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A Conceptual Framework For Describing Enterprises.

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1 Introduction

We have applied management experience to the development of theoretical models capable of representing effective Enterprise Management Systems (EMS). For example, an EMS may be the organisational or group decision-making system by which investment and spending decisions are made by the leading stakeholders. Enterprise managment refers to the activity of stakeholders who apply resources to changing the states of key parameters.

We are experimenting with a five-dimensional description of EMS quality which provides a template for diagnosing actual systems, and for evaluating proposed quality-improving changes to EMS designs. This framework has been derived from experience gained in international executive management and it has helped us develop hypotheses about the dependence of stakeholders' performance prospects on their EMS designs. These hypotheses are particularly important in assessing the ability of an EMS to provide attractive performance prospects in the complicated, distributed, interdependent organisation designs for enterprises which are required to operate competitively in highly dynamic environments.

To be useful, we believe that Design Process Models must produce outputs which define the target organisation's decision-making system (its EMS), and which indicate the quality of this design with respect to its impact on the performance prospects of leading stakeholders. Otherwise, there are no useful criteria for evaluating the Designs, and potentially a large number of design solutions might be generated without the benefit of criteria for discarding the ineffective ones. On the other hand, if performance prospects of leading stakeholders can be related to parameters in the output design, large areas of potential designs might be eliminated from consideration *automatically*.

This framework is being specified in the Object-Z formal specification language because of the benefits we believe can be derived using this approach.

2 The Enterprise Framework

The decision-making system in use within an enterprise is a matter of agreement among leading enterprise stakeholders. Many individual decisions are made in the course of planning and managing an enterprise. However, we believe that there are five important dimensions or factors on which different decision-making systems can be compared. This decision-making system sets the context in which the individual decisions are deliberated and made. The quality of this system in terms of its self consistency and its match with business strategy are characteristics which can be examined by leading stakeholders, given prompting and reference frameworks supplied by a support system.

2.1 Determining Imperatives

Choice of Performance Measures

Consider the logic of first agreeing about how a successful outcome could be indicated. This is typically a target range of economic performance. For example, a level of profitable growth for the enterprise – a level targetted to be reached and maintained within some time frame for each business unit.

Choice of Roles and Role Relationships

Next, an agreement is required among the stakeholders of that business unit as to who will play which roles and what the role relationships will be in achieving this overall level of performance.

The combination of agreements on these first two factors establishes the work imperatives of each of these stakeholders. If, as sometimes happens, these agreements are not clearly established, then reaching the target performance is in jeopardy because some stakeholders are not committed.

The configuration of roles, for example of managers, is determined by the business strategy among other factors. Two extremes are the hierarchical forms and the networked forms of organisation. Whatever form is chosen, roles and role relationships have to be agreed to and overall performance translated into the performance goals for individual units and managers.

2.2 Assumptions about Behaviour

2.2.1 Motivation Mechanisms

The organisational form has another impact. We can illustrate this by comparing hierarchical versus networked forms of organisation. Managers make assumptions about peoples' motivation mechanisms, in deciding how to create healthy enthusiasm among stakeholders to contribute to enterprise success. Hierarchical forms of organisation use different assumptions from networked organisational forms regarding what is required for establishing enthusiasm for high performance in producing outputs. In making transitions from hierarchies to networks, an increasingly common transformation, it is vital that the assumptions about motivation that are made and acted on are also changed along with the role definitions. If this is not done then agressive performance goals are unlikely to be set or met. The quality of the decision-making system is reduced by mismatch between assumptions about stakeholder behaviours and the structures of stakeholder roles.

2.2.2 Use of Information and Knowledge

There is more to the assumptions about stakeholder behaviours. Before we can (re)design the management processes by which work is done, we have to make assumptions about how managers use information and knowledge both to recognise and resolve the important issues. These issues are typically how to change an important management parameter from its current to its target state. Stakeholders develop and manage the plan to accomplish this change using deliberation. It is based on the stakeholders' knowledge and on access to critical information about the state of the enterprise. Typically managers make implicit assumptions about how information and knowledge is used by stakeholders in making successful decisions.

2.2.3 Summary

Among the models which we are testing are models for the motivations and information processing structures and activity of enterprise stakeholders. Although such models are usually implicit, we believe that by introducing more explicit, if experimental models, we can improve the opportunities for supporting stakeholder deliberations and for testing the models in a clear context specified by the above agreements about measures and roles.

