Study and analysis of methods and techniques for control-command applications

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Abstract: - After an introduction to systemic analysis and the OOPP (oriented objectives project planning) method, we present a systems analysis methodology based on the OOPP method applied to various modeling methods and techniques: we particularly cite Petri Nets (RdP), Logic Fuzzy and the UML object-oriented modeling language This methodology made it possible to describe the exchanges of information between the different components of a system and to define the different parameters involved in the constitution of the models.

Key-Words: - Systemic, OOPP method, Petri Nets, Fuzzy logic, UML

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1 Introduction

Today, systems analysis belongs to the scientific movement which analyzes the elements of complex processes as components of a whole in which they are in a relationship of reciprocal dependence [1], [2]. Its field of study is not limited to the mechanization of thought: systemic analysis is a methodology that organizes knowledge to optimize action. The aim of the system approach is to schematize any complex whole, and to produce a model that allows you to act on it, once you've understood its material configuration and dynamic structure.

The role of systemic analysis of a production system is to define the general strategy of the modeling study to be carried out. This strategy must make it possible to precisely define the boundaries of the system to be modeled, and to specify which of the data actually exchanged between the various components of the production system will be covered by the modeling study.

The various known systemic analysis tools (AMS, Causal Analysis, SADT, OOPP, etc.) [3], [4] adopt a hierarchical analysis approach and help to answer the questions relevant to project management: What? Who? How? When? Where? Depending on the method and tool used, other parameters may be defined, such as performance indicators.

The systemic approach is a methodology for representing and modeling an active object, whether physical or immaterial, interacting with its environment through the intermediary of flows (energetic, informational or material) on which the system exerts an action. This modelling, which complements more analytical techniques, does not aim for an intrinsic truth, but only for a better understanding of the object of study for the purposes of future action. From the study of increasingly complex active objects, to the most advanced living systems, theorists have synthesized their principal characteristics: this is the systemic approach [1], [2].

In order to facilitate the use of the various system modeling methods and techniques (OOPP, Fuzzy Logic, Petri nets and UML), we have mainly exploited the OOPP method (oriented objectives project planning) [5], [6], [7]. The analysis carried out provided a decision-making tool.

2 OOPP method presentation

The OOPP method was originally based on the "Logical Framework" concept originating in the USA [5], [6], [7]. It is based on a logic of cause-and-effect analysis: if you want to achieve objectives, you need to know what the results will be. To achieve results, a number of activities are required.

The GTZ, an instrument of German development cooperation, has developed a methodology that leads to the Logical Framework, based on a process comprising five well-defined stages (participation analysis, problem analysis, objectives analysis, alternatives analysis, project planning scheme or Logical Framework). It is known as ZOPP in German and PIPO in French.

The OOPP method enables problems to be clearly defined. Representatives of the most important players take part in workshops to reach a common understanding of the problem. Not everyone's opinion is necessarily the same, so it's essential to arrive at a shared vision of the problems through debate and negotiation. OOPP contributes to this. Every idea put forward by a group member is immediately recorded in writing. Two outcomes are then possible: consensus and the creation of a joint project, or the impossibility of embarking on a project together.

The Problem Tree (Fig. 1), which represents a negative statement, can be used to build an Objective Tree (Fig. 2) by simply inverting it (transforming a negative state into a positive one), which will form the basis of any action plan.

