

Organisational Change: Deliberation and Modification

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Abstract For an information-agent-based system to support virtual (Internet-supported) organisations, changes in environmental conditions often demand changes in organisational behaviour, i.e., organisational changes. As organisational behaviour relates to organisational structure, rethinking the structure of an organisation as environmental conditions demand so, renders such an organisation imperatively flexible and adaptive. This paper presents a formal modelling approach for such organisational dynamics. The contributions of the reported research are (1) a formal model as a basis for simulation (2) formal specifications of dynamic properties of organisational behaviour at different aggregation levels, (3) logical interlevel relationships between these properties, (4) a prototype implementation, and (5) simulation and checking results.

1 Introduction

Within the field of Organisation Theory organisational structures regulating societal dynamics, and thus entailing organisational behaviour are studied; e.g., [6], [12], [14]. A particular area for which this field has become quite relevant is the area of virtual (Internet-supported) organisations. Supporting the design of virtual organisations based on information agents on the Internet asks for a dedicated organisation modelling approach. Within the area of Computational Organisation Theory and Artificial Intelligence, a number of organisation modelling approaches have been developed to simulate and analyse dynamics within organisations; e.g., [16], [13], [15], [3]. Some of these approaches explicitly focus on modelling organisational structure, abstracting from the detailed dynamics. Other approaches put less emphasis on organisational structure but focus on the dynamics in the sense of implementing and experimenting with simulation models. The Agent/Group/Role (AGR) approach as described in [3] is an example of an approach focussing on organisational structure, abstracting from the details of the dynamics. However, [4], [5] are some first steps to specify the organisational behaviour by adding specifications of dynamic properties to the organisational structure provided by AGR.

In [9] it is shown how the relation between an organisational structure and organisational behaviour can be founded formally. In [7] practical application of the connection between structure and behaviour is presented in the form of an approach that enables to derive organisation properties from role properties (and interaction properties), according to the organisational structure. However, in these papers it is not addressed how to model *organisational change*, i.e., an organisation that is changing its behaviour over time, a phenomenon that receives much attention in recent literature on Organisation Theory; e.g., [12], [13]. Organisational change is a process that allows an organisation to adapt its behaviour to changing environmental conditions. In virtual organisations such changes occur on a regular basis, and in fact may be part of the normal functioning of such an (evolving) organisation.

The initiative for changes of organisational structure usually lies within the organisation (in interaction with the environment). In organisations in human society, often the underlying decision process is embedded within the organisation in the form, e.g., of a director or management board supported by a strategic management department. In this sense, the process to obtain a changed organisation is itself part of the organised dynamics. This makes the organisational dynamics a reflective process.

To model the dynamics of this reflective process in order to support the evolution of virtual, information agent-based organisations is the challenge addressed in this paper. In Section 2 an overview of the modelling approach is presented, together with an example scenario. Section 3 provides more detail about the manner in which the strategic management for organisational change is modelled. Finally, Section 4 concludes, among others, by briefly discussing the prototype implementation and some simulation results.

2 Modelling Approach and Example Scenario

Processes of organisational change (in succession) realise an evolving organisation that is able to adapt to its (changing) environment; e.g., [12], [13]. From a strategic management perspective, this evolution is to be guided by deliberation. Based on such deliberation the organisational changes are initiated and accomplished. The deliberation may involve (the demands from) the environment, organisational goals, organisational structure, allocation of agents, and actions to achieve goals.

In the approach presented in this paper, to obtain a changed organisational structure is a means to achieve a goal. Such a goal concerns (dynamic) properties of the organisational behaviour. So, the deliberation starts by identifying the goals in terms of the required changes in organisational behaviour, given changed environmental conditions.

To model such a process, models are needed for deliberation and modification. Moreover, a number of explicit representations play a role: for organisational behaviour, organisational structure and relations between behaviour and structure. In the adopted modelling perspective two models play an important role. In the first place a goal-directed agent model is used to model the deliberative aspects of the organisational change, and in the second place a model for modification of the organisation structure and agent allocation. The deliberation model of the organisation-as-deliberative-agent is embedded within the organisation structure.

