Enterprise Knowledge and Information System Modelling in an Evolving Environment

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Abstract

The assumption of the work presented in this paper is the situatedness of the enterprise modelling process in a continuously evolving environment. The Enterprise Knowledge Development - Change Management Method (EKD-CMM) provides multiple and dynamically constructed ways of working to organise and to guide the enterprise knowledge modelling and organisational change processes. The method is built on the notion of labelled graph of intentions and strategies called a map and the associated guidelines. This paper presents the EKD-CMM map and highlights the relationships between the enterprise objectives, processes and the supporting information and communication technology (ICT) systems.

1. Introduction and motivation

1.1. Evolution of enterprises' requirements and of types of management

Before the seventies, companies used the principle of scientific management founded by Frederik W. Taylor and were strongly production-oriented. The resulting organisation lead to a vertical division of the activities to be performed and to functional and extremely hierarchical structures.

Since the eighties, companies are nowadays facing huge pressures to improve their competitiveness. Responses to these were restructuring, downsizing and reengineering along with a strong commitment to customer satisfaction. Organisational transformation became then a major issue. In this competitive and evolving market, quality is fundamental to obtain and to keep market share. Stora and Montaigne (Dumas and Charbonnel, 1990) define quality as "... *the conformity of products or services with the needs expressed by internal or external customers and undertaken by internal or external suppliers*". The concept of quality went through four successive stages. Around 1940, Taylor's theories about work organisation came strongly into effect and caused a separation between producers and quality controllers. Quality was obtained essentially by the final control of the products (*inspection)*. Between 1950 and 1960, emphasis lay on the quality of the process and not only on the quality of the product. Roles and responsibilities between production and quality changed. The production function was responsible for the quality of its products, and controls were transferred to it. The quality function was responsible for the quality procedures necessary to meet customer needs (*quality assurance)*. In 1980, experts acknowledged that the total management of quality is one of the factors in improved competitiveness. The *Total Quality Management* (TQM) was thus defined as a management method which aims towards long-range success. It is based on collective participation of each member in the improvement of processes, products, services and organisation of the company. Each business process is (re)designed to contribute to the quality of the products and services. The last stage is around the wave of the *Business Process Reengineering* (BPR), proposed by Hammer and Champy (Hammer and Champy, 1993), which consists of a radical remodelling of the organisation around its processes[1]. The difference between TQM and BPR is that the former deals with continuous change whereas the latter

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[1] a set of activities which produces, from one or several inputs, an output valuable for the customer

deals with discontinuous, radical change.

Over the past decade, continuous challenges have been made to traditional business practices. Rapid market changes such as electronic commerce, deregulation, globalisation and increased competition have led to a business environment that is constantly evolving. Companies change to better satisfy customer requirements, address increasingly tough competition, improve internal processes, modify the range of products and services they offer (Jacobson *et al.*, 1994). At the same time, organisations also experience the effects of the integration and evolution of information technology. While information systems continue to serve traditional business needs such as co-ordination of production and enhancements of services offered, a new and important role has emerged, namely the potential for such systems to adopting a supervisory or strategic support role. Information and Communication Technologies (ICT) were thus positioned as a strategic resource that enables automation, monitoring, analysis and coordination to support the transformation of business processes (Grover *et al.*, 1994).

While ICT and information systems are becoming an integrated aspect of organisations, the efficient communication between the stakeholders and requirements engineers became more and more critical because systems should be *continuously adapted* to changing business practices and needs. Stakeholders and requirement engineers have to well understand each other when eliciting and understanding requirements and reconciling differences at technical and social levels.

1.2. New requirements for information systems development

In such an unstable environment, information system developers were challenged to develop systems that can meet the requirements of modern organisations. The paradigms of Business Process Reengineering and Business Process Improvement contrast with traditional information system development that focused on automating and supporting existing business processes (Guha *et al.,* 1993). Now, enterprises should create -entirely- new ways of working to survive in a competitive environment. As stated in (Barrett, 1994), organisational transformation depends of the creation of a powerful vision of what future should be like. We claim that an in depth understanding of the current functioning is also required. In this context, *enterprise knowledge modelling* can help understanding the current business situation (Jarzabek and Ling, 1996) and establishing a vision of what the future should be like. Therefore, *modelling of enterprise knowledge becomes a pre-requisite for system requirements elicitation and system development.*

