

^{1,3}. M.N. LAKHOUA, ^{2,3}. M. RAHMOUNI

REVIEW OF THE METHODS OF MODELING AND ANALYSIS USED FOR THE MEDICAL GUIDELINES AND PROTOCOLS

¹ ISSAT MATEUR, UNIVERSITY OF CARTHAGE, TUNISIA

² ESSTT, TUNIS COLLEGE OF SCIENCES AND TECHNIQUES, TUNISIA

³ LABORATORY OF ANALYSIS AND COMMAND OF SYSTEMS, ENIT, TUNISIA

ABSTRACT: This paper gives an overview of the methods of modeling and analyzing used for the medical framework. The use these method is an important step within the medical framework which is concerned with the quality assurance of medical guidelines and protocols. It's about four methods that have already been applied for the medical framework: SADT (Structured Analysis Design Technique), OOPP (Objective Oriented Project Planning), GRAI (Graph with Results and Actions Interrelated) and UML (Unified Modeling Language). Our objective is to show how to improve protocols and implement them in medical guidelines.
KEYWORDS: Modeling, planning, methodologies, medical framework

❖ INTRODUCTION

The modeling is the first stage of all survey centered on the engineering of a system, hospitable or no. This stage is very important because the theoretical model permits to understand the working of the system, and to determine a method of resolution according to the problem. In fact, it exists numerous methods of modeling dedicated to the origin in enterprises or industrial systems; the term "enterprise" must here be understand to the large sense, designing production systems, particularly hospitals.

The major part of the methods of conception and analysis used in the system reengineering domain rests on the same procedure: modeling of the present system permitting the realization of a diagnosis, then modelling of the system targets in order to offer objectives of the reorganization and to construct a plan of action. The modeling is an essential phase of the analysis procedure, and the appropriated tool of modeling must be selected judiciously.

The modeling of the system permits the representation of the structure and processes of the studied system. This activity is essential to understand the working of the system, to facilitate the communication with actors, to isolate the applicable performance indicators and to proceed to the simulation of the system.

The main tools of modeling and analysis in enterprise in particular for the medical framework are presented in this article. We present in this paper four tools that has already been applied for the medical framework: SADT (Structured Analysis Design Technique), OOPP (Objective Oriented Project Planning), GRAI (Graph with Results and Actions Interrelated) and UML (Unified Modeling Language).

The main part of this paper gives an overview of the methods of modeling and analyzing an enterprise particularly for the medical framework. The paper is organized as follows. In Sect. II we will give a state of the art of the methods of modeling and analysis and their application for the medical framework followed by a presentation of the methods SADT, OOPP, GRAI and UML in Sect. III and Sect. IV concludes.

❖ STATE OF THE ART OF THE METHODS

In this part, we present a state of the art of the application of the methods of modeling and analyzing in enterprise particularly for the medical framework.

Researchers Staccini & al. [1], have used a modeling technique designed for manufacturing processes (IDEF0/SADT). They enhanced the basic model of an activity with descriptors extracted from the Ishikawa cause-and-effect diagram (methods, men, materials, machines, and environment). They proposed an object data model of a process and its components, and programmed a web-based tool in an object-oriented environment. This tool makes it possible to extract the data dictionary of a given process from the description of its elements and to locate documents (procedures, recommendations, instructions) according to each activity or role. Aimed at structuring needs and storing information provided by directly involved teams regarding the workings of an institution (or at least part of it), the

process-mapping approach has an important contribution to make in the analysis of clinical information systems.

Researchers Bursztyn & al. [2], have presented a model for participatory evaluation of the Adolescent Health Program (PROSAD) in Brazil. The study focuses on the concept of participation, with a review of internationally validated planning methodologies (RAP, logFRAME, ZOPP, PCM) and the programmatic characteristics of PROSAD. The proposed model comprises 4 steps, involving the constitution of the analytical matrix, a self-evaluation workshop, a summary of results, and graphic representation. The model promotes participatory practice in health program management by using techniques that allow a workshop to be held in 70 minutes (mean time), producing results that are recognized and easily grasped by the local team.

