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Full Length Research Paper

Investigation of the methods of the enterprise modeling

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This paper presents briefly the domain of conceptual modeling of the enterprise and the famous methods used. Some techniques present hiatuses and they are not precisely coherent or complementary for modeling the functional and decisional system of the enterprise. The objective of this paper is to show the relevance of these methods particularly for the methods of SADT (Structured Analysis Design Technique) and GRAI (Graph with Results and Actions Interrelated) in order to offer a complete and combined modeling of an enterprise.

Key words: Enterprise modeling, SADT, GRAI, complementarities of the methods.

INTRODUCTION

Because of the competition and facing changes, the enterprise must be reactive and supple. Indeed, it is indispensable to think on the upgrading or the industrial reorganization to reach a target in continuous improvement view (Mhamedi, 2003). In this context, the enterprise modeling that aims to facilitate the analysis of performances of a production system in report with its internal organization and its external environment became a requirement.

The primordial objective of the enterprise modeling is the notion of integration that aims to provide the good information, suddenly to the good place, to the good moment, under the good format in the enterprise. Besides, the modeling is an indispensable strategy to spread out the different domains of the enterprise (functional, decisional, organizational, organic and informational) of a well structured manner (Meir and Levi, 1999; Merlo, 2009).

Indeed, the modeling of an industrial system consists in defining its properties and its specifications. It is about specifying the external interactions (environment/system) and interns (functions, information, resource, etc.). In other term, a model permits the description of the reality of the enterprise (Touzi, 2006; Lauras, 2004), the appreciation of the production system and its improvement.

In this paper, first, we present the domain of enterprise modeling. Then, we present the most known and more used modeling methods. This is why these methods are classified according to their domains of utilization.

PRESENTATION OF THE ENTERPRISE MODELING

The initial research works concerning enterprise modeling that began in the 80's, drove to a very complete modeling environment that wins a large acceptance in the industry (Meir and Levi, 1999). Indeed, an enterprise is defined as a complex reality requiring a modeling to give back its environment comprehensibly (Roque, 2005).

In the domain of enterprise modeling, an enterprise is defined by the whole experienced function while using some indispensable resources (Ducq, 2008). The enterprise modeling represents the description of the organization and the operational processes of an enterprise, either in the goal to simulate these processes to compare various scripts, or in the goal to analyze them and to restructure them to improve the performance of the enterprise (Vernadat, 1996).

The enterprise modeling consists in executing models admitting the association and the explanation of different aspects and behaviors of the enterprise to reach a very

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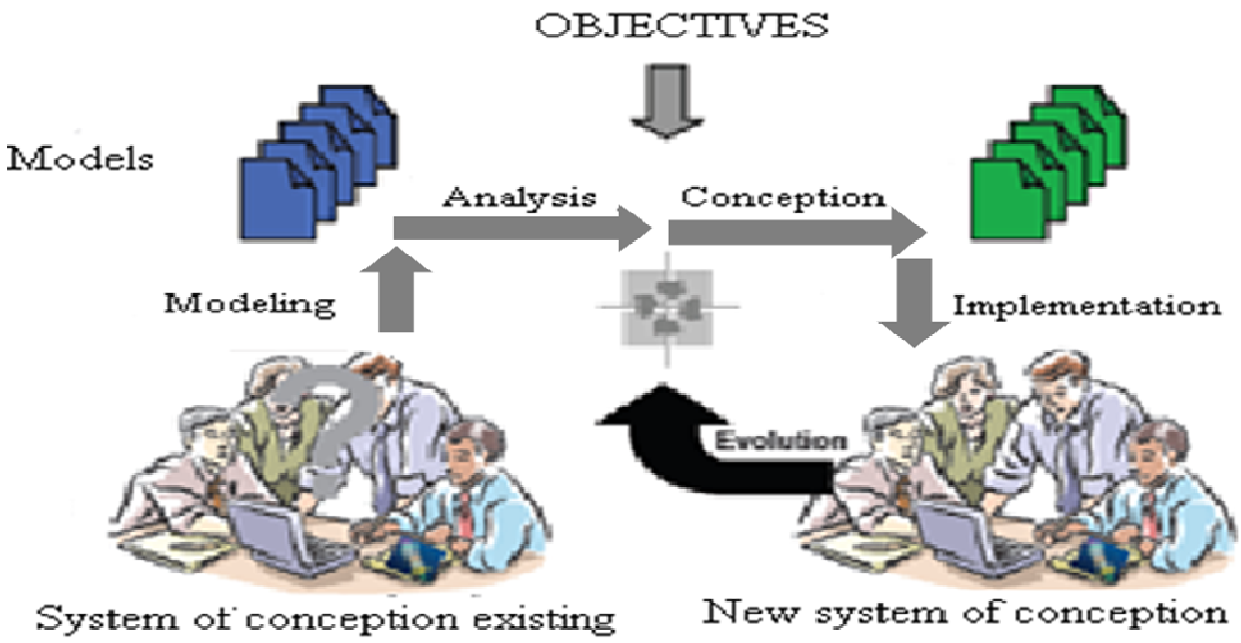