Enterprise knowledge modelling refers to a collection of conceptual modelling techniques for describing different facets of the *organisational domain* including operational (information systems), organisational (business processes, actors, roles, flow of information etc), and teleological (purposes) considerations (Bubenko, 1994). Existing enterprise knowledge modelling frameworks (Dobson *et al.*, 1994), (van Lamsweerde *et al.*, 1995), (Yu and Mylopoulos, 1996), (Loucopoulos *et al.*, 1998), (Nurcan *et al.*, 1998), (Rolland *et al.*, 1998b), (Bubenko, 1994), (Loucopoulos and Kavakli, 1995) stress the need to represent and structure enterprise knowledge. However, very few approaches investigate the dynamic aspect of knowledge modelling; i.e., how enterprise knowledge models are generated and evolve and how reasoning about enterprise knowledge can guide the organisational transformation. Therefore, *process guidance* concerns the support provided to the enterprise modelling and the organisational transformation. Work in this area mainly focuses on prescriptive approaches. However, due to its social and innovative nature, the organisational change can not be fully prescribed. In fact, the enterprise modelling process in an evolving environment is a decision making process i.e. a non-deterministic process. Accordingly, process guidance should allow selecting dynamically the next modelling activity to be performed depending on the situation at hand (Rolland *et al.*, 1996), (Rolland *et al.*, 1997a), (Rolland *et al.*, 1999), (Rolland et al, 2000). To this end, this paper puts forward an intentional framework known as the EKD-CMM[2] approach. EKD-CMM is the confluence of two technologies: *Enterprise Knowledge Modelling* and *Process Guidance*.

This paper is organised as follows: Section 2 sets the terminology and the background of our proposal and presents a state-of the-art in order to situate the EKD-CMM method among several others that

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[2] The term EKD-CMM stands for Enterprise Knowledge Development-Change Management Method

have been published under similar research themes. Section 3 defines the EKD-CMM views of enterprise knowledge modelling and proposes a way-of-working which can be used for several organisational purposes from business process reengineering to information systems design.

2. State of the Art

For the purposes of information systems planning, enterprises used first functional, exhaustive and bottom-up approaches like Business Systems Planning (IBM, 1984) which core concept was the information architecture of the analysed business describing which data is handled by which business function. The need to taking into account higher level (strategic) objectives led afterwards to the use of non exhaustive and top-down approaches based for example on the study of the critical success factors of the enterprise (Ward and Griffiths, 1996). But even by taking into account the critical success factors, the enterprise can not obtain the maximum benefits from the ICT. In fact, in these classical approaches, the choices are done first in the strategic and organisational levels before thinking about support systems. A more recent approach suggests to reverse the usual way-of-doing by studying first the possibilities of ICT, identifying then which innovating activities the enterprise can perform supported by them and finally eliciting the corresponding organisational objectives (Österle *et al.*, 1993). Obviously, the new activities elicited by this way, should be compatible with the mission of the enterprise.

Most of the current approaches for modelling enterprise knowledge and organisational change view change management as a *top-down* process. Such approaches (e.g., BPR) assume that the change process starts with a high level description of the business goals for change. The initial goals are then put into more concrete forms during the process, progressively arriving at the specification of the future system requirements that satisfy these goals. Other approaches (e.g., TQM) advocate a *bottom-up* orientation whereby the need for change is discovered through analysis of the current organisational situation and reasoning about whether existing business structures satisfy the strategic concerns of the stakeholders. In the first case, the goals for change are *prescribed* in the sense that they do not explicitly link the need for change to the existing organisational context, rather they reflect how change is perceived from the strategic management point of view or is codified in the organisation's policies and visions. Such goals do not always reflect reality (Anton, 1996). On the other hand, in bottom-up approaches, goals for change are *described* i.e., they are discovered from an analysis of actual processes. However, descriptive goals tend to be too constrained by current practice, which can be a serious drawback when business innovation is sought (Pohl, 1996).

From the point of view of method engineering, a business model is a product (Odell, 1996), (Brinkemper, 1996). In fact, the product is the desired output of the design process, whereas the process keeps track of how the product has been constructed in a descriptive manner. A process and its related product are specific to an application. A *Product Model* defines the set of concepts and their relationships that can be used to built a product, i.e., in our case, to built a model representing a given business. Nevertheless, method engineering establishes that a well-defined method should also have a Process Model that guides the construction of the product. The *Process Model* defines how to use the concepts defined within a Product Model and may serve two distinct purposes: descriptive or prescriptive (Curtis *et al.*, 1992), (Lonchamp, 1993). A *descriptive Process Model* aims at recording and providing a trace of what happens during the development process (Gotel and Finkelstein, 1996). A *prescriptive Process Model* is used to describe "how things must/should/could be done". Prescriptive Process Models are often referred to as ways-of-working (Seligmann *et al.*, 1989). A *Process Model* and its related *Product Model* [3] are specific to a *method*.

The study of the state-of-the-art on *Product Models* suggests that existing approaches to enterprise knowledge modelling can be classified into two categories. In the first category, an organisation is represented as a set of inter-related elements satisfying common objectives (Checkland and Scholes, 1990), (Flood and Jackson, 1991). For instance, VSM (Espejo and Harnden, 1989) allows us to model an organisation as a set of viable sub-systems representing respectively the operation, co-ordination,

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[3] We use capitalised initials in order to differentiate the method specific Models from the application specific models (for instance a business model) that compose the product.

control, intelligence (reasoning, analysis) and politics (strategy) aspects of an organisation.

