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Business Process Modeling for Developing Process Oriented IT Systems

Selmin Nurcan
Associate Professor, Université Paris 1 - Panthéon - Sorbonne, Centre de Recherche en Informatique
90, rue de Tolbiac 75634 Paris cedex 13 France and IAE de Paris (Sorbonne Graduate Business School), Université Paris 1 -Panthéon - Sorbonne, 21, rue Broca 75005 Paris France, Phone : 33 - 1- 53 55 27 13 ; Fax : 33 - 1 - 53 55 27 01

ABSTRACT

Information system developers are challenged to develop systems that should meet the requirements of modern organizations. By promoting the enterprise-wide integration, the paradigm of Business Process Management contrasts with traditional information system development. The latter was suffered, but also crystallized, the vertical division of the enterprise activities. In addition, the paradigms of Business Process Reengineering and Improvement contrast with traditional information system development that focused on automating and supporting existing business processes. Now, enterprises should create new ways of working to survive in a competitive environment. In this context, enterprise modeling can help understanding the current business situation and establishing a vision of what the future should be like. Therefore, business process modeling becomes a pre-requisite for system requirements elicitation and system development.

1. INTRODUCTION

Before the seventies, companies used the principle of scientific management founded by Frederik W. Taylor and were strongly production-oriented. The resulting organization let to a vertical division of the activities and to functional and extremely hierarchical structures having, most of the time, their own information systems (ISs). Over the past decade, continuous challenges have been made to traditional business practices. Rapid market changes such as electronic commerce, deregulation, globalization and increased competition let to a business environment that is constantly evolving. Organizational transformation became then a major issue. Several management methods have been proposed to this end. One of the most recent ones is the *Business Process Reengineering* (BPR) [11].

Companies change to better satisfy customer requirements, address increasingly tough competition, improve internal processes and adapt the products and services they offer [13]. At the same time, they experience the effects of the integration and evolution of information technology (IT) [18]. While ISs 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 were thus positioned as a strategic resource that enables automation, monitoring, analysis and coordination to support the transformation of business processes [10].

In this evolving environment, companies need also (a) to integrate their new solutions with their legacy systems in a global IT architecture and (b) to orchestrate the execution of their activities in an integrated environment. This can be achieved by developing process-centric Enterprise Application Integration solutions. The paradigm of Business Process Management stresses the importance of integrating entire processes rather than simply integrating data or applications [2], [35].

At 1977, J. L. Lemoigne proposed the "Operation-Information-Decision" (OID) model that set the articulation of the organization around three systems: the operation system (OS), the information system (IS) and the decision system (DS). In this model [17], the IS was considered as a system, which will memorize all information useful for the operation system. The IS interacts also with the DS for providing the production data and information on control variables. According to this articulation between the three systems, the DS usually acts on the OS by setting actions through the IS. The major contribution of the OID model was to provide the symmetry on the coupling of operation and information systems on one side and decision and information systems on the other side. Nevertheless, this apparent symmetry let to a generation of ISs providing solutions based on the OS/IS couple, leaving the scope of the second couple (DS/IS), especially in France, to another research community working around the topics of artificial intelligence, expert systems or decision support systems. Today, an IS does not exist only as an image of the real world but sometimes it could be the unique reality. In fact, we are more and more dealing with products and services that are only "information". It seems more appropriate to consider the organization as a whole system with its multiple facets: its strategy, its structure and its information systems. These three facets should be considered, not as different systems of the organization but as various views of the same system, the organization [19], [24].

This paper is organized as follows: Section 2 presents a state of the art on process modeling and situates briefly the WFMSs with respect to the nature of business processes they can execute. Section 3 proposes a conceptual framework for modeling business processes and illustrates the proposed concepts with an example.

2. STATE OF THE ART FOR PROCESS MODELING

The study of the literature suggests that existing approaches to enterprise modeling can be classified into two categories. In the first category, an organization is represented as a set of inter-related elements satisfying common objectives [4], [9]. For instance, VSM [8] allows us to model an organization as a set of sub-systems representing the operation, co-ordination, control, intelligence and politics aspects of an organization. In the second category, the focus is given to developing different views of the organization dealing respectively on actors, roles, resources, business processes, objectives, rules, etc. [1], [5], [16].

Business processes can be roughly classified into two categories. The first concerns well-structured and -often- repetitive processes having important coordination and automation needs. The second concerns ill-structured processes. The essential preoccupation with the latter is the information and knowledge sharing between the actors implied in the processes. Clearly, well-structured and ill-structured processes coexist and must be handled in the final business model [25], [26]. This requires homogeneity and coherence of handled concepts and a common technology for their enactment or at least interoperable ones.

