STUDIA INFORMATICA 2001
Volume 22 Number 1 (43)

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INTELLIGENT AGENTS IN ENTERPRISE MODELING

Summary. The purpose of the paper is to present process-knowledge oriented architecture built of collection of Intelligent Agents co-operating to solve common goals, both local and global. Requirements necessary for strongly decentralised process oriented enterprise modelling are discussed in context of Distributed Artificial Intelligence Methodology.

TECHNOLOGIA INTELIGENTNYCH AGENTÓW W MODELOWANIU ORGANIZACJI

Streszczenie. W pracy został omówiony zdecentralizowany i zorientowany procesowo model organizacji gospodarczej stworzony z wykorzystaniem elementów Teorii Rozproszonych Sztucznych Inteligencji. Procesowo-wiedzowa architektura organizacji została przedstawiona jako zbiór Inteligentnych Agentów, którzy działając kolektywnie realizują zarówno lokalne, jak i globalne cele jednostki gospodarczej.

1. Introduction

The paper presents a model of the strongly decentralized, process oriented organization. The model employs Distributed Artificial Intelligence (DAI) tools. The knowledge and process oriented architecture of an organization consists of cooperating Intelligent Agents (AIA) carrying out global and local goals.

A satisfactory organizational model would require encapsulation and integration of the following elements:

- Social subsystem,
- Coordination subsystem,
- Collective rational behavior subsystem.

In order to build such organization model, author employs methodology of Computational Organization Theory (COT) and DAI as a toolbox.

The contemporary business organizations (BO) operate under conditions of dynamic changes, global competition, globalization of economy, and its transformation to so called knowledge economy. All these factors are source of strategies allowing smooth functioning and adaptation to the environment. The process orientation, decentralization and knowledge orientation are the strategies that have radically changed enterprises' functioning in nineties [Champy,Hammer] [Davenport] [Matsuda].

The following figure describes that evolution (Fig.1.)

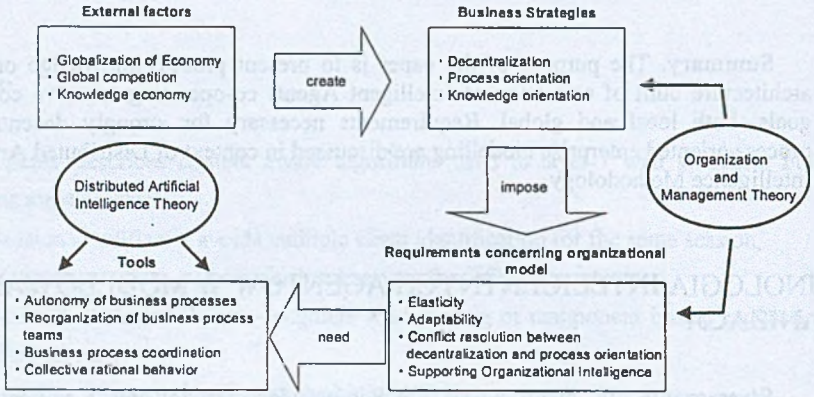

Fig. 1. The evolution of organizational model
Rys. 1. Ewolucja modelu organizacji

An effective implementation of those strategies requires an appropriate information-knowledge infrastructure. The vision of informational integrated, computerized organization [Tapscot,Caston] demands new tools for enterprise analysis and design.

Organizations of the future will operate in virtual environment as cooperating abstract objects processing knowledge and information in order to make profits for owners. Such organizations cannot be properly managed and analyzed with the traditional Organization and Management Theory (OMT). Moreover current methodologies like Object Oriented Analysis (OOA) lack sufficiently sensitive mechanisms to deal with all the nuances.

Moreover fractalization (i.e. distribution of cognitive competencies, responsibilities, and knowledge) requires appropriate coordination, control and management mechanisms able to replace the traditional hierarchical planing. Finally the model should preserve organizational fractal (OF) and business process (BP) autonomy.

To meet the above requirements one needs a "toolbox" allowing to represent organization as a system of cooperating intelligent objects, with flatten organizational structures, oriented on making quality products, according to priority tasks, satisfying customer needs.

2. Organizational modeling

2.1. Formal representation of organization

At present Organization and Management Theory more often uses qualitative models instead of quantitative models. An apparent shift of paradigm is noticeable. It is a result of trials to create model of organizational actors collective activities susceptible to micro level analysis. The question of advantages qualitative over quantitative model arises.

