



Multi-Agent Organizations:

Coordinating Individual and Global Goals

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What is the point of information systems?

„The only logical answer ... is to improve the ability of an enterprise ... to achieve its objectives. In other words, to help it to be successful in the eyes of its stakeholders, i.e., customers, constituents and employees.“

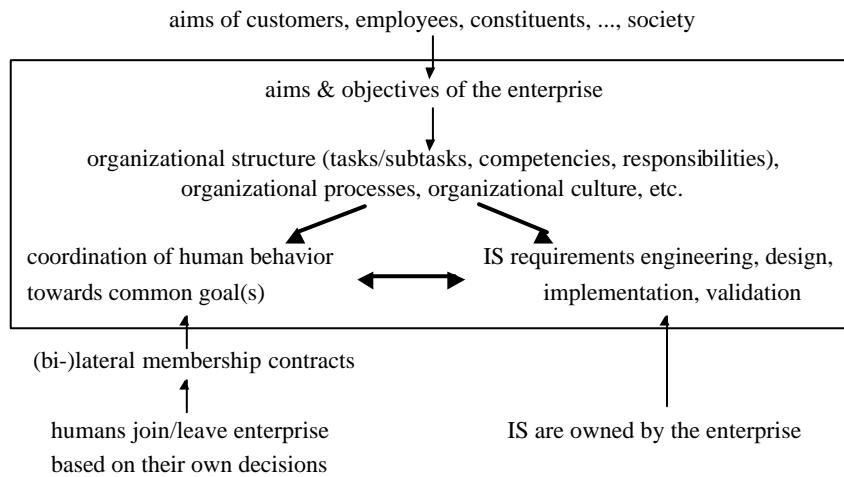
A positive contribution can come in three forms:

- Efficiency measured by productivity — doing things better
- Effectiveness — doing better things including: what an organization could never do before
- Competitive advantage — doing better and new things *for the customer*.

[J. Callon, 1995, Competitive Advantage through IT, p. 11]



Aims & Objectives in Enterprises



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Robocup-Team Prof. Christaller, GMD, 1999

Zur Anzeige wird der QuickTime™
Dekompressor "Sorenson Video"
benötigt.

Do the robots really perform as they are supposed to do ?

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Specification of organizational positions

- provides definitions of formal organizational roles:
task(s), competencies, responsibilities, communication channels, etc.
- allocation of organizational resources (money, materials, etc.)
- position holders are linked to positions
- positions are linked to business processes
- any information system supporting / automating the work of a position holder shall address the requirements specified in the definition of the position

Two assumptions:

- Agents are linked to positions.
- They are thus related to individual workspaces / work situations of position holders.

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Example: position specification in VDM

```
OrgPositionType  ::  
  
  pos_id:                PrimaryKeys  
  tasks,competencies,  
  responsibilities,constraints:  FormalRepr  
  resources:              ResourceType-set  
  org_links:              LinkType-set  
  org_goals:              OrgGoalType-set  
  org_processes:         ProcessType-set
```

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Relating agents to organizational positions

Individual behavior (micro-level):

- bottom-up perspective dominates
- intelligence → problem solving by search
- cooperation, if a problem is beyond individual capabilities
- interaction of individual search spaces → emergence
- commitments: bilateral in general, more or less “fluid” in time

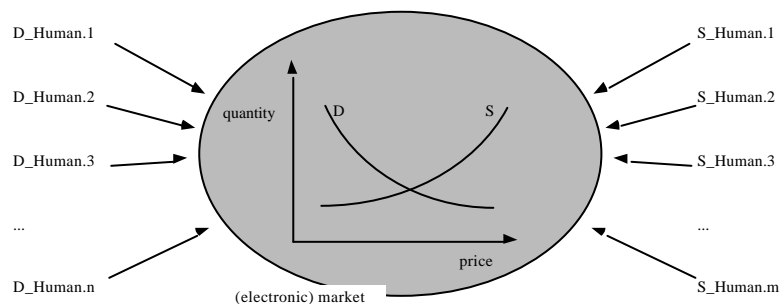
Global behavior (macro-level):

- individual intentions → joint intentions
- predictability?
- security?
- consistency with organizational system (culture, balance of power, strategies, goals, tasks, processes, resource allocation, etc.)?

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Example: Electronic Market



Actors are related to organizational positions,
pursuing the aims / objectives of their enterprises

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D_Human.1 → D_Agent.1

D_Agent.1 capabilities required for acting on the e-market:

- observing the market v
- collecting necessary information v
- interpolation & interpretation of trends v
- learning about strategies / expected behaviors of third parties v
- bidding for goods/services, contracting v
- transferring money for getting the right of ownership v
- physical access to / transportation of purchased goods etc. (v)

=> implementation is possible

BUT: Will D_Agent.1 really do what it is supposed to do?