Figure1. Scientific gait of reengineering.

definite objective (Darras, 2004). Indeed, it admits the understanding and the writing of essential features of the enterprise in a systematic manner (Chapron, 2006) and plays the role of definition and writing of the quality procedures in the industrial domain. It can be seen as the process of construction of models of all or a part of an enterprise. It admits the externalization of knowledge on the enterprise, lasting all the phases of its life, that is-to-say, since its creation until its disappearance and even in case of the reuse of some of its entities to evolve (Mathieu, 2004).

The modeling permits to analyze, conceive, value, and study the evolution of a system while considering the problems of the industrial system representation (Bennour, 2004).

The modeling is a primordial stage of the reengineering gait (Figure 1) that consists to present the real world of the enterprise.

The enterprise modeling treat especially the working of a production system while valorizing the enterprise and admits the analysis of the complex networks of the virtual or extended enterprises. It is capable of answering to needs of the customers of the enterprise, to appreciate the system and improve on it so that it is necessary to contribute in the conception of the new systems in the enterprise and to implant some applicable solutions with a least cost (Roque, 2005).

This strategy leans on models presenting the enterprise and captured easily by its members. Besides, these models or methods of modeling permit retailing the behavior of the enterprise and to improve it to a reasonable manner (Bennour, 2004).

PANORAMA OF METHODS AND TOOLS OF CONCEPTUAL MODELING

The process of enterprise modeling is a structured methodological gait aiming at the representation of an enterprise while developing models or modeling languages with contribution of all actors of the enterprise in order to arrive at an identified finality (Bernus, 2007).

The application of this process requires the utilization of appropriate modeling methods (Figure 2). There are numerous methods of modeling that have been developed for a long time to explain the enterprise working. The main methods of enterprise modeling are further discussed.

Indeed, methods of modeling consist of solving a problem while using them according to the established rules and permitting to describe the evolution of an entity of enterprise. A team of method development must be composed of members having vast experience in the methodology and modeling languages. For the enterprise modeling, there are several method oriented functions (SADT, IDEF, etc.), or decisions (GRAI, GIM, etc.), or organization (GEM) or reorganization (PETRA), or information (UML, IEM, etc.), or resources (MECI, MOVES, etc.), or built-in methods as CIMOSA and GERAM. These tools or methods of enterprise modeling will be developed thereafter.