Why qualitative model would better depicts organizational reality than quantitative model? In an attempt to answer it lets consider two different conceptualizations of the same domain with available information.

In the case of quantitative conceptualization combined with quantitative information one can create quantitative representation. The same concerns qualitative information and conceptualization. A problem appears when conceptualization and information are different. In order to create organizational model on micro level with qualitative information we are faced with ad hoc aggregation and necessity to move up the analysis to macro level. It means that nodes in a search tree symbolize organizational units or organizations interacting one with another.

Therefore we are unable to create the model of individual behavior in such approach. The majority of information concerning organization is qualitative, especially the description of individual actors behavior.

Qualitative representation tools allow describing an organizational model on micro level while avoiding ad hoc aggregation. Such models have a certain advantage because the nodes represent individuals.

2.2. Distributed artificial intelligence theory

DAI is subfield of Artificial Intelligence (AI) dealing with knowledge and communication models employed by Abstract Intelligent Agents (AIA) during their activities in an abstract society, toward cooperative solutions of problems.

DAI provides AIA's collective behavior model, which is used for solving specific problems. AIA's can be either simple information processing entities [Hewitt] or rationally behaving objects [Bradshaw].

Without doubts, the main known intelligent objects are [Gadomski]:

- Humans: it means, insufficiently defined intelligent agent with: heuristic knowledge bases, black box reasoning, and personal untransparent preference system.
- Societies: sets of cooperative, coexistent, and autonomous intelligent agents.
- Human organizations: distributed intelligent goal-oriented agents composed with humans.

3. AIA's in context of organizational reality

3.1. AIA as organizational fractals

I assume that AIA's teams will represent OF. Each and every of them will represent certain business functions like information and knowledge processing.

Therefore AIA's working in the OF area should have proper cognitive and reactive abilities; for example AIA's performing accounting functions should have suitable accounting abilities, be familiar with balance sheet or cash flow, and skills to follow obligatory requirements. AIA's managing finances should have the abilities to manage financial liquidity and proper investment policies.

Apart from cognitive skills AIA's acting as OF should also have reactive abilities, which means they should be sensitive to specific conditions existing in their environment. This reactive knowledge can be represented as simple or complex behavior. These reactive abilities are extremely important when monitoring organizational financial and economic situation.

Cognitive abilities should also include precise strategies. The strategy is a way of choosing and applying a certain method in order to solve problems in specific organizational context.

3.2. AIA's as a business process team

Process orientation creates multifunctional worker teams built according to the requirements of certain process. Those teams act collectively in order to find the solution suitable for customer. Depending on the range and scale of the process the team should be created in bottom-up manner by AIA acting as OF.

The process orientation also implies elimination of redundant steps.

In case of realization of this business process by AIA, we can limit their abilities to value adding steps. At the end it means better service and cost reduction. The following figure (fig.2) depicts AIA's that realize a business process.

Fig. 2. AIA's as business process performers
Rys. 2. AIA realizujący działania w obrębie procesu biznesowego

4. The basic building blocks - main characteristic

VIRTUAL TEAM MANAGING THE CASE (VTMC) will represent so called case managing teams (the concept introduced by Hammer [Hammer,Champy]). Such team would consist of OF representatives performing certain part of the process. Where the need to perform certain collective process arises, the team will be created dynamically from OF members.

THE MEMBERS OF VTMC are independent decision-makers. It is the analogies with the organizational reality existing with process orientation and decentralization. Organization is responsible not only for horizontal but also vertical process integration. The vertical integration means that the workers are treated as independent decision-makers and they do not have to ask for decisions their superiors. AIA's would reach their decisions using subsystem of rational activities and would react to certain stimuli coming from environment and use standard operating procedures.

AIA PROCESS OWNER (AIAPO) it is AIA responsible for organization and establishing of process team and for coordination its activities. Owner should choose dynamically AIA, which is used to realization singular functions within the process.

AIA MEMBER OF VTMC (AIAM) it is AIA assigned to organizational role and performing its tasks depending on its cognitive competition.

Within the functions performed by AIA one can distinguish functions as follow:

- The functions do not requiring the rational behavior in context of whole organization. Such functions are performed with the use of reactive knowledge consisting of formalized standard operation procedures.
- The functions requiring some metaknowledge that enables AIA's to maintain rationality while choosing the certain solution (subsystem of collective rational activity).

5. Architecture of virtual organization

In the next chapters I would present implied architecture of VO based on subsystems as follow:

- Social subsystem (SS)
- Coordination subsystem (CS)
- Collective rational activity subsystem (CRAS)

SS presents concept of process roles. The roles are the base for CS, which uses them to obtain dynamical creation of Virtual Process Teams. CRAS is presented in comparison with the process of decision-making taken by AIA. Such process requires rational collective activity.

5.1. Social subsystem

Efficient knowledge management depends on the set of roles and skills required in order to perform them in organizational context.

Thanks to it choosing of most important knowledge its distribution and effective use is possible. Organizational actors, performing certain tasks on tactical or strategic level, add certain values by transforming data and information into knowledge. This process is being performed by organizational actors (OA) fulfilling specific roles and equipped with certain abilities.

The concept of the roles in the case of the model described below refers to social subsystem. On the base of this subsystem dynamical virtual teams performing certain business processes will be created.

I assume that organization is beyond the fractalization phase and singular OF are the sets of AIA equipped with abilities and knowledge.

$$OF_i = \{AIA_1,...,AIA_N\} \quad (1)$$

where OF_i denotes organizational fractal, $AIA_1,...,AIA_N$ denote agents working within organizational fractal.

Therefore we can conclude that daily activities are based on performing certain organizational roles defined in the BO context by AIA.

$$BO = \{ro_1, \ldots, ro_N\} \quad (2)$$

,where BO is a set of roles existing within business processes.

Each role is connected with certain pattern of activity. It is the set of skills concerning the functions performed within certain role.

$$RO = \{f_1, \ldots, f_N\} \quad (3)$$

, where $f_1, \ldots, f_N$ indicate the business functions.

Business function can be defined as the following formal structure

$$f_{jk} = <D_{jk}, S_{jk}, Z_{jk}, T_{jk}, R_{jk}, w> \quad (4)$$

, where

D_{jk} – indicates finite set of basic activities building the function

S_{jk} – finite set of sequent activities created from D_{jk} set

Z_{jk}- finite set of events evoking singular sequences, which realize business functions

T_{jk} – set of time moments

R_{jk} – set of results giving the solutions to perform the sequences

w- "execution" relation determined on the set S

therefore, $< s , r , t > \in w$ means that the realization of a sequences $s \in S$ produces an effect $r \in R$ of a moment $t \in T$.

The AIA abilities depend on the cognitive system that allows solving certain problem. Owner function should map proper models of skills of AIA on role or set of roles (pattern or activity pattern) according to given criteria for example: estimated time of performing certain task.

After selection of certain set of AIA from OF by a process owner satisfying RO, virtual processing team performing certain PG will be created.

VIRTUAL PROCESS TEAM is the AIA set existing within i^{th} business process BP_i, such as that AIA can play one or more roles depending on its own competences.

$$VPT = \{(AIA_i, ro_{jk}) \mid AIA_i \in F \wedge ro_{jk} \in Rc^{ai}\} \quad (5)$$

, where Rc^{ai} is the set of such roles, where the set of activities describing certain function, can be performed by cognitive system of i^{th} AIA (k = 1...N indicates the number of roles performed by i^{th} AIA).

Assignments given AIA to perform singular organizational roles can be based on ability pattern matching mechanism.

Let us define Organizational Social Subsystem

ORGANIZATIONAL SOCIAL SUBSYSTEM (SS) it is the set of organizational roles $\{ro_1,...,ro_N\}$ existing within business process in given context Ω.

OSS is defined by the following formal structure:

- Languge L
- Dynamic set of AIA's (the set is dynamic as availability of AIA's within OF is changed in time because of assigning them certain roles within a processes). With certain abilities required to fulfil one or several roles within BP to them.
- Owner function of PO which maps certain role or roles to AIA

$$PO: AIA \rightarrow P(RO) \quad (6)$$

- Organizational context Ω, which is the set of clauses defining decisional situation.

5.2. Coordination subsystem

5.2.1. Coordination in organization

Even in organization with intelligent actors (as opposed to task oriented – with actors treated as mindless robots) process realization goes beyond capabilities of an individual. Collective actions of actors should be coordinated toward achievement of a common goal. Moreover fractalization requires to replace the traditional hierarchical planning with the decentralized coordination conceptions.

Coordination is:

" ...the process by which an agent reasons about its local actions and the actions of others to try and ensure the community acts in coherent manner..."[Jennings]

"...the process of managing interdependencies between activities..." [Malone,Crowston]

The context of the above mentioned definitions is organizational scenario. This scenario describes several OA's who perform actions toward realization of common goal. Mutual dependencies are relations among activities. Those relations are consequence of collective behavior toward common goal realization. The assumption that OF represented by a group of autonomous AIA's will create bottom-up business processes, requires some coordination mechanisms. Otherwise the AIA's are quickly being reduced to the group of chaotically acting individual.

Organizational strategies need coordination of the activities within and among processes for the follow reasons:

- The reduction of uncertainty which is caused by control distribution (decentralization-fractalization)
- Ensuring that all main parts of BP are being performed by at least one AIA's
- There are dependencies among AIAs' actions. Moreover goals are mutually related and local decisions AIA can affect process teams. For example the estimations of financial situations done by one AIA can affect credit policy done by another one
- There is a need to meet global constraints. For example in order to optimize process parameters AIA will operate under some local or global constraints. These constraints are imposed on some process parameters of effectiveness time limit or costs level. In the case of coordination of processes constraints can come from the budged.

Malone [Malone] states that basic components of coordination are:

- Allocation of scarce resources
- Communication of intermediate results

In the case of realization of activities within processes a transformation of intermediate result is necessary. Let us analyze financial process. AIA estimating financial condition of the

firm requires intermediate results considering singular positions of balance sheet. AIA estimating credit policy of the firm requires results of financial analysis.

The activities, which engage more then one OA, require.

- Some way of division of activities among the different actors
- Some way of managing the interdependencies between the different activities [March,Simon]

Interdependencies among activities can be of tree kinds:

- **POOLED**, where the activities share or produce common resources but are independent
- **SEQUENTIAL**, where some activities depend on the completion of others before beginning
- **RECIPROCAL**, where each activity requires input from the other.

The interdependencies can be managed by three coordination mechanisms:

- **STANDARDIZATION** – predefined rules governing the performance of each activity
- **DIRECT SUPERVISION** – one actor manages interdependencies on case-by-case basis
- **MUTUAL ADJUSTMENT** – each actor makes on-going adjustments to manage interdependencies.

While analyzing the above mentioned methods in process fractal orientation and assumption context, which we have accepted it seems that the coordination of activities AIAM's will be based mainly on strategy of *mutual adjustment*. AIA's realizing BP are autonomic individuals that have to mutually adjust their activities.

None of them is superior to the others and decision-making is collective process. In case of process team in phase of assigning the roles AIAPO will supervise this stage using *direct supervision strategy*.

5.2.2. Coordination Of Virtual Organization

The coordination of informational-decisional activities within business processes as well as coordination of processes can be shown from the point of view of commitment and conventions.

COMMITMENTS AND CONVENTIONS

Business process as a search tree (AND/OR)

Hereby below I present coordination concept of AIA's within BP in form search tree. (Fig 3)

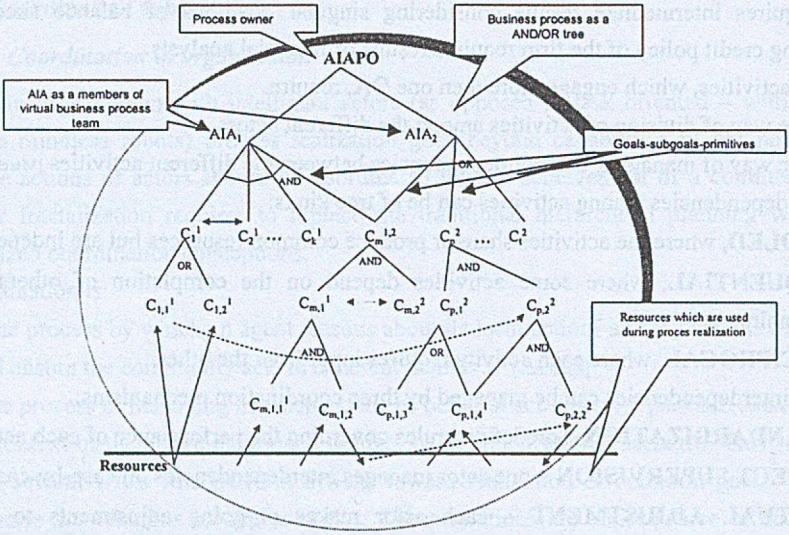

Fig. 3. Business process as a AND/OR search tree
Rys. 3. Proces biznesowy jako drzewo AND/OR

Durfee [Durfee,Montgomery] has presented DAI system as an AND/OR search tree. Jennings [Jennings] has broadened that basic formalism by introducing relations between goals and resources necessary to goal leaves realization (crucial of business process because of mutual relations among AIA's activities).

From the definition BP is a sequence of activities tied with each other in stated manner and leading to achieving of certain result. By featuring BP as AND/OR tree the root would symbolize the main task for example certain service given by WZP and the nodes would define partial aims performed by AIA's depending on their competencies. The leaves (the ones which are not divided into partial aims) require resources, which are often being the final results of different sub goals. Moreover some sub goals should be realized simultaneously.

COORDINATION WITHIN THE PROCESS WITH THE USE OF COMMITMENTS AND CONVENTIONS

Proper coordination within the process can be achieved by the use of commitment and conventions mechanisms.

COMMITMENTS

Commitments can be described using following organizational scenario:

- AIA that operate within some process commits to activities and beliefs.
- When AIA wants to play some role in business process then it commits itself to it.

- Moreover AIA should honor its commitments Different AIA's, which commit themselves to perform process functions, are operating on those commitments.
- From perspective of coordination the most important commitments are related to present and future actions.
- Information concerning reached commitments should be announced to process society on the proper level of abstraction.
- Reached commitments constrain other commitments in the future according to limited resources in organization.

From our model perspective, the most important are common commitments.

COMMON COMMITMENTS

Collective behavior VPT needs commitments to common goal, which gives intended result. Group commitments contain additional constraints coming from the involvement of several AIA's. The global state of commitment is distributed.

Hence business process is represented as AND/OR tree, commitments supply a structure for process team abstract members interactions, conventions allow for elasticity of actions in dynamic environment, and social conventions support activities toward business process results – collective goals.

The ability to accept the performance of few roles by individual AIA (not necessarily simultaneously) enables reorganization of AZPS according to the variable needs of the customer. The situation can arise when due to the changing of the roles AIA is not able to keep up whit his commitments. In order to maintain coherent behavior of process team other AIA's acting within the process should redefine their commitments. A mechanism, which allows such action, is called convention.

CONVENTIONS

Conventions describe the conditions in which AIA's should again reformulate their commitments [Jennings]. They should also point out proper ways of acting in order to maintain, fix or quit the commitments. Because of collective character of activities performed by AIA's within business process the most important ones that appear are so called social conventions.

Interdependencies among goals within BP require that in case of change of the commitment, which influences other goals, other member or the team should be informed. Social commitments describe the way of behavior in accordance with other members of the team, when above mentioned commitments are changed. Therefore successful realization of common goals depends on keeping their commitments taken by the member of VTMC, the change of commitments by singular AIA can make the whole team fail. If singular AIA believes that other member broke his commitments it should apply conventions of common behavior.

Basic joint action convention [Jennings]

INVOKE WHEN:
- Status of commitment to join goal changes
- Status of commitment to attaining joint action in present team context changes
- Status of joint commitment of a team member changes

ACTIONS:
R1: **IF** status of commitment to join action changes or
status of commitment to present team context changes
THEN inform all other team members about the change
R2: **IF** status of joint commitment of a team member changes
THEN determine whether joint commitment still viable

5.3. Collective rational behavior subsystem

The behavior of OA should be analyzed as a result of their rational strategy aiming at the best use of their own knowledge to maximize organizational payoffs.

Tools taken from the Game Theory can regulate the process of cooperation. These tools aggregate freedom and force together.

Players are treated as autonomic individuals. In order to win they have to apply rational strategy and follow its rules. An outcome of the game should lead to final result satisfying organizational needs.

Modern organizational structure can be described as sets of games.

Players are autonomic OA's, their behavior being managed by game rules triggering choice of proper strategy. Rationality of selected strategies is limited by the nature of the game itself [Crozier,Friedberg].

5.3.1. The business process as a game

Let us change the previous perspective. Instead of treating organizational functioning as a result of adaptation processes of individuals and groups in accordance with certain procedures and roles, let us treat them as a collection of game result. The constraints, which are imposed by a game on AIA's, do not determine their behavior but enable them to use the full range of available strategies. This perspective will make our considerations easier. [Crozier,Friedberg]

In following chapters I will describe BP as a game, with OA's equipped with certain decision-making abilities. I will use formalism introduced by Ginsberg [Ginsberg].

5.3.2. The measure of performance – payoff function

In common organization, the value of the work is hard to assess. Let us try to evaluate the value of verified data regarding employment in the application form lodged with insurance

company. Such the evaluation would be futile. In such case only signed up insurance policy itself has certain value for company [Hammer,Champy].

In the case of the employees performing certain work within BP they can be assessed by effectiveness on the basis of their activities undertaken in order to obtain the final result: service or product. However considering the above mentioned activities in context of visions and goals of the whole firm might be very complicated.

It is necessary to create the measure of performance, which would determine in quantitative manner the level of firms' goals and visions accomplishment as a function of the course of action that have been undertaken. That seems to be the possible solution, which can be attained by the mechanisms created by R.S Kaplan and D.P. Norton [Gach]. The payoffs evaluation will be analyzed in my further research.

In this paper we assume that the performance measure is the value of payoff, which is estimated by so-called payoff function.

Therefore we can assume that the evaluation of performance of i^{th} AIA acting within BP will be connected with payoff function p. This payoff function would be estimated according to alternative course of action m. Thus each m will be rewarded with payoff.

Payoff function is defined as follow:

$$p: M \rightarrow R \tag{7}$$

, where **R** is a set of payoffs.

In case of activities within BP, we cannot exclude the lack of interactions because of collective behavior of OA's. Therefore the value of the payoff function for individual AIA will depend on activities undertaken by different AIA's within the process. For example the choice of a certain installment system by AIA_1 would interfere with the price calculation result, performed by AIA_2.

The function below expresses the case when individual AIA's are involved in certain interaction.

$$p_i: \prod_{i \in P} M_i \rightarrow R \tag{8}$$

,where

P – set of interacting AIA's acting within certain business process, p_i – estimates the payoff of i^{th} AIA according to activities performed by another AIA's within P.

For $S \subset P$, I will denote $P\text{-}S = \overline{S}$, I will also write M_S for $\prod_{i \in S} M_i$.

Then we can define interaction with the associated payoff function as a formula:

$$p_i: M_p \rightarrow R \tag{9}$$

The payoff function for several AIA's is

$$p: P \otimes M_p \rightarrow R, \tag{10}$$

,where $\otimes$ and $\prod$ denote Cartesian product for two or more sets respectively.

5.3.3. The rational realization of business process

The employees of an organization are undertaking certain activities using their knowledge and experience, are trying to act rationally within the business process. They are applying certain decisional procedures in order to choose proper course of action while performing certain activity. (However the use of such procedure is limited because of so called bounded rationality) [March,Simon].

Changing the approach and treating BP as a game, we have to keep in mind, that rational activity mechanisms should consider the relation between undertaken and assigned activities to individual AIA's, in individual parts of BP. The main goal of CRBS is to enable coherent common behavior within specified business process.

The following paragraphs explain the mechanisms, which give AIA's the possibility to behave rationally.

Let us concentrate on business meta-process M, in which the action of i^{th} AIA is a choice of decision procedure D_i, D_S indicates collective action that is a choice of common decision procedure. Therefore the payoff function within M is described as a formula:

$$p(i, D_P) = pay(i, D_P) \tag{11}$$

The theorem, which explains the AIA's rational behavior within whole organization, follows:

(The mechanism of organizational rational behavior)

If all AIA's poses matching density functions and all processes are locally unambiguous then each common globally rational decision procedure D_P satisfying the mutual behavior assumption for given AIA's acting within P, will be optimal in Pareto sense in business meta-process M.

According to the formalism introduced by Ginsberg [Ginsberg], let us assume that P indicates the set of AIA's involved in organizational game. According to this the individual BP can be treated as a games.

