Designing Organizations with OperA

Virginia Dignum
Delft University of Technology

Huib Aldewereld
Utrecht University
Agenda

- Introduction
- OperA Model
  - Organizational Model
  - Social Model
  - Interaction Model
- Design Exercise
  - Scenario: Conference
- Discussion
Modeling organizations

- Organizational structure:
  - Structure is what persists when components or individuals enter or leave an organization. (Ferber, 2003)

- Organizational dynamics:
  - Participating entities change, environment change

- Organizational strategy
  - What does the organization want?
  - And how does the organization want to achieve it?
Components of organizations

• Entities (roles, positions, people, groups, components, ...)
• Relationships (networks, interactions, coordination ...)
• Goals (purpose, intention, shared, ...)
• Norms (culture, rules, ...)
• Environment (physical, social, open, dynamic, restrictive...)

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Characteristics of entities

- The entities to be organized are heterogeneous
- The entities to be organized are expected to be *rational*, cognitive
  - (Olmstead, 2002): The people in this definition are physical organisms and psychological processes [...] [whose] influence is a function of both his or her psychological properties and the properties of the coordination and decision making roles assigned to him or her.
Characteristics of relationships

• The organization should create order among entities.
• Relationships result in more than the individuals
  – (Morin 1977): Endowed with qualities not apprehended at the level of the components or individuals.
• The organization is responsible for the achievement of the overall goal of the system.
• The organization should create a coherence of the whole.

• Possible relations between entities are:
  – Delegation of tasks
  – Transfer of information
  – Obligation and norms
  – Synchronization of actions
  – Responsibility between agents
  – Access to resources and services
Characteristics of goals

- Organizational goals are not necessarily goals of any of the individuals
- Combined activity is needed to achieve organizational goals
- Global strategy but local decision
Characteristics of norms

- Describe desired organizational states
- Norms as Constraints
  - Cannot be violated: guaranteed fulfillment
- Norms as Regulations
  - Can be violated: agent decides
- Balance between CONTROL and EFFICIENCY
Characteristics of environment

- Organizations need to perceive, reason, and act in relation to the surrounding environment
- Contingent:
  - match among (business) strategy, organizational structure, and the characteristics of the environment is necessary for high performance
- Dynamic:
  - Agents can migrate, behavior can evolve.
  - Organizational structures change, disappear or grow
  - Organizational objectives change
- Open:
  - Distributed management, knowledge and data
  - Components are not controlled by one entity
OperA Model

- **Organizational Model**
  - represents organizational aims and requirements
  - roles, interaction structures, scene scripts, norms
- **Social Model**
  - represents agreements concerning participation of individual agents (‘job’ contracts for agents)
  - rea = role enacting agent
- **Interaction Model**
  - represents agreements concerning interaction between the agents themselves (‘trade’ contracts between reas)
Organizational Model

- Social Structure
  - roles, groups, dependencies
- Interaction Structure
  - scene scripts, connections, transitions
- Normative Structure
  - role, scene and transition norms
- Communication Structure
  - communicative acts, domain ontology
Social Model

- Role negotiation scenes
- Individual agents have own goals and requirements, that not necessarily meet role specification
- Social Contract
  - describes a specific agreement for a role enacting agent (rea)
  - Meets organizational expectations
  - Incorporates individual behavior
Interaction Model

- Script negotiation scenes
- Interaction contract
  - describes a specific performance of a scene
- Scene Instantiation
  - Reas are not exactly as the role descriptions
  - Describe the specific interaction protocol realizing landmarks and incorporating rea capabilities
OperA

Interaction Model

Social commitment
agent
role

Interaction pattern
Interaction commitment
Designing OperA models

- Organizational goals imply different requirements concerning coordination
- Analysis and facilitation of social context
  - Organizational Model
  - Flexible structures: landmarks
- Analysis and facilitation of individual context
  - Social model: instantiation to individual requirements
  - Interaction model: protocols
Example:

Conference organization

• Objective:
  – Realize a scientific conference

• Organizational requirements
  – Separation of duties between program and local organization
  – Ensure scientific quality
  – Ensure large attendance
  – ...

• Agent requirements
  – Present own research
  – Receive information about new research development
  – Network
  – ...

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Designing the Coordination

- **Organization**
  - Global objectives and requirements
    - Functional (what)
    - Interaction (how)
  - Objective decomposition (to roles)

- **Stakeholders**
  - Objectives
  - Dependencies
  - Requirements
  - **Role tables**: relation to stakeholders

<table>
<thead>
<tr>
<th>Role</th>
<th>Relation to society</th>
<th>Objectives</th>
<th>Dependencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Role 1</td>
<td>Stakeholder X</td>
<td>...</td>
<td>Role N</td>
</tr>
<tr>
<td>Role M</td>
<td>From coordination model</td>
<td>...</td>
<td>Role P, Role 1</td>
</tr>
</tbody>
</table>
Scenario: Conference organization