Functional modeling

The modeling oriented functions consist of describing

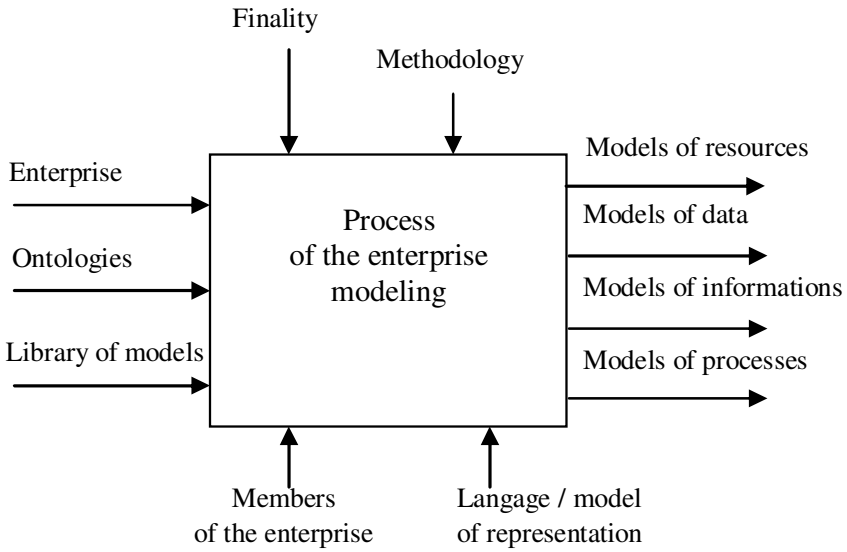

Figure 2. Process of enterprise modeling.

processes of the enterprise. They must be capable of showing interactions between these processes and to proceed to a decomposition of functions or activities (Sticklen and William, 1991). Different methods have been used for the analysis and the modeling of functions, such as, SADT, IDEF0, etc.

The SADT method has been developed by Ross (Schoman and Ross, 1977). It permits the analysis of the functions of a system put in a box graphically in a structured manner and their links represented by arrows (Jaulent, 1989, 1992). It consists of analyzing the system in sub systems and to study its processes while identifying activities, their elements of entrances, exit, and controls.

The construction of an SADT model starts with the more general description of the system. This description, restrained in only one module, can be decomposed in under-modules; each representing a component of the initial box. This process can then be iterating until obtaining the wanted detail degree. Each of the under-modules or module-son neither adds nor entrenches to the context of the father module. This decomposition is illustrated in Figure 3 and corresponds to a downward analysis of the system.

Some researchers proposed a combined approach, MERISE – SADT, which permits to study separately, and with relevance, the treatment and the homogeneous data of the system (Draghici, 1998).

Besides, some researchers used specifications of the SADT method and included them in Petri networks. It is therefore, about a combined approach Petri networks - SADT that permits the system modeling with a dynamic manner (Sperandio, 2009). The SADT method has been adopted for the analysis of the working of a SCADA system of a thermal power station (Lakhoua, 2009a), the heavy fuel-oil storage system (Lakhoua, 2009b) as well as the system of natural gas numbering of the power station (Lakhoua, 2009c). It has also been adopted for the analysis of an automated system of a grain silo (Lakhoua, 20009d).

Besides, an analysis of different methods of structured analysis used in real time applications, as well as the methods of analysis and conception, has been led (Lakhoua, 2010a, b).

The IDEF method (Integrated computer aided manufacturing DEFinition method) represents the set of functional modeling methods: IDEF0 (modeling based on activities), IDEF2 (models for the simulation) and IDEF3 (seizure of process descriptions) (Castagna, 2004).

These methods have been developed by the department of the American defense from the year 1960. The method of IDEF0 is developed while referring to the SADT method to analyze and to communicate the functional aspect of a system and to describe processes by a hierarchical model presenting decisions and activities in a system.

The method IDEF2 permits the modeling of a system functioning with waiting lines. This method answers to lacks of the method SADT/IDEF0 at the level of the dynamic analysis of a system. Indeed, it involves the model of the physical system and its control, flows of entities, and the management of resources.

IDEF3 complete hiatuses of IDEF0 concerning modeling of flows of control of the enterprise. It consists of describing processes or activities and transitions of objects used in a system graphically. On the other hand, it does not permit the management of resources and matters flows, and it is an oriented process of modeling,