Apart from interactions within processes interactions may also occur between the processes. Those are the result that the activities performed within parallel processes interacting with each other due to mutual dependencies.

Let G indicates the agents' game and g_l would indicates the set of possible activities performed by AIA's in the say g game. Let G symbolize the total set of the games existing within BO, and G_l denote the set of total acceptable activities performed by AIA in a certain

game. Total acceptable activities for certain AIA consist of the set of alternative ways of realizing certain function within the process during realization of certain collective tasks.

Interacting AIA's are reaching their decisions with use of so called decision procedures. A decision procedure is defined as the following function:

$$D_i: G \rightarrow G_i \tag{12}$$

The above mentioned procedure encodes the selection process of proper course of action. Let us analyze concrete BO with the finite number of AIA's operating within business process. Then we can define the collective decision procedure as:

$$D_s(g) = \prod_{i \in S} D_i(g) \tag{13}$$

where, D_s denotes collective decision procedure enabling to choose proper collective behavior by interacting AIA.

Certainly collective behavior should be fully rational in the sense of accepted goals within the BP's. A condition establishing which decisional procedures are irrational follows:

$$\text{pay}(i, D_p) < \text{pay}(i, C_p) \tag{14}$$

The choice of rational activity is possible thanks to operator of irrationality, which eliminates irrational procedures. We can define operator of irrationality in the following manner:

D – is the collection of joint decision procedures

i – denotes AIA realizing business process

I_i – global irrationality operator for i

$I_i(D)$ – set of all decision procedures D_i satisfying the following constraints:

there exist C_i in $\pi_i(D)$ such that for all C_P and D_P, if $\pi_i(D_p) = D_i$ i $\pi_i(C_p) = C_i$ then

$$\text{pay}(i, D_p, g) < \text{pay}(i, C_p, g) \tag{15}$$

In other words, decision procedure is uniformly irrational if there is another decision procedure which is better is some specific game, treated as interaction among the AIA's within or between BP, and no worse in others.

The set of rational collective decision procedures can be obtained with the use of the rationality operator:

$$R(D) \equiv D - \bigcup_{j \in P} \pi_j^{-1}[I_j(D)] \tag{16}$$

To avoid side effects of uniform rationality which trigger blind AIA activity and using independent rationality assumptions we have to equip AIA in the assumption of common rationality. It is applicable in the cases in which uniform rationality is leading to disadvantageous choices of the course of action for both sides. The following theorems describe some properties of the common rationality.

Assume common uniform rationality of AIA's and suppose that game g has move $\vec{c}$ and $\vec{d}$ such that $\vec{d}$ is Pareto subobtimal, with $\vec{c}$ being an improvement which is possible as the outcome of a common decision procedures for the players involved.

Then $D_P(g) \neq \vec{d}$ [Ginsberg]

Assume common uniform rationality, and suppose that g has a move $\vec{c}$ such that for any $\vec{d} \neq \vec{c}$

$$p(j,\vec{c}) \geq p(j,\vec{d}) \tag{17}$$

for all players j, with the inequality being strict for at least one j. Then $D_p(g) = \vec{c}$.

5.3.4. Global rationality as activity satisfying the organizational goals

Organizational goals should be realized in global sense. Sometimes when an employee or a team performing certain process achieves good results those results can have negative influence on the other ones. The main idea of the model under consideration is to perform activities under assumption of the global rationality. In every process more than one activity might be suboptimal in Pareto sense. I such case the cooperation of AIA will not allow choosing the unique, rational course of action within the process. Moreover in some cases the mechanisms of common rationality are not sufficient.

These cases concern symmetric processes in which payoff values are arranged in the manner as follows.

	Activity C	Activity D
Activity A	**0**	*1*
Activity B	**1**	**0**

If given process is unambiguous the symmetry problems do not exist. It means that $p_\sigma \neq p$ given to nontrivial agent permutation performing say g process.