Process modeling usually combines three views: (i) the *functional view* is based on Data Flow Diagrams [20]; (ii) the *behavioral view* focuses on when and under which conditions activities are performed; it is described using state diagrams or interaction diagrams [12], [14]; and (iii) the *structural view* focuses on the static aspect of the process capturing the objects that are manipulated and their relationships [34].

The study of the literature shows also that existing *process modeling formalisms* can be classified into three categories: *activity*, *product* and *decision oriented*.

Activity-oriented models allow us to describe a process as a set of activities with conditions constraining their order. These are useful for representing the functional view introduced below. Nevertheless, the linear view of activity decomposition promoted by this paradigm is inadequate for modeling ill-structured processes.

Product-oriented models do not put forward the activities of a process but rather the result of these activities. 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 representing the structural view. This kind of models is more appropriate than activity-oriented models for representing ill-structured processes. However considering the non-deterministic nature of the strategic business processes, it is difficult to write down a realistic state-transition diagram that describes what has to happen.

The most recent type of process models, developed for IS engineering or requirements engineering processes [15], [28], [32], are based on the *decision-oriented paradigm* according to which the successive transformations of the product (business objects, products or services in our case) 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. Their enactment guide the decision making process that shapes the business, help reasoning about the rationale of decisions [22]. The decision-oriented modeling paradigm seems the most appropriate for representing ill-structured business processes [23], [24], [27], [30].

Each process modeling technique adopts some of the previous views to represent a process. For instance, STATEMATE [12] deals with the traditional "who, what, where, when and how" of the process using activity, state and module charts while IDEF0 [33] employs a data flow perspective to model processes.

The I* framework [37] developed for supporting process modeling and reengineering includes a Strategic Dependency model and a Strategic Rationale model. The former is an intentional model and allows a richer representation of an organization than conventional workflow models that are based on non-intentional entity and activity relationships. It describes the dependency relationships among actors. The latter shows "how" an actor meets its incoming dependencies or internal goals by modeling actor's "ways of doing things" which are called tasks.

The OSSAD method (Office Support System Analysis and Design) [6] developed within the context of an ESPRIT project aims to handle business transformation. OSSAD proposes two levels of modeling. The abstract level aims to represent the organization from the point of view of its objectives. The descriptive level aims to represent the achievement conditions of these objectives taking into account organizational and technical means.

In terms of automated support for executing and monitoring business process models, commercial WFMS and the underlying control flow models are useful for well-structured processes. In fact, most of the existing workflow models are activity-oriented and are devoted to the representation of business processes whose execution could be automatically supported by a WFMS based on the same paradigm [7], [21]. Nevertheless, these systems cannot be used for ill-structured business processes and do not allow the dynamic modification of well-structured process models. More and more, users ask for adaptive tools to enact and to control the execution of the business processes and flexible models for their definition [3], [36].

3. MAIN CONCEPTS FOR ANALYZING AND MODELING BUSINESS PROCESSES

We propose a conceptual modeling framework offering at one hand the rigor necessary for modeling well-structured business processes, and at the other hand, the flexibility and adaptability required for ill-structured and even ad-hoc business processes. The meta-schema shown in Figure 1 includes the concepts that we judge essential to model any kind of business processes and their supporting systems. It is represented using UML notations.

3.1. Intentional view of the enterprise

Reasoning on the enterprise objectives makes easier the understanding and the communication on essential aspects (what and why instead of who, when, where and how). According to [31], a *map* is a process model providing a non-deterministic ordering of intentions and strategies. It is a labeled directed graph with intentions as nodes and strategies as edges between intentions. The *Map* approach was applied for specifying process models in the domains of method engineering, process engineering, requirements engineering and change engineering [23], [24], [29].

