Overview of Conceptual Modeling for Complex Systems

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Abstract. This paper presents the domain of conceptual modeling of complex systems in 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 a complex system in an enterprise. The objective of this paper is to show the relevance of these methods particularly for the functional modeling, the decisional modeling, the organizational modeling, the resources modeling, the informational modeling and the integrated modeling.

Introduction

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

The primordial objective of the system 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 automated system. 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 [1].

Indeed, the modeling of a complex automated system consists in defining its properties and its specifications. It is about specifying the external interactions (environment/system) and interns (functions, information, resources…). In other term, a model permits the description of the reality of the enterprise, the appreciation of the automated system and its improvement [2].

This work presents a review of the literature to date of the domain of the enterprise modeling. It proposes a comprehensive analysis of the theses methods.

In this paper, first we present the domain of modeling. Then, we present the most known and more used modeling methods of the system modeling. 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 drove to a very complete modeling environment that wins a large acceptance in the industry. Indeed, an enterprise is defined as a complex reality requiring a modeling to give back it comprehensible [3].

In the domain of enterprise modeling, an enterprise is defined by the whole experienced function while using some indispensable ressources.

The complex automated system modeling represents the description of the organization and the operational processes of a system, either in the goal to simulate these processes to compare various scripts, either in the goal to analyze them and to restructure them to improve the performance of the system. In fact, the modeling is a primordial stage of the reengineering gait that consists to present the real world of the enterprise.

Figure 1 presents the process of the enterprise modeling.
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 definite objective. Indeed, it admits the understanding and the writing of essential features of the enterprise in a systematic manner 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 to be-to-say since its creation until its disappearance and even in case of the reuse of some of its entities to evolve [4].

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

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 to answer to needs of the customers of the enterprise, to appreciate the system and to improve 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.

This strategy leans on models presenting the enterprise and captured easily by its members. Besides, these models or methods of modeling permit to retail the behavior of the enterprise and to improve it of a reasonable manner [5].

**Methods of the Conceptual Modeling**

The process of enterprise modeling is a structured methodological gait aiming the representation of an enterprise while developing models or modeling languages with contribution of all actors of the enterprise in order to arrive to an identified finality [6].

Conceptual models range in type from the more concrete, such as the mental image of a familiar physical object, to the formal generality and abstractness of mathematical models which do not appear to the mind as an image. Conceptual models also range in terms of the scope of the subject matter that they are taken to represent. A model may, for instance, represent a single thing, whole classes of things, and even very vast domains of subject matter such as the physical universe. The variety and scope of conceptual models is due to then variety of purposes had by the people using them. Conceptual modeling is the activity of formally describing some aspects of the physical and social world around us for the purposes of understanding and communication.

A conceptual model’s primary objective is to convey the fundamental principles and basic functionality of the system which it represents. Also, a conceptual model must be developed in such a way as to provide an easily understood system interpretation for the models users.
The conceptual model plays an important role in the overall system development life cycle. If the conceptual model is not fully developed, the execution of fundamental system properties may not be implemented properly, giving way to future problems or system shortfalls. These failures do occur in the industry and have been linked to: lack of user input, incomplete or unclear requirements, and changing requirements. Those weak links in the system design and development process can be traced to improper execution of the fundamental objectives of conceptual modeling. The importance of conceptual modeling is evident when such systemic failures are mitigated by thorough system development and adherence to proven development objectives/techniques.

The application of this process requires the utilization of appropriate modeling methods.

We present in this part the main methods of the enterprise modeling.

Indeed, methods of modeling consist in solving a problem while using them according to the established rules and permitting to describe the evolution of an entity of enterprise [7].

A team of a method development must be composed of members having a big experience in the methodology and modeling languages.

For the enterprise modeling, there are several methods oriented functions (SADT, IDEF0…) [8], [9], [10] or decisions (Graphs with Results and Actions Inter-related : GRAI, GRAI Integrated Methodology: GIM…) [11], [12], [13], or organization (GRAI Evolution Method: GEM) or reorganization (PETRA) [14], [15] or information (Unified Modeling Language: UML, Integrated Enterprise Modeling: IEM…) [16], [17], [18] or resources (MECI, MOVES…), or built-in methods as Computer Integrated Manufacturing Open System Architecture: CIMOSA and Architecture of Integrated Information Systems: ARIS. These tools or methods of enterprise modeling will be developed thereafter.

Figure 2 presents the different systems of the enterprise modeling.

Figure 2. Different systems of the enterprise modeling.

In fact, the modeling oriented functions consist in describing processes of the enterprise. They must be capable to show interactions between these processes and to proceed to a decomposition of functions or activities [19], [20].

The modeling oriented decisions aims the detailed description of decisions to take 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.

The organizational modeling consists in representing and improving the organizational structure of an enterprise.

The 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.

For the informational modeling, the architecture of information is composed of a combination of structures fixed and objects that have some short life cycles.

The integrated modeling permits to observe the organization, resources, and models of information process of the system in real time and to analyze processes quantitatively extent. It covers all aspects of the system.
Conclusion

In this paper, we presented the principals models used and applied concerning enterprise modeling. This panorama is not finished. In fact, the new approach generation results the elders and different model updating have been executed. This justifies the necessity to develop and to use these methods.

This panorama of methods of conceptual modeling of an enterprise permitted to note the importance and the relevance of the SADT and GRAI methods, seen 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.

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

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