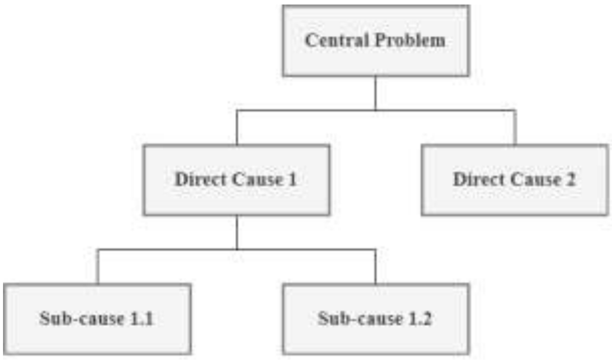

Fig. 1: Problem tree

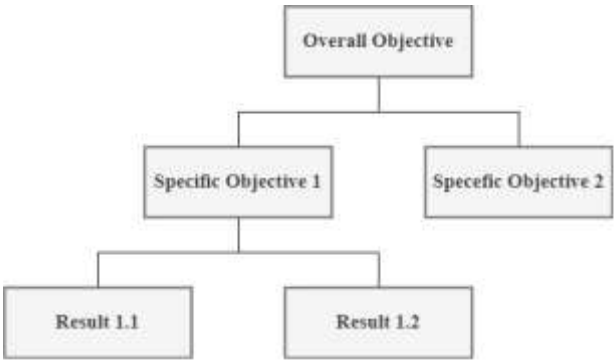

Fig. 2: Objective tree

To analyze an objective, a result, an activity or a derived activity, we always ask the question: What must be done to achieve the objective, the result or the activity identified?

The answer to this question lies in de-composing the level of analysis into lower levels.

The OOPP method is collective, transparent work, with a facilitator whose attitude does not take the side of any direct or indirect stakeholder in the project. He must not put forward any interests in the project. This attitude is essential for managing the process, particularly in the event of conflict.

3 Systems analysis methodology using the OOPP method

For the modeling approach we are proposing, the main objectives expected from a system analysis study [8], [9], [10] using the OOPP method are:

- to provide a means of communication between system operators,
- to create a performance analysis tool,
- have a decision-making support tool.

Particular attention will be paid to the information system [11], [12], [13], [14], [15], which consists, in the first stage, in determining the information environment of each activity, distinguishing between imported information (previously produced by other activities in the system) and information produced by the activity in question, which reflects the state of its execution; the latter will in turn be imported and used by the other activities in the system. The consistency of all this information ensures the robustness of the modeling. In this way, such an analysis enables the specification of an information system with a view to the subsequent development of project management and control tools, and facilitates the development phase of IT supports.

To facilitate the description of a systemic analysis using the OOPP method, we present (Table1) a linear and hierarchical analysis of activities.

N°	Code	Activity
1	OG	Systemic analysis using the OOPP method assured
2	OS1	Workshop preparation assured
3	R1.1	Rules for working in defined production workshops
4	R1.2	Organization of the production workshop
5	R1.3	Editing means of Workshop Production defined
6	OS2	Analysis of problems assured
7	R1.1	Use of a causality logic assured
8	R1.2	Achievement of various hierarchical levels of analysis assured
9	R1.3	Continuation of the analysis up to a level deemed sufficiently assured
10	R1.4	Expressing a Problem in a negative manner
11	OS3	Analysis of objectives assured

12	R3.1	Reversal of the Problem Tree assured
13	R3.2	Use of "Means – End" Relationship assured
14	R3.3	Decomposition of the level of analysis into lower levels assured
15	R3.4	Construction of the objective tree assured
16	OS4	Planning of activities assured
17	R4.1	Answer to various questions assured
18	R4.2	Determination of achievement indicators assured
19	R4.3	Development of the Activities Matrix ensured
20	R4.4	Development of the information matrix assured
21	R4.5	Determination of the cost assured
22	R4.6	Monitoring and evaluation of the project assured

Table 1: Analysis of the activities of an application of the OOPP method

4 Application to modeling methods and techniques

In recent decades, significant effort has been devoted to systems modeling, in several disciplines, particularly in Automation. Different modeling methods and techniques have been studied; which has enabled significant scientific and technological development in various fields (electrical machines, robotics, biotechnology, etc.).

It should be noted that modeling is a necessary step before undertaking any system control study. It can be carried out using three methods. The first method (analytical method) uses a theoretical analysis, that is to say that the formulation of the mathematical model is based on the universal laws which govern the system to be modeled. The resulting mathematical model is called a knowledge model. The parameters involved in this type of model have a physical meaning. The second method (experimental method) is based on an experimental analysis, where a set of measurements recorded on the system makes it possible to develop, using an identification method, a mathematical model describing its dynamic behavior. This mathematical model is called a representation model or "black box" model. The parameters used in this model have no physical significance. As for the third method (theoretical-experimental method), it enables us to formulate a mathematical model based on knowledge of experimental measurements taken on the system and theoretical information on the evolution of physico-chemical phenomena relating to the system. The resulting mathematical model is of the representation type. This third method is therefore a combination of the first and second.