2.3 (Re)Designing Management and Other Processes

We are now equipped to design management processes by which stakeholders will be able to plan and manage their task activities. For example, the planning and management of investments. The above factors:

1. the performance measures,
2. the structure of roles and role relationships, and
3. the assumptions about behaviour in terms both:
   - motivation to contribute and
   - using information and knowledge to recognise and resolve important issues

together set the framework in which the management processed can systematically be (re)designed. If these three factors are not congruent, then there is little to no possibility of designing effective processes. A quality decision-making system is impossible to establish by working the processes alone.

2.4 Designing Supporting Information and Knowledge Processing Systems

Finally, in many organisations today, the deliberating stakeholders are distributed geographically. This leads to communication systems being an important part of the support system for the successful execution of management and other processes. Geographic distribution frequently means time-zone differences, and, in any case, accommodating non-synchronous communications is a frequent reason for adopting computer networks for deliberations among the stakeholders. The kinds of computer system support that are required are tending to go beyond information processing, and to include knowledge processing. We mean by this the accelerated development, sharing and application of knowledge by the stakeholders. The development of such systems is part of our research program. In situations which are highly dynamic and in which many kinds of "world class" experts might be involved in the deliberations, the rate of evolution and application of new knowledge from different experts makes the support of stakeholder knowledge processing a significant competitive advantage.

2.5 The Overall Decision-Making System

The logic summarised above leads us to anticipate that we can support the enterprise stakeholders in diagnosing decision-making system pathologies. This can be done for existing systems, and the same tests can be applied to any prospective changes to these five parameters. A small number of cases has been examined to date. This revealed that the diagnosis was straight forward. It is accomplished by asking five questions, then comparing the answers with the requirement that the logic of the system be maintained.

2.6 Analysing Enterprises

In analysing or designing enterprises, we ask the following questions:

- What measures are used for goaling managers and teams?
- What are the manager roles and role relationship structures?
- What assumptions are made about stakeholder behaviour?
- What management processes are used to get the work done?
- What management information and/or knowledge processing systems are used?

2.7 A Generic Enterprise Planning and Management Task

We now summarise the models which we are using to characterise the deliberation process. We introduce a generic enterprise planning and management task. This is, given a key management parameter which is in a state different from its target state, what interventions can we make to move it closer to this target state? Deliberations must identify the key management parameters and the means for measuring their current states, as well as the target states related to the stakeholder vision for the scenario of change which defines an enterprise's success.

Figure 1 illustrates the context of stakeholder actions that plan and manage state changes in key management parameters. The picture is by no means a specification of all the important objects that are involved in the deliberations, nor is it a program of activities for achieving the desired state changes. Instead we consider this kind of picture to be a "Framework Model" (FM), a simplified model that is easily communicated about and discussed, its meaning explored, and its mapping to actual cases established on the basis of this meaning. As the stakeholders improve their capability to plan and manage state changes in different enterprise circumstances, so the FMs evolve to summarise the new knowledge developed and applied by the stakeholders. An explicit research objective is the development, testing and application of new FMs.

