Information Organization of a Flexible Manufacturing based on System Modelling Approach

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Abstract

The development of a consistent information system in a production system is elemental. In fact, we elaborated a methodology in view to study the information organization of a flexible manufacturing system while treating the environment of management of the physical information. In this paper we present an application of the system modeling approach for the project of development of an information system of a flexible manufacturing system in order to web access.

Keywords — *System modeling, information organization, flexible manufacturing system.*

I. INTRODUCTION

Analysis system, or system approach, belongs today to the scientific current that analyzes the elements of complex processes as components of a together where they are in relationship of dependence mutual. His area of study is not limited to the mechanisation of idea [1]: systemic analysis is a methodology that organizes information to optimize action. The system approach aims to simplify any complex, lead to a model that allows acting on it, once we have understood its hardware configuration and dynamic structure [2].

The various known tools of systems analysis (Analysis causal, SADT...) adopt a process of hierarchical analysis and deal with relevant issues to drive a project: what?, who? how? when? where?

According to the method and the tool applied, additional parameters can be defined [3], [4].

The aim of this paper is to adopt the system modeling approach in order to study the Information System and the automation project of a flexible manufacturing system. This kind of analysis facilitates the web access of the flexible manufacturing system.

II. PRESENTATION OF A FLEXIBLE MANUFACTURING SYSTEM

The principle of a flexible workshop is to adapt very quickly to the new parts without changing the machine tools manufacturing or the provision of these. It allows loading and the conduct of these machines partially or fully automated [5].

In one first stage, the stations of the flexible manufacturing system have been identified (See Figure 1).

- Station of distribution:

It extracts parts of the cylinder store double effect. Then, it transfers them to the test station using a rotating cylinder.

- Station of test:

It tests the height of parts, if it is included in a specific interval, the piece continues its way to other stations otherwise it is evacuated to outside.

- Station of treatment:

This is the phase of machining.

- Station robot and assembly machining:

This station consists of an industrial robot and several shops supply station. The robot who, once the actuator is assembled, put it on the conveyor to be transfer to the next station.

- Station of sorting:

It provides the sort of products according to their colors (red, black and silver) in separate bins.

- Station of storage:

This station enters into function if bins of the sorting station are full. It contains a manipulator arm which allows taking the finished piece on the conveyor and stores it in the final store.

Fig 1: Flexible manufacturing system

III. SYSTEM APPROACH MODELING

In this part, we adopt a system analysis approach allowing us the institution of a reliable information system and an automation project dedicated to the flexible manufacturing system. Then, we present the system analysis method and the details of this methodology.

A. Presentation of the OOPP method

The OOPP method (Objective Oriented Project Planning) is presented as a communication device, an analysis and a project planning, anything its nature and its position [6]. It is made up of three essential phases (See Figure 2): 1st problem analysis phase; 2nd objective analysis phase and 3rd activity planning phase.

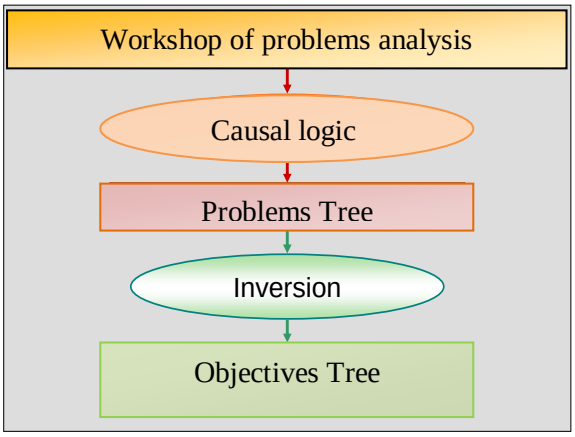

Fig 2: OOPP method

The problem analysis phase is extremely frequent that the conception and implementation of a project meets many difficult situations presented by a sponsor.

The approach used is federative because endorses the theory of organizing workshops bringing jointly diversity of capability domain. This is why the analysis of this state must be conducted according to a structured methodology based on causal logic identifying its effects and causes [7].

The aims of the analysis phase are presented by the problems tree constituting a negative report, it allows an easy inversion (transform a negative state to a positive one) to make an Objectives Tree which represent the foundation of any action plan [8].

The causal logic of problem analysis is made to present "means-end" logic for developing the objectives tree. This is why we create relations:

Central Problem: ⟶ Global Objective

Direct Cause: ⟶ Specific Objective

Sub-Cause: ⟶ Result

Sub-Sub Cause: ⟶ Activity

To study objective, result, activity or under activity, is arisen always we are confronted with the question: What is to be done to accomplish the analyzed objective or accomplish the result that should achieve the identified activity?