- Modeling the organization of a conference

- Stakeholders
- Objectives
- Dependencies

<table>
<thead>
<tr>
<th>Role</th>
<th>Objectives</th>
<th>Dependencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Author</td>
<td>Paper accepted</td>
<td>Program chair</td>
</tr>
<tr>
<td>Local organizer</td>
<td>Successful conference</td>
<td>Program chair, Participants...</td>
</tr>
<tr>
<td>Program chair</td>
<td>High quality conference</td>
<td>Authors, reviewers</td>
</tr>
<tr>
<td>Reviewers</td>
<td>Quality papers, independent evaluation</td>
<td>Program chair</td>
</tr>
<tr>
<td>...</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Designing the (Institutional) Environment

- Identify organizational norms
  - Responsibility analysis
  - Resource analysis
  - Trigger analysis
  - Norm specification
  - Sanction specification

- Norm tables

<table>
<thead>
<tr>
<th>Description</th>
<th>Norm Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type (O, F, P)</td>
<td><strong>Responsibilities</strong></td>
</tr>
<tr>
<td>Textual description</td>
<td>Initiator: <em>role</em></td>
</tr>
<tr>
<td></td>
<td>Action: <em>role</em></td>
</tr>
<tr>
<td>Triggers</td>
<td>Pre condition: <em>state</em></td>
</tr>
<tr>
<td></td>
<td>Post condition: <em>state</em></td>
</tr>
<tr>
<td>Specification</td>
<td>whenever <em>state</em> then <em>role</em> is O,F,P</td>
</tr>
<tr>
<td></td>
<td>to achieve <em>state</em> otherwise sanction</td>
</tr>
</tbody>
</table>
Norms

• Statutes: Abstract norms
  – Main objective of the organization,
  – Values that direct the fulfilling of this objective
  – Context
  – E.g. Fairness of exchange

• Concrete norms
  – Protocols and Rules: enable agents to comply with organizational norms
  – Constraints: cannot be violated
  – Regulations: agent can decide
Communication Dimension

• Abstract Level
  – Generic Terms
    • Incontextual concepts
  – Model Ontology
    • concepts of the framework itself
    • E.g. norm, rule, role, group, violation, landmark...

• Concrete Level
  – Concrete domain ontology
  – Generic communication acts
 Scenario: ontology and norms

- Ontology for the conference organization
  - Author, paper, session, review, PC-member, website, deadline, notification, proceedings, ...

- Norms in the conference organization
  - Role: PC member cannot review own papers
  - Interaction: Session chair can stop presentation if too long
  - Global: English language must be used for all communication
- Social Structure
  - Roles
  - Sub-objectives are identified by means-ends analysis
  - Role dependencies identify interaction between roles -> scenes

<table>
<thead>
<tr>
<th>ROLE DEFINITION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Role id</strong></td>
</tr>
<tr>
<td>Identified in Environment Level</td>
</tr>
<tr>
<td><strong>Objectives</strong></td>
</tr>
<tr>
<td>Formalization of objectives identified in the role table</td>
</tr>
<tr>
<td><strong>Sub-objectives</strong></td>
</tr>
<tr>
<td>Result of means-end analysis for each role objective</td>
</tr>
<tr>
<td><strong>Rights</strong></td>
</tr>
<tr>
<td>From means-end analysis and norm analysis</td>
</tr>
<tr>
<td><strong>Norms</strong></td>
</tr>
<tr>
<td>From the Norm analysis in Environment Level</td>
</tr>
<tr>
<td><strong>Type</strong></td>
</tr>
<tr>
<td>Roles associated with the coordination model are institutional, and operational roles are in principle external.</td>
</tr>
</tbody>
</table>
Role example

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concept Name</td>
<td>Concept PC-Member</td>
</tr>
<tr>
<td>Dependant On</td>
<td></td>
</tr>
<tr>
<td>Dependee In</td>
<td>Hierarchy Dependency paperReviewed</td>
</tr>
<tr>
<td>Name</td>
<td>PC-Member</td>
</tr>
<tr>
<td>Norms</td>
<td></td>
</tr>
<tr>
<td>Objectives</td>
<td>Objective correctReview</td>
</tr>
<tr>
<td>Role Type</td>
<td>Int</td>
</tr>
</tbody>
</table>
Designing the Behavior

- Interaction Structure
  - Scene scripts
  - Interaction structure
    - Partial ordering of scenes
    - Relationships between scenes
      - Causal dependency: Sequence of scenes
      - Synchronization: AND relation between scenes
      - Parallelism: OR relation between scenes
      - Instantiation: new scene instances
### SCENE DEFINITION

<table>
<thead>
<tr>
<th><strong>Scene identifier</strong></th>
<th>From role dependency</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Roles</strong></td>
<td>Participants in scene</td>
</tr>
<tr>
<td><strong>Description</strong></td>
<td>Textual description</td>
</tr>
<tr>
<td><strong>Results</strong></td>
<td>Objectives of scene -&gt; relate to role dependency</td>
</tr>
<tr>
<td><strong>Patterns</strong></td>
<td>Partial ordering of landmarks to achieve result, for each scene result</td>
</tr>
<tr>
<td><strong>Norms</strong></td>
<td>From norm analysis</td>
</tr>
<tr>
<td><strong>Rationale</strong></td>
<td>Further information</td>
</tr>
</tbody>
</table>
Scene example