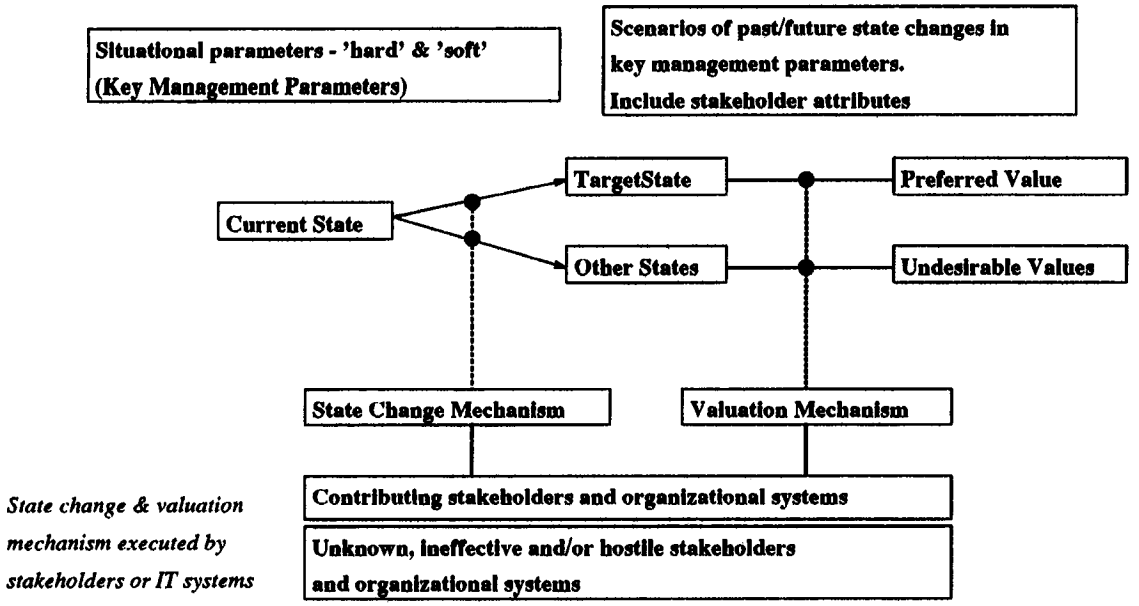

Figure 1: A Framework Model for enterprise planning

A stakeholder's knowledge is imperfect and their planning method must take into account the need for and the means to develop new knowledge. Furthermore, they are not the only stakeholders who may be active in the state-changing space. Therefore, stakeholder knowledge needs at least to include speculation about the behaviour possibilities of indifferent, hostile and even unknown stakeholders. The following list summarises the framework, a process model, that we have adopted for dealing with a stakeholder's knowledge problems:

1. Making use of assumptions about who people are and might become to agree on the Key Management Parameters & Goals for their enterprise.

2. Commiting to their respective roles & objectives for these parameters.

3. Recording urgent/important issues requiring deliberated resolution.

4. Deliberating resolution plans and setting expectations using Knowledge.

5. Executing assigned intervention plans on cue to priority using skill.

6. Comparing actuals with expectations, and updating Knowledge.

7. If deliberations fail, resolving the meta-issue of finding new Knowledge.

8. If new Knowledge can't be found in time, renegotiating commitments.

9. If a manager is thwarted by renegotiation, evolving assumptions behind step 1.

This framework is the basis of our experiments with the development of formal specifications for enterprise planning and management processes through which we can guide stakeholders. Further along with our research we plan to add simulations in providing support for stakeholders, and in testing our body of knowledge developed to date as abstractions from successful and unsuccessful enterprise management experiences. One particularly interesting part of the research are our experiments in the categorisation of types of stakeholder knowledge. To do this we are testing the power of a generic enterprise planning and management task as a means for containing the categorising problem, yet doing it within a ubiquitous kind of task framework which adapts to many levels and kinds of enterprises, and of planning and management problems.

3 Object-Oriented Formal Specification

Formal specification languages being developed in computer science attempt to abstract essential properties of systems without getting

bogged down in 'implementation' or inessential details. Although primarily developed for the specification of software, these languages can be used for describing non-software systems. They can provide the 'glue' between the rarified world of mathematical theorizing and the nuts-and-bolts of implemented code. With the aid of theorem provers one can try to prove properties of abstract specifications just as in mathematics. And with the aid of a refinement calculus one can derive correctly implemented code. The object-oriented paradigm is a powerful device for constructing software in which the constructed objects mirror natural categories. This paradigm is being extended into the field of formal specification languages. The coupling of the object-oriented paradigm with formal specification techniques has the potential of providing a powerful means of modelling the world.

The Z formal specification language [2] is based on typed set theory, but uses a 2-dimensional structuring device called a *schema* to provide modularity. Schemas include declarations of state, input and output variables, and predicates giving logical constraints amongst the variables. These schemas can be used and modified in various ways according to the *schema calculus*. Three types of schemas are distinguished: *state schemas*, *initial state schemas* and *operation schemas*. State schemas designate the state variables of a system together with any constraints. Initial state schemas give the initial state of the system. Operation schemas encode operations that may be performed on the states. There also exist other constructs in Z such as *axiomatic definitions*.

Object-Z [1] is an object-oriented extension to Z. The major extension to Z is the *class* which encapsulates a state schema and any operation schemas which affect the states, and is also specified as a box like a schema.

We have begun applying Object-Z to the modelling multi-agent systems and enterprises. Extensions to Object-Z are being made, such as allowing self-reflection and choice operators with transition probabilities.

4 Conclusions and Further Work

An extension of an object-oriented style of formal specification is being developed to describe enterprises. The very attempt of formally specifing a model of enterprises helps in explicating hidden assumptions and misunderstandings, and in clarifying important issues.

We believe that considerable additional leverage can be obtained by using such formal techniques. One direction we are pursuing is to use our formal descriptions to generate simulations of enterprise behavior. In another direction, these specifications can be used as the basis for designing distributed, knowledge-based enterprise management systems.

References

[1] DUKE, R., AND ET. AL. The Object-Z specification language. In *TOOLS USA '91* (1991).

[2] SPIVEY, J. M. *The Z Notation. A Reference Manual*, 2 ed. Prentice-Hall, 1992.