The respond of this question is made by the decomposition of the analysis phase in the inferior levels [9], [10].

The OOPP method enables us, in addition to the determination of the diverse phases in the analysis of a project: track its evolution, evaluate the project at its various phases; identify dysfunctions and deviations among performances and planning; study the causes, recognize the responsibility.

As a final point, the activity planning phase is represented by an activity matrix also known as activity planning scheme. This matrix is composed of the activity sequence number, the activity code, the activity designation, the person in charge of the activity, the staff responsible for the activity, the objectively verifiable indicator (OVIs), the Source of verification (SOVs), the essential resources according to their category: infrastructure, human resources, equipment and consumables, logistics (energy, transport...).

The identification and the analysis of information exchanged by activities inform us on the dynamics and the communication among components of the system that one intends to either study to manage. This is why we define a matrix of information that establishes an interrelationship between activities and information.

Information leading an activity can be classified in two types:

imported information by the activity and supposed to be accessible ; they are produced by other activities of the system, either coming from outside sources,

produced information by the activity and that reproduce the condition of this activity. This last information will be used and shared by other activities of the project.

In reality, produced information by an activity can be considered resembling to a change of imported information by this activity.

B. Description of the methodology of system analysis

Leaving from the systemic analysis of the flexible manufacturing system [11], [12], [13], and after a technical diagnosis of the various stations, an] analysis of the various technical documents and management, a focusing retailing the various levels of analysis has been done according to five phases [14], [15], [16]:

1st phase: Global functional analysis

We exploited the system analysis methods: SADT (Structured Analysis and Design Technique) and OOPP (Objectives Oriented Project Planning to delimit the domain.

2nd phase: Compilation

The results of the first phase permitted to elaborate a global architecture of the automation project of a flexible manufacturing system, an algorithm of working, a diagram of order and a Grafcet.

3rd phase: Simulation and validation

This phase allows us to identify the necessary equipment, the chronology of the working sequences, the parameters of order and control of the system, the sensors and the necessary actuators, the various fashions of working, the interfaces of the Homme - Machine relation, the partial and global supervision of the system, the fashion of management, the fashions and levels of security.

4th phase: Technical specification

This phase determines the dimensionality and the alternative of the technology and essential programmable automaton features in addition to the desks operators of the global supervision of the system. These alternatives allow for the technological evolution, the availability on the market, the industrial references and the quality with the cost.

5th phase: Development of the notebook of the loads

This phase allows us to submit the notebook of the loads to the decision-maker for approval.

IV. RESULTS OF THE ANALYSIS

The system method used for the analysis of the activities of the flexible manufacturing system is the OOPP method for the specifications of the equipment of the flexible manufacturing system.

The OOPP method is based on a structuring gait and is hierarchized. Once identification of the GO of the project that one intends to analyze, we determine the Specific Objectives to reach previously and, according to the same logic, one specifies the lower levels.

A. Modeling of the information system

The model presented (Table.1) illustrates eight specific objectives to achieve the global objective (OG): Information System of a flexible manufacturing system defined.

The Specific Objectives identified are:

- OS1: Management of the Information System;
- OS2: Security of the Information System;
- OS3: Circulation of the information;
- OS4: Appropriate information media;
- OS5: Analysis of effective information;
- OS6: Efficient information processing;
- OS7: Archive information;
- OS8: Characterization (properties / elements) of the information.

The decomposition of these specific objectives into results (Table.1) lead to

intermediate results, activities, sub-activities, tasks and under tasks.

TABLE I
OOPP model of Information System of the flexible manufacturing system

N°	Code	Activity
1	OG	Information System of the flexible manufacturing system defined
2	OS1	Management of the Information System assured
3	R1.1	Improvement of the Information System assured
4	R1.2	Assessment of the Information System assured
5	R1.3	Control of the Information System assured
6	R1.4	Maintenance of the Information System assured
7	R1.5	Functioning of the Information System assured
8	OS2	Security of the Information System assured
9	R2.1	Security of the information assured
10	R2.2	Confidentiality of the information assured
11	OS3	Circulation of the information assured
12	R3.1	Implementation of a secure information flow circuit assured
13	R3.2	Availability of timely information assured
14	OS4	Appropriate information media assured
15	R4.1	Operation of information media assured
16	R4.2	Conviviality of supports assured
17	R4.3	Availibility of supports assured
18	R4.4	Supports of the information identified
19	OS5	Analysis of effective information assured
20	R5.1	Actions of Improvement proposed
21	R5.2	Causes of failure identified
22	R5.3	Failures detected
23	R5.4	Information traited interpreted
24	OS6	Efficient information processing assured
25	R6.1	Efficiency of the treatment system assured
26	R6.2	Information enregistred
27	R6.3	Information collected
28	OS7	Archive information assured
29	R7.1	Security of archived information assured
30	R7.2	Locations of archival information identified
31	R7.3	Supports of archival information identified
32	R7.4	Duration of archival information determined
33	R7.5	Archival information identified
34	OS8	Characterization (properties / elements) of the information assured
35	R8.1	Information needs identified
36	R8.2	***Information source defined***
37	R8.3	Destinations for the information defined