In the second category, the focus is given to developing different views of the organisation dealing respectively on actors, roles, resources, business processes, objectives, rules, etc. (Bubenko, 1994), (Decker *et al.*, 1997), (Jarzabek and Ling, 1996). Business process modelling usually employs and/or combines three basic views: (i) the functional view expressed based on Data Flow Diagrams (DeMarco, 1979), (Ross, 1985), (Marca and McGowan, 1993); (ii) the behavioural view focused on when and under which conditions activities are performed and based on state diagrams or interaction diagrams (Jacobson *et al.*, 1993), (Harel, 1990); and (iii) the structural view focused on the static aspect of the business process capturing the objects that are manipulated by the business process and their relationships (Rumbaugh *et al.*, 1991). Existing Workflow Models belong also to the second category (Ellis and Wainer, 1994), (Medina-Mora *et al.*, 1992), (McCarthy and Sarin, 1993).

The study of the state-of-the-art suggests that existing *Process Models* can be classified into three categories (Dowson, 1987) (Rolland *et al.*, 1999): *activity-oriented Models*, *product-oriented Models*, and *decision-oriented Models*. Each category has an underlying paradigm that we examined in terms of its appropriateness to enterprise modelling in an evolving context.

Activity-oriented Models attempt to describe the development process as a set of activities with conditions constraining the order of these activities (Emmerich *et al.*, 1991), (Jacherri *et al.*, 1992), (Armenise *et al.*, 1993), (Finkelstein *et al.*, 1994). They were inspired by generic system development approaches (e.g. the Waterfall model, the Spiral model, the Fountain model, etc.). The linear view of activity decomposition promoted by this paradigm is inadequate in the context of enterprise modelling and organisational change (Lehman, 1987) which require creative activities essential to development, for instance in the use of heuristic, the choice of alternatives, back tracking decision, etc...

Product-oriented Models do not put forward the activities of a process but rather the result of these activities (Finkelstein *et al.*, 1990), (Humphrey, 1989), (Nadin and Novak, 1987). A positive aspect is that they model the evolution of the product and couple the product state to the activities that generate this state. They are useful for tracing the transformations performed and their resulting products. However as far as guidance is concerned, and considering the highly non-deterministic nature of the enterprise knowledge development process, it is difficult to write down a realistic state-transition diagram that adequately describes what has to happen during the entire process.

The most recent type of Process Models are based on the *decision-oriented paradigm* (Jarke *et al.*, 1992), (Potts, 1989), (Rolland and Grosz, 1994), (Rose *et al.*, 1991) according to which the successive transformations of the product are looked upon as consequences of decisions. Such models are semantically more powerful than the two others because they explain not only how the process proceeds but also why transformations happen (Lee, 1991), (Ramesh and Dhar, 1992). Their enactment guide the decision making process that shapes the development, help reasoning about the rationale of decisions, and record the associated deliberation process. The decision-oriented modelling paradigm seems to be the most appropriate for the enterprise modelling and organisational transformation processes both for trace and guidance purposes. The addition of a capability to record the design decisions facilitates understanding of the engineer's intention, and thus, leads to a better reuse of the results and an easier introduction of change in systems requirements. However, enterprise knowledge development processes, whether the enterprise is in a stable situation or in a transformation process, are not adequately covered in existing decision-oriented models. Clearly, there is a high need for methods which offer process guidance to provide advice on which activities are appropriate under which situations and how to perform them (Wynekoop and Russo, 1993), (Dowson and Fernstrom, 1994), (Rolland, 1996), (Rolland *et al.*, 1999) and to handle the modelling of evolving organisations.

In the following section, we present a method, namely *Enterprise Knowledge Development- Change Management Method (EKD-CMM),* which intends to provide such guidance.

3. Enterprise Knowledge Development – Change Management Method

Due to its social and innovative nature, the enterprise knowledge modelling and the organisational change can not be fully prescribed because these are, first of all, decision making processes, therefore non deterministic in nature.

Sub-section 3.1 presents the EKD-CMM framework and more precisely the organisational situations in which the so called EKD-CMM method can be applied. This sub-section gives also a short summary of the EKD-CMM Product-Models. Sub-section 3.2 presents the high level vision of the EKD-CMM Process Model. Sub-section 3.3 highlights the relationships between the modelling of the business processes and of the ICT systems supporting them.

3.1. EKD-CMM Framework

Enterprises that can manage complexity and can respond to rapid change in an informed manner can gain a competitive advantage. EKD-CMM is a method to documenting an enterprise, its objectives, business processes and support systems, helping enterprises to consciously develop schemes for implementing changes. EKD-CMM satisfies two requirements : (i) assisting enterprise knowledge modelling and (ii) guiding the enterprise modelling and the organisational transformation processes.