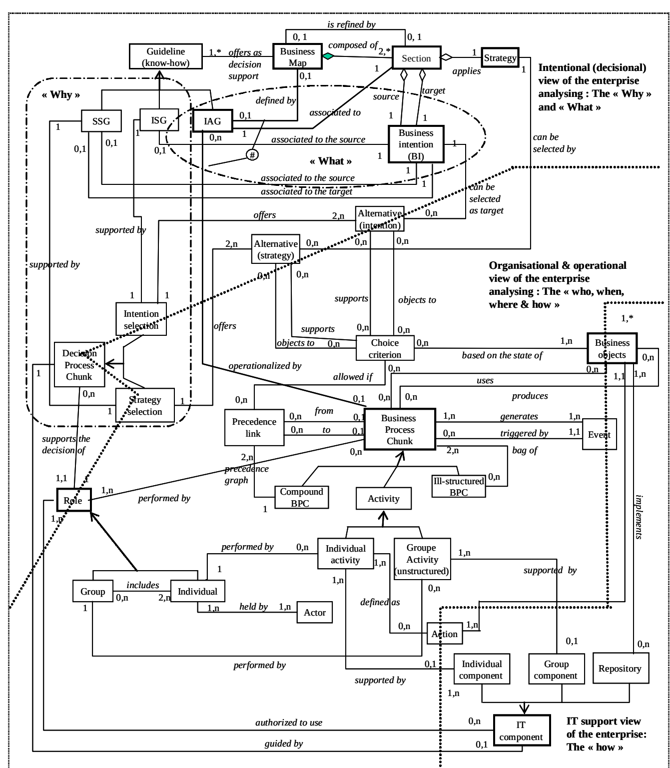
In this paper, we adopt it for representing enterprise objectives and the underlying business processes. As shown in Figure 1, a *business map* consists of a number of *sections* each of which is a triplet <source intention I_i, target intention I_j, strategy S_{ij}>. There are two distinct intentions 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*. A *business intention* expresses what the enterprise wants to achieve. It defines stable characteristics of the enterprise (disregarding the considerations about who, when and where) that any organization choice must respect.

A *strategy* is an approach, a manner to achieve an intention. The strategy, as part of the triplet <I_i,I_j,S_{ij}> characterizes 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. A target intention I_j can be achieved from a source intention I_i in different ways expressed as sections corresponding to specific strategies. In this sense the business map offers *multi-thread flows*. There might be several strategies from different intentions to reach an intention I_i. In this sense the map offers *multi-flow paths* to achieve a business intention. The business map contains a finite number of paths, each of them prescribing a way to develop the product (for instance a service to be delivered for a customer), i.e. each of them is a *Business Process Model*. Therefore the map is a *multi-model*.

Figure 1 also shows that a section of a business map can be refined as another map through the *refinement relationship*. Refinement is an abstraction mechanism by which a complex assembly of sections at level i+1 is viewed as a unique section at level i.

A decision driven business process resolves repeatedly two issues, namely, (1) how to fulfill the business intention according to a strategy and (2) how to select the right business map section to progress. Because the next intention and strategy to achieve it are selected dynamically,

Figure 1 - A conceptual framework for modeling business processes and their IT support



guidelines that make available all choices open to handle a given situation are of great importance. The map has associated guidelines, namely one *'Intention Selection Guideline'* per node I_i, except for *Stop*, one *'Strategy Selection Guideline'* per node pair $<I_i, I_j>$ and one *'Intention Achievement Guideline'* per section $<I_i, I_j, S_{ij}>$. Given an intention I_i, an *Intention Selection Guideline* (ISG), identifies the set of intentions $\{I_j\}$ that can be achieved in the next step. Given two Intentions I_i, I_j and a set of possible strategies S_{ij1}, S_{ij2}, .., S_{ijn} applicable to I_j, the role of the *Strategy Selection Guideline (SSG)* is to guide the selection of an S_{ijk}. ISGs and SSGs describe the business know-how belonging to the decisional level.

The execution of each map section is *supported by* an IAG that provides an operational or an intentional means to fulfil a business intention. For the former, the IAG is operationalized by a *business process chunk* which is a process knowledge specified in the organizational and operational level. In this case, the IAG describe the knowledge related to the production/operation aspects of the organization. For the latter, the IAG is defined as a refined map.

3.2. Organizational and operational view of the enterprise

Enterprises are structured as networks of business processes in order to achieve their objectives. Business processes (BPs) can be first analyzed in terms of *roles* played by *actors*. A *role* is the definition of an organizational intention shared by a collection of users having the same privileges and obligations. It can describe an *individual* or a *group*.

In the domain of the enterprise modeling, it is a common way to consider that operationalizable business intentions are implemented using BPs. In our framework, we consider that the *business process chunk* operationalizes a business map section (which cannot be refined any more). Accordingly, we have to describe the *roles*, which will act in order to achieve the *business intention* according to the *strategy* associated to the *section*; the *actors* holding these *roles*; the *activities* they will perform and the pre-order of these activities when the BP is well-structured. A *business process chunk* is triggered by an *event* and its execution generates events.

Actors perform *activities* that specify the smaller work steps in a BP. An *individual activity* can be defined as a set of primitive actions performed by an *individual role*.

The essential preoccupation of well-structured processes is the coordination of their component work steps. A well-structured BP is defined as a pre-order of individual activities. Using the concepts of our framework, it can be defined as a *compound business process chunk* with *individual activities*, at the lower level of the decomposition. The pre-order (sequence, parallelism and alternatives) is defined using *precedence links* and *choice criterion*. The latter is based on arguments set on the states of the *business objects*.

