Application of Structured Analysis Design Technique on a Pathology Process

MOHAMED NAJEH LAKHOUA[1], FATMA KHANCHEL[2]
[1]Research Laboratory Smart Electricity & ICT, SEICT, LR18ES44,
National Engineering School of Carthage,
University of Carthage,
TUNISIA

[2]Depaetment of Pathology, Habib Thameur Hospital – FMT,
University of Manar,
TUNISIA

Abstract: - To analyze processes, to improve them, to assure quality management and quality assurance, to integrate hardware and software components as well for education, training, and communication between different domains experts, analysis and modeling business processes in a pathology department is certain. The objective of this paper is to present an application of the Structured Analysis Design Technique (SADT) method in the medical framework. Then, we present the application of this method in a case study of a pathology process. Thus, the authors underline the need for system analysis of a pathology process.

Key-Words- Pathology process, SADT method, system analysis, medical framework.

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1 Introduction

Early in the system design process, a variety of design methods is usually dictated by what methods the designer has earlier used, not by an open selection process. Particular interest in the use of graphical modeling methods and techniques to aid changes in system operations and the interactions of staff to effectively build and use modeling for analysis, design, and communication of systems in the manufacturing industry.

Besides systems specification supposes two essential characteristics: temporal evolution of the system components and the system-environment interaction. Indeed, the complexity of relations between a system and its environment is especially verified in the domain of process conduct.

Among the techniques of system specification, we mention: (1) methods of analysis that permit to systematization and canalizing of the various perceptions, (2) specification languages possessing syntax and very definite semantics, and (3) simulation languages.

Structured Analysis Design Technique (SADT), which was designed by Ross in the 1970s, [1], was originally designed for software engineering but quickly additional areas of application were found, such as aeronautics, production management, etc.

SADT is a standard tool used in designing computer-integrated manufacturing systems, [2]. A significant complexity of automated manufacturing systems requires methods and tools that must allow preliminary safety analysis beginning right from the start of the design cycle, [3], [4].

There are many reasons for analyzing and modeling a pathology process, [5], [6]. A business process analysis and modeling can improve the workflow in a department of pathology; the integration of new software and hardware components; quality management; the communication with non-domain experts representing hospital units such as system administration and business administration; the educational and training, [7], [8].

The general models are reusable and can be adapted to different levels of specialization up to a specific use case and a specific situation in a pathology department, [9]. Then, the different steps of the pathology process are presented.

This paper can be loosely divided into four parts: First, we present an introduction to design process methods in particular pathology processes and second, we present the SADT method used in the design and communication of systems in the manufacturing industry. In section three, we present the application of this method in a case study of a pathology process. Then, we underline the need for system analysis of a pathology process. Finally, the last section presents the conclusion and future work.

2 Presentation of the SADT Method

As the inventor of SADT, Ross was an early developer of structured analysis methods. Through the 1970s, along with other contributors from SofTech, Inc., Ross helped develop SADT into the IDEF0 (Icam DEFinition for Function Modeling) method for the Air Force's Integrated Computer-Aided Manufacturing (ICAM) program's IDEF group of analysis and design methods, [10].

Although SADT does not require any specific supporting tools, several computer programs implementing SADT methodology have been developed. IDEF0, a function modeling building on SADT, is designed to characterize the decisions, actions, and activities of an existing or prospective organization or system, [11], [12].

IDEF0 graphics and accompanying texts are presented in an organized and systematic way to gain understanding, support analysis, provide logic for potential changes, specify requirements, and support system-level design and integration activities. IDEF0 may be used to model a wide variety of systems, composed of people, machines, materials, computers, and information of all varieties, and structured by the relationships among them, both automated and non-automated.

For new systems, IDEF0 may be used first to describe requirements and to specify the functions to be carried out by the future system. As the basis of this architecture, IDEF0 may then be used to design an implementation that meets these requirements and performs these functions. For existing systems, IDEF0 can be used to analyze the functions that the system performs and to record how these are done.

Figure 1 shows the Top-down, modular, and hierarchical decomposition of SADT.

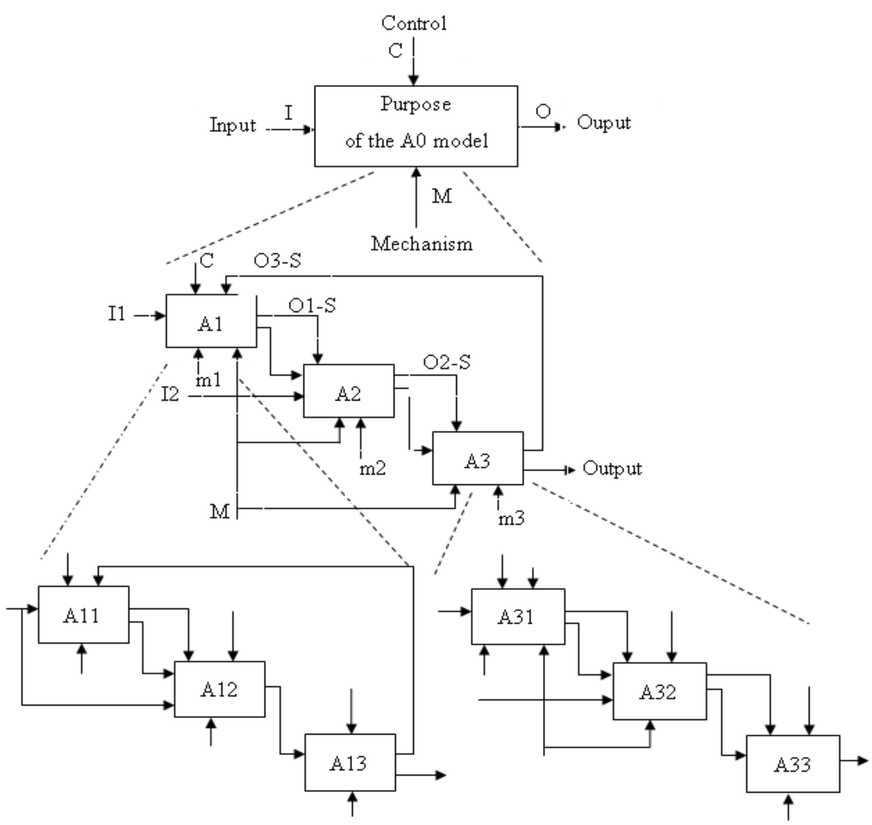

Fig. 1: Top-down, modular, and hierarchical decomposition of SADT.

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 modeled system at each level of the decomposition, [13], [14], [15], [16], [17].

Unfortunately, they are static, i.e. they exclusively represent system activities and their interrelationships, but they do not show direct 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. Preconditions and postconditions describe what is required for and what results from the activation. Both preconditions and postconditions are logical expressions of ICOM codes, where each ICOM code identifies a single control, input, output, or mechanism arrow for that particular box. When an ICOM arrow does not participate in activation, it is simply omitted from the precondition. Similarly, when some of the outputs of a box are produced during activation, the ICOM codes for those outputs not generated are omitted from the postcondition. A precondition expresses the required presence (or absence) of any of the objects associated with the inputs, controls, outputs, or mechanisms involved in the activity. A postcondition indicates presence (or absence) after the activity has occurred.

3 Case study of a Pathology Process

The model of the pathology process that we propose means to represent the different activities of the pathology process and to consider it like an information system. The number, the complexity, and the interference of information exchange taken in the study of a model need a systemic approach defining the limits of the process (through establishing communication between the outside environment) and identifying the principal activities and the parameters conditioning these activities.

Business process analysis and modeling in pathology is a quite serious communication process (Figure 1, Figure 2 (Appendix) and Figure 3 (Appendix)): the domain experts - pathologists, medical technical assistants, and secretaries have to clarify their work, related processes, and outcomes.

Recall that the techniques such as SADT are semi-formal. As a consequence, for the same subject, different correct models can be built without having to know with certitude which model is the good or, at least, the best. This kind of model allows users sufficient freedom in its construction and so the subjective factor introduces a supplementary dimension for its validation. That is why the validation step on the whole necessitates the confrontation of different points of view.

As to the SADT technique, users can follow rules or recommendations to the level of the coherency of the model, such as the distinction between the different types of interfaces, the numeration of boxes and diagrams, the minimal and maximal numbers of boxes by the diagram, etc. One intends, by coherency application of the heritage rule i.e. when data are placed at an N decomposition level, it is explicitly or implicitly present at the inferior levels. However, a complementary means to check the coherency of centigrams is a confrontation between centigrams and datagrams, which is not possible in our case.

For the SADT box, there is the function (verb to infinitive) and around this box, the associated data are specified of which the nature (input, output, control, or mechanism) appears directly.

The model of the pathology process developed is complex. The SADT method applied to this process has enabled, through its steps of analysis to understand better and better the description of this model and to facilitate after that the different expressions of relations constituting this model.

4 Conclusion

Conceptual Modeling (CM) has gained a lot of attention in recent years and it is generally agreed that CM is the most important phase of a simulation study. Despite its significance, there are many techniques that can assist in developing well-structured and concise conceptual models.

The complexity of the pathology process and the important number of information intervening in its constitution enables to elaboration of a systemic method allowing the facilitating of the system.

This kind of analysis enables to specification of the information system to elaborate a management and conduct tools of projects; then the development of the data processing supports will be facilitated.

References

[1] D.T. Ross, Structured Analysis (SA): A language for communicating ideas, *IEEE Transaction On Software Engineering,* 3(1), 1977, pp. 16-34.

[2] D.T. Ross, Applications and Extensions of SADT, *IEEE Computer*, 18(4), 1985, pp. 25–34.

[3] P. Jaulent, *SADT un langage pour communiquer*, IGL Technology, Eyrolles, Paris, France, 1989.

[4] M.N. Lakhoua, The Need for systemic analysis and design methodology of the medical equipments, *International Journal of Applied Systemic Studie*s, Inderscience, Vol.8, N°1, 2018.

[5] P. Quirke, M. Risio, R. Lambert, L. von Karsa, M. Vieth, Quality assurance in pathology in colorectal cancer screening and diagnosis-European recommendations, *Virchows Archiv* 458, 2011, pp. 1-19.

[6] F. Khanchel, N. Lakhoua, I. Helal, R. Jouini, A. Chedli, The Need for System Analysis of a Pathology Process, *Open Access Journal of Biomedical Engineering and Biosciences (OAJBEB)*, Lupine publishers, 4(1), 2020.

[7] T. Schrader, B. Blobel, M. Garcia-Rojo, C. Danial, J. Slodkowsica, *State of the Art in Pathology Business Process Analysis*, Modeling, Design and Optimization, Perspectives on Digital Pathology, (Eds.) IOS Press, 2012.

[8] M. Garcia-Rojo, C. Daniel, T. Schrader, Standardization efforts of digital pathology in *Europe, Anal Cell Pathol*, Amst, 35 2012, pp. 19-23.

[9] F. Khanchel, S. Zaghdoudi, R . Jouini, W. Koubaa, A. Chadli, E. Ben Brahim, Perception of Tunisian pathology training residents about their evaluation process: a national survey, *Virchows Archiv* 473, S145-S146, 2018.

[10] P. Jaulent, *Génie logiciel les méthodes : SADT, SA, E-A, SA-RT, SYS-P-O, OOD, HOOD*, Armand Colin, Paris, France, 1992.

[11] M. Lissandre, *Maîtriser SADT*, Editions Armand Colin, Paris, France, 1990.

[12] D. Marca and C.L. McGowan, *SADT: structured analysis and design technique*, New York: McGraw-Hill Book, 1988.

[13] D. Marca, *IDEF0 and SADT: A Modeler's Guide*. Boston: OpenProcess, Inc., 3rd edition, 2006.

[14] D. Marca, Augmenting SADT to develop computer support for cooperative work, Proceedings 13th *International Conference on Software Engineering*, 1991.

[15] A. Soltani, T. Battikh, I. Jabri, M.N. Lakhoua, A new expert system based on fuzzy logic and image processing algorithms for early glaucoma diagnosis, *Biomedical Signal Processing and Control*, Vol. 40, February 2018, pp. 366–377.

[16] M.N. Lakhoua, J. Ben Salem, M.F. Karoui, System Analysis and Information System Development of a Smart Grid, *Independent Journal of Management and Production*, Volume 13, Issue 5, 2022.

[17] M.N. Lakhoua, F. Khanchel, Overview of the methods of modeling and analyzing for the medical framework, *Scientific Research and Essays*, Academic Journals, ISSN: 1992-2248, Vol. 6(19), pp. 3942-3948, 2011.

APPENDIX

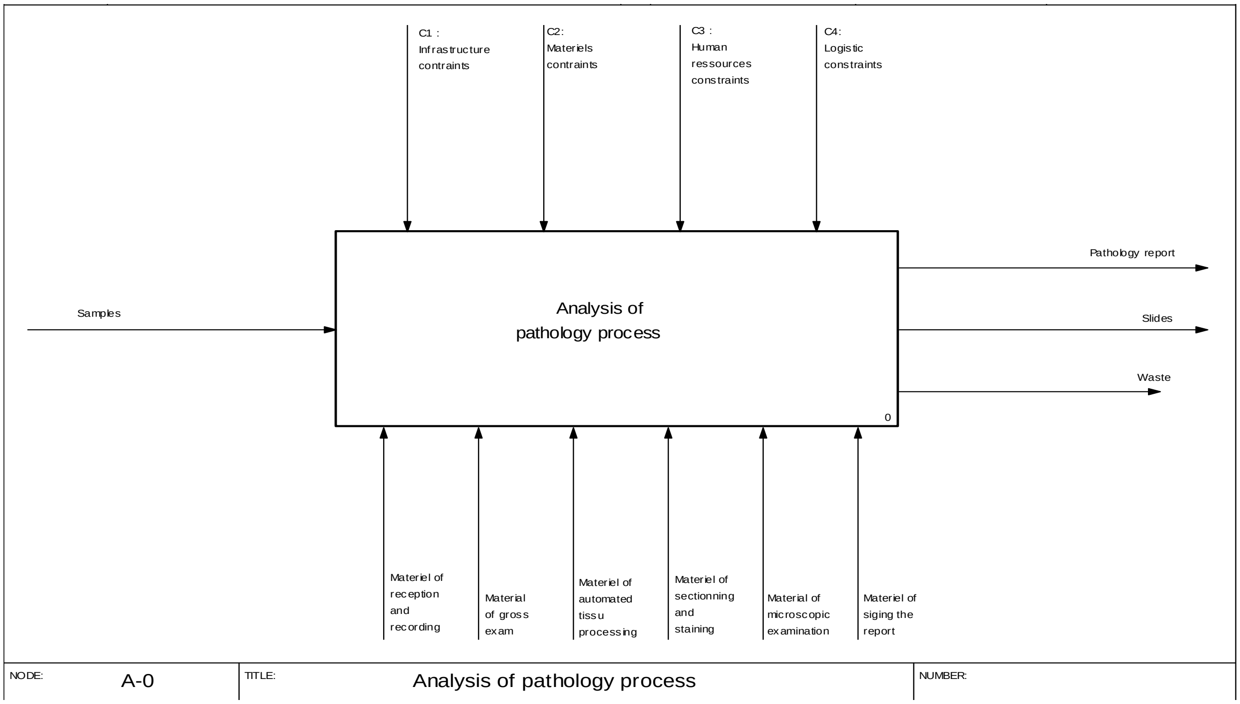

Fig. 2: Node A-0 of the SADT model

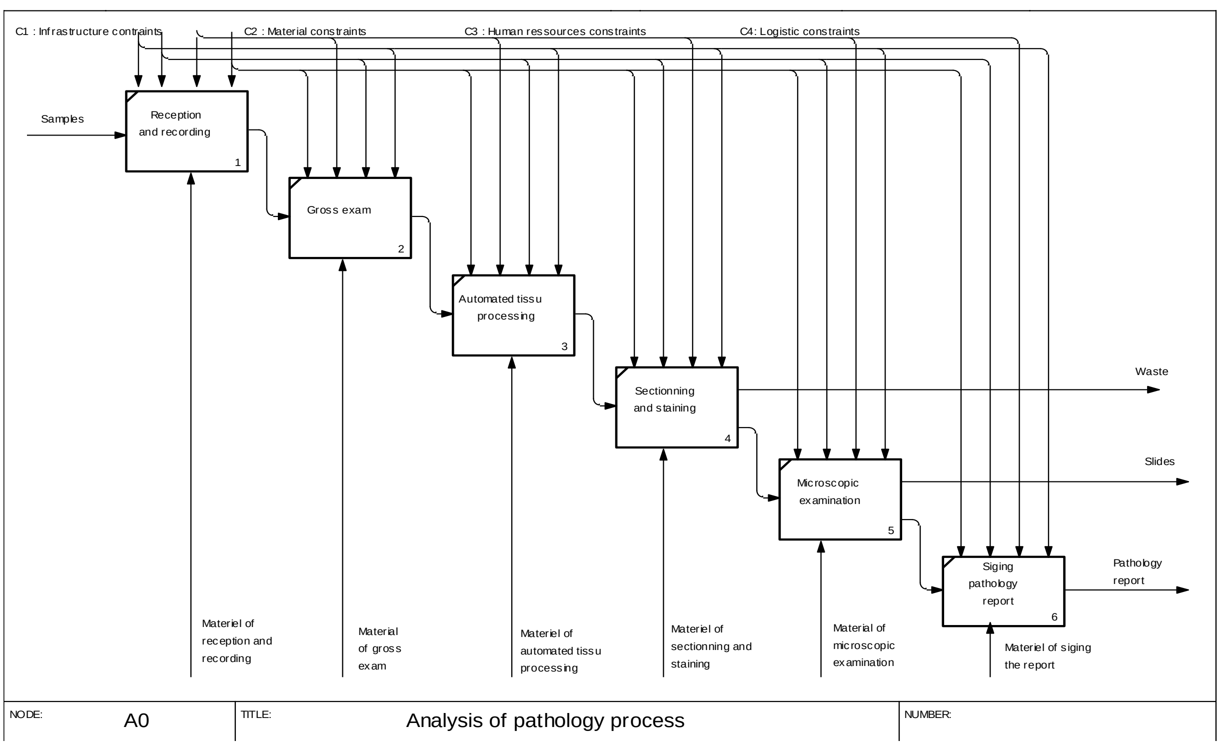

Fig. 3: Node A0 of the SADT model

Contribution of Individual Authors to the Creation of a Scientific Article (Ghostwriting Policy)

- Mohamed Najeh Lakhoua wrote and he was responsible for the scientific continuation of this work.
- Fatma Khanchel has participated in the design of the model.

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The authors have no conflict of interest to declare.

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