The EKD-CMM *enterprise knowledge modelling* component (Nurcan *et al.*, 1999), (Loucopoulos *et al.*, 1998), (Rolland *et al.*, 1998c), (Bubenko, 1994), (Loucopoulos and Kavakli, 1995), (Nurcan and Rolland, 2003) recognises that it is advantageous to examine an enterprise from multiple perspectives. As shown in Figure 1, the inter-connected set of EKD-CMM models describing an enterprise are structured in three levels of concern: *Enterprise Goal Model, Enterprise Process Model* and *Enterprise Information System Model*. The first two levels focus on *intentional and organisational aspects of the enterprise*, i.e. the organisational objectives and how these are achieved through the co-operation of enterprise actors manipulating such enterprise objects. The third level, is useful when the EKD-CMM approach is applied to define the requirements for an information system. In this case, the focus is on *system aspects* i.e., the computerised system that will support the enterprise, processes and actors in order to achieve the enterprise objectives.
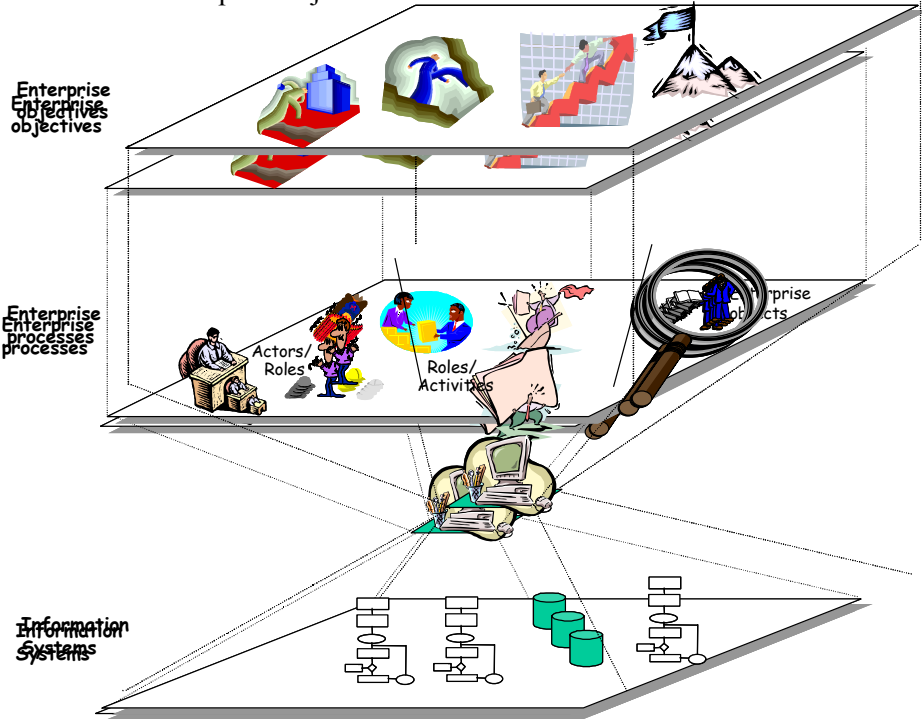

Figure 1: The EKD-CMM view of enterprise modelling

Therefore, within EKD-CMM, the product is a set of operational (information systems), organisational (business processes) and intentional (business objectives) models describing the new system to be

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constructed and the organisation in which it will operate. The Product Models used in the two higher levels of abstraction have been previously presented in (Nurcan *et al.*, 2002), (Barrios and Nurcan, 2002), (Nurcan and Rolland, 2003). We list them hereafter to remind their purposes.

- The *goal models* represent the current or future enterprise objectives. Their purpose is to describe what the enterprise wants to achieve or to avoid.

- Enterprise business processes, motivated by enterprise objectives, are modelled at the second level according to several points of view. Consequently, *enterprise process models* resulting from these descriptions require different Product Models:

    o What happens in enterprise processes can be analysed in terms of the *roles* that individuals or groups play in order to meet their responsibilities. Roles correspond to sets of responsibilities and related activities. The *actor/role model* aims to describe how actors are related to each other and also to enterprise objectives.

    o People *perform activities* to achieve enterprise objectives. The *role/activity model* is used to define enterprise processes, the way they consume/produce resources to achieve enterprise objectives.

    o Activities carried out by different roles deal with *business objects*. The *object model* is used to define the enterprise entities, attributes and relationships.

Using models to represent the enterprise allows a more coherent and complete description of enterprise objectives, business processes, actors and enterprise objects than a textual description. These models are useful because they allow (i) to improve the knowledge about the enterprise, (ii) to reason on alternative solutions and diverging points of view, and (iii) to reach an agreement. They proved their efficiency as well as for improving communication than making easier the organisational learning.