Researcher Hill [3] has questioned the appropriateness of highly structured strategic planning approaches in situations of complexity and change, using the Cambodian German Health Project as a case study. Based on participant observation and organisational analysis in the Cambodian public health sector, the authors examine the rhetoric of values, objectives and strategies outlined in the original project documents and their assumptions and implications, and the responses to the changing political situation. Project planning had included an intensive goal oriented planning process (ZOPP) undertaken in collaboration with counterparts from the Ministry of Health, Provincial Health Departments and other bilateral, international and non-government stakeholders. Following the military action, the project was initially suspended, then substantially re-drafted within a new framework of assistance, and eventually re-established after an interval of eight months.

Researchers Fogh & al. [4], have presented complex computational analyses which are greatly facilitated by metadata standards, both in terms of the ability to compare data originating from different sources, and in terms of exchanging data in standard forms, e.g. when running processes on a distributed computing infrastructure. However, standards thrive on stability whereas science tends to constantly move, with new methods being developed and old ones modified. Therefore maintaining both metadata standards, and all the code that is required to make them useful, is a non-trivial problem. Memops is a framework that uses an abstract definition of the metadata (described in UML) to generate internal data structures and subroutine libraries for data access and data storage. The principles behind the Memops generation code have been presented, along with example applications in Nuclear Magnetic Resonance (NMR) spectroscopy and structural biology.

Researchers Pérez & al. [5], have provided a framework to enable authoring and verification of clinical guidelines. The framework is part of a larger research project aimed at improving the representation, quality and application of clinical guidelines in daily clinical practice. The verification process of a guideline is based on (1) model checking techniques to verify guidelines against semantic errors and inconsistencies in their definition, (2) combined with Model Driven Development (MDD) techniques, which enable us to automatically process manually created guideline specifications and temporal-logic statements to be checked and verified regarding these specifications, making the verification process faster and cost-effective. Particularly, UML statecharts have been used to represent the dynamics of guidelines. The proposed framework allows (1) the authoring and (2) the verification of clinical guidelines against specific requirements defined based on a set of property specification patterns, enabling non-experts to easily write formal specifications and thus easing the verification process.

Researchers Shiki & al. [6], have proposed a new business-process analysis approach, Time Process Study (TPS), which comprises process analysis and time and motion studies (TMS). TPS offsets weaknesses of TMS; the cost of field studies and the difficulties in applying them to tasks whose time span differs from those of usual tasks. In TPS, the job procedures are first displayed using a unified modeling language (UML). Next, time and manpower for each procedure are studied through interviews and TMS, and the information is appended to the UML diagram. TPS have been applied in the case of a hospital-based cancer registry (HCR) of a university hospital to clarify the work procedure and the time required, and investigated TPS's availability. Meetings for the study were held once a month from July to September in 2008, and one inquirer committed a total of eight hours to the hospital survey. TPS revealed that HCR consisted of three tasks and 14 functions. The registration required 123 hours/month/person, the quality control required 6.5 hours/ 6 months/person and filing data into the population-based cancer registry required 0.5 hours/6 months/person. Of the total tasks involved in registration, 116.5 hours/month/person were undertaken by a registration worker, which shows the necessity of employing one full-time staff. With TPS, it is straightforward to share the concept among the study-team because the job procedure is first displayed using UML. Therefore, it requires a few workload to conduct TMS and interview.

Researchers Glau & al. [7], have introduced the longitudinal organization of the patient handling called "emergency path" and it discusses the application of the company modelling methods especially the GRAI methodology in the emergency department. In fact, the emergency department in a hospital, as its name implies, is a facility to be utilized by those who require emergency medical care. The goal is to optimize these paths and to improve the quality of the patient handling while mastering the costs. The development of this model was based on the ED and three geriatrics, neurology and traumatology services. Simulation was used in this paper to assess the effects of some changes at the ED of the Medical Center of Valenciennes in France. The survey is integrated into the

regional project whose theme are the emergency paths that have just been created at the ED of Valenciennes Hospital center and will contribute to the ED service project achievement.