Organizations cannot only be described in terms of well-structured processes. An ill-structured BP is defined as an *ill-structured BPC* grouping *business process chunks* of any type.

An *ad-hoc process*, which cannot be represented in terms of flow of activities, can be specified as a non-structured *group activity* performed by a *group role*; triggered by an *event*; generating *events*; using and producing *business objects*.

3.3. IT support view of the enterprise

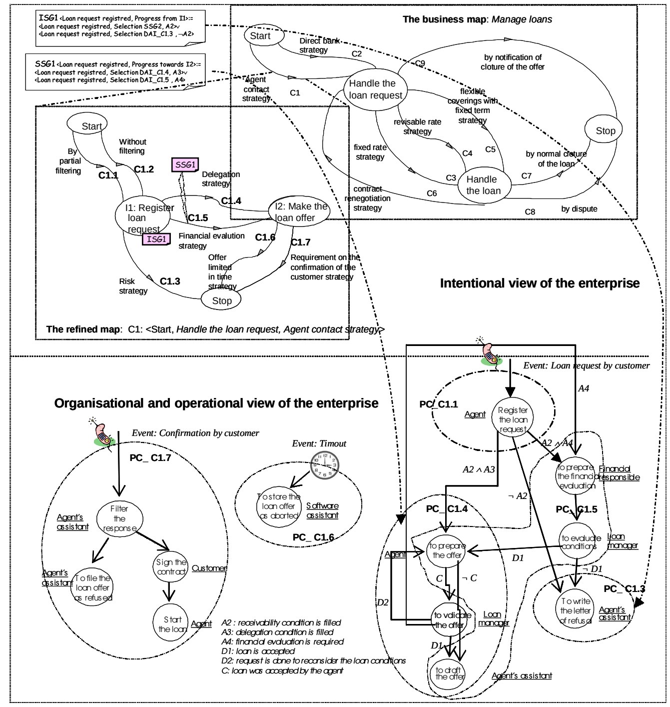
The focus of the bottom level of the conceptual framework is the IT system that has to support the BPs in order to achieve the enterprise objectives. An *individual software component* supports an individual activity and a *group component* supports a group activity.

The *individual software components* are specified thanks to the actions that define the *individual activity* at the organizational level. This corresponds to a traditional transactional activity, which performs well-identified operations on the database (*repository*). Each *action* handles a *business object*.

3.4. Example

We wish to model the loan handling process in a bank. The process is triggered by the customer request. The agent in charge of the customer sets up a file with the data corresponding to the request. The evaluation could be done either by the agent (if delegation conditions are satisfied) or by the financial department and then the loan manager. If the agent has delegation for the evaluation, the manager should validate his/her decision. The manager can either accept the agent's decision, ask him to reconsider the decision, or ask a complete re-evaluation of the request by the financial department. If the decision is favorable, the agent's assistant sends an offer to the customer. Otherwise, the assistant sends a refusal letter. The customer has to sign the offer, in the authorized time, for going on the loan handling, otherwise the offer is cancelled.

Figure 2 – An example of intentional modeling of business processes



The business map, shown in Figure 2, is specified by instantiating the concepts of the intentional level of the conceptual framework. There are two high-level business intentions in the business map of the loan domain and nine strategies are used. As shown in this business map, a loan can be handled following different ways, for instance <C1, C5, C7> or <C1, C4, C6, C8>. The map section C1 is refined by another map.

The execution of each section of the refined map (except C1.2) is supported by an IAG operationalized by a business process chunk surrounded in dotted line (lower part of Figure 2). A BPC can be an individual activity performed by an individual role. For instance, PC_C1.1 is performed by a human actor, which holds the role agent, whereas a software assistant performs PC_C1.6. A BPC can also be compound of other chunks, the composition being described using the precedence links. This is the case for the BPCs PC_C1.4 and PC_C1.5.

5. CONCLUSION

In the field of ISs, the notion of *"Enterprise modeling"* refers to a collection of conceptual modeling techniques for describing different facets of the *organizational domain* including operational (information systems), organizational (business processes, actors, roles, etc..), and teleological considerations. The intention driven modeling provides basis for understanding and supporting the enterprise objectives, the alternative way-of-workings, and when required, the reasons of change. The intentional view of the business represents the enterprise from the point of view of its objectives disregarding the considerations of the operational level. In fact, this view should be completed with the realization conditions of these objectives, i.e. taking in consideration the organizational and operational choices in order to develop the ISs and IT architectures needed by this enterprise.

Using models to represent the enterprise allows a coherent and complete 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 organizational learning.

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