The intention based modelling used in EKD-CMM provides basis for understanding and supporting the enterprise modelling, organisational change and helping the development of the supporting information systems. *Process guidance* in EKD-CMM is based on a map which is a *navigational structure* in the sense that it allows the requirements engineer to determine a path from *Start* intention to *Stop* intention. The approach suggests a dynamic construction of the most appropriate path by navigating in the map. Thus, EKD-CMM proposes several ways of working, and in this sense, it is a multi-method. In fact, using the EKD-CMM framework, one can start at any level and move on to other levels, depending on the modelling and organisational situations. As illustrated in Figure 2, the proposed method can be used for both business engineering and information system engineering purposes, allowing:

(a) *business process reengineering*: from business processes level to the business objectives for change (Rolland *et al.*, 1998b), (Nurcan *et al.*, 1999), (Nurcan and Rolland, 1999), (Rolland *et al.*, 1999b) and then to the business process architecture for the future ;

(b) *reverse engineering*: from legacy information systems to the information system level which may be than used to model the business processes level (Kavakli and Loucopoulos, 1998), (Kardasis and Loucopoulos, 1998) ;

(c) *forward engineering* or *information system design*: from business objectives to business process modelling and to the choice of the processes to be supported by the information and communication technologies (ICT) and than to the IS modelling ;

(d) *business process improvement*: by modelling and analysing the business processes in order to enhance them by specific modifications such as role definition or activity flow ;

(e) *quality management*: by defining the business processes and quality procedures and by aligning them ones with respect to others.
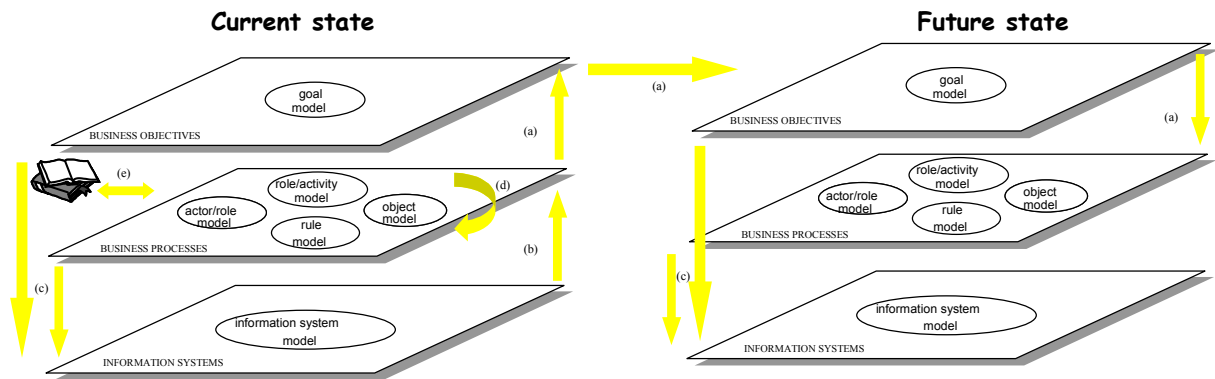
Figure 2: Purposes for using EKD-CMM

During our previous work, we were particularly interested to the definition and modelling of the organisational change processes. To this end, we focused our attention on business processes to understand the current way of working of the enterprise (second level in Figure 1) and reasoned on the organisational change at the intentional level (Nurcan *et al.*, 1999), (Nurcan and Rolland, 1999), (Rolland *et al.*, 1999b). The EKD–CMM approach has been thus successfully applied in an European Project (ELEKTRA) aiming to discover generic knowledge about change management in the electricity supply sector for reusing it in similar settings. Two end-user applications have been considered within the project. The common theme underpinning their requirements was their need to deal with change in a controlled way which would lead to an evaluation of alternative options of possible means to meet the objectives for change.

Our conclusion was that reasoning on the enterprise objectives makes easier understanding of problems and communication on essential aspects (what and why instead of who, when, where and how). This representation "by objectives" may (i) constitute a document for business analysts to discuss about the enterprise and its evolution, and (ii) help, in term, analysts, designers and developers of information systems.

Our current work consists to focus on the two lower layers shown in Figure 1, namely enterprise process models and information systems in order to highlight the relationships between the enterprise process models and the specifications of the ICT systems.

3.2. EKD-CMM Process Model

This sub-section presents first the concepts used for defining the EKD-CMM Process Model, and then introduce the EKD-CMM Map which defines the multiple ways-of-working offered by the method.

3.2.1. The Map Meta-Model

A map (Rolland *et al.*, 1999c) is a Process Model in which a non-deterministic ordering of intentions and strategies has been included. It is a labelled directed graph with intentions as nodes and strategies as edges between intentions. As shown in Figure 3[4], a map consists of a number of *sections* each of which is a triplet < source intention I^{5}_{i}, target intention I_j, strategy S_{ij}>. There are two distinct intentions called *Start* and *Stop* respectively that represent the intentions to start navigating in the map and to stop doing so. Thus, it can be seen that there are a number of paths in the graph from *Start* to *Stop*. The map is a navigational structure that supports the dynamic selection of the intention to be achieved next and the appropriate strategy to achieve it whereas the associated guidelines help in the achievement of the selected intention.

A *strategy* is an approach, a manner to achieve an intention. The strategy, as part of the triplet

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[4] We use an E/R like notation. A box represents en Entity Type (ET), the labeled link represents a Relationship Type (RT) and the embedded box refers to an objectified RT.
[5] Intention are in italics (I_i, I_j)

$<I_i,I_j,S_{ij}>$ characterises the flow from I_i to I_j and the way I_j can be achieved. The specific manner in which an intention can be achieved is captured in a section of the map whereas the various sections having the same intention I_i as a source and I_j as target show the different strategies that can be adopted for achieving I_j when coming from I_i. Similarly, there can be different sections having I_i as source and I_{j1}, I_{j2}, ...I_{jn} as targets. These show the different intentions that can be achieved after the achievement of I_i.