❖ PRESENTATION OF THE METHODS – SADT METHOD

There are many methods that have been used for the medical framework. We review some of these methods here because we think them to be fairly representative of the general kinds of methods in use. The methods include SADT, OOPP, GRAI and UML.

The SADT method [8][9] represent attempts to apply the concept of focus groups specifically to information systems planning, eliciting data from groups of stakeholders or organizational teams. SADT is characterized by the use of predetermined roles for group/team members and the use of graphically structured diagrams (See Figure 1). It enables capturing of proposed system's functions and data flows among the functions.

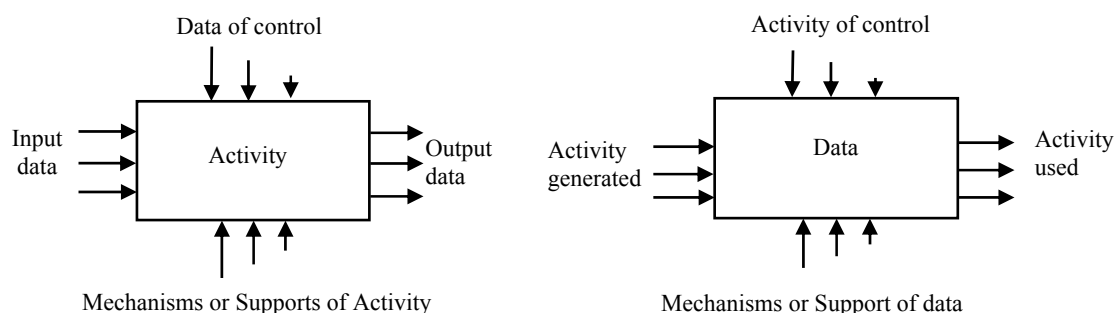


Figure 1. Organization of the SADT model

SADT, which was designed by Ross in the 1970s, was originally destined for software engineering but rapidly other areas of application were found, such as aeronautic, production management, etc.

SADT is a standard tool used in designing computer integrated manufacturing systems, including flexible manufacturing systems [10]. Although SADT does not need any specific supporting tools, several computer programs implementing SADT methodology have been developed. One of them is Design: IDEF, which implements IDEF0 method. SADT: IDEF0 represents activity oriented modelling approach (See Figure 2).

IDEF0 representation of a manufacturing system consists of an ordered set of boxes representing activities performed by the system. The activity may be a decision-making, information conversion, or material conversion activity. The inputs are those items which are transformed by the activity; the output is the result of the activity. The conditions and rules describing the manner in which the activity is performed are represented by control arrows. The mechanism represents resources (machines, computers, operators, etc.) used when performing the activity [11].

The boxes called ICOM's input-control-output-mechanisms are hierarchically decomposed. At the top of the hierarchy, the overall purpose of the system is shown, which is then decomposed into components-subactivities. The decomposition process continues until there is sufficient detail to serve the purpose of the model builder. SADT: IDEF0 models ensure consistency of the overall modelled system at each level of the decomposition. Unfortunately, they are static, i.e. they exclusively represent system activities and their interrelationships, but they do not show directly logical and time dependencies between them. SADT defines an activation as the way a function operates when it is 'triggered' by the arrival of some of its controls and inputs to generate some of its outputs. Thus, for any particular activation, not all possible controls and inputs are used and not all possible outputs are produced. Activation rules are made up of a box number, a unique activation identifier, preconditions and postconditions.

SADT method has got several advantages:

- Large field of applications such as automation, software developments, management systems and so on.
- Facility and universality of the basic concepts.
- Existence of a set of procedures, advises and guidelines.

❖ OOPP METHOD

The OOPP method also referred to as Logical Framework Approach (LFA) [12][13], is a structured meeting process. This approach seeks to identify the major current problems using cause-effect

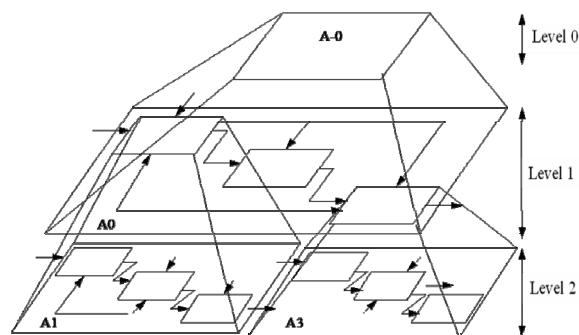


Figure 2. Top-down, modular and hierarchical decomposition of SADT method

analysis and search for the best strategy to alleviate those identified problems. OOPP method has become the standard for the International Development Project Design. Team Technologies have continued to refine the approach into TeamUP [14].

The design methodology of the OOPP method is a rigorous process, which if used as intended by the creators will impose a logical discipline on the project design team. If the process is used with integrity the result will be a high quality project design. The method is not without its limitations, but most of these can be avoided with careful use of ancillary techniques. Many things can go wrong in the implementation phase of a project, but if the design is flawed, implementation starts with a severe handicap.

The first few steps of the LFA are: situation analysis; stakeholder analysis; problems analysis [14]. In fact, the document of “Situation Analysis” describes the situation surrounding the problem. The source could be a feasibility study, a pre-appraisal report, or be a compilation done specifically for the project design workshop. Typically, the document describes the problem situation in detail, identifies the stakeholders and describes the effects of the problems on them.

The stage of “Stakeholder or Participation Analysis” is an analysis of the people, groups, or organizations that may influence or be influenced by the problem or a potential solution to the problem. This is the first step to understanding the problem. We might say, without people or interest groups there would be no problem. So to understand the problem, we must first understand the stakeholders. The objectives of this step are to reveal and discuss the interest and expectations of persons and groups that are important to the success of the project [15].

If there is no agreement between participants on the statement of the problem, it is unlikely there will be agreement on the solution. This stage of “Problem Analysis” therefore seeks to get consensus on the detailed aspects of the problem. The first procedure in problem analysis is brainstorming. All participants are invited to write their problem ideas on small cards. The participants may write as many cards as they wish. The participants group the cards or look for cause-effect relationship between the themes on the cards by arranging the cards to form a problem tree (See Figure 3).

In the step of “Objectives Analysis” the problem statements are converted into objective statements and if possible into an objective tree (See Figure 3). Just as the problem tree shows cause-effect relationships, the objective tree shows means-end relationships. The means-end relationships show the means by which the project can achieve the desired ends or future desirable conditions. Frequently there are many possible areas that could be the focus of an “intervention” or development project. The next step addresses those choices.

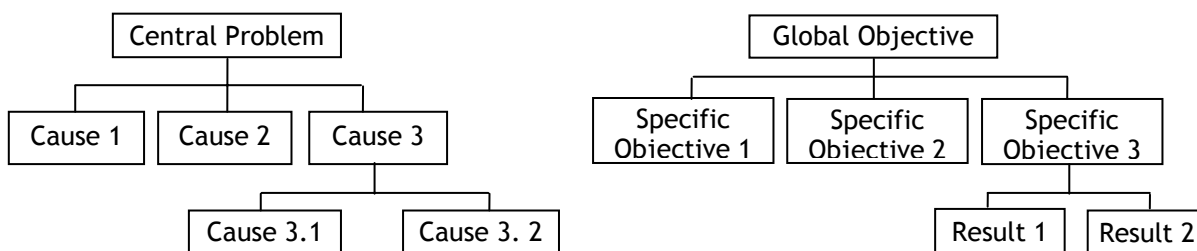


Figure 3. Problem tree and Objective tree of the OOPP method

The objective tree usually shows the large number of possible strategies or means-end links that could contribute to a solution to the problem. Since there will be a limit to the resources that can be applied to the project, it is necessary for the participants to examine these alternatives and select the most promising strategy. This step is called “Alternatives Analysis”. After selection of the decision criteria, these are applied in order to select one or more means-end chains to become the set of objectives that will form the project strategy.

After defining the objectives and specifying how they will be measured (OVIs) and where and how that information will be found (MOV) we get to the detailed planning phase: “Activities Planning”. We determine what activities are required to achieve each objective. It is tempting to say; always start at the situation analysis stage, and from there determine who are the stakeholders.