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Agent behavior (simple model)

- Situated:
 - situation model sufficiently sound, and empirically valid?
 - can the situation model be formalized appropriately?
 - ==> (in case of e-markets) probably easy to achieve
- Goal-driven:
 - does the agent apply to the right goal(s)?
 - are there individual goals of the agent, independent from the enterprise?
 - how to validate agent goals against the requirements of agent owner?
 - how to resolve conflicts between local goals / enterprise goals?
 - ==> well-defined goals may become inappropriate in changing situation
 - ==> may require to re-think IS-design, and org/IS-integration

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Agent behavior (simple model, cont'd)

- Local autonomy:
 - local autonomy of agent against goals of the enterprise
 - may D_Agent.1 change its role (e.g. seller) to maximize local profits?
 - who is responsible (ethic, economic, legal) for the actions of D_Agent.1?
 - different levels of autonomy acceptable? If yes: conceptualizations?
 - ==> agent autonomy must be restricted, at least in open systems!

- Coalition formation for better results:
 - coalitions with agents from competing enterprises?
 - coalitions and transfer of local knowledge, resources, etc.?
 - resource allocation in case of conflicting demands for local resources?
 - new coalitions require new situation models - provided by whom?
 - ==> sincere conflicts between agent theory, and enterprise requirements?

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From agents to multi-agent systems

Assumed, the e-market is to be conceptualized/implemented as MAS.
In realistic economic scenarios the creation of an e-market supposes:

- own personality (identity, aims/goals, tasks, market profile, etc.) of the market
- long-term existence independently from any participant
- efficient institutional arrangements
- management of market transactions
- well-defined set of organizational procedures (i.e. "inference processes")
- membership criteria
together with appropriate application & withdrawal procedures

==> this is quite different to the agent society metaphor in DAI
==> approach required: 'organized' artificial social systems

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MA organizations I: conceptualization

Agents are assumed to

- belong to exactly one owner (enterprise)
- join >1 agent societies
- contribute capabilities & resources to an agent society BEFORE they produce (partial) solutions to a problem / problem solving process
- accept a reduced level of individual autonomy when applying to a multi-agent organization
- apply to a multi-agent organization iff the benefit from joining seems appropriate (“motivation”)

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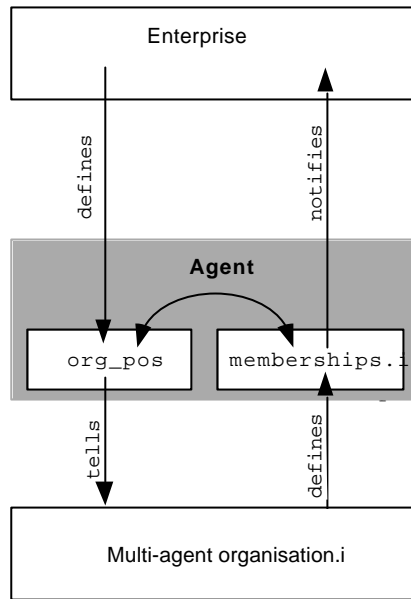


MA organizations I: conceptualization (cont'd)

Multi-agent organization

- formally established entity with own personality and own organizational KB
- existence is independent from any particular member of the MA organization
- four types of organizational inference models
 - management of the formal structure of the MA organization:
creation/termination of MA organizations
 - membership criteria and membership application / withdrawal procedures
==> MA organizations are not fully open systems
 - MA problem solving
 - organizational knowledge base: bottom-up learning, top-down learning

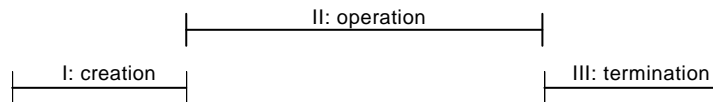
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MA organizations II: life cycle



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Multi-agent organizations III: status

- model refers to an organizational design approach
- potentially good integration with goals, structure and processes of enterprises
- limited to (artificial) deliberative agents
- no integration of non-agent types of information systems

- (“simple”) conceptual model of structure and behavior available
- small context and situation models
- formal specification of structure and behavior (VDM)
- not yet fully implemented

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Discussion I: problems

- computational complexity of organizational inferences?
- reduced local autonomy, well-defined levels of autonomy?
- relationship between (individual) autonomy and computational complexity?
- different levels of MAS openness required
- “mechanistic” organizational design model
- does only partially apply to the social systems metaphor in DAI (and organizational theory)
- powerful methods/tools needed for developing realistic context/situation models

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Discussion II: advantages

- legitimated agents (membership-”certificate”)
- individual commitments about future contributions
- goals (etc.) of organizations are addressed by MA organization
- stability and flexibility can be designed into a MA organization
- adaptation of MA organization to changing individual contributions
- adaptation of agents to changing MA organization
- MA organizations are secure multi-agent spaces
- approach introduces different new questions/research perspectives into DAI

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Future Work

- autonomy of agents in MA organizations
- MA security
- better integration with social systems approach in organizational theory

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