There might be several flows from I_i to I_j, each corresponding to a specific strategy. In this sense the map offers *multi-thread flows*. There might also be several strategies from different intentions to reach an intention I_i. In this sense the map offers *multi-flow paths* to achieve an intention. The map contains a finite number of paths, each of them prescribing a way to develop the product (for instance a business process model), i.e. each of them is a *Process Model*. Therefore the map is a *multi-model*. The approach suggests a dynamic construction of the actual path by navigating in the map. Because the next intention and strategy to achieve it are selected dynamically, *guidelines* that make available all choices open to handle a given situation are of great importance. A *guideline* is a set of indications on how to proceed to achieve an intention. A guideline embodies *method knowledge* to guide the designer in achieving an intention in a given situation. The execution of each map section is *supported by* a guideline which can be atomic or compound. Some sections in a map can be *defined as* maps in a lower level of abstraction.
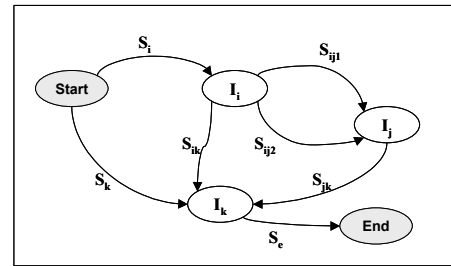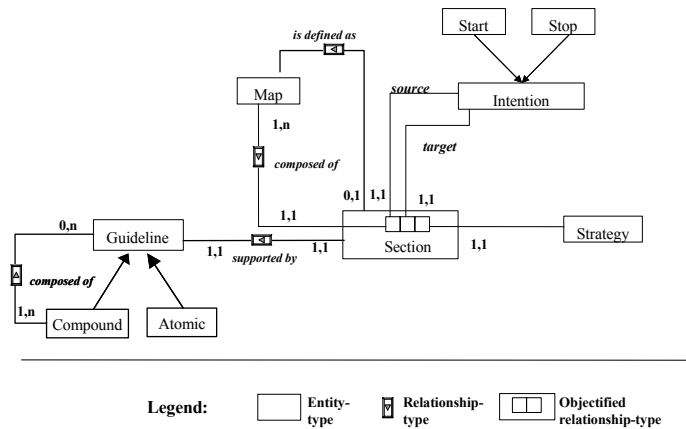

Figure 3: The Map Meta-Model

3.2.2. The EKD-CMM Map

We assume enterprise modelling and organisational transformation processes to be intention-oriented. The EKD-CMM map is shown in Figure 4. As shown in this figure, there are three key intentions in EKD-CMM, namely *Elicit Enterprise Goal Structure, Conceptualise Enterprise Business Process Model and Conceptualise Information Systems Model*. We refer to them as 'Process Intentions'. *Conceptualise Enterprise Business Process Model (BPM)* refers to all activities required to construct a business process model whereas *Elicit Enterprise Goal Structure* refers to all those activities that are needed to identify goals and to relate them one another through AND, OR (exclusive OR) and AND/OR (inclusive OR) relationships. Finally, *Conceptualise Information System Model* refers to all activities required to construct the supporting software systems.

The EKD-CMM map contains a finite number of paths, each of them is a *EKD-CMM Process Model*. Therefore the EKD-CMM map is a *multi-model*. None of the finite set of models included in the map is recommended 'a priori'. Instead the approach suggests a dynamic construction of the actual path by navigating in the map. In this sense the approach is sensitive to the specific situations as they arise in the process. The multiple purposes, listed in sub-section 3.1, for which EKD-CMM can be applied are all included in the EKD-CMM map. Guidelines aiming at helping EKD-CMM users to construct dynamically their path are also provided by the EKD-CMM map. These guidelines help users to choose between two alternative sections between a source process intention and a target process

intention (strategy selection guidelines) or to choose between possible target intentions when moving from a source intention (intention selection guidelines).

The experience gained during our previous work shown that the path to be followed in the EKD-CMM map during a particular enterprise modelling project is situation-dependent. For instance, the selection of the bottom-up[6] path for one of the two end-users in the ELEKTRA project was influenced by the uncertainty regarding both the current Electricity Distribution Business Unit situation and its possible re-organisation alternatives. Application of the specific strategies forming this path was also affected by a number of situational factors including: (i) *organisational culture* (organisational actors that were not used to working in groups in a participative way, felt awkward in such a situation and found it difficult to contribute as intended) ; (ii) *ability to commit resources* (the quality of the enterprise models largely depended in the participation of the 'right' people both in terms of business experts and method experts); (iii) *social skills and consensus attitudes of participating actors* (conflicts between individuals and groups within the project increased the complexity of the situation); (iv) *use of software tools* to facilitate the process execution (the use of group support technologies in participative sessions increased both productivity and the quality of results obtained); and (v) *familiarity with applied strategies and supporting technologies (*understanding, among project participants, of the capabilities and limitations of the strategies and tools applied was vital in order to make the best use of them and to produce useful results).