Representations of organisational behaviour play an important role both to describe existing (possibly undesired) behaviour as has been monitored, and to describe desired or required behaviour that can be taken as goal. A formalisation is needed of the dynamic properties that characterise organisational behaviour. To this end the formal specification language for dynamic properties of organisational behaviour as presented in [8] is adopted. An example of such a representation is:

$$\begin{aligned} & \forall \text{tid} : \text{TaskId}, \forall t1, t2 : T \\ & \forall C : \text{CLIENT} : \text{client_service} \forall R : \text{RECEPTIONIST} : \text{client_service} \\ & [[t \leq t1 \leq t2 \& \text{state}(T, t1, \text{output}(C)) \models \text{comm_from_to}(\text{requested}(\text{tid}, \text{tf}), C, R) \Rightarrow \\ & \exists t2 : T [t1 \leq t2 \leq t1 + d \& \\ & [\text{state}(T, t2, \text{input}(C)) \models \text{comm_from_to}(\text{rejected}(\text{tid}), R, C) \vee \\ & \text{state}(T, t2, \text{input}(C)) \models \text{comm_from_to}(\text{accepted}(\text{tid}), R, C)]] \end{aligned}$$

This organisation behaviour property specifies that for trace T, at any point in time between t and t', if a client communicates a request to the receptionist, then within time duration d the receptionist will communicate either an acceptance or a rejection of the request to this client. Using the abstraction mechanism introduced in [10] such properties can be expressed in a conceptual high-level (but yet formal) language, without having to involve all (temporal) details. For example the property above can be represented in an abstract manner by

$$\text{has_maximal_request_response_time}(T, t, t', d)$$

This abstraction mechanism allows the deliberation model to work with relatively simple expressions and relations between them.

To model the organisational aspects, the Agent-Group-Role (AGR) organisation modelling approach [3] was adopted. This approach abstracts from the behaviour of individual agents by considering organisational concepts as roles, groups and structures as first class citizens. As such, an agent is considered an active communicating entity which plays roles within groups. Groups are aggregated sets of agents and a role is an abstract representation of an agent function within a group. Organisational structure is considered at group and organisation level. On group level, a structure is an abstract description of a group, identifying all roles and interactions within the group. An organisational structure is a set of group structures together with intergroup interactions. The actual realisation of the organisation then constitutes the allocation of a set of agents to roles. The original aim of the AGR organisation modelling approach concentrates on organisation structure, while our concern is more with the actual dynamics. To incorporate the structure within the logical description of the internal dynamics of the organisation: firstly, for each element (e.g., group, role, interaction) in the organisational structure, a specific set of dynamic properties is introduced; secondly, relationships are identified between these sets, based on the structural relations between these elements; for further details on this formalisation, see [9].

The approach is illustrated by a toy example: a banking case study (see Figure 1). Clients put in requests, e.g., opening an account or withdrawing funds from an account, to the bank through a central call center. The call center forwards such a request to a bank in the region where the client resides. If a local bank then has fulfilled the request, the client is informed by the call center that the request is finished. Client requests come in via the Client Service group, from where they are forwarded to representatives of local banks. Client requests are allocated to local banks on the basis of the regions in which clients live. In local banks employees fulfill these requests. Interaction is bidirectional: requests go upstream from the clients to the employees and the different possible statuses of these requests (finished, accepted, rejected) go downstream.

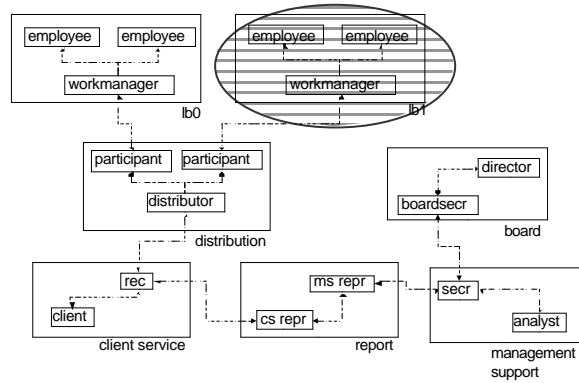


Figure 1 Organisational AGR structure of the case study

Here, organisational change can be illustrated as follows. Assume that at some moment, the organisation has a single local bank called lb0 in region reg0, but dealing with client requests from reg0 and reg1. As the number of client requests increases over time, management may decide to open up another local bank, called lb1. After this reorganisation, lb0 deals with requests from region reg0 and lb1 deals with requests from region reg1. The Report group communicates statistics on the incoming requests, to the Management Support group. Based on this information within this group new organisational goals and actions are generated, upon which final decisions are made by the Director.

3 Strategic Management

Strategic management involves the deliberation process that takes into account (changed) environmental conditions, goals on the organisational behaviour, and organisational structure which is the vehicle to realise behavioural goals. In this section it is discussed how such a deliberation process takes place (Section 3.1) and how such a process is embedded within the organisational structure (Section 3.2).

3.1 Organisational Behaviour and Structure

The deliberation process is explained by means of an example scenario. Suppose in the period between t and t' a substantial increase in number of clients in a certain region occurs (for example due to an extension of a city). Based on monitor information this environmental change is detected. Moreover, as part of the analysis process it is found out that for the given organisation structure, the maximal response time has increased, i.e. the dynamic property $\text{has_maximal_request_response_time}(T, t, t', d, d')$ holds, where d' is larger than before: $d' > d$. As part of the deliberation process on goals on the future organisational behaviour, this d' is considered much too high. Moreover, if an organisational change is performed, then this is considered as an

opportunity to get the maximal response time even less than before: a number $d'' < d$ is determined such that a goal is that $\text{has_maximal_request_response_time}(T, t_0, t_0', d'')$ will hold. The new goal is this; without repeating this all the time, also the goal that the permanent costs per client are limited to some bound b will be imposed. As part of the deliberation process about organisational structure modification actions it is found out that this new combined goal will be achieved if the organisational structure is modified in the sense that a new location of the bank is set up for the region. As a consequence of this deliberation it is decided to actually make the modification to the organisation structure. Within the deliberation process as sketched, supporting techniques and tools can be used. First, within the monitor and analysis process, on the basis of a trace, dynamic properties of the current organisational behaviour and environment can be checked in a formal and automated manner by the approach described in [7]. Moreover, in deliberation about an organisation structure modification action it can be determined what the behavioural properties for a possible organisational structure are, also in a formal and automatically supported manner as in [7].

3.2 Embedding the Deliberation Model in the Organisation Model

The deliberation process consists of an analysis of the recent past (say of the last 3 months) of organisational behaviour, and a planning process to determine a goal and a modification action that will influence the organisation behaviour in the future. Both determination of a goal and determination of an action are performed by first generating one or more options and then select one (possibly with a slight change).

For the example organisation in the example domain the Management Support group is responsible for analysing the monitoring results, for suggesting goals for the future behaviour of the organisation, and for proposing modification actions to the organisation structure to satisfy certain goals. The Board is responsible for deciding on the goals and modification actions. Below, properties of groups will be indicated by GP and properties describing intergroup interaction by GI.

Proper transfer of information is important throughout the deliberation process and throughout the organisation. For all roles $R1$ and $R2$ that have to communicate with each other, a transfer property has been formulated:

$TP(R1, R2, m)$ _ If $R1$ communicates m to $R2$ then $R2$ receives m .

If this holds for any m , this is denoted by $TP(R1, R2)$, and two-way transfer by $TTP(R1, R2)$. Within each group, group properties can be related to transfer properties and role behaviour properties.

Monitoring

The monitoring requires that response time report is generated on a regular basis. The following properties show where in the organisation this is performed and how it can be specified that the monitoring results arrive timely at the appropriate places within the organisation.

Client Service group

$GP1 \equiv$ If in a certain week the Clients generate a number of requests, then the Receptionist will receive these requests in this week.

Client Service – Report group interaction

GI1 ≡ If in a certain week the Receptionist in the Client Service group receives a number of requests, then the Client Service representative in the Report group will communicate the weekly response time report to the Management Support group representative within the Report group.

Report group property

GP2 is the transfer property TP(CSrepr, MSrepr, weekreport)

Report - Management Support group interaction

GI2 ≡ If the Management Support representative in the Report group receives the weekly response time report, then the Secretary of the Management Support group communicates this report to the Analyst of the Management Support group.

Goal Determination

The goal determination process in our example is a joint responsibility of the Management Support group (generating options for goals) and the Board (selecting a goal). The following properties show a specification of the shared responsibilities, from receipt of monitoring information to formulation of new goals.

Management Support group

GP3 ≡ If the Secretary within the Management Support group communicates a weekly response time report to the Analyst in which the maximal response time is unacceptable given the organisation's directions, and in the previous week report this was not the case, then the Secretary will receive one or more goal proposals from the Analyst.

Management Support – Board group interaction

GI3 ≡ If the Secretary of the Management Support group receives goal proposals from the Analyst, then the Secretary of the Board communicates these goal proposals to the Director.

Board Group

GP5 ≡ If the Secretary of the Board communicates goals proposed by the analyst to the Director, then the Secretary of the Board will receive a (possibly slightly altered) selected goal from the Director.

Board – Management Support group interaction

GI4 ≡ If the Secretary of the Board receives a goal from the Director, then the Secretary of the Management Support group communicates this goal to the Analyst.

Modification Action Determination

After a decision has been made as to what the goal for the organisational behaviour is, it is determined which modification action is used to satisfy that goal. In the example organisation that responsibility is shared by the Management Support group (generating options) and the Board (selecting an action).

Management Support group

GP4 ≡ If the Secretary of the Management Support group communicates a director's goal to the Analyst, then the Secretary will receive from the Analyst one or more modification action proposals to satisfy this goal.

Management Support – Board group interaction

GI5 \equiv If the Secretary of the Management Support group receives a modification action proposal from the Analyst, then the Secretary of the Board communicates the proposal to the Director.

Board group

GP6 \equiv If the Secretary of the Board communicates a modification action proposal (from the analyst), then the Director performs a (possibly slightly altered) modification action.

4 Discussion

The contribution of this paper is a rather complex model, designed as a specific type of composition of diverse ingredients. Due to this complexity, a rather simple (toy) example case study was used to illustrate the model. Moreover, given the model as a composition of various ingredients, one or more of the ingredients can be replaced by others without changing the overall model in an essential manner.

A prototype has been developed for validating the ideas introduced in this paper. This prototype involves temporal formalisation of the dynamics, part of which was described in Section 3, specified as an executable organisation model in $\text{\textcircled{C}}$ format; cf. [11], and executed using the available software environment. The prototype includes some simplifications, without compromising the main ideas underlying the model presented in the paper. For example, the prototype does not include weekly response time reports. Instead, requests are communicated individually by the Receptionist to the Secretary of the Management Support group; subsequently, the Analyst accumulates the number of incoming requests and, if applicable, generates a corresponding goal proposal, e.g., to decrease the response time.

In [1] and [2] modification of a multi-agent system was addressed, both from the angle of simulation (the former paper) and analysis (the latter paper). Differences between these papers and the current paper are as follows. First of all, in these two papers no organisational structure is used within the multi-agent system, what is the focus of the current paper. As a consequence, what is modified in [1] and [2] is the multi-agent system, extending it by one new agent, not an organisational structure as in the current paper. Second, in these papers the deliberation about modification of the multi-agent system is performed within one of the agents, by a specific design agent including a task model for redesign, it is not distributed over the organisation and integrated within the organisation model. Furthermore, in [1] no explicit formalised representations and formal analysis of behaviour are used, and in [2] no simulation is performed. In the current paper, in the context of organisational structure both are addressed in an integrated manner.

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