A Systemic Approach for Modelling Virtual Enterprise's Management Features

Nikitas A. Assimakopoulos & Aggeliki D. Theodosi
Department of Informatics, Univerisity of Piraeus
Karaoli & Dimitriou 80, 185 34 Piraeus.
Email: assinik@unipi.gr

Abstract
In this paper we investigate essential properties of virtual enterprises and the consequent modelling requirements. Apart from that, we define agent's autonomy. As agents in AI (Artificial Intelligence), virtual enterprises are treated as autonomous entities. Requirements are derived from two types of virtual enterprises, a repetitive and a one-of-a-kind production or service enterprise. A virtual enterprise model should represent properties which include the dynamics of decision-making, the negotiations among participants for the definition of autonomy, authority, beliefs and responsibilities, the mapping of organisational entities to decisional roles, the ability to identify and analyse a variety of conflict types and the existence of conflict resolution paths.

These properties have to be analysed by matching enterprise-engineering tools. An ontological theory is also needed to systematise the concepts that must be supported by the protocol languages for parallel distributed planning, scheduling and control algorithms in the virtual enterprise. We are presenting an approach to this problem using systemic methodologies such as TSI (Total Systems Intervention), SAST (Strategic Assumption Surfacing & Testing), SSM (Soft Systems Methodology), and PSM (Problem Structuring Methodology) in order to decompose the enterprise to autonomous entities – and trace possible problems - and solve participants disagreements in an edifying, for the enterprise, way. A useful trial example to implement and comprehend the above methodologies is that of the virtual team of an enterprise, which offers management services to hospitals and health centers in Greece.

Keywords:
Systems approach, SAST, SSM, PSM, TSI, Virtual enterprise, Enterprise modelling.

1. Introduction

A virtual enterprise is a temporary alliance of companies for the lifetime of a common project, solution for a problem, or joint production of service or product. The rapid development of communication and networking infrastructures gave new impetus to the development of virtual enterprises, because new ways of interactions between participants have eliminated the time and space gap between partners. We can say that it goes even beyond outsourcing and strategic alliances and its more flexible in that it has continuously changing partners, arrangements loose and goal oriented. Further more it emphasises on the use of knowledge to create new products and services and its processes can change quickly by agreement of the partners.

A virtual organisation or enterprise, removes many of the barriers especially that of time and location, but there is more to them than simply replacing the location where people work.

Virtual enterprises are such entities, which, from the point of view of their service to the customer, appears to be one entity, but in fact are formed from several autonomous entities, or partners. The property that differentiates a virtual enterprise from an ordinary value chain is the fact that there is a single locus, which takes full responsibility for the entire value chain of its product or products, even though the task is carried out by many participants and for that reason they cooperation must be harmonic.

There are, of course, reasons for organisations and enterprises to become virtual, accepting the fact that they are not only a trend of our e-century. Some of these reasons are:

- Globalization, with growing trends to include global customers,
- Ability to quickly pool expert resources,
- Creation of communities of excellence,
- Rapidly changing needs,
- Increasingly specialized products and services,
- Increasing required to use specialized knowledge

A virtual organisation or enterprise removes many barriers especially that of time and location. It emphasises concentrating on new services and products, especially those with intensive information and knowledge characteristics.

Several disciplines have treated the problem of how to build a larger autonomous system out of autonomous components. The artificial intelligence literature developed blackboard systems and co-operative dialogues to externalise mental states and beliefs, the planning and schedulling area developed co-operative planning and holonic manufacturing cells similar techniques were used for computer supported co-operative work, management science developed dynamic forms of organisation, e.g. matrix organisations. Co-ordination science attempts to develop methodologies and paradigmatic models for the same purpose. All have an application of the basic approach: building agents out of agents.

There is a new interest in how virtual companies can be created easier than using traditional methods. Enterprise modelling holds a promise because it takes out some of the trial and error component from creating a new, better-managed value chain. Enterprise modelling languages have been developed and used to describe and simulate business processes, but the development of viable structures, good quality reusable models for virtual enterprises is far from trivial. We investigate some of the properties that virtual enterprises need to have. These properties must then be predictable from the models, which we use to design such enterprises.

Typical virtual enterprise formations are:

- One of a kind engineering endeavors such as designing and building large petrochemical, road, major facilities, organised as major projects - often on an international scale
- Consortia for production service or for research, with an alliance of partners limited to a common mission.
- The creation of virtual enterprises is mainly done by business executives, or highly paid (and stressed) project managers who have little more help then their experience as to how, under time pressures, successful virtual enterprises can be set up. Because of the lack of accepted design tools and methods, once a design is in place the change of such a virtual organisation is often lagging behind the needs.

The steps to virtual enterprise are:

- Outsourcing mainly to reduce costs where there is some experience in working at a distance, but three is one dominant party and high certainty of what everyone must do.
- Forming strategic alliances to share the work and gain experience in developing and sharing common goals. Here there is no dominant party although the parties are fixed and
- Then becoming virtual enterprises-organisations to achieve flexibility. Now the partners themselves can quickly change, with greater emphasis on the use of knowledge to create new and innovative products.

Our goal is twofold:

Firstly, we want to analyse, and identify what are the desired types of properties that management should be able to design and verify at the initial creation of a virtual enterprise, and to continuously assess and control during its operation;

Secondly, we want to derive needs, or requirements, based on this analysis, as to what types of modelling tools and languages are, or would be especially suitable for the support of the virtual-enterprise engineering process. Hopefully an appropriate combination of existing tools, or some extension to such combination, will be able to answer to the so identified needs.

2. Research Method

We are trying another approach on the problem using systems methodologies such as TSI (Total Systems Intervention) [11], SAST (Strategic Assumption Surface & Testing) [11] and SSM (Soft Systems Methodology) [11] in order to eliminate the gap between partners and to find the best acceptable solution to the problem. By using SAST, we talk with the partners; listen to their problems and views on the subject, trying to see the world through their own eyes in order to understand their objections and opinions. The best solution to the problem will be a combination of different ideas and opinions, expressed by teams and individuals. By using SSM, we are trying to solve the problem using the pluralism of cultures and ideas. While using TSI we use in a creative way the results extracted from the above systemic methodologies, analysing them, and design possible future solutions to the problem(s). We are following these steps in a repetitive manner until we are satisfied with the outcome.

We also use the theory of GRAI Grids, which are the foundation for the decisional modelling capability of GRAI-GIM [9] and PSM (Problem Structuring Methodology) [20] in order to represent the segmentation of the enterprise to teams and the division between the management architecture and the mission fulfillment.

