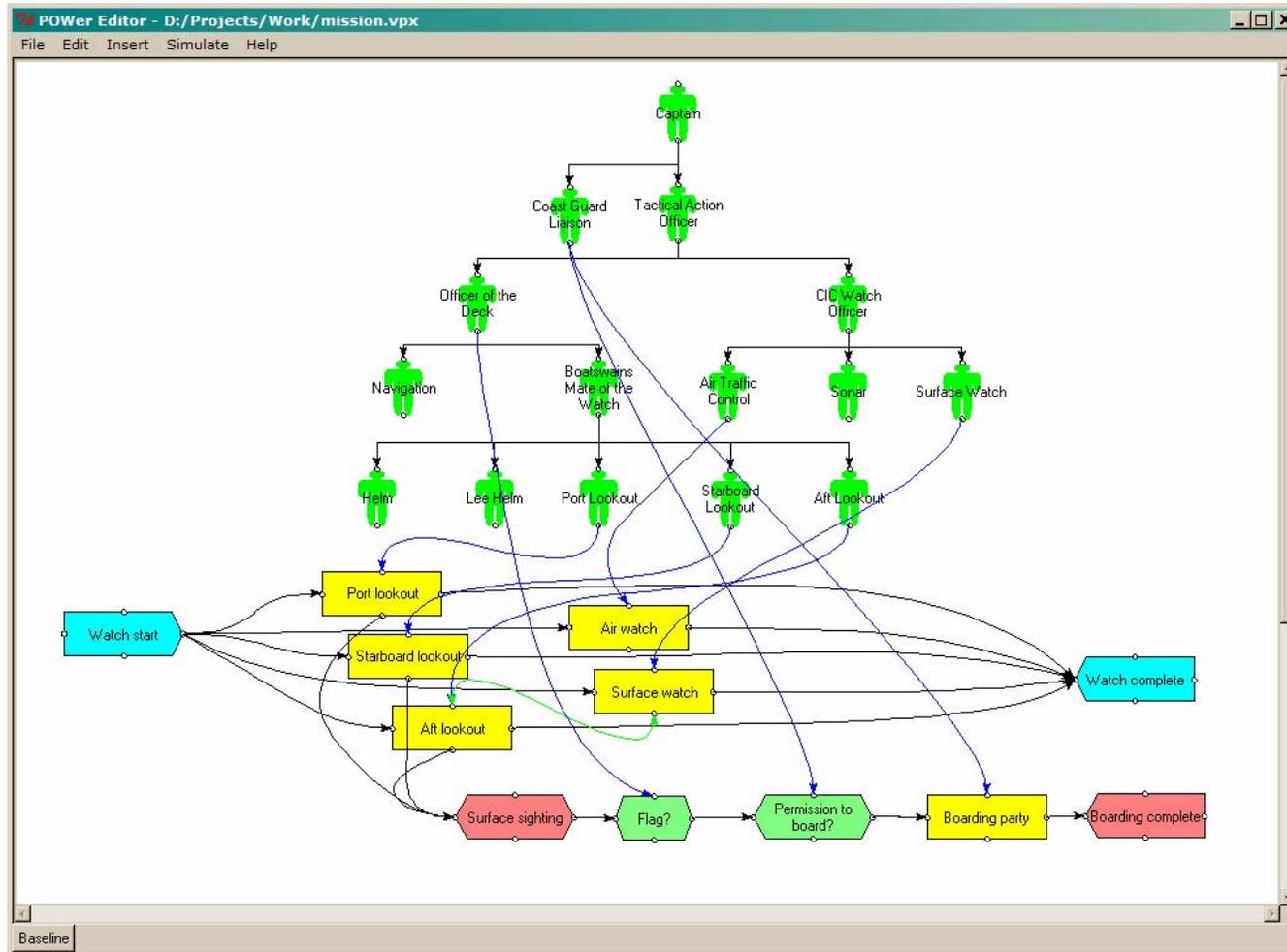


Modeling a Command & Control System

- Watch-standing tasks on guided missile cruiser
 - ▶ Drug interdiction operation in Gulf of Mexico
- Simulated agents
 - ▶ Commanding Officer
 - ▶ Tactical Action Officer
 - ▶ Officer of the Deck
 - ▶ Combat Information Center Watch Officer
 - ▶ Subordinates of the above
- Simulated activities
 - ▶ Lookout
 - ▶ Air watch
 - ▶ Surface watch
 - ▶ Decision making



Command and Control System - Model





Discussion and Future Research

- The POW-ER platform shows potential in testing the fitness of competing organizational forms
- We are developing requirements for modeling Power-to-the-Edge organizations
 - ▶ Case studies of command and control scenarios, including ethnographic research
- Development continues on the simulation engine
 - ▶ Completed model of knowledge acquisition and loss
 - ▶ Adding a stochastic task scheduling mechanism to the existing support for pre-defined tasks



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