ANNALS OF FACULTY ENGINEERING HUNEDOARA
– INTERNATIONAL JOURNAL OF ENGINEERING
Tome X (Year 2012) – FASCICULE 3 (ISSN 1584 – 2673)

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COMPLEMENTARITIES OF THE METHODS OF THE ANALYSIS OF THE PROCESS SYSTEMS

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ABSTRACT: *Of the fact of the complexity of the modeling of the process systems on the one hand, and the majority of the methods of analysis and conception concentrates on the treatment of information on the other hand, it is necessary to adopt a structured methodology of development. The object of this paper is to propose a gait based on the exploitation of a global analysis approach for the representation of process systems in view of their analysis and their conception. This approach is based on the combined approach of the system analysis methods and the risk management methods.*
KEYWORDS: *Process systems, system analysis, risk analysis, methods*

INTRODUCTION

Today enterprises operate in a market in constant evolution, characterized by cycles of more and shorter product life, a demand increased of flexibility and the frequent changes of techniques and technologies.

In order to master these factors of complexity, the enterprise modeling became a primordial preoccupation, as attests it the whole of works led in this domain since the middle of the XXe century. Indeed, the modeling is indispensable for the understanding and the analysis of phenomena in the case of the industrial systems. Such system conduct also rests on the utilization of models. These models must give account of the structure and the behavior of the system and must permit the analysis of its qualitative and quantitative properties [DUC 08] [LAU 04].

We consider two modeling types:

- *the enterprise modeling, that is relative to the expression of needs;*
- *the behavior modeling, that is relative to the specification of properties of the system.*

The fact of the complexity of a process system and the interdependence of its various functions, its analysis and its conception cannot achieve themselves only according to a global approach. This is why the gait proposed to lead such an action is a systemic gait. A systemic and participative approach is interesting to facilitate the modeling of the process system. In this perspective, a previous consists in studying this systemic approach proposed in the literature and that will be kept in this work.

This paper is organized as follows: Section 1 presents the enterprise structure and the process systems. Section 2 puts the accent on the contribution of an approach of global analysis of the process systems. Section 3 presents the main methods of analysis and conception. Section 4 presents the risk management methods. Finally, section 5 presents the conclusion and some perspectives of this research work.

PRESENTATION OF THE ENTERPRISE STRUCTURE AND THE PROCESS SYSTEMS

An enterprise is an economic and social structure that regroups the human means, materials and financiers. Indeed, the enterprise combines and remunerates some necessary production factors to the creation of possessions or services. The enterprise searches for the productive efficiency that is the most efficient productive combination [ROQ 05].

This efficiency of the productive combination is measured thanks to the fruitfulness. The objective of the enterprise is to improve its fruitfulness to increase its profitability.

According to Bennour, the enterprise modeling is the interaction of the different modeling languages and the enterprise methodologies [BEC 04] (Figure 1).

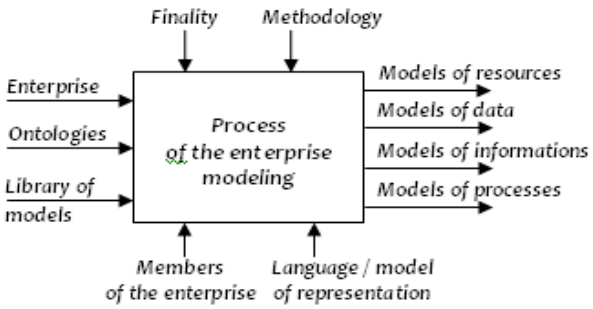

Figure 1. Process of the enterprise modeling

The process system is a key element to increase the fruitfulness and the competitiveness of the industrial enterprises. Indeed, a process system is all transformation of a whole of raw materials or components semi-finished in finished products (Fig.2) while answering if need be for the customer and

satisfactory of the various constraints (delay, cost, competitiveness, customer service, presentation, communication...) [BRO 87].

The process system puts the accent on the notion of the production that is one of the economic activities the more old and traditional in the evolution of the humanity. Several researchers define the production as being a transformation of resources belonging to a productive system and driving to the creation of possessions and services. Resources can be facilities, men, matters (raw materials and components), the technical information or procéduraleses (ranges, nomenclatures, operative cards...) [GAU 00].

The process system can be modeled under three subsystems:

- *The conception system that conceives some new products, modify and improve products already made and conceives manufacture tools.*
- *The management system that permits the production management, the organization and the stocks management.*
- *The manufacture system that manufactures the product from the well stocked data by the subsystem of conception (manufacture documents).*

In order to model a process system, it is important to have a good management of the production that is destined to apply methods and techniques in the goal to accomplish the transformation of matters in finished product. It is the material means combination, human and of raw materials to assure the manufacture of products in quality and in quantity.

The process of production makes part of a coherent chain permitting to assure the satisfaction of the customer and a profit in the enterprise. This process can be described through the following stages:

- *Survey of the external environmental: choices, existing products and demands.*
- *Definition of customer needs in relation to the existing product.*
- *Survey of the product in scientist its cost, the quality and the quantity asked to assure needs of customers.*
- *Realization of the product by the identification of production means, the determination of raw materials and the implantation of means.*
- *Manufacture with its production phase and its control phase.*
- *Insurance of the service after the sale.*

The fast evolution of the process system in enterprises is, of the fact, that the system of production or lines of production have been automated entirely. This evolution has been advanced to the year 2000, by the existence of the harmonization of the human operators and the automatic machines what should be a human process system [HAT 07].

Indeed, an automated process system is a means to assure the objective primordial of an enterprise and the competitiveness of its products. It permits to add a value to the incoming products.

The notion of the automated system can apply to a freestanding machine as well as to a unit of production, or even to a factory or a group of factories. It is therefore indispensable, before all analysis, to define the border permitting to isolate the automated system studied of its outside.

GLOBAL APPROACH OF ANALYSIS

The XXe century knew an important change of method: the apparition of the systemic paradigm, coming to complete the causal paradigm. How the knowledge of the structure of a system proves to be more interesting than the detailed knowledge of its initial conditions in of other terms, in the objective to foresee its behavior [LAN 94].

In the world of business, the tendency is to adapt global approaches of management, synthetic or systemic to replace the traditional analytic approach. This last consists in subdividing a complex problem in a certain number of small problems [MEL 90]. Each of these is then easily resolute and the global solution of the problem is considered, to harm, as being the sum of small problem solutions. The division of work is a demonstration of the analytic thought. In the case of simple situations, when the concerned parts are independent, the analytic approach is very applicable. However, it proves to be inefficient if parts have some complex relations between them or with other elements. The solution of a part can, in the case of the analytic approach, to take to an under-optimization that is to the optimization of a part at the expense of the all. Indeed, the understanding of mechanisms that governs systems is a common preoccupation to the analysis and the systemic approach.

The systemic analysis, also called system analysis, uses a model established on the basis of features and open system properties. It comes back, in a way, to make bring in the reality in a normalized mold, the one of the systemic model. This tool is especially adapted to understand and to optimize the working of a process of production of flux of matters, energy or information. Besides, it permits one fashion of apprehension and common understanding to the analysis and the decision. It serves as a reference to make some graphic modeling.

The systemic analysis belongs today informed scientific that analyzes the complex process elements as components of a whole where they are in reciprocal dependence relation. Its field of survey doesn't limit itself to the mechanization of the thought: the systemic analysis is a methodology that organizes knowledge to optimize an action.

The objective of the system approach is to schematize a complex system, to lead to a modeling that permits to act on it, after one understood its material configuration and its dynamic structure [CAV 94].

The systemic analysis encourages the acquirement of knowledge and permits to improve the efficiency of actions. Indeed, it brings to clear some intended general rules to understand these systems better and to act on them.

The systemic analysis of a process system has for role to define the general strategy of the modeling survey to achieve. This strategy must permit to fix a way specifies limits of the modeling, while defining borders of the system to model, and to specify among data that are really exchanged between the different components of the process system, and those that the survey of modeling is going to cover.

Under the appellation of system analysis, one finds a diversity of methods, languages and symbolism that all propose some representations of organizations and the problematic in game.

The systemic approach, as for it, is a global gait that answers to a demand of change, and no a systematic approach that analyzes of sequential manner all elements of a system, or a method of change or a tool of communication. It is a methodology that permits to gather and to organize knowledge in view of a bigger efficiency of the action [MEL90]. It leans on the notion of system and includes the totality of the elements of the studied system, as well as their interactions and their interdependences.