We identify typical virtual enterprise types, and essential types of properties that should be accounted for in the Enterprise Models (EMs) describing them. Enterprise modelling languages (EMLs) and appropriate enterprise engineering tools (EETs) can be selected for the support of virtual-enterprise engineering based on their competency to support the description and analysis of the above properties.

Through the use of suitable modelling tools business executives will get a help to better design multi-company ventures, e.g. to be able to analyse and optimise, through explicit models, the global behavior of their virtual enterprise.

Because the management system of virtual enterprises needs to be different from incorporated ones (due to looser connection between partners) it has to be studied and understood what special needs virtual enterprise designers face, and only after that attempt to select the modelling methods and languages to model them. At this point, we should mention that, one of the challenges one can face as a project manager or generally a leader of a try is the coordination and the effective management of a geographically distributed team. Nowadays almost everybody has to accept the fact that this is the present and the future of project management.

2.1. Available systemic methodologies for enterprise modelling

Business process modelling has been extensively used to improve the material and information flow in a company, ameliorating the process from some respect or another (cost, quality of product, time to market etc). Similar modelling exercises are expected to be applicable (with like expected results) in the context of virtual enterprises improving the information and material exchange among the parts of the process as implemented by the participating partners. In other words such models help integrate the supply chain. Special care must be taken with virtual enterprises in the information exchange and management of the chain (or product life-cycle), to avoid misinterpretation and rework. From the above elements of the enterprise, we can see a rich picture of the problem something that lead us - under the light of the pluralism of functions and ideas - to use systemic methodologies and metaphors in order to approach the problem (even if it is not defined yet!!).

At this point we should make a brief reference to systemic methodologies that we are proposing.

2.1.1 Total Systems Intervention

Total Systems Intervention (TSI) [11] represents an approach to planning, designing, "problem solving" and evaluation. The process employs a range of systems metaphors (machine, organic, neurocybernetic, cultural and political) to encourage creative thinking about the organisations and the difficult issues that managers have to confront. These metaphors are linked through a framework "system of systems methodologies", to various systems approaches (here we are using SAST, SSM [11]and PSM [20]), so that once informed agreement is reached about which metaphors most thoroughly expose an organisation's concerns, an appropriate systems methodology will guide "problem solving" in a way that ensures that it addresses what are found to be the main concerns of the particular organisation involved.

There are seven operational principles embedded in the three main phases of TSI. These are:

1. Organisations are too complicated to understand using one management “model” and their problems too complex to tackle with the “quick fix”.
2. Organisations, their strategies and the difficulties they face should be investigated using a range of systems metaphors.
3. Systems metaphors, which seem appropriate for highlighting organisational strategies and problems, can be linked to appropriate systems methodologies to guide intervention.
4. Different systems metaphors and methodologies can be used in a complementary way to address different aspects of organisations and difficulties they confront.
5. It is possible to appreciate the strengths and weaknesses of different systems methodologies and to relate each to organisational and business concerns .
6. TSI sets out a dynamic cycle of enquiry with iteration back and forth between the three phases.
7. Facilitators, clients and others are engaged at all stages of the TSI process.

The three phases of TSI are labeled “creativity”, “choice” and “implementation”. We shall consider these in turn, looking in each case at the task to be accomplished during that phase.

- In the creativity phase, systems metaphors are used as organising structures to help managers to thing creatively about their enterprises.
- In the choice phase, an appropriate systems-based intervention methodology (here a set of methodologies) is (are) chosen to suit particular characteristics of the organisation’s situation as revealed by the examination conducted in the creativity phase.
- In the implementation phase, particular systems methodologies are employed to translate the dominant vision of the organisation, its structure, and the general orientation adopted to concerns and problems, into specific proposals of change.

During this process of constructing diagrams that represent organisational and managerial processes, we work under the philosophy and principles of TSI mainly in its “Creativity” aspect. We constantly analyse and design diagrams that must reflect the organisation, at the situation, which is under examination, but among them we select those that best mach the organisation’s status. This is the phase of “Selection” that TSI defines. In the final phase of “Application” we test those diagrams in order to verify that they truly represent the organisation’s current state. Then we follow all these steps from the beginning in a repetitive manner, until we are satisfied with the outcome.

2.1.2 Soft Systems Methodology

SSM (Soft Systems Methodology) [11] refers to unstructured or complicated problems and situations where we don’t know what the problem is and what it consist of. It can be applied only in cases with pluralism of ideas and/or cultures and not in cases where one has to decide without taking into consideration the others - or even allow them to express their opinion. SSM uses the rich picture of the problem.

SSM’s philosophy is quite simple. It approaches hard systems based on the approach of “end procedure” and it appears as a mean to organise opinions about problematic situations rather than a way of describing parts or modules of the reality. Apart from that, it uses two ways of thinking, hard and soft, which are counting on the comparison of hypothesis which leading to different principles of the methodology. Hard way of thinking leads to the assumption that the real world is systematic as the methodologies that we are using in order to describe that world, where as the soft way of thinking assumes that the real world is problematic but the methodologies can be systemic

SSM has seven steps in its typical form, which are:

a. Steps 1 and 2, is the creation of a reach icon of the problem, something that allows to different subjects, problematic and interesting characteristics, and systems, to show up.
b. Step 3, expands these short and well-defined definitions. Each definition is going to pass a preliminary test between steps 2 and 5. Our aim is to give a definition about what should be done, why it should be done, who has to do it, who will profit of it and who's not, which are the environmental constrains are restricting the actions and activities.
c. Step 4, creates direct the conceptual models under the condition that the fundamental definitions of the above step are enough to give the picture of the ideal systems in order to satisfy the demands of the fundamental definition.
d. Step 5, comparison of the models that we have created through the above steps and checking whether there are changes to be done.
e. Step 6, we are making the necessary changes that have possibly risen from step 5.
f. Step 7, acting and implementing changes, which are desirable and applicable.

2.1.3 Strategic Assumption, Surface & Testing

The Strategic Assumption, Surface & Testing (SAST) [11] is a systemic methodology, which concentrates the attention of the managers to the relationship between people - members, which take part in a problem. SAST is the answer to bad structured problems in which a large number of different opinions prevent from taking the best one.
Churchman stated that:

"Systems Approach starts when you see the world through the others eyes." That means that we have to embody subjectivity to Systemic Thought. This will be added to the need of objectivity approach, which is based to Hengel's theory.