By opposition, for the second application of the ELEKTRA project, a different path of the map, called top-down, was used. The map sections composing this path use mainly the participative modelling strategy. For this end-user, the future enterprise goal structure was first elicited and then future enterprise process models were conceptualised.
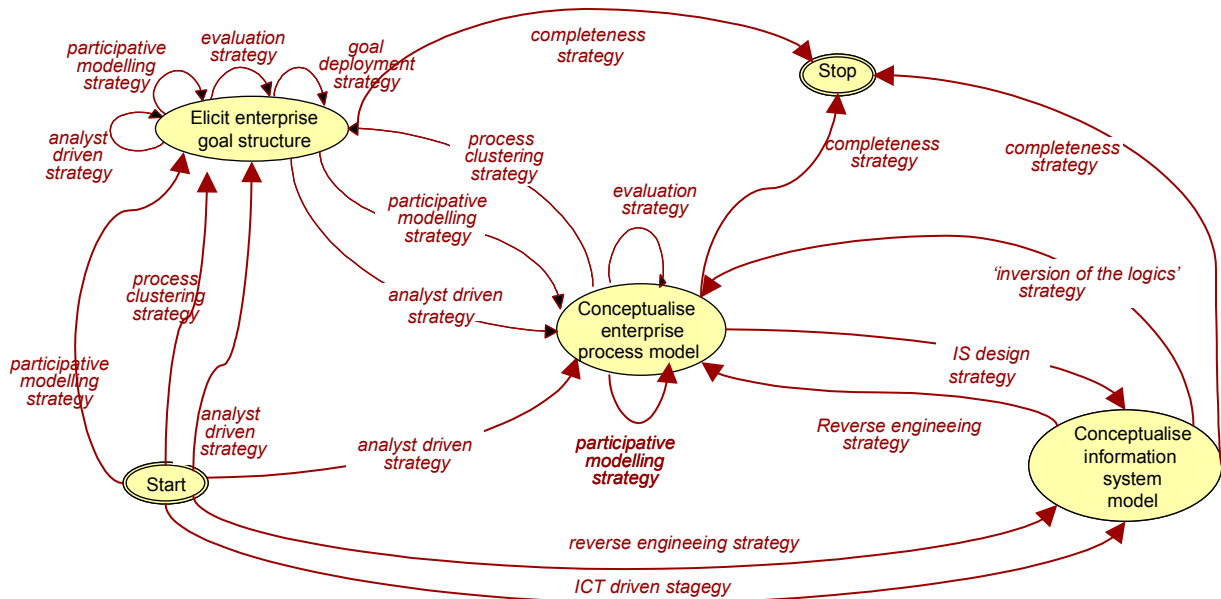

Figure 4: The EKD-CMM map

All guidelines corresponding to the sections between the process intentions *Elicit Enterprise Goal Structure* and *Conceptualise Enterprise Business Process Model* have been developed in (Nurcan and Rolland, 2003) and (Barrios, 2001). Our current work consists in identifying and developing the guidelines associated to the map sections having the process intention *Conceptualise Information System Model* as source or as target.

3.3. The path of the EKD-CMM map for forward engineering

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[6] so called because this part suggests first to conceptualize the current enterprise process model, then to elicit the current enterprise goal structure and finally to model alternative change scenario.

As stated in (Erikson and Penker, 2000) a business model can act as the basis for modelling and designing the supporting software systems in an enterprise. Typically, business modelling and software modelling use different languages and concepts making integration of the two models difficult. The set EKD-CMM Product Models aims to ease this integration providing methodological tools to use a business model (enterprise goal model and enterprise process models) to define the supporting information systems' architecture. Nevertheless, some parts of the business models that are performed manually can not become part of the IS models.

Let us suppose that the future business processes have been modelled from different perspectives (see (Nurcan and Rolland, 2003) and (Nurcan *et al.*, 2002) for details) , i.e. by modelling actors that are responsible for their execution and the set of activities that are under the responsibility of those actors, as well as the resources involved in the execution of those activities. The resulting business process models are –instances of- actor/role models, role/activity models and the business object model with their relationships as depicted in Figure 5.
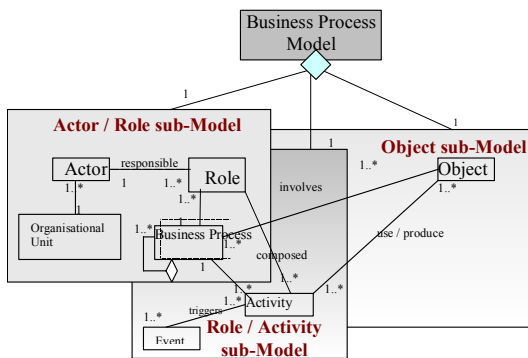