An effort has been provided in order to refine the OOPP method. In fact, the OOPP method has been spread and a new MISDIP denomination (Method of Specification, Development and Implementation of Project) was adopted [16]. The MISDIP method adopts the OOPP analysis and the complete it to specify the system of organization, to specify the system of information, and to contribute to its development and implementation.

Table 1. Information matrix associated to the OOPP method

N°	Code	Activity	Code Entity Activity	Information						
				If1	If2	If3	If4	If5	If6	If7
1	SO1		EA1	0	0	1	1			
2	R1.1		EA2		0	0		1	0	
3	A1.1.1		EA3	1	0	0	0		0	0
4	A1.1.2		EA4		1	0			0	0
	A1.1.3		EA5	0		0		0	1	0

In the MISDIP model, the matrix of information, by its constitution, can be considered like a support illustrating relations between information imported by an entity "Activity" and information produced by this last; these last information are considered then as the transformation of information imported by the entity "Activity".

❖ GRAI METHOD

Developed by the laboratory for automation and production at the university of Bordeaux-France since 1970's [17] [18]. Before developing the GRAI method, some existing works had been reviewed, notably SADT method. It was found that the decisional aspects were not very well taken into account in these methods. So, it was important for the GRAI method particularly to deal with the

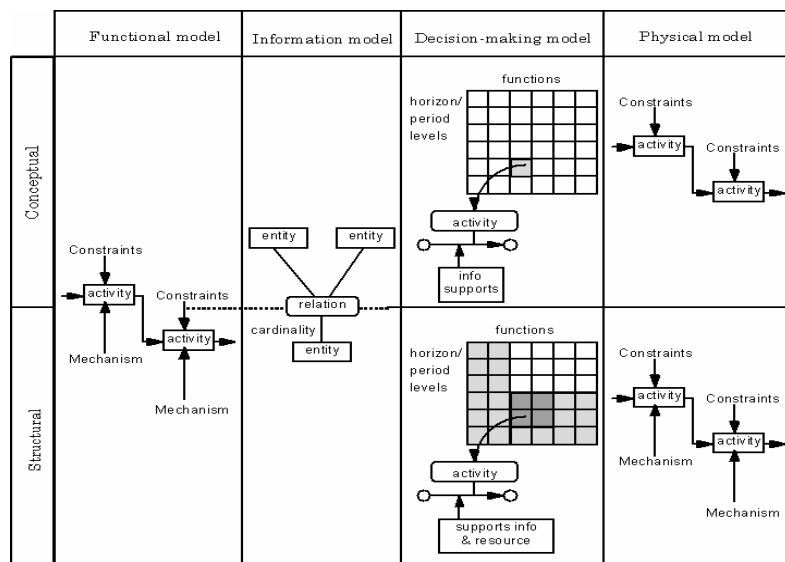


Figure 4. GIM Modeling Formalisms

decisional aspects of manufacturing systems. Based on the GRAI models, two formalisms were developed to model the macro decision structure and the micro decision centre; the GRAI grid and the GRAI nets. A structured approach was defined to show how to apply the method.

Another work performed at the GRAI laboratory was the extension of the GRAI method to GRAI-GIM (GRAI Integrated Methodology). GIM is composed of the following elements (See Figure 4):

- GRAI conceptual model: a representation of basic concepts of a manufacturing system decomposed into three sub-systems: physical system, decision and information system.
- GIM modeling framework (RA) with three dimensions: views, life cycle, and abstraction level.
- GIM structured approach: guide to show how to perform analysis and design of the manufacturing system in three main phases: analysis, user-oriented design, and technical-oriented design.
- GIM modeling formalisms (languages): GRAI grid and GRAI nets for decision system modeling, IDEF0 and stock/resource for physical system modeling, ER for information system modeling, IDEF0 for functional system modeling.