SAST methodology has four main stages:

1. Group Definition,
2. Assumption Structure,
3. Dialectical Discussion,
4. Composition.

During the first stage the more people who may have an opinion about the structure of the problem cooperate, the best results we get. Members are divided into groups, which are defined according to some criteria such as:

- Type of personality.
- Time definition (long/short-term).
- Personal profits.
- Supporters of specific strategies.

Etc.

During the structure of the assumption each group should develop its preferable strategy/solution. There are three techniques, which should be followed.

In the first all members in key-positions should be defined.

In the second the assumptions are defined. For all members who defined before every group exposes its proposals for each of them in order to succeed their strategy.

The third technique is the classification of each group.

The classification takes place according to two criteria.

- The importance of the hypothesis to the influence of the success or not of the strategy.
- How certain we are that the assumption is justified.

During the Dialectic Discussion all groups presenting their strategies and they accept questions from the other groups, which they have to answer. After this conversation, each group should think about the adjustment of their assumption as long as there is a progress on the strategy.

Composing is the last stage in which we are targeted on a compromise between the assumptions. The new strategy should be born by the old ones and be even better than them.

SAST, certainly is very good method for the simple pluralistic problems whereas in complicated, it is doubtful if it can give a solution as it ignores every problem but the pluralism.

2.1.4 A New Multi-Methodology

There is no doubt that all of the above methodologies are remarkable but in any enterprise and especially in virtual enterprises, which we are studying here, we need something more than just one systemic methodology. In the context of TSI, we propose a new multi-methodology, which actually combines the above well known system methodologies in to one, based on the idea of STIMEVIS methodology [2] in order to achieve better results on our problem, which is the modelling of virtual enterprises.

This new multi methodology, we call it **TASP** (**T**SI, S**A**ST, **S**SM, **P**SM) consists of four basic steps along with the details of corresponding methodologies that are used. These steps are:

The basic steps of TASP
Step 1: TSI
Step 2: SAST
Step 3: SSM+SAST
Step 4: PSM+SSM+SAST+TSI

The idea of this multi methodology is that we are working in the general context of TSI, where we are applying the other system methodologies; so we consider this as the first step of our multi methodology.

The second step is to implement SAST in the context of TSI. We are using this methodology in order to concentrate the attention of the managers to the relationship between people - members, which take part in a problem. We divide people into groups and we ask them to develop its preferable strategy. Then, during the Dialectic Discussion at the presentation of the strategies, groups should think about the adjustment of their assumption. Finally, we are compromising between the assumptions.

The third step is to use the above groups - which means pluralism of opinions - and their strategies - which means pluralism of ideas- to implement SSM. We are using the previous step result to create the reach icon of the problem and their strategy and opinions in order to build the definitions of this methodology (SSM). Then we are implementing the known steps of it, as we have already presented them.

Finally, the fourth step is to represent the above results in a comprehensible and simple -but not naïve - way, we have chosen PSM in order to represent these results at all the levels. Apart from that, the ability of PSM to re-organise the structure very easily and to adapt to possible changes is something that enhanced our choice.

At the end of this paper, we will see TASP in practice. We will study the case of the virtual team of an enterprise, which offers management services to hospitals and health centers, in Greece. Here we are going to implement TASP. After a strategic merge the enterprise had to review the way that services were offered in the context of the new strategy and profile. More precisely they wanted to attract more hospitals and foundations of long time health care.

CIMOSA [26, 27] advocates the modelling of the enterprise's control system such that the resulting models, when mapped to the implementation and operational levels, can be used to control business processes. The resulting paradigm is called model-based control and is an important technique of supply chain integration, because of its ability to integrate the operational control level. In virtual enterprises the same operational control integration is applicable, only the integration infrastructure must be distributed over a wider area.

Traditional enterprise modelling (applied extensively in many industries in the design of flexible manufacturing cells, job shops, banking business processes, or integrated circuit development processes) separates the design of the business process from the management and operation of the process. I.e. first design (or re-design) the processes of the enterprise, institutionalize them and then operate them.

Virtual enterprises are dynamic in nature (e.g. a project enterprise starts operating its project management component before the actual project gets fully designed) and enterprise design and change is a function of the operation itself (more specifically it is part of its management component).

Virtual enterprise design needs various level interactions with partners who take part of the virtual enterprise's business functions. Thus the design process involves various interactions between partners. But because this interaction is also part of the enterprise operation, enterprise modelling must extend to the determination of protocols among partners, which are suitable for negotiating about enterprise design.

The coordination of a distributed virtual team is not only a challenge, but also a demand of our times. What can one do to achieve as a manager on the coordination of a team that has no cultural uniformity, as their members have different cultural identity when they are from different enterprises or even countries as in our example. We can take for granted the fact that they can communicate just because they are of the same occupation and they can understand each other's needs.

3. Operational Characterisation of virtual enterprises

3.1. Virtual enterprise

As any enterprise, a virtual enterprise, must have a clear goal and a clear mission. It also should demonstrate a goal seeking behavior in its autonomous decision making, act upon its set of beliefs, and interact with its environment [19]. In general it is expected that a virtual enterprise makes plans, and its activities follow those plans to achieve the objectives.

The term 'agent' is used to describe this type of behavior, in the traditional AI meaning of planning agent. From the point of view of the applicability of this model it is immaterial if planning indeed takes place or not, and if missions and goals are made explicit; what matters is that an external observer can describe the enterprise as (if it were) a planning agent. Since the partners that make up the virtual enterprise are also agent-like, in the followings we make an attempt to treat a virtual enterprise as an agent, or collection of agents, which contribute to the virtual enterprise's mission but 'keep their autonomy'. Since what this autonomy is not defined yet, we placed the statement between inverted commas – autonomy being defined later in this paper.

Modelling an enterprise has to consider the function of the enterprise, from its mission down to operational level procedures. The level of modelling detail should correspond to the level for which there is suitable human organisational, hardware or software entities that can perform each elementary activity modelled. The description not only needs to give a static picture, the dynamics (e.g. the expected life history) is also to be accounted for.

The model must also reflect the actual structure of the enterprise, including its resources (such as human and machine), so that the behavior, reactions and operation (i.e. the functions) can be understood in relation to the structure. This latter type of relationship becomes an important issue when autonomy is considered.

In the following we concentrate on the modelling of the management and control of the virtual enterprise.

Workplace structures must mirror the way that a virtual organisation works.

They must easily grow and evolve with the enterprise. In order to achieve this goal, they must support the enterprise mission by developing and using information consistently with the mission

Workspaces should make it easy to:

- Create new roles and assign people to them, change goals,
- Add new documents,
- Set up new communication links between people.

Typical structures include:

- A production system where there is a workplace for each production task. As one task completes it activates the workspace for the next task. It should be possible to easily create a new task and provide a workspace for it.
- Design systems where people in a design can "meet" at an electronic workspace to discuss coordination issues. They then go to their individual workspaces to carry out their part of the design.

Functionally, enterprise management can be described as carrying out three main types of functions (a) managing the products, (b) managing its resources, and (c) co-ordinating (a) and (b) ([9]). Product management covers all product-related activities from product planning to production planning and related services. Resource management includes human, machine, financial and other resources that are needed to perform the operations that fulfil the enterprise's mission, and is responsible for operational level control. Co-ordination is resolving the conflicts between the objectives of (a) and (b) as well as gives them direction or mission. These functions make up the decisional system of the enterprise.

Structurally, enterprise management can be described as a management organisation, consisting of the agents (people and groups of people) who take the decisions. The above-mentioned relationships among these individuals and groups are determined by a) the decisional roles they take and the dynamics of this system, and (b) intangible social relationships. It is expected that at least the tangible relationships are brought to light in the form of a model, such that organisational conflicts be apparent and can be designed-out of the system.

In traditional value chains one problem is that links between participating agents are limited to the operational or executional levels. This is represented in Fig.1. and extensively in Fig.4. of the example.

Figure 1: Interaction in a Traditional Value Chain

3.2. Service level agreements / outsourcing

One approach that has been adopted by many large organisations is to decompose what was once one organisation into several autonomous parts. This is done through giving increased autonomy for the individual components, and choosing a co-operation method (e.g. from 1-3 above). The technique is commonly known in today's management as service level agreements and outsourcing (depending on the level of autonomy of the components).

For example, we have workspace networks where we have:

- A number of workspaces, each of them is a computer screen, contains any number of people (roles, work objects, access to discussion systems for exchange of views and knowledge sharing among others).
- The workspaces can be connected in a variety of ways, such as:
    - -A workspace creates a new workspace, which then becomes its owned workspace.
    - -A workspace can be linked to any other workspace to share knowledge.
- Workspaces are created by users themselves
- Workspaces can include rules that define role responsibilities and other norms such as access to information or governance structures.

The method is trying to avoid conflicts by setting out the rules in the enterprise design phase and requiring clarification or explicit agreement on these rules before any decision is taken. The co-ordination among the organisational partners is implemented in a hierarchical manner (method 3), and upper level decisions in the domain of non-autonomous functions are observed at lower levels ('level' refers here to strategic, tactical and operational). This is not to say that information exchange and feedback is not preceding such hierarchical decisions.

The strategic level interactions define the rules, (or redesign them) and the component agents have high autonomy in the design dialogue. The strategic level dialogue ends with the definition of autonomy domains and non-autonomy domains. The co-ordination starts on the strategic level, where the domains of autonomous actions are determined for each participant and the interfaces for communication and co-operation get defined. This sets then the environment for co-operation at all other levels. The tactical and operational levels will interact obeying those rules.

The planning and operational levels are working within this framework; the interfaces between participants comply with the settings defined on the strategic level. Mechanisms are provided for feedback to the level above, so the efficiency of the system can be continuously monitored. Policies (i.e. the rules) are set at the strategic level, and they can be modified if the system's behavior deviates from normal significantly. The feedback mechanisms can be used to modify the structure of the whole framework, adjust interfaces or domains of autonomous actions, etc., in order to improve the system's overall performance.

The system is organised in a hierarchical manner, meaning that at any one time when a decision is taken the co-ordinating agent (via method 3) can determine the contents of the decisional objectives passed down to the lower level agent. However, the co-ordinating agent’s tactical level does not have authority to change the decisional structure, so this hierarchical relationship (and loss of autonomy) is limited in scope.

The more the tactical decision frameworks encroach on the lower level’s autonomy the more the amount of communication between the levels. This additional load put on the communication system will eventually impact on overall system performance. The functional responsiveness of the system may be slowed down, as the agreements take time to evolve and the upper, decision making level receives the information through a preliminary filtering of the lower ones.

Designers of virtual enterprises must be able to model the dynamics of decision-making and the efficiency of responsiveness of the different design variants.

Evaluating this architecture from the enterprise modelling aspect the system has the advantage of having a clear, well-organised and easily traceable structure. Functions at all levels are distinctly defined; the interfaces are handled without ambiguity. As we stated earlier, agents are providing solutions that satisfy certain criteria, but are not expected to provide strictly optimal solutions. This can lead to performance deficiencies. Each level has certain autonomy, but its degree varies at different levels. The higher-level entity does not have in fact full autonomy, because it has responsibility for the lower level, e.g. it must observe constraints that are legitimately (according to the rules) submitted as information by the lower level agents.

The lesson from this analysis is that the protocols which must be set up as a part of the design of the enterprise must be suitable for the definition of authority and obligation, and responsibility, in a formal enough manner, so that the resulting set of beliefs, responsibilities, obligations etc. can be analysed for common types of deficiencies.

For example, the decision framework set by the higher level restricts the lower levels' autonomy. At the same time, if the coupling between the higher and lower levels is not close enough, then the limited autonomy of the lower levels can result in conflicts, or lack of harmony, between the higher and the lower levels' objectives. This distance between the decisional centers can be a serious issue, and indicates the need for tighter coupling, albeit curtailing the lower levels of autonomy. In fact a reasonable balance between tight coupling and local autonomy can be easier to establish than trying to maintain local autonomy at all costs and going through several steps of iteration to achieve an acceptable outcome.

This is the point to implement SAST. The interaction between different level teams and the exchange of ideas and visions can result a very successful enterprise modelling. For example the patients demand study team mission is to provide information about needs and patients demands and this is a crucial point because this information needs to be interpreted by marketing technique team in order to launch new services on the market. Cooperation and communication at this point is not just important. It is vital.

3.3. Project enterprise

Project enterprises are typical forms of virtual enterprise, used in one-of-a-kind production or other one-off human endeavors. Project enterprises are built on the basis of the knowledge of the life cycle of the product the design and, or building of which is the mission of the enterprise.

A particular property of project enterprises is that the management structure is designed and operated before the rest of the enterprise is set up. Therefore the project enterprise is self-building in nature. It is not necessarily adaptive (the project enterprise is usually built after the pattern of earlier projects used as blueprints), because adaptively assumes that the pattern itself is capable of being changed by the enterprise itself in response to changes in the environment.

However, the dynamics of the organisation and its adaptability is a system property, which would be of interest to investigate by designers of project enterprise.

Unlike in virtual enterprises, which are created by breaking up large organisations into autonomous parts to form a better quality value chain, virtual project enterprises are assembled according to a unique business process tailored to the particular product or service in question. The individual entities (partners, or agents) can usually be selected on the basis of competencies, geographic location, and other characteristics, including price of service or product, strategic alliance possibilities etc.

For example here again we will use workspace structures. There we can see that the structures elements are:

- The documents available to the workspace,
- The workspace roles,
- The actions that can be taken in the workspace by people who take on the roles,
- The collaborative services, such as discussion databases to maintain personal relationships and share knowledge,
- Any special support, such as that specifying milestones or dealing with surprises,
- The norms, which specify what a role can do in a workspace

In project enterprises often hundreds of participants must be co-ordinated, but the selection of potential partners may be quite limited for any particular service and product to be made available at the time, in the desired quality and at the desired location. In addition, the time pressure on enterprise design decisions is usually great, either because it is part of a tendering process with short deadlines, or because it is part of the project itself. Structurally, this type of brokerage is simple to represent, but protocols should be defined (definable) and ability to create a system of management of resource types is needed.

For large projects to run smoothly it is necessary to have a clearly delineated responsibility structure and protocols are needed to set up and follow these. This is crucial to ensure that obligations are met and schedules are kept. Apart from the usual project management models and tools, it is necessary to design standard interfaces between the respective levels of participants to ease the burden of negotiations by project management and make it more automated.

On the strategic level, commitments are sought and obtained with the precision of usual planning negotiations. It is necessary to be able to prove of any virtual enterprise model that the types of information necessary for parallel distributed planning will be available through the decisional frameworks passed among the partners. For this to be a viable analysis possibility ontology of distributed parallel planning should be defined and be made available for the enterprise modeler.

Similarly the ability of the virtual enterprise to carry out parallel distributed scheduling necessitates the definition of information requirements (and interfaces through which to supply them).

Finally, operational level interfaces could be analysed as for their ability to support an enterprise-wide monitoring of state.

The ontology (i.e. the formal definition) of concepts, which must be supported by the protocol languages, could be derived from studying various parallel distributed planning, scheduling and control algorithms.

3.4. Virtual enterprises management

In partial hierarchies transfers should be hardly wired with standard regions of responsibilities. Hierarchy assumes that somebody else knows what each member of the team has to do, and which transfers can be done to the whole orders chain. The functions are predefined and the staff is stored in order to achieve the best match. Such organisational structure lacks of adaptability and flexibility in order to correspond to the multiple demands that virtual organisations and enterprises have. On the other hand, when people are considered as resources, with capabilities of supporting the others rather than owners of strictly defined cells, becoming virtual resources.

Virtual enterprising is a process through which enterprises are grouping their capabilities, counting on their ability to define multiple cross-operational teams. These teams can include and other members apart of the members of the enterprise but even people from the customers enterprise vector. Virtual enterprising counts more on the knowledge and capabilities of their people rather than their operations. Managers, professionals and labors, can multiplex their attention to many projects with different parts of projects during a method of a day, a month, or a year. Up to a point they can cope with the operational questions, while in a short time working on planning exercises or even thinking personal maters. They might even see the connections between these typically irrelevant disciplines. In addition these teams are not necessarily at the same place.

We are counting on the use of this flexibility; we should not define the enterprise in spatial terms, as the hierarchical diagram does. Instead of this, we could use the principles of human time as the organisational principle for the distribution of the responsibilities.

It is very important to understand the idea of the job as much as the dialog in the view of the operation of the enterprise. People request access to their views and knowledge, as in the core view and the knowledge of virtual teams.

Hierarchical models suppose that the main job is the segmentation of the operations of the production and the right people to attend the partial operations. On the contrary, virtual enterprise operations, are grouping their activities as projects while teams are working as an interactive and parallel way to form a patchwork of teams. Management of virtual enterprises and organisations supports in this case the team working of these teams.

Virtual enterprises have the intention to keep themselves as small as they can, because this is the easier way to make their job. It is not necessary to have representatives from all the functions and operations, because the cooperation of the teams secures the focus and the co-ordination. Teams can deal with multiple challenges from approximation of market chances, but even to launch the development of new products, using approximations as QFD. It is expected that these teams will clear firstly their own problems and operations and then they will share them with the other teams, evolving them together in order to achieve a better result. Further more it is expected that they will resume projects as their knowledge adds to the enterprise. Time-to-market has been stronger through time-to-learn.

Enterprises have to cope with multiple subjects at the same time. Subject of great and little importance, have to confront at the same time something similar to the noisy and static of the background which can detach the attention from key subjects. The subjects have been separated to different teams, which are facing the challenge of interconnection between different subjects, because they could give some very important conclusions as the best buy, product, or correspondence to service.

In this procedure we are something more than just labors. We are taking part in the procedures and our subjects can affect those of the others in the market, whether they are customers or competitors. This is part of the work as dialog, when an enterprise create a product, it creates it under the vision that another enterprise will create a competitive product. There is enough space for active implication in this procedure form all the participants.

4. Modelling Needs

4.1. Conflicts in the decisional model

The decisional subsystem of an enterprise implements the goal seeking behavior. It is navigating the enterprise within the constraints of the environment while trying to pursue an enterprise level goal, and adjust and react to any changes in this set-up. An ideal decision making structure would work in this framework for the sole benefit of the organisation, and would do all to find the optimum solution in any situation. In practice, however, finding or even defining the optimum can be a too time consuming or sometimes impossible task.

Therefore the participating agents are usually not required to produce optimum decisions: if the outcome satisfies a set of criteria, it is accepted.

Another, even more important limitation is the possible conflict of interest between the decision making system and its components. These factors indicate that any decision structure needs to be examined for efficacy and conflict of interests. As decision-making is performed by a system of individuals, the objectives and strives of the human as an individual cannot be neglected. Decisional roles taken by an individual may be in conflict with a) the individual's role in another part of the system, b) with the individual's personal aspirations, or c) with the interests of another individual in the same organisation. The same is true of group interests and aspirations.

In is necessary to harmonize individual interests and interests that correspond to the decisional roles taken by each individual or group. This can be done in a formal manner, once appropriate tools or frameworks are set up for verification of the decisional structure.

When two or more enterprises are combining their efforts for a common project, a new type of conflict emerges: that between the organisational structures. The common goal is supposed to be the main driving force for the participants (with regards to the joint action), but the interests of individual companies may interfere with that of another participant.

It is necessary to be able to demonstrate that no conflict is present between the interest of the virtual enterprise as a whole and that of its components, and if conflicts arise, as they eventually do, that there is suitable conflict resolution path provided for the virtual enterprise to resolve them.

The harmonization of the mental models and beliefs of the individuals (e.g. the assumptions on trust, or what is the 'way things are done here') makes up a company culture and precisely by developing and explicitly displaying such mental models and beliefs can a company culture be ingrained. When a virtual enterprise is set up, partners will have slightly (or extremely) different cultures, so the harmonization of the mental models and beliefs to create a culture of the virtual enterprise needs special attention.

In virtual enterprises where participants change and structure is never constant, it is necessary to be able to explicitly represent agreements and common beliefs that will govern interaction on the lower levels. This is an important part of the 'enterprise engineering process'.

It is expected that autonomy, responsibilities, obligations and beliefs should be able to be analysed from a structural point of view to reveal conflicts among decisional roles and conflicts that arise from the way they are assigned to organisational entities.

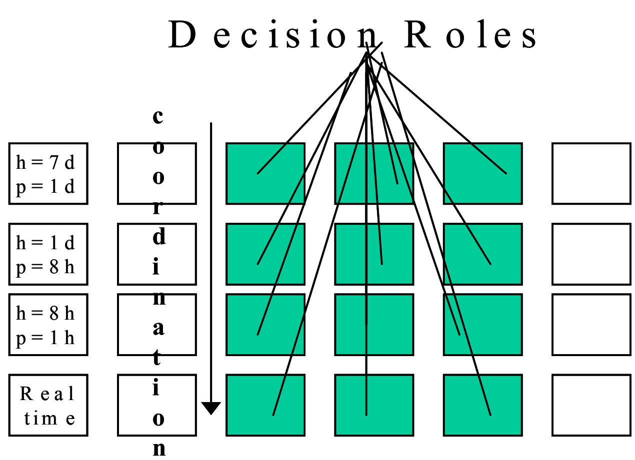

Figure 2: Decision Roles Represented in GRAI Grid

4.2. Autonomy

A virtual enterprise is intended to work for the benefit of its participants, while endeavoring to harmonize the individual interests. This requires the co-operation of autonomous systems in a conflict-prone environment. Considering each participant in the virtual enterprise to be an agent, here is a need to co-ordinate the autonomous behavior of these agents. Various approaches to this problem are:

1. Agents make decisions in their own environment, detect and try to resolve conflicts locally when implementing those decisions;

2. Agents interact with one another and make decisions in co-operation with the others;

3. A dedicated agent is assigned to representing the interests of the whole (virtual) enterprise and co-ordinates the activities and decisions of the others.

Co-operation of autonomous entities always requires careful consideration. In optimistic control where only individual goals are pursued in the hope that there will be no conflict in most of the cases, the conflicts can become irresolvable when they do occur. It is very important to define the domain where autonomous decisions should take place, and clearly identify the points where harmonization of individual interests must occur. In other words:

Autonomy is assumed only in a well-defined domain of functions (decisional or operational), and it is limited both in space and in time. The models of virtual enterprise thus must take into account the need for explicit conflict resolution, as a type of co-ordination activity.

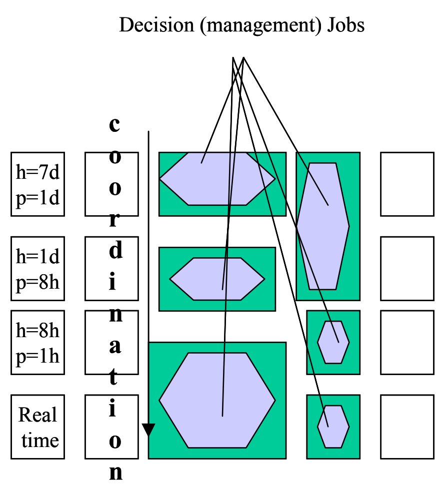

Figure 3: Organisational Entities and Decisional Roles

5. Theory in Practice

As we have stated above, a useful example in order to understand our multi methodology approach in practice, the teams and the communication level between them is that of the virtual team of an enterprise, which offers management services to hospitals and health centers, in Greece. After a strategic merge the enterprise had to review the way that services were offered in the context of the new strategy and profile. More precisely they wanted to attract more hospitals and foundations of long time health care.

They were demanding something more than just a virtual team. They wanted to co-ordinate (and therefore to communicate) their services and to interact through service functions. In order to achieve this accomplishment they form a new team under the name New Marketing Strategy Team (NMST), witch it includes the division of medical care, presides and the older staff off the company, have been the official body for the Strategic Procedure.

Now we can see in practice all the ideas and the new multi methodology that we have exposed in this paper. In the context of TSI, we are working on the approach of the problem using TASP, in order to achieve better result on our problem, which is the modelling of virtual enterprise and here, the sub problem of NMST. We will implement the four basic steps along with the details of corresponding methodologies that are used.

The first one is the context of TSI and the ability of repetitiveness and the variety of systemic methodologies that offers us.

The second step is to implement SAST in the context of TSI. We are using SAST in order to concentrate the attention of the managers to the relationship between people-members, which take part in a problem. We divide NMST into groups and we ask them to develop its preferable strategy.

At first NMST formed eight virtual teams. Three of them had to watch the customer's needs and marketing practices form different departments of the customers. The other three had to think about their customer's customer and the demands of the last (patients and their demands). The seventh team was to check the payments of the health services (health organisations, insurance companies etc). The last team had to develop marketing statistics useful for the other teams. Each team had members from all geographical and functional divisions of the enterprise.

Then, during the Dialectic Discussion at the presentation of the strategies, virtual teams should think about the adjustment of their assumption. Finally, we are compromising between the assumptions.

The third step is to use the above virtual teams, which means pluralism of opinions, and their strategies, which means pluralism of ideas, to implement SSM. We are using the previous step result to create the reach icon of the problem and their strategy and opinions in order to build the definitions of SSM. Then, we are implementing the known steps of it, as we have presented them above.

Finally, the fourth step is to represent the above results in a comprehensible way, we have chosen PSM in order to represent these results at all the levels. Apart from that, the ability of PSM to re-organise the structure very easily and to adapt to possible changes is something that enhanced our choice. In figure 4 we can see, and understand the structure of the problem as it has risen after the implementation of our TASP methodology.

Subsystems and individuals of the systems catalog for PSM

Type of Coding	***Subsystems***
1S	NMST
11S	Market Techniques Monitoring Team
111S	Sub team M.T.M
112S	Sub team M.T.M
113S	Sub team M.T.M
12S	Patients Demand Study Team

121S	Sub team P.D.S.
122S	Sub team P.D.S.
123S	Sub team P.D.S.
13S	Checking Payments Teams
14S	Statistical Study Team

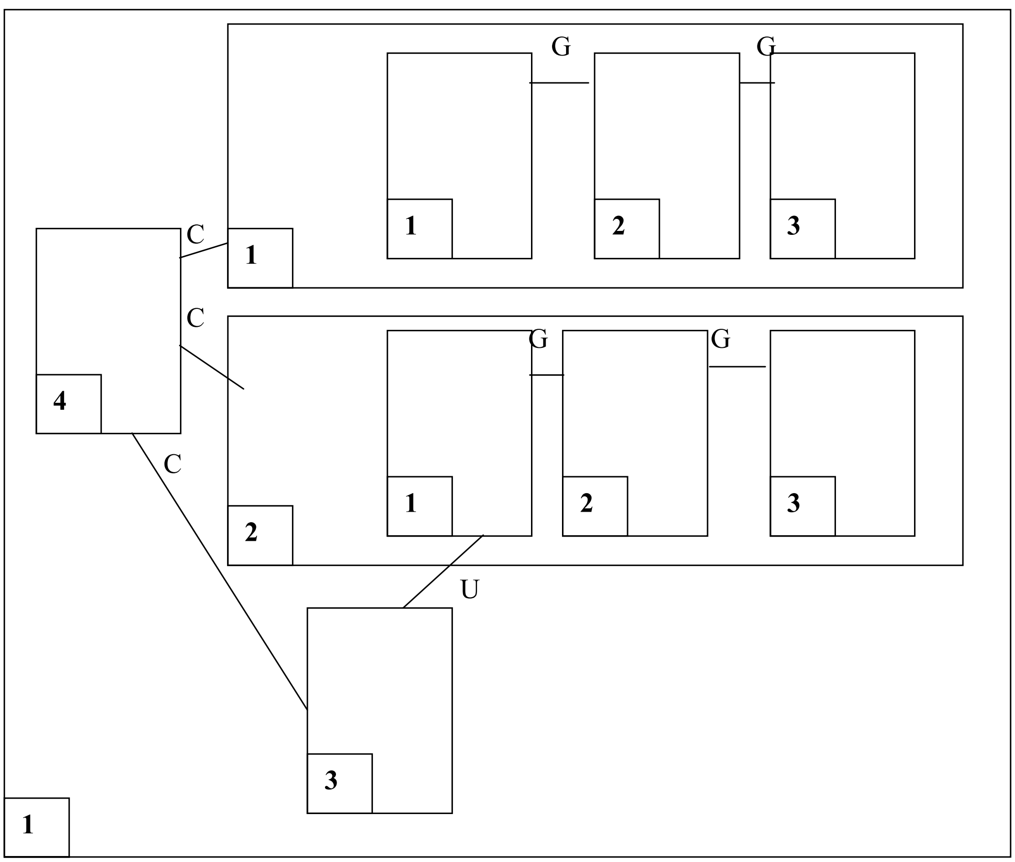

Figure 4: Applying PSM systems methodology on the teams of NMST

Figure 4 shows us clearly that Hierarchy's scheme has been supplanted and the connection between teams of different levels, departments and organizations have increased. The distribution of the teams and the processes that are taking place at different points of the network, allows us to implement Client-Server architecture. Each team's information is stored at distributed databases all over the network, and the different points are communicating as coordinates without the need of a halfway node. That way, all teams are overlapping information, and other expensive network resources.

A Local Area Network (LAN) consists of a number of PCs and other devises which are distributed in spacing and are connected in a way that any devise of the network can interact with any another. This type of network was common in our case for all teams. At the switches family, a Virtual LAN is a logical group of terminals, independent of the physical place, with a public set of features (switchers are supporting port centric VLAN) but here we need something more than that.

The need for videoconference, demands high-speed connections, something that an ATM (Asynchronous Transfer Mode) network can provide, led us to the decision that the communication between the virtual sub teams of the above scheme must be based on a LAN Emulation (LANE) [LAN Emulation and MultiProtocol Over ATM], in order use the existent technological equipment in conjunction with ATM.

Figure 5 shows how LANE works. With the blue line we an trace a connection with signaling and with the red a data path connection.

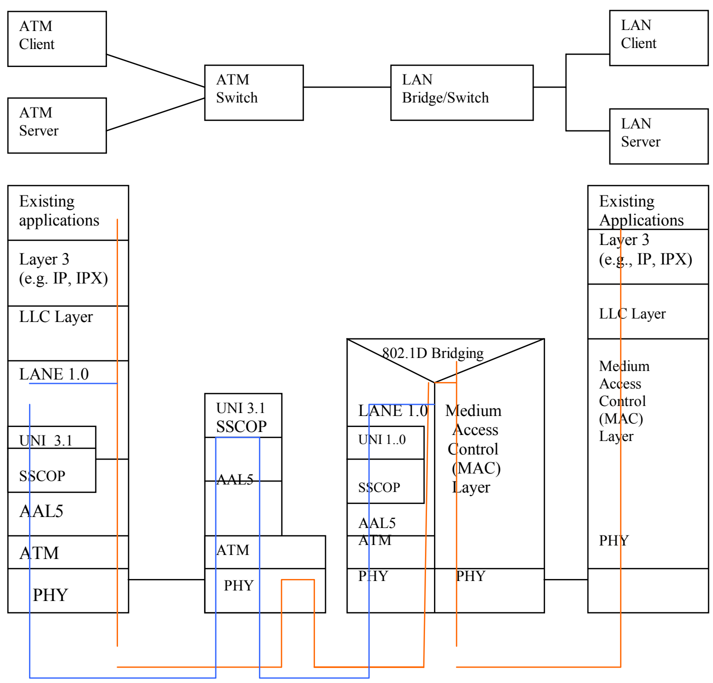

Figure 5: The LANE

6. Conclusions

Virtual enterprises are becoming increasingly popular for addressing and solving special problems, for approaching common projects or for joint production. in this paper we have examined methods of modelling virtual enterprises, and virtual enterprise as an entity itself, in order to understand their operation and suggest efficiency improvements. We identified a number of requirements that virtual enterprises, their managers and their models need to satisfy. The requirements were based on real-life problem cases as that of the virtual team of an enterprise, which offers management services to hospitals and health centers, in Greece and network workspaces.

Through systemic approaches, we have established a multi methodology, TASP, which implements TSI, SAST, SSM and PSM systemic methodologies on the problem. We have used these methodologies in order to benefit from the pluralism and the ideas that can be expressed by teams or individuals (SAST, SSM), to define the boundaries and the structure of the problem (PSM) and to combine all these methods (TSI).

In particular, we identified autonomy at all levels comprehensive conflict handling and resolution and agent-like behavior of components as key issues. In future, these requirements will have to be translated into technical terms, so that the expressive power of the proposed enterprise modelling languages can be evaluated, and necessary adjustments can be made.

7. References

1. Assimakopoulos, N. (1994), Systemic Project Management process for information Systems, Information and Decision Technologies vol 19, 1994, 349-364.
2. Assimakopoulos, N. (2000), Structured Total systems Intervention systemic multi-MEthodology of VIable Systems and metasystems (STIMEVIS), *Human Systems Management*, vol. 19(1), 61-69 .
3. Balasubramanian, S.; Maturana, F.P.; Norrie, D.H. (1997), Multi-agent planning and co-ordination for distributed concurrent *engineering Int.J. of Coop. Inf. Sys*., 5 (2-3) pp. 153-79
4. Bernus, P.; Nemes, L. (1996) A framework to define a generic enterprise reference architecture and methodology, *Computer-Integrated Manuf. Systems*, vol.9, no.3, pp. 179-91
5. *Bernus, P, Bertok, P., Nemes, L* (1998) Modelling Dynamic Management Features of Virtual Enterprises
6. Checkland, P. (1985) From optimizing to learning: a development of systems thinking for the 1990's, J of the O.R. Society vol 36,1985,757-767
7. Churchman, C. (1971) The Design of Inquiring Systems, Basic Books, New York
8. Deen, S.M.(1993) Co-operation issues in holonic manufacturing systems*, IFIP Tr.B (Appl.inTechn.),*B-14, pp.401-12
9. Doumeingts, G.; Fenie, P.; Chen, D. (1994), GIM (Grai Integrated Methodology): a methodology to specify and to design advanced manufacturing systems, Proc. ILCE '94. Integr. Logistics and Conc. Engineering, pp. 346, 271-80
10. Erman, L.D.; Hayes-Roth, F.; Lesser, V.R.; Raj Reddy, D. (1980) The Hearsay-II speech-understanding system: integrating knowledge to resolve uncertainty *Computing Surveys*, 12 (2) pp. 213-55
11. Flood, R. and Jackson, M. (1991). *Creative Problem Solving*, Wiley, England.
12. Janiwski T. Lugo G.G, Zheng H. Modelling an Extended Virtual Enterprise by the Composition of Models.
13. Kahn, H.J. (1995) STEP methodology – an overview*, Object Technology and its Appl. in Engng*.,p. v+178, 66-75
14. Kotorov, R.P. "Virtual Organisation: Conceptual Analysis of the Limits of its Decentralization " Program in Institutional Theory and History Bowling Green State University
15. Lawson, J.W. (1986) A quick look at matrix organisation from the perspective of the practicing manager *Engineering Management International*, 4(1) pp.61-70
16. Malone, T.W.; Crowston, K.; Jintae Lee; Pentland, B. (1993) Tools for inventing organisations: toward a handbook of organisational processes, Proc. 2nd Worksh. on Enabling Technologies Infrastructure for Collab. Enterp.pp.72-82
17. Mathews, J. (1995) foundations of intelligent manufacturing systems: the holonic viewpoint *Comp. Integ. Manuf. Syst*. 8 (4) pp. 237-43
18. Minsky, Marvin Lee (1996), First person : the society of mind, Voyager Company.
19. O'Leary, D.; Kuokka, D.; Plant, R. (1997) Artificial Intelligence and Virtual Organisations, *Communications of the ACM* vol.40 /1 pp.52-59.
20. Panayotopoulos, A. & Assimakopoulos, N. (1987). "Problem Structuring in a hospital", *European J. of Operational Research*, vol. 29 : 135-143.
21. Preston S.M "Virtual Organisation as a Process: Integrating Cognitive and Social Structure Across Time and Space"

22. Schmidt, K.; Simone, C. (1996) Co-ordination mechanisms: towards a conceptual foundation of CSCW systems design, *J CSCW* 5(2-3) pp. 155-200
23. Sims O. (1996) the Virtual Enterprise -The Internet and object technology are providing the infrastructure
24. Stamps J, Lipnack J (1997) Virtual Teams
25. Tamura, S.; Luh, P.B.; Oblak, J.M.; Watanabe, S., (1995) A planning and scheduling architecture for holonic manufacturing systems, Proc 1st World Congr. on Intell. Manuf. Processes and Sys., vol.2 pp790-801.
26. Vernadat, F.B. (1994) Business process and enterprise activity modelling: CIMOSA contribution to a general enterprise reference architecture and methodology (GERAM), ICARCV '94 vol.1 pp. 378-82
27. Vernadat, F.; Drira, K.; Azema, (1996) P. An integrated description technique for distributed co-operative applications. CESA'96 IMACS. *Comp. Eng. in Sys. Applications,* pp. 794, 608-12
28. Wall, W.C., Jr. (1984) Integrated management in matrix *organisation IEEE Trans. on Eng. Mgmt*, 31 (1) pp. 30-6
29. Williams, T.J. (1994) The Purdue Enterprise Reference Architecture *Computers in Industry*, 24, (2-3) pp. 141-58
30. Winograd, T; Flores, (1990) Understanding computers and cognition: a new foundation for design, Addison-Wesley
31. Configuring Token Ring LAN Emulation for Multiprotocol over ATM www.cisco.com/univercd/cc/td/doc/product/software/ios121/121cgcr/switch_c/xcprt8/xcdmpotr.pdf
32. 'LAN Emulation and MultiProtocol Over ATM', White Paper, http://www.cabletron.com/white-papers/atm/lan-emulation.html