B. Modeling of the automation project

The OG "automation of the flexible manufacturing system assured", includes four Specific Objectives: OS1: Survey of the project automation of the flexible manufacturing system; OS2: Equipments of the flexible manufacturing system identified; OS3: Notebook of the loads of the stations elaborated; OS4: Setting of the automation of the flexible manufacturing system assured.

The analysis of the Specific Objective OS1 is presented (Table.2).

TABLE III
A level of the OOPP analysis of the flexible manufacturing system

N°	Code	Activity
1	OG	Automation of the flexible manufacturing system assured
2	OS1	Survey of the automation project of the flexible manufacturing system assured
3	R1.1	Diagnosis of the existing assured
4	Ri1.1.1	Observation of the work stations assured
5	A1.1.1.1	To identify the stations
6	A1.1.1.2	To observe the stations
7	A1.1.1.3	To observe the working mode
8	Ri1.1.2	Documentation collected
9	A1.1.2.1	To collect the existing documentation on site
10	A1.1.2.2	To collect the documentation by the suppliers
11	Ri1.1.3	Analysis of the existing assured
12	A1.1.3.1	To identify the insufficiencies

13	A1.1.3.2	To put in consistency of the existing activities
14	R1.2	Scripts of working identified
15	A1.1.3.1	To identify the different necessary equipment
16	A1.1.3.2	To identify the sequences of working
17	A1.1.3.3	To synchronize the stages of working
18	A1.1.3.4	To identify the parameters of order
19	A1.1.3.5	To identify the parameters of control
20	A1.1.3.6	To identify the security and the necessary protection
21	R1.3	Elaborate final report
24	OS2	Equipment of the flexible manufacturing system identified
25	OS3	Notebook of the Loads of the flexible manufacturing system elaborated
26	OS4	Setting of the automation of the flexible manufacturing system assured

Following the analysis based on the OOPP method and the identification of the diverse information allows us to define the features of the Programmable Logic Controller (PLC) used in the flexible manufacturing system in order to control the various stations, and to study the automation solution architecture.

V. CONCLUSIONS

The methodology adopted by its participative nature and systemic also leaning on a large discussion of the documentary resources (proceeding, internet, specialized magazines) a variety of innovating actions have been proposed.

The system modeling based on the OOPP method that we spread permitted to describe exchanges of information among the diverse components of the flexible manufacturing system and to describe the diverse parameters presented in the constitution of models in order to web access. This is why an application of a system modeling approach has been presented.

Starting from this study of the application of the system approach on a flexible manufacturing system presented in this paper, we will extend the analysis and modeling methodology to the different stations of the flexible manufacturing system and supervise their working.

REFERENCES

[1] E. Puik, D. Telgen, L. Moergestel and D. Ceglarek, Structured Analysis of Reconfigurable Manufacturing Systems, A. Azevedo (ed.), Advances in Sustainable and Competitive Manufacturing Systems, Lecture Notes in Mechanical Engineering, Springer International Publishing Switzerland, 2013.

[2] M.N. Lakhoua M.N., F. Khanchel, S. Laifi, S. Khazemi, System analysis of medical equipment for healthcare management, Annals of the Faculty of Engineering Hunedoara 14 (4), 17, 2016.

[3] M.N. Lakhoua, Systemic Analysis of a Wind Power Station in Tunisia, Journal of Electrical and Electronics Engineering, ISSN: 1844-6035, University of Oradea Publisher, vol.4, N°1, 2011.

[4] I. Mashkina, I. Garipov, Development of Protection Object Model - Industrial Control System Using System Analysis, International Russian Automation Conference (RusAutoCon), 2018, pp. 1 – 5.

[5] W. Marroquín , C. Jiménez and M.Fernández, Web access for flexible manufacturing system, CHILEAN Conference on Electrical, Electronics Engineering, