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SYSTEM ANALYSIS OF MEDICAL EQUIPMENTS FOR HEALTHCARE MANAGEMENT

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ABSTRACT: The diversity of the medical equipments in hospital systems requires a structured methodology of analysis in order to get perceptions and correct understandings of the internal working of these equipments. Indeed, medical equipments are intended to help the diagnosis and the medical problem treatment. They are conceived in general according to rigorous rules of security. Then, we identify various types of the medical equipments: diagnosis, therapeutic, vital, monitors and laboratory equipments. To answer to this problem, the proposed methodology is based on the use of a systemic approach in order to analysis various medical equipments. This is why it is necessary to identify the rigorous security rules of various medical equipments as well as all the technical aspects related to their conception and development systems based on electronics and data processing.
Keywords: healthcare management, medical equipments, system analysis, anesthesia respirator

1. INTRODUCTION

The medical equipments represent health products and they are little or poorly known, particularly to the general public. It is difficult to give a precise definition or simply to represent what they are. However, medical equipments are an integral part of our health care system and they are present in a hospital where they are found as well at the level of the patient's room to the operating block, home, ambulatory care...

In parallel, the medical equipments industry is a complex sector, due to the diversity of products and technologies implemented. The fields of application are varied and the multiplicity of equipments is at the origin of various activities [1]. In addition, progress over the last decade in areas such as electronics, information technology, materials, had direct consequences on the supply of care being the source of more and more sophisticated techniques. Therefore, the equipment industry saw its field of activity to expand. This sector has a strategic position within the health systems organization and contributes to the quality of life of the patient as well as to the reduction of mortality.

Medical equipments are instruments, devices or software intended by the manufacturer to be used in humans for the purpose of diagnosis, prevention, control, treatment administration, mitigation of symptoms or care for an injury. Furthermore, medical equipments are designed to help the diagnosis and treatment of medical problems. They are generally designed according to strict safety rules [2] [3]. Indeed, one can identify different types: diagnostic equipment; therapeutic equipment; vital equipment; medical monitors and medical laboratory equipment.

The complexity and the diversity of the medical equipments require a scientific methodology of analysis and the majority of the methods focus on processing information, even though it does not allow obtaining the perceptions and correct understanding of the functionality of these equipments [4].

To address this problem, the proposed approach is based on the use of the systemic analysis methods in order to represent the medical equipment working.
The object of this paper consists in the proposition of a methodology of analysis of the functionality of the medical equipments. It intends to analyze the relevance of the model achieved relatively to different functions, on the one hand and to study the technical aspects bound to the conception and the development of the medical equipment based on electronics and data processing, on the other hand.

2. MATERIAL AND METHODS

The systemic approach, sometimes named systemic analysis, constitute a relative interdisciplinary field to the survey of objects in their complexity. It permits to fear an object of survey in its environment, in its working, in its mechanisms and in what doesn't appear while doing the sum of its parts [5] [6].
In this part, first we present the case study of the medical equipment that we propose to analysis its functionality. It is about an anesthesia respirator (DRAGER mark; FABIUS type). Second, we present two methods OOPP (Objective Oriented Project Planning) and SADT (Structured Analysis Design Technique).

2.1. Presentation of anesthesia respirator

In this study, we have identified five basic types of the medical equipments:

- Diagnostic equipments such as ultrasound, MRI, radiation CT scans...
- Therapeutic equipments such as the infusion pumps, medical lasers and surgical devices…
- Vital equipments used to maintain bodily functions of the patient: medical ventilator, ECMO, and dialysis device.
- Medical monitors that allow the medical team to measure the patient's medical condition such as ECG and EEG.
- Laboratory equipments such as electron microscope, operating microscope, scanning microscope…

There many facilities in surgery according to the type of the act achieved. We present few examples of facilities: respirator of anesthesia; surgical endoscopy; electric lancet; cold light source; surgical vacuum cleaner; surveillance monitor; defibrillator; operating table; electronic insufflators; oxygen extractor; electrocardiogram [7-10]...
At the time of a surgical intervention under general anesthesia, the patient cannot breathe anymore by himself. The anesthesia respirator (Figure 1) permits it to breathe automatic manner, while delivering the product anesthetizing. This respirator is a device controlling the ventilation of the patient electronically; it delivers to the patient a composed sparkling mixture of oxygen, air and monoxide of nitrogen (gas loosening the muscular tone).

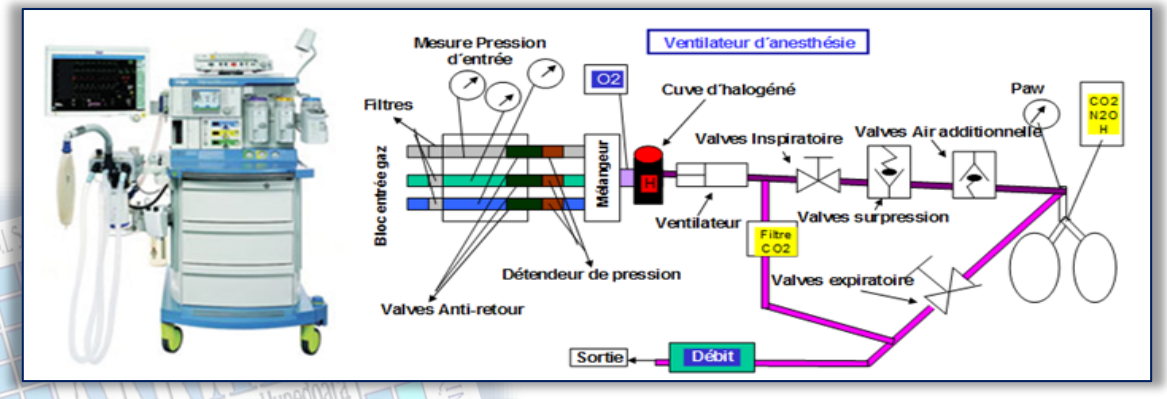

Figure 1. Principle of the anesthesia respirator (DRAGER mark; FABIUS type)

2.2. OOPP method

The OOPP method which is also referred to Logical Framework Approach (LFA) is a structured meeting process. This approach is based on four essential steps: Problem Analysis, Objectives Analysis, Alternatives Analysis and Activities Planning. It seeks to identify the major current problems using cause-effect analysis and search for the best strategy to alleviate these identified problems [11-13].
The first step of "Problem Analysis" 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 (Figure 2).

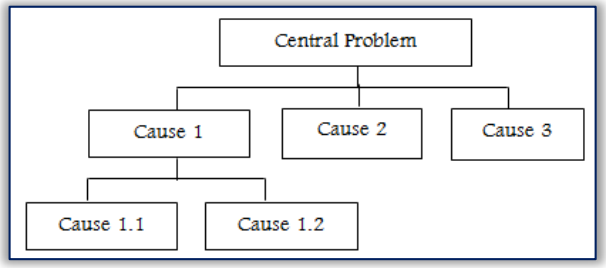

Figure 2. Problem tree of the OOPP method

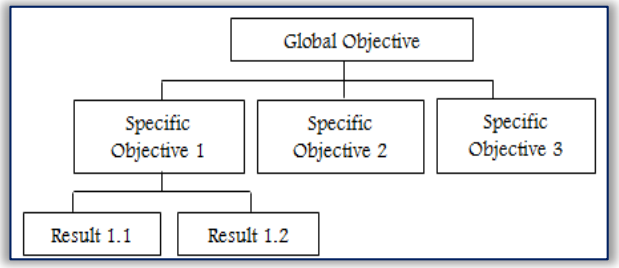

Figure 3. Objective tree of the OOPP method

In the step of "Objectives Analysis" the problem statements are converted into objective statements and if possible into an objective tree (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 [14], [15], [16]. 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 (Objectively Verifiable Indicators: OVIs) and where and how that information will be found (Means of Verification: MOVs) 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.

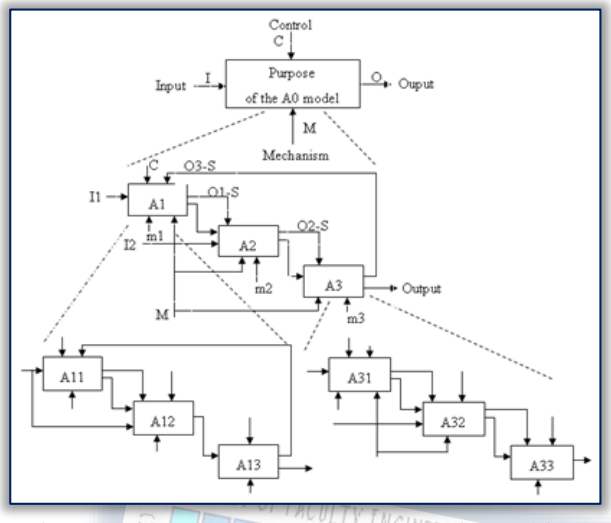

Figure 4. Top-down, modular and hierarchical decomposition of SADT method

2.3. SADT method

The SADT method 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. It enables capturing of proposed system's functions and data flows among the functions [17], [18].

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 [19].

SADT is a standard tool used in designing computer integrated manufacturing systems, including flexible manufacturing systems. 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 modeling approach.

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 [20]. The decomposition process continues until there is sufficient detail to serve the purpose of the model builder (Figure 4).

4. CONCLUSION

In this paper, we presented a methodology of analysis of the medical equipments in a hospital system using the methods OOPP and SADT. A case study of the anesthesia respirator was

presented. In fact, the OOPP analysis enables us to identify the various medical equipments. Then, the SADT analysis elaborated was permit to model the structure of the anesthesia respirator. These two models are decomposed in hierarchic and structured manner and they permit to assure the effective communication between all the users of the system.

Finally, it seems important to continue this study in order to make procedures of maintenance of this analysis and to spread the system approach to all the processes and the equipments in a hospital system; this will give the evaluation and the improvement more easy and efficient.

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