<table>
<thead>
<tr>
<th>Core</th>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Description</td>
<td>Scene in which the papers are assigned to PC-members, papers are re</td>
</tr>
<tr>
<td></td>
<td>Results</td>
<td>Landmark decision on paper</td>
</tr>
<tr>
<td></td>
<td>Scene ID</td>
<td>Review_Process</td>
</tr>
<tr>
<td></td>
<td>Type</td>
<td>normal</td>
</tr>
</tbody>
</table>

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Interaction Structure
Scenario: verification
Further: Social and Interaction Model

- Specification of role negotiation scenes
- Specification of negotiator agent

- Based on the role descriptions specified in the OM
  - minimum requirements
  - negotiable characteristics, and their range

<table>
<thead>
<tr>
<th>Role Negotiation Scene: Role R</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Roles</strong></td>
</tr>
<tr>
<td><strong>Results</strong></td>
</tr>
<tr>
<td><strong>Plans</strong></td>
</tr>
<tr>
<td><strong>Norms</strong></td>
</tr>
</tbody>
</table>
Roles vs. agents

• Role
  – Abstract representation of a function, service or identification within a group/society
  – Desired activity and behavior, from society perspective

• Agent
  – is capable of flexible, autonomous action in order to meet its design objectives.
  – Agents act, roles not
Example

\[
\text{rules(mary)} = \{\text{supervise(s)} \Rightarrow_{\text{mary}} \text{read(p)}\}\]
\[
\text{rules(PC-member)} = \{\text{review(p)} \Rightarrow_{\text{PC}} \text{send-cfp}\}\]
\[
\text{review(p) } \Rightarrow \text{ read(p)}
\]

selfish PC(mary): supervise(s); review(p); advertise-conference

social PC(mary): review(p); advertise-conference; supervise(s)

max social PC(mary): review(p); advertise-conference
Social Model

- Based on role negotiation scenes
- Depending on the characteristics of the agents that apply for society roles
- Results in:
  - Role enacting agent
  - Enactment contract

<table>
<thead>
<tr>
<th>Social Contract</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agent</td>
</tr>
<tr>
<td>Role</td>
</tr>
<tr>
<td>Clauses</td>
</tr>
<tr>
<td>1.</td>
</tr>
<tr>
<td>2.</td>
</tr>
<tr>
<td>3.</td>
</tr>
</tbody>
</table>
SM Design Steps

- For external roles:
  - Identify minimum requirements
  - Identify negotiable characteristics, and their range
- Specify role enactment scripts
  - Negotiator (internal) agent
  - Negotiation pattern for role characteristics

Example:
- Reviewer agent:
  - Minimum reqs: provide areas of interest, ...
  - Negotiable: number papers, deadline, ...

- Results in role enacting agent design and contract
Interaction model

- Based on script interaction scenes
- Depending on the characteristics of the agents that apply for society roles
- Results in
  - Specific protocols for the scenes, that are supported by the agents

<table>
<thead>
<tr>
<th>Interaction Scene: PC-member role enactment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Roles</strong></td>
</tr>
<tr>
<td><strong>Results</strong></td>
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</tr>
<tr>
<td><strong>Norms</strong></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
IM Design Steps

• For each scene:
  – Identify negotiable landmark range

•Specify script negotiation scripts
  – Negotiator (internal) agent
  – Negotiation pattern for landmarks
  – Other protocol requirements

Example:
• Review scene:
  • Fixed Landmarks: papers send to reviewer, review received
  • Negotiable: review deadline, reminder, ...

• Results in interaction protocols and contracts
Conclusions

- Organization is a complex and rich dimension in MAS:
  - represented in different “eyes”: Designer – Observer – Agents,
  - expressed with two points of view: Agent-Centered vs. Organization-Centered,
  - using multiple models: e.g. Joint intentions, shared plans, dependence theory, ...
- Organization is built to fulfill different aims
  - To help the cooperation between the agents,
  - To control the cooperation between the agents
    - Accounting or not for the autonomy of the agents.
- Multiple ways of Modeling and Programming Organizations
  - Within Agents,
  - Within the system itself (e.g. Organization services),
  - Both in the Agents and in the System.
Conclusions

• Organizing is a complex process:
  – Bottom up or top down,
  – Used in different contexts and applications:
    • knowledge exchange,
    • Simulation, coordination.

• Reorganizing is a dynamic process:
  – Multiple dimensions (who, when, what, why)
  – Multiple styles
  – that could be predefined using an organizational language (same or different form of the domain level)
Literature / More information

- OperA
  - Virginia Dignum: A Model for Organizational Interaction: Based on Agents, Founded in Logic, 2004
  - My Webpage: http://www.cs.uu.nl/~virginia

- OperettA tool
  - http://www.cs.uu.nl/research/projects/operat/