We should establish assumption guarantee the unambiguity of the process. Let us define orbit g denoted by $o(g)$. $o(g)$ is the set of global interactions provided by AIA's permutation within g process. Now we can modify payoff function by allowing it to operate on the $o(g)$ orbit.

$$\overline{pay}(i, D_p, g) = \sum_{g' \in o(g)} \rho_i(g') p(i, D_p, g') \tag{18}$$

The G process is globally unambiguous if

$$\overline{pay}(i, D_p, g) \neq \overline{pay}(i, C_p, g), \text{ for } D_i(g) \neq C_i(g). \tag{19}$$

Unambiguity forces the existence of the unique global rational collective behavior. The existence of the mentioned above procedure does not necessarily imply common rationality. Behavior of AIA's depends on the density functions. Therefore the following theorem holds:

Let us assume that each agent acting within the process had accepted common rationality assumption and the density functions of different agents are identical, then the common rationality assumption will be fulfilled.

There is no need to equip interacting AIA's with decision procedures that are being a permutation of other procedures. If AIA's are provided with global behavior assumption and the instructions given are maintained in global rational manner then decision procedures will be the same.

With the use of above mentioned Ginsberg's [Ginsberg] formalism one can create rational global subsystem enabling interacting AIA's to choose proper activities in order to perform collective business functions.

6. Conclusions and further research

The goal of the paper has been to present a newly built model of modern organization. The employed formalisms use tools from DAI and Computational Organization Theory.

It seems that DAI methodology will allow to build an appropriate architecture for organizations operating according to new strategies (process orientation, knowledge orientation and decentralization).

In author's opinion pooling resources of DAI, and OMT will cause that the appearing on the horizon Agent Oriented Business Engineering paradigm will be fruitfully used in designing and analyzing of intelligent and self-adaptive organizations. Further research will concentrate on:

- Choice of an appropriate architecture for AIA's acting in the process contexts.
- Building of an abstract model of process team, a basic building block of modern organization.
- Model implementation with Java and Prolog languages.

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Wpłynęło do Redakcji 7 kwietnia 2001 r.

Streszczenie

Strategie, które radykalnie zmieniły funkcjonowanie organizacji gospodarczych (OG) lat 90. to orientacja procesowa, decentralizacja oraz orientacja wiedzowa. Efektywna realizacja tych strategii wymaga odpowiedniej infrastruktury procesowo - wiedzowej.

Z kolei wizja zintegrowanej informacyjnie, skomputeryzowanej organizacji jest zapowiedzią zupełnie nowych wymagań dotyczących narzędzi projektowania i analizy współczesnych firm oraz systemów ich wspierających.

Organizacje przyszłości będą działały w wirtualnym otoczeniu jako abstrakcyjne obiekty przetwarzające informację i wiedzę oraz kolaborujące między sobą w celu wypracowania zysku dla właścicieli.

Do odpowiedniego zarządzania i analizy takich organizacji tradycyjna Teoria Organizacji i Zarządzania wydaje się być niewystarczająca. Ponadto próbując stworzyć model infrastruktury procesowo-wiedzowej, z wykorzystaniem narzędzi takich jak np. paradygmat obiektowy, okazuje się, że nie dostarczają one wystarczająco subtelnych mechanizmów.

Odpowiedni model OG wymaga enkapsulacji i integracji następujących komponentów:
- podsystemu rozwiązywania problemów,
- podsystemu socjalnego,
- podsystemu przetwarzania informacji i wiedzy.

Z kolei ze względu na rozproszenie kompetencji kognitywnych, odpowiedzialności oraz wiedzy potrzebne są odpowiednie mechanizmy kontroli i zarządzania procesami gospodarczymi oraz mechanizmy koordynacji, które powinny zastąpić tradycyjne planowanie hierarchiczne. Ponadto model powinien zachowywać autonomię zespołów procesowych.

Aby spełnić te wszystkie wymagania potrzebna jest odpowiednia „skrzynka z narzędziami", która pozwoli przedstawić model organizacji jako system kooperujących inteligentnych obiektów gospodarczych o spłaszczonych strukturach organizacyjnych,

zorientowanych na wykonywanie wg priorytetów zadań przyczyniających się do tworzenia odpowiadających oczekiwaniom klientów usług (produktów) o żądanej jakości.

Celem niniejszej pracy jest przedstawienie modelu organizacji gospodarczej mocno zdecentralizowanej i zorientowanej procesowo, stworzonego z wykorzystaniem elementów Teorii Rozproszonych Sztucznych Inteligencji. Architektura procesowo-wiedzowa organizacji została przedstawiona jako zbiór Inteligentnych Agentów, którzy kooperując realizują zarówno lokalne, jak i globalne cele firmy.