The GRAI model is a reference through which various elements of real world can be identified. The macro conceptual model is used to express one's perception and ideas on the manufacturing system which is decomposed into a decision subsystem, an information subsystem and a physical subsystem. Particularly within the decision subsystem one finds a hierarchical decision structure composed of decision centers. Decision centers are connected by a decision frame (objectives, variables, constraints and criteria for decision making) [19]. The operating system is an interface between the decision system and the physical system. The micro conceptual model is used to represent the internal elements and structure of the decision center.

GRAI-GIM contains a user-oriented method and a technically-oriented one. The user-oriented method transforms user requirements into user specification in terms of function, information, decisions and resources. The technically-oriented method transforms the user specification into technical specifications in terms of information and manufacturing technology components and the organization. The technical specification must allow the implementor to choose (buy, commission, or develop) all the components needed to implement the system. A computerized support tool known as CAGIM (Computer Aided GIM) is being developed at the GRAI Laboratory within the framework of the IMPACS project on Unix systems with X-Windows, to support the GRAI-GIM method.

❖ UML METHOD

UML is a standardized general-purpose modeling language in the field of software engineering [20]. UML includes a set of graphic notation techniques to create visual models of software-intensive systems.

UML is used to specify, visualize, modify, construct and document the artifacts of an object-oriented software intensive system under development. UML offers a standard way to visualize a system's architectural blueprints, including elements such as: actors; business processes; logical components; activities; programming language statements; database schemas and reusable software components.

UML combines techniques from data modeling (entity relationship diagrams), business modeling (work flows), object modeling, and component modeling. It can be used with all processes, throughout

the software development life cycle, and across different implementation technologies. UML has synthesized the notations of the Booch method, the Object-modeling technique (OMT) and Object-oriented software engineering (OOSE) by fusing them into a single, common and widely usable modeling language. UML aims to be a standard modeling language which can model concurrent and distributed systems. UML is a de facto industry standard, and is evolving under the auspices of the Object Management Group (OMG).

UML models may be automatically transformed to other representations (e.g. Java) by means of QVT-like transformation languages, supported by the OMG. UML is extensible, offering the following mechanisms for customization: profiles and stereotype.

UML 2.2 has 14 types of diagrams divided into two categories [21]. Seven diagram types represent structural information, and the other seven represent general types of behavior, including four that represent different aspects of interactions. These diagrams can be categorized hierarchically as shown in the following class diagram (See Figure 5).

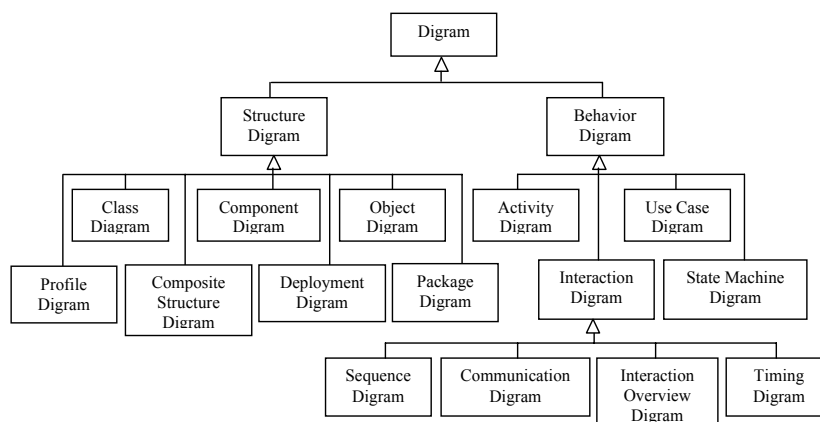


Figure 5. Different diagrams of the UML notation

❖ CONCLUSIONS

In this paper, we presented an overview of the methods of modeling and analyzing used for the medical framework. The methods include SADT, OOPP, GRAI and UML. In fact, the methods of modeling and analysis are destined to model the information system of the enterprise. They permit to assure the circulation of information in the enterprise concerning processes, functions, resources, organization...

The function model consists in describing processes of the enterprise. It must be capable to show interactions between these processes and to proceed to a decomposition of functions or activities.

The decisional model 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.

Then the use of these methods is an important step within the medical framework which is concerned with the quality assurance of medical guidelines and protocols.

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