Currently, representation models are the most used in controlling systems; this is due to their simplicity of practical implementation. However, their validity is limited to an operating domain determined by the learning set, while that of knowledge models is determined by the accuracy of the assumptions and the appropriateness of the approximations made during the physical analysis of the phenomena governing the system.

To facilitate the use of these different system modeling methods and techniques, we present an analysis approach based on the OOPP method to identify the various activities and provide a decision-making tool. In particular, we present an analysis of modeling methods and techniques: Fuzzy Logic, Petri Nets, and UML.

4.1 Application of the OOPP method to Petri Nets

The Petri Net approach is suitable for carrying out the control part of a project. Indeed, to simulate an operation described by a petri network, it is enough to control the successive evolutions of the markings according to the structural rules of evolution of the network [16], [17].

Petri Networks, at the origin of GRAFCET, are of great interest for flow simulation. It is made up of places and transitions. The major advantage of this representation lies in its vigor and readability, greatly facilitated by the reduced number of primitives used to construct the graph. Indeed, the Petri net graph can be used to animate the operation. The graphical Petri net editor which allows their construction is based on a user-friendly multi-window environment.

We applied the OOPP method to analyze the activities of modeling using Petri Nets (Table 2).

N°	Code	Activity
1	OG	Petri Nets modeling of the production system assured
2	OS1	Elementary modeling of the organs of the production system assured
3	R1.1	Modeling of transport organs assured
4	R1.2	Modeling of switching devices assured

5	R1.3	Modeling of handling devices assured
6	OS2	Development of a global model of the production system assured
7	R2.1	Interconnection of elementary models of production system operations assured
8	R2.3	Petri net representation of the overall model of the production system is assured
9	OS3	Programming of network state equations is assured
10	R3.1	Determination of the fundamental equation of each network is assured
11	R3.2	Determination of the variation of the arc weights of each network assured
12	R3.3	Determination of the evolution of the incidence matrix of each network assured
13	OS4	Development of a user model for the simulation of physical flows assured
14	R4.1	Development of the graphical interface of the user model assured
15	R4.2	Elaboration of controls for access to information is assured

Table 2: OOPP analysis of modeling using Petri Nets

4.2 Application of the OOPP method to Fuzzy Logic

Fuzzy logic is a new concept, which can legitimately be considered as a small revolution, at least intellectual. Like any new concept, fuzzy logic requires an effort of understanding or rather an availability of mind to resolve certain problems where mathematics struggles due to impossibility or difficulty of modeling. Fuzzy logic provides astonishing efficiency [18], [19],[20].

Le concept de la logique floue vient de la constatation que la variable booléenne, qui ne peut prendre que deux valeurs (vrai ou faux) est mal adaptée à la représentation de la plupart des phénomènes courants.

The first step in treating a problem using fuzzy logic consists of modeling each of the system's inputs by curves (membership functions) giving the degrees of belonging to different states identified for these inputs whose value varies between 0 and 1. This step is also called fuzzyfication.

After having "fuzzyfied" the input and output variables, it is necessary to establish the rules linking the inputs to the outputs. Indeed, we must not lose the final goal that we are pursuing which consists, at each moment, of analyzing the state or the value of the inputs of the system to determine the state or the value of all the outputs.

Fuzzy logic works according to the principle:
The more the condition on the inputs is true, the more the action recommended for the outputs must be respected.

The values of linguistic variables, suitably defined by the membership functions, are therefore linked together by rules, in order to draw conclusions. We then speak of fuzzy deductions, or inferences.

In this context, we can distinguish two kinds of inference rules: Inference with a single rule and Inference with several rules.

The case of inference with a single rule arises when it is necessary to compare several competitors (objects or people) in a certain situation and choose the optimal one. We find this problem mainly in non-technical areas, where a decision must be made.

We applied the OOPP method to analyze modeling activities using Fuzzy Logic techniques (Table 3).