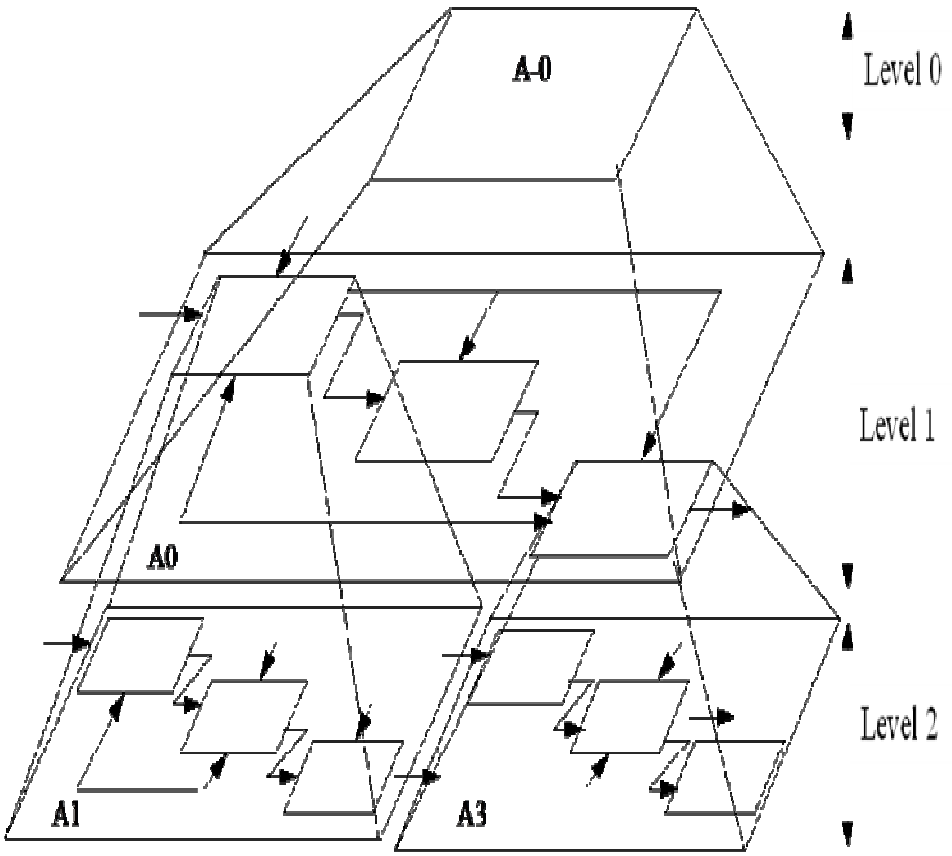

Figure 3. Structure of the SADT model.

following a well linked methodology while insisting on the logical ties. Petri nets permit the modeling of the working as well as the dysfunction of a complex system (Vincent, 2010). Indeed, they can replace the methods oriented functional modeling and those dysfunctional of enterprise. Petri nets are based on the state-transition models.

Petri nets represent the evolution of a production system graphically. They describe the state of products before and after the execution of every task. In fact, Petri nets can adjust with problems of competitions synchronism, parallelism and sharing of resources, and can treat numerous relative data to the production system.

Some researchers used the Petri nets for the modeling of a dynamic production chain while integrating the politics of maintenance (Vincent, 2010). Petri nets will be illegible in case of modeling of a complex system and they will be less understood by no experienced people.

Decisional modeling

This gait aims at the detailed description of decisions to be taken in a very definite time horizon and according to activities. In fact, the decision is about an interfacing between the strategy and the operation in the enterprise.

Methods of modeling oriented decision most known are GIM and its origin is GRAI. The GRAI method (Graph with Results and Actions Interrelated) has been developed at the University of Bordeaux. It consists of analyzing the present decisional system of the enterprise and to conceive the future system while guaranteeing the functional and temporal global consistency (Doumeingts, 1984; Roboam, 1993). It is about a matrix representing functions (in column) and time (in line) fundamental for the decision making to short, medium and long term. The GRAI model is based on theories of the complex systems and on the discreet activity theory. This approach is characterized by three elements: models of reference, formalisms of modeling and structured approaches.

The GRAI grid (Figure 4) shows the objectives and performance indicators in every decision center and admits a conceptual survey of the production system. The GRAI nets (Figure5) permits retail activities (decision and execution) of the decision center established by the GRAI grid.

The GRAI modeling is the only existing modeling that proposes a representation of the decisional structure of the enterprise. This representation is important to detect incoherencies in the coordination and the synchronization of decision making and in the dynamics of evolution of

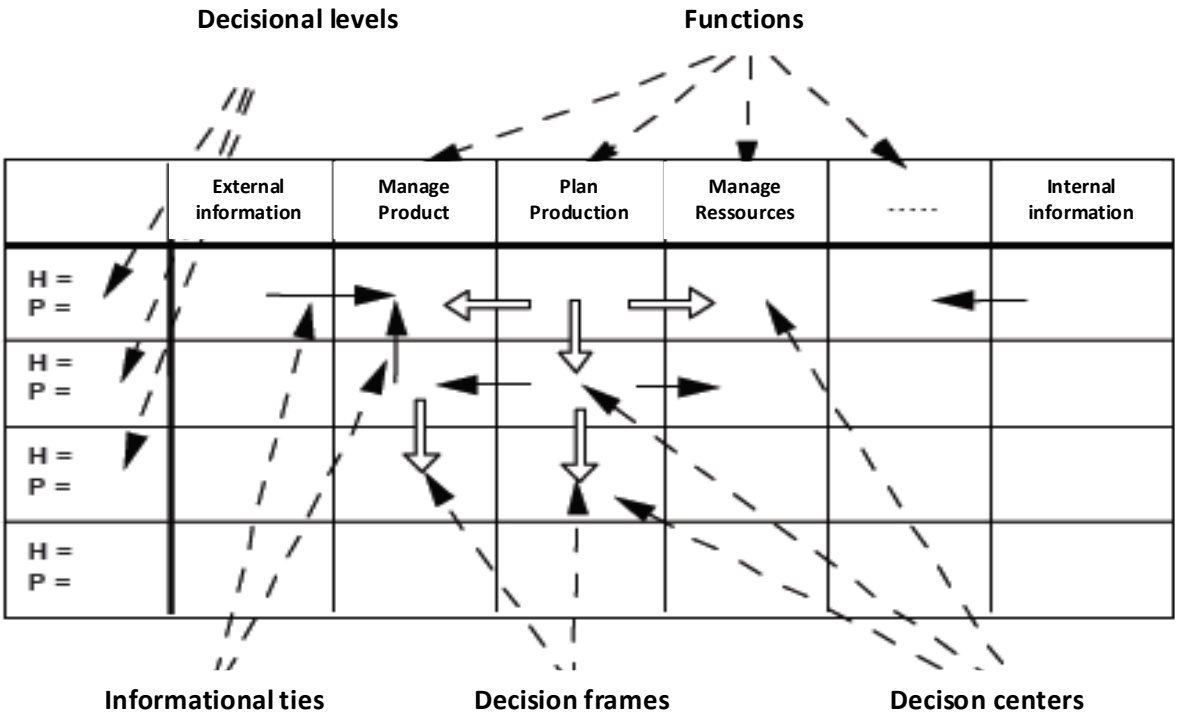

Figure 4. GRAI grid.

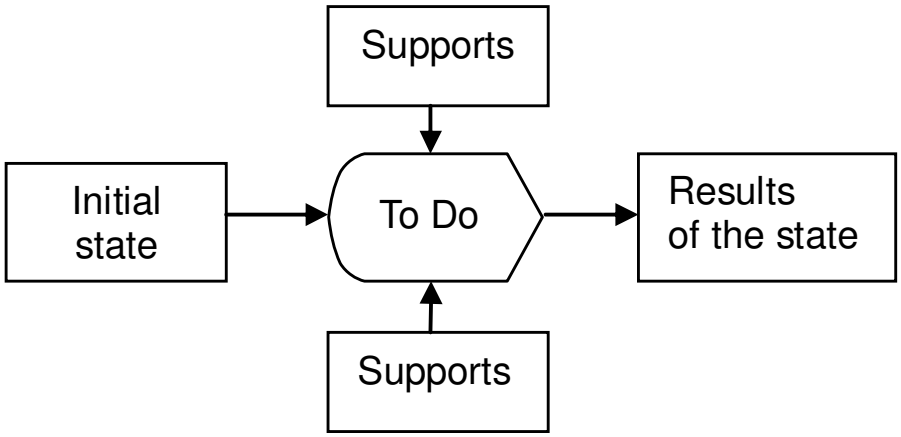

Figure 5. GRAI nets.

the enterprise.

The GIM method (GRAI Integrated Methodology) has been developed to the GRAI laboratory of the University of Bordeaux in 1988. It assured the consistency of modeling formalisms. It made references to the GRAI model to study and to improve the performance of the enterprise (Errasti, 2008).At the level of its integration, GIM presents incoherence problems and autonomies of the methods GRAI, IDEF0 and MERISE. GIM consists in representing the informational views, decisional, functional and physical of the enterprise while studying levels of abstraction. It proposes different formalisms and it permits assimilation of ideas and to hold the dialogue and exchanges between actors in order to structure a production system.

Organizational modeling

This technique of modeling involves representing and improving the organizational structure of an enterprise. The most known methods of modeling oriented enterprise organization are PETRA and GEM. The PETRA gait has

been developed to answer to upgrading or industrial reorganization. This method involves noting, analyzing and reorganizing processes, information, expertise and the enterprise organization.

PETRA has elects ideas of the GRAI method in order to manage the project of reorganization and apply the IDEF model in the phase of the functional analysis.

Resources modeling

Methods of modeling oriented resources admit the necessary resource description to the realization of an activity while taking into account constraints of affectation of these resources. Among methods of resource modeling, one considers approach multi-agents and the PERA methodology.

Approach multi-agents aim to drive a complex industrial system while following a gait of modeling of resources, or conception of functions. This method is close to a systemic analysis gait. It admits personalization and the decomposition of system in entities considered like physical agents (machines, tools, etc.) and functional (management of stock, management of the production, etc.) (Stéphane, 2001). The PERA method (Purdue Enterprise Reference Architecture) has been developed by Prof. Williams in the Purdue Laboratory for Applied Industrial Control in USA. It is a detailed methodology of engineering of an implanted industrial enterprise.

This method is neither about a global gait nor a mathematical model that requires redoing the modeling every time while using some specific methods.

Informational modeling

The architecture of information is composed of a combination of structures fixed and objects that have some short life cycles. Methods of modeling are destined to model the information system of the enterprise (Zouggar, 2006). They assure the circulation of information in the enterprise concerning processes, functions, resources, the organization, etc.

Some languages have been developed to answer to this need as UML (Unified Modeling Language), UEML (Unified Enterprise Modeling Language) and IEM (Integrated Enterprise Modeling). UML has been created after unification of three techniques of modeling OMT, Booch and OOSE. It was officially born in 1997. It is a graphic language of process modeling spread out and streamlined by Rational Software and Object Management Group. This method treated an object since its analysis until its implementation using nine diagrams (use case diagram, sequence diagram, etc.).

Some authors used the UML language for the modeling of a collaborative information system. They developed a new oriented approach that is service compatible with the UML and which permits the representation of the different views of a system (Glassey, 2007).

UML does not have of a modeling methodology that gives back its difficult training. It is weakly legible and adapted to the simulation. It can manage flows and resources in a dynamic manner temporally.

UEML is a project of network thematic financed by the union European. It has been developed to assure the exchange of information, data and knowledge between the different organisms of normalization specialized in the modeling and the integration of enterprises. It permits to represent the GRAI network while schematizing the different activities and entities (information, objectives, resources, etc.) of the enterprise.

The IEM method is a generic modeling method oriented object to describe information and functions of objects of a manufacturing system while doing reference to models IDEF0 and CIMOSA. IEM is capable of modeling discreet process and studying interactions between resources and elements of control for the activities execution. Contrary to the method IDEF0, IEM permits to present the three states of entrances and exits of an activity that are the order, the product and resources. It permits the organization processes, recording data, facilitating the production and the circulation of information easily.

IEM does not admit to represent the detailed interactions for the complex discreet systems. It presents hiatuses at the level of the problem communication between designers of the system and simulators.

Integrated modeling

This modeling technique permits to observe the organization, resources, and models of information process of the enterprise in real time and to analyze processes of the enterprise quantitatively extent. It covers all aspects of the enterprise (Talbi, 2002; Vallespir, 2003). We present two modeling tools: CIMOSA (Computer Integrated Manufacturing Open System Architecture) and GERAM (Generalized Enterprise Reference Architecture and Methodology).

CIMOSA method permits to model th different do-mains of the enterprise (resources, organization, function, information) and to conceive a system of global production of a more applicable way. Indeed, it permits to integrate two disjointed systems and to give back to them homogeneous after a semantic unification of different system concepts (Anis, 2004).

CIMOSA is the method of modeling mostly used that represents the different views and essential resources for the execution of processes. Besides, this method does not permit to schematize activities and processes and it is not adapted directly to the simulation. To this effect, it describes them while using a formal language of integrated modeling of the different aspects of the enterprise.

On the base of the famous models CIMOSA GRAI/GIM and PERA, the GERAM method has developed organized

Table 1. Survey of the relevance of methods of conceptual modeling of the enterprise.

Methods	Domain of the modeling				Consistency	Polyvalence	Simulation
	Function	Resource	Decision	Information			
SADT/IDEF0	Yes	Yes	No	No	Yes with GRAI grid	Yes	Yes
IDEF2 and IDEF3	Yes	No	No	No	No	No	Yes
Petri nets	Yes	No	No	No	Yes with UML	No	Yes
GRAI	No	No	Yes	Yes	Yes with SADT	Yes	Yes
GIM	No	No	Yes	No	Yes with MERISE	No	Yes
Multi-agents	No	Yes	No	No	Yes with UML	No	Yes
PERA	No	Yes	No	No	No	No	No
UML	No	No	No	Yes	Yes	No	Yes
UEML	No	No	No	Yes	Yes	No	Yes
IEM	No	No	No	Yes	No	No	Yes
CIMOSA	Yes	Yes	No	Yes	No	Yes	No
GERAM	Yes	Yes	Yes	Yes	No	Yes	No

concepts for the integrated modeling of the enterprise.

Validation of the coherent methods of combined conceptual modeling

This panorama of methods of conceptual modeling of an enterprise permitted the study to note the importance and relevance of the SADT and GRAI methods, having observed their consistency and polyvalence in the domain of modeling of the different aspects of an enterprise. Indeed, every method among methods presented before, present inconveniences in the conceptual modeling of an enterprise as their no consistency, their no polyvalence in this domain and their no adaptation to the simulation (Table1). This table proved the relevance and the performance of the SADT and GRAI methods that present some major advantages in the domain of combined modeling as their complementarities. Thus, it answers simultaneously to the criteria of consistency, polyvalence and adaptation to the simulation. Besides, some methods do not answer to all criteria although they are applicable in the domain of conceptual modeling. They are not about methods of combined or complete enterprise modeling.

CONCLUSION

For the fact that the industrial system modeling is complex on the one hand and the majority of methods concentrate on the treatment of information on the other hand, it is necessary to adopt a structured methodology of development. To solve this problem, the proposed gait is based on the exploitation of a systemic approach for the industrial system representation in view of its analysis and conception.

This gait leans mainly on the two methods of SADT and GRAI. The strength of the second method resides efficiently in its capacity to model decisional system of the enterprise. In this paper, the principal models used and applied concerning enterprise modeling were presented. This panorama is not finished. In fact, the new approach generation results in the elders and different model updating have been executed. This justifies the necessity to develop and use these methods.

Thus, all enterprises need to understand its internal working through the intermediary of models developed like SADT and GRAI. These complementary and coherent methods consist of specifying the different functions contributing to the decision making and analysis of the decisional system of the enterprise.

REFERENCES

Anis A (2004). Components for the modeling of the processes based on CIMOSA. LGIPM – ENIM.
Bennour M (2004). Contribution to the modeling and the affectation of human resources in the processes. Thesis. Montpellier.
Bernus P (2007). Using the globemen reference model for virtual enterprise design in after sales service.
Castagna P (2004). Contribution to the modeling, the simulation and the command of production and transit systems. Thesis. Nantes.
Chapron J (2006). The organizational urbanism: method and decision making for piloting the evolution of the information system of the enterprise. Thesis. Saint Etienne.
Darras F (2004). Proposition of a reference framework for the design and the exploitation of integrated management software. Thesis. Toulouse.
Doumeingts G (1984). The GRAI method. Thesis of the state. University of Bordeaux I.
Draghici NB (1998). The modeling and the simulation in order to pilot the production systems, Francophone study copybook. Romania.
Ducq Y (2008). Evaluation of the enterprise performance by the models. Bordeaux I.
Errasti A (2008). Engineer to order supply chain improvement based on the GRAI meta-model. London.
Glassey O (2007). Comparison of three techniques of process modeling: ADONIS, OSSAD and UML. Chavannes-près-Renens: IDHEAP.
Jaulent P (1989). SADT a langage for communication, IGL Technology, Eyrolles, Paris.

Jaulent P (1992). Software engineering the methods: SADT, SA, E-A, SA-RT… Armand Colin. Paris.
Lakhoua MN (2009a). Application of Functional Analysis on a SCADA system of a Thermal Power Plant, Advances in Electrical and Computer Engineering journal, Suceava, Romania, Issue, 2: 9.
Lakhoua MN (2009b). Application of functional analysis for the design of supervisory systems: Case study of heavy fuel-oil tanks, Int. Transactions Syst. Sci. Appl., 5(1): 21-33.
Lakhoua MN (2009c). Methodology for Designing Supervisory Production Systems: case study of a counting system of natural gas, J. Electrical Eng., 9: 3.
Lakhoua MN (2009d). Using Systemic Methods for Designing Automated Systems, Int. J. Appl. Syst. Stud., 2(4): 305-318.
Lakhoua MN (2010a). Approach of analysis of the structured methods used for real time applications, J. Comput. Sci. Control Syst., 3: 1.
Lakhoua MN (2010b). Review of Structured Analysis and System Specification methods, J. Electrical Eng., 10: 2.
Lauras M (2004). Methods of diagnostic and evaluation of performance for supply chain management. Toulouse.
Mathieu H (2004). Modeling combined of the infrastructure and the processes for the proactive administration of a distributed enterprise. Lyon.
Meir H, Levi MP (1999). First STEP Process Modeler–a CIMOSA Compliant Modeling Tool, Elsevier, p. 13.
Merlo C (2009). Information Systems supports of the actors in the design piloting. Bordeaux I.
Mhamedi A (2003). Contribution of the Projet ACNOS to the methodology PETRA. CPI2003. Meknes.
Roboam M (1993). The GRAI method: Principles, tools, gait and practice. Teknea.
Roque M (2005). Contribution to defining of a generic language of the enterprise modeling. Bordeaux I.
Schoman K, Ross DT (1977). Structured analysis for requirements definition, IEEE Trans. Softw. Eng., 3(1): 6-15.
Sperandio S (2009). Use of the multi view modeling of the enterprise for the piloting of production systems. Thesis. Bordeaux I.
Stéphane G (2001). Multi agents approach for the design and the construction of simulation environment in order to evaluate the performances of workshops multi-sites.
Sticklen J, William E (1991). Functional Reasoning and Functional Modelling, IEEE Expert: Intelligent Systems and Their Applications.
Talbi IA (2002). Analysis of the enterprise in an integrated gait. Journal Européen des Systèmes Automatisés.
Touzi J (2006). Design of a collaborative information system in an approach oriented services. Toulouse.
Vallespir B (2003). The integration in the enterprise modeling: U.E.M.L. 4eme Conférence Francophone MOSIM, Toulouse.
Vernadat F (1996). Entreprise modeling and integration. England: T.J Press Ltd, Padstow.
Vincent A (2010). Modeling, analysis and piloting of flows with UML and Petri nets. Saint-Etienne.
Zouggar N (2006). Use of ontology in the enterprise modeling by. 6eme Conférence Francophone MOSIM, Maroc.