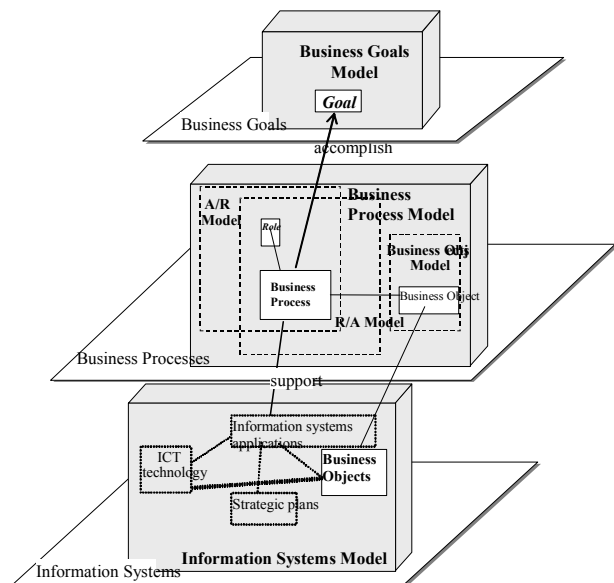**Figure 5: The Integrated Business Process Model**

Figure 6 : The methodological framework and the relationships between the three layers
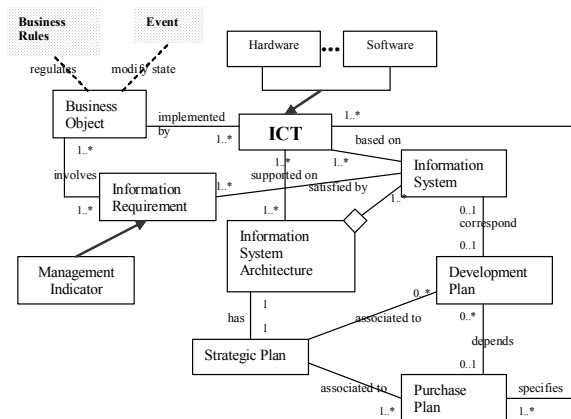

Figure 7: The Information System Model

The methodological framework can than be used to define the most appropriated information system architecture to support this business model. This is possible because the framework permits to establish a detailed view of what the relationships between new processes execution and future information systems are. The objective of the business model is twofold. First, to help organisational members to understand what they wanted to be as a service organisation, corresponding to the identified enterprise goals and consequently, to (re)define business processes. Second, to design the information systems architecture that best fits their future needs.

The *business object model* constitutes the main link between the business processes and the information systems that support them. It represents all business elements involved in business processes execution as shown in Figures 6 and 7.

The Information System model should contain not only the set of information systems (IS), but the definition of the local and shared databases, as well as the information requirements and management indicators that should be satisfied by different applications.

Figure 7 shows the main concepts included as part of the Information Systems model. The object model is a refinement of the business object model which is a sub-model of the second level. It must be refined and expressed according to the adopted software engineering techniques.

The way this model has been structured assures that business processes are at the origin of the business objects as well as the definitions of information requirements and management performance indicators. In consequence, they will be taken into account for the design and distribution of the software components.

4. Conclusion

This paper reports on the use of an intentional framework for modelling enterprise knowledge using business models and IS models. A major advantage of the proposed approach is the systematic way of dealing with enterprise modelling and organisational transformation in terms of *knowledge modelling* used with a *process guidance* framework.

The experience gained during our previous work has substantiated the view that the path of the EKD-CMM map to be followed in a particular enterprise modelling project is very much dependent on the enactment context of the project and a number of situational factors including degree of formal hierarchy (few vs. many formal levels), decision structure (authoritative vs. management by objectives), company culture (collectivistic vs. individualistic), degree of distance of power (short vs. long), type of market (deregulated vs. regulated), etc. The implication of these empirical observations is that the enterprise modelling processes in an evolving environment cannot be fully prescribed. Even when one follows a certain strategy the situational factors dominating the project may cause a number the adaptations to this strategy. This fact strengthens the position advocated by the EKD-CMM map that in order to support the execution of enterprise modelling processes in an evolving environment, flexible guidelines are more relevant than rigid rules. Thus, the *EKD-CMM framework* provides a systematic, nevertheless flexible, way to organise and to guide the enterprise knowledge development processes.

We also observed that the ability of the company to commit the right resources as well as the familiarity of the involved people with the EKD-CMM formalism and the supporting technologies have a major impact in the success or the failure of the enterprise modelling project. Clearly, the EKD-CMM experts need the domain knowledge to fully understand the organisation. Rather than trying to gain huge amounts of knowledge, a better solution seems to involve one or several employees of the company in the project. These employees will provide organisational knowledge or will know where it may be found. Simultaneously they will become an important resource by gaining knowledge of EKD-CMM, which will be useful if the organisation desires to continue work with enterprise modelling and analysis.

Our framework contributes to define accurate and precise decision making processes inside modern organisations which are highly dependent of information and communication technologies. It reinforces also the ability of companies which apply it to adopt a policy of knowledge management.

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