Contrary to the systemic analysis, the systemic approach takes a print of the reality to reveal all its specificity of it. Says otherwise, if the systemic analysis applies its own and unique model on all organization for in to translate the working better, the systemic approach rather endeavors to reveal the specific configuration of the system to consider in the goal to come with the change.

Thus, at all system to human components and all unit of transformation can be looked through the systemic model. As we already saw him, the organization of the system can be retailed in terms of subsystems until the elementary level that one considers like a black box. According to the objective of the observation, the black box can be situated to a superior level to the one of the element; it is a part of the system whose observer is unaware of the internal working voluntarily to only fear its entrances and its exits.

The systemic approach doesn't consist in looking of systematic manner at an organization through models, but well to make emerge the specific model of this organization following the logic of the system to which it belongs. It means that one interests itself by no means to the institutional systems but to the real exchanges. It is a global gait that answers to a demand and no a systematic approach that examines of sequential manner all elements of a system, or a method of communication or again a method of change. Difficulties of this systemic approach are rather attached to the process of requisite information collection to have a complete vision of a global and complex system.

METHODS OF ANALYSIS AND CONCEPTION OF THE PROCESS SYSTEMS

Methods of analysis and conception provide the notations standard and the convenient advices that permit to lead to the reasonable "conceptions", but one will always make call to the inventor's creativeness [LAR 94].

It exist different manners to sequence these methods [STR 96]:

- *the distinction composition / decomposition: puts on the one hand in opposition the ascending methods that consist in constructing a software by composition from existing modules, and on the other hand, the downward methods that analyze the system until to arrive to the programmable modules;*
- *the functional distinction / oriented object. In the functional strategy a system is seen like a whole of units in interaction, having each a clearly definite function. Functions arrange a local state, but the system has a shared state, that is centralized and accessible by the whole of functions. Strategies oriented object consider that a system is a whole of objects interacting. Every object arranges a whole of attributes describing its state, and the state of the system is described (of decentralized way) by the state of the whole.*

The functional methods find their origin in the procedural languages [STI 91]. They put in evidence the functions to assure and propose a downward and modular hierarchical approach.

The functional methods use the successive sophistications intensively to produce specifications whose main thing is under graphic notation shape in diagrams of data streams [ATT 96]. The highest level represents the whole of the problem. Every level is decomposed then while respecting

inputs/outputs of the superior level [STI 91]. The decomposition continues until to arrive to the controllable components.

In a structured analysis method, the highest level is called context diagram. A box of the data flow diagram represents a process and must be decomposed [MAR 92]. Every process (or treatment) no decomposed is described by a mini - specification; a dictionary specifies the definition of data, processes and zones of storage.

Structured analysis methods are generally static and don't take account of constraints of time and synchronization. Extensions have been brought to this effect by one addition of the control flow diagrams and the specifications of control: information of activation; deactivation of processes and the utilization of states - transitions diagrams.

The modeling oriented function consists 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 [STI 91].

Different methods have been used for the analysis and the modeling of functions as: SADT, IDEF0, SA-RT…

The SADT method has been developed by Ross in 1977 [ROS 77]. It permits to analyze graphically and of a structured manner the functions of a system put in a box them and their links represented by arrows [JAU 89; JAU 92]. It consists in analyzing the system in sub systems and to study its processes while identifying activities, their elements of entrances, exit and controls.

The construction of an SADT model, start with the more general description of the system. This description, restrained in only one module, can be decomposed in under-modules; each representing a component of the initial box. This process can then be iterating until obtaining of the wanted detail degree. Each of under-modules or module-son does not add anything either entrenches to the context of the father module. This decomposition is illustrated by the figure 3 and corresponds to a downward analysis of the system (Figure 2).

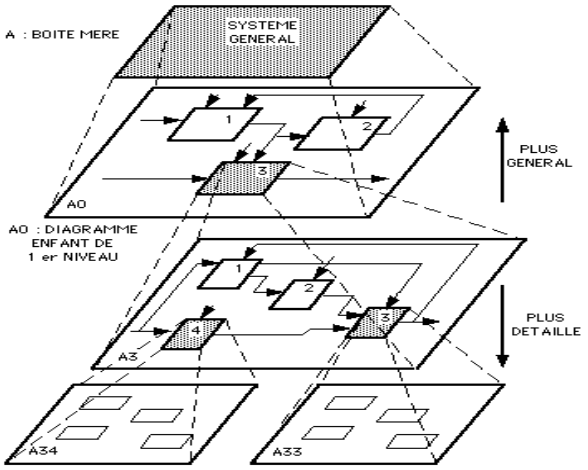

Figure 2. Structure of the SADT model

Some researchers proposed a combined approach: MERISE - SADT that permits to study separately and with relevance the treatment and the homogeneous data of the system [DRA 98].

Besides, some researchers used specifications of the SADT method and included them in Petri networks. It is therefore, about a combined approach Petri networks - SADT that permits the system modeling with a dynamic manner [SPE 09].

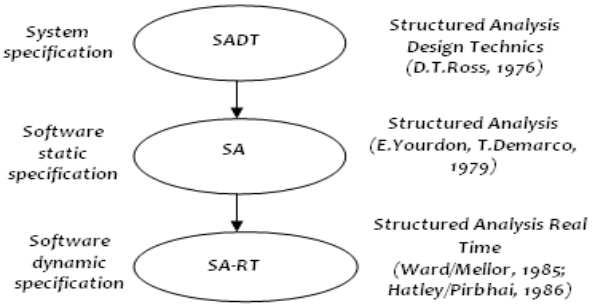

Figure 3. Chronologic position of the methods

The SADT method has been adopted for the analysis of the working of a SCADA system of a thermal power station[LAK 09a], the heavy fuel-oil storage system [LAK 09b] as well as the system of natural gas numbering of the power station [LAK 09c]. It has also been adopted for the analysis of an automated system of a grain silo [LAK 09d].

Structured Analysis for Real-Time Systems, or SA-RT, is a graphical design notation focusing on analyzing the functional behavior of and information flow through a system. SA-RT, which in turn is a refinement of the structural analysis methods originally introduced by Douglass Ross and popularized by Tom DeMarco in the seventies, was first introduced by Ward and Mellor in 1985 and has thereafter been refined and modified by other researchers, one well-known example being the Hatley and Pirbhai proposal (Figure 3).

SA-RT is a short name for Structured Analysis Methods with extensions for Real Time. The model is represented as a hierarchical set of diagrams that includes data and control transformations (processes). Control transformations are specified using State Transition diagrams, and events are represented using Control Flows. The other graphical and state based paradigm for specification of real time systems is Statecharts. The system is represented as a set of hierarchical states instead of processes. Each state can be decomposed into sub states and so on. The statecharts notation is more compact than the SA-RT notation and has been formally defined (Figure 4).

RISK ANALYSIS METHODS OF THE PROCESS SYSTEMS

The risk analysis is an indispensable tool to the good conception of a device and the assessment of dangers and induced risks by its utilization risk. The analysis of risks takes all its value in processes of risk management developed by manufacturers. In fact, the analysis of a process system is defined as being an analysis of the failing arborescence [JIA 08] [BAS 05] [SYA 09].

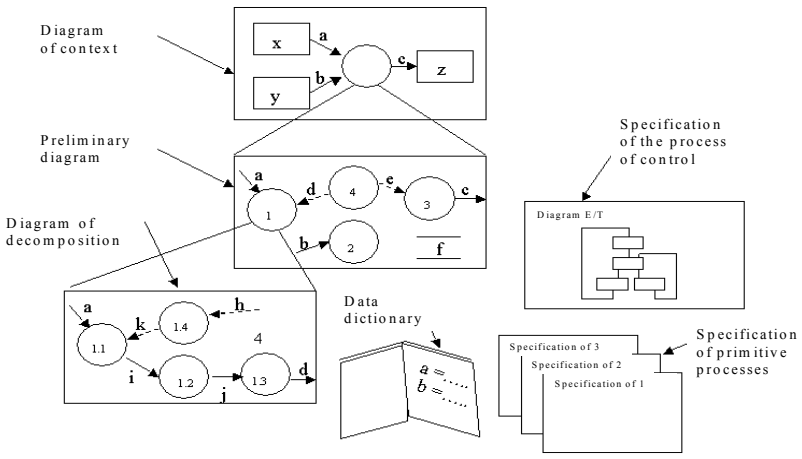

Figure 4. Organization of the SA-RT model

Several methods are applicable to the risk analysis of a process system: a method defined by a method for the analysis of risk and management of risks, a method for systems of information, a method defined by a guide of risk management for systems of technology of information, and another guide of security management that is defined as being a guide of management of security risk. All these methods define an assessment of risks and really provide a detailed guide for the analysis of risk.

Other methodologies for the analysis of risk of a process system are defines by a cognitive model that puts the accent on the analysis of relations between factors of risk and risks a graphic representation feels this method.

It exist different norms treating the safety of working. They propose a complete system going from the general recommendations, to put in room to assure the safety of working, until the adjust specific implementation [BOW 98].

The Failure mode, effects and criticality analysis (FMECA) method is an extension of failure mode and effects analysis (FMEA). FMEA is a bottom-up, inductive analytical method which may be performed at either the functional or piece-part level. FMECA extends FMEA by including a criticality analysis, which is used to chart the probability of failure modes against the severity of their consequences. The result highlights failure modes with relatively high probability and severity of consequences, allowing remedial effort to be directed where it will produce the greatest value [BUZ 99].

The FMECA analysis procedure typically consists of the following logical steps:

- *Define the system;*
- *Define ground rules and assumptions in order to help drive the design;*
- *Construct system block diagrams;*
- *Identify failure modes (piece part level or functional);*
- *Analyze failure effects/causes;*
- *Feed results back into design process;*
- *Classify the failure effects by severity;*
- *Perform criticality calculations;*
- *Rank failure mode criticality;*
- *Determine critical items;*
- *Feed results back into design process;*
- *Identify the means of failure detection, isolation and compensation;*
- *Perform maintainability analysis;*
- *Document the analysis, summarize uncorrect design areas, identify special controls necessary to reduce failure risk;*
- *Make recommendations;*
- *Follow up on corrective action implementation / effectiveness.*

FMECA may be performed at the functional or piece part level. Functional FMECA considers the effects of failure at the functional block level, such as a power supply or an amplifier. Piece part FMECA considers the effects of individual component failures, such as resistors, transistors, microcircuits, or valves. A piece part FMECA requires far more effort, but is sometimes preferred because it relies more on quantitative data and less an engineering judgment than a functional FMECA.

The criticality analysis may be quantitative or qualitative, depending on the availability of supporting part failure data.

Strengths of FMECA include its comprehensiveness, the systematic establishment of relationships between failure causes and effects, and its ability to point out individual failure modes for corrective action in design.

Weaknesses include the extensive labour required, the large number of trivial cases considered, and inability to deal with multiple-failure scenarios or unplanned cross-system effects such as sneak circuits.

FMECA is an excellent hazard analysis and risk assessment tool, but it suffers from other limitations. This alternative does not consider combined failures or typically include software and human interaction considerations. It also usually provides an optimistic estimate of reliability. Therefore, FMECA should be used in conjunction with other analytical tools when developing reliability estimates.

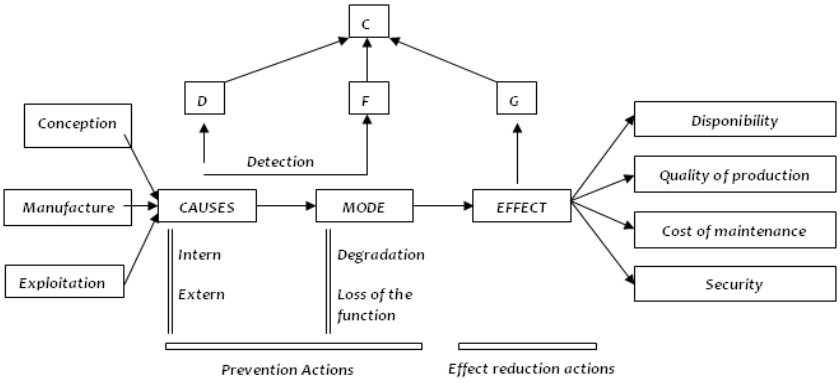

Figure 5. Corrective actions of the FMECA method

According to the figure 5, one notes that exist three corrective action types: prevention actions, actions of preventive detection and actions of effect reductions.

CONCLUSIONS

The modeling of the process systems is a complex activity and requires a structured methodology of development. This is why the proposed gait is based on the exploitation of a systemic approach for the representation of the process systems in view of their analysis and their conception.

Besides, it is necessary to adopt a method permitting to manage to best risk them bound to the utilization of the process system. This method is as useful at the time of the re-conception of the process systems, that it was about a modernization or an optimization.

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