N°	Code	Activity
1	OG	Modeling of the production system using Fuzzy Logic techniques assured
2	OS1	Application of the evaluation criteria to the system to be modeled assured
3	R1.1	Membership functions of linguistic variables determined
4	R1.2	Evaluation criteria for the system to be modeled determined
5	R1.3	Classification by evaluation criteria assured
6	OS2	Application of fuzzy controllers to the system to be modeled assured
7	R2.1	Membership functions of input parameters of fuzzy controllers determined
8	R2.2	Membership functions of output parameters for fuzzy controllers determined
9	R2.3	Inference rules for fuzzy controllers of the system to be modeled determined
10	OS3	Validation of the application of fuzzy techniques to the system to be modeled assured
11	R3.1	Validation of the application of evaluation criteria assured

12	R3.2	Validation of the application of fuzzy controllers assured

Table 3: OOPP analysis of modeling using Fuzzy Logic Techniques

4.3 Application of the OOPP method to UML

UML (Unified Modeling Language) allows you to model an application according to an object vision. Indeed, UML has several facets. It is an OMG (Object Management Group) standard, an object modeling language, a communication support, a methodological framework [21], [22].

UML fills an important gap in object technologies. It allows you to express and develop object models, independently of any programming language. It was designed to support an analysis based on object concepts. It is above all a powerful communication support, which facilitates the representation and understanding of object solutions: Its graphic notation makes it possible to visually express an object solution, which facilitates the comparison and evaluation of solutions. The formal aspect of its notation limits ambiguities and misunderstandings. Its independence from programming languages, application domains and processes makes it a universal language.

Another important characteristic of UML is that it frames the analysis. UML allows you to represent a system using different complementary views: diagrams. Indeed, a UML diagram is a graphical representation, which focuses on a specific aspect of the model; it is a perspective of the model.

Each type of UML diagram has a structure (the types of modeling elements that compose it are predefined) and conveys precise semantics (it always offers the same view of a system). Combined, the different types of UML diagrams offer a complete view of the static and dynamic aspects of a system. Diagrams therefore allow a model to be inspected from different perspectives and guide the use of modeling elements (object concepts), because they have a structure.

An important characteristic of UML diagrams is that they support abstraction. This makes it possible to better control the complexity in the expression and development of object solutions.

UML opts for the development of models, rather than an approach that imposes a strict barrier between analysis and design. The analysis and design models only differ in their level of detail, there is no difference in the concepts used. UML does not introduce modeling elements specific to an activity (analysis, design, etc.); the language remains the same at all levels of abstraction.

UML therefore not only makes it possible to represent and manipulate object concepts, it implies an analysis approach which makes it possible to design an object solution iteratively, thanks to diagrams, which support abstraction.

We applied the OOPP method to analyze the activities of UML modeling (Table 4).

N°	Code	Activity
1	OG	Modeling of the production system using UML assured
2	OS1	The preliminary study of the system to be modeled has been conducted
3	R1.1	Development of specifications assured
4	R1.2	Context modeling assured
5	OS2	Capture of the needs of the system to be modeled assured
6	R2.1	Capture of the functional needs of the system to be modeled assured
7	R2.2	Capture of the technological needs of the system to be modeled assured
8	OS3	Development of the static model of the system to be modeled assured
9	R3.1	Class Refinement assured
10	R3.2	Refinement of Associations assured
11	R3.3	Addition of the attributes assured
12	R3.4	Addition of the operations assured
13	R3.5	Optimization with generalization assured
14	R3.6	Development of the object diagram assured
15	OS4	Development of the dynamic model of the system to be modeled assured
16	R4.1	Identification of scenarios assured
17	R4.2	Formulation of scenarios assured
18	R4.3	Construction of the state diagrams assured
19	R4.4	Validation of the dynamic model assured
20	R4.5	Confrontation of the dynamic and static model assured

Table 4: OOPP analysis of a modeling by UML

5 Conclusion

In this article we presented on the one hand, the systemic analysis approach and on the other hand the OOPP method (oriented objectives project planning) which we have extended. This method made it possible to describe a modeling situation of a given system by various methods and techniques such as: Fuzzy Logic, Petri Nets, and UML. It also made it possible to describe the exchanges of information between the different components of a system and to define the different parameters involved in the constitution of the models.

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Contribution of Individual Authors to the Creation of a Scientific Article

J. El Khaldi, H. Wertani they prepared, created and presented the published work.

J. Ben Salem, formulated general aims and objectives of the research.

M. N. Lakhoua, has supervisory and leadership responsibility for the planning and execution of research activities. In addition, he prepared, created, and published the work, in particular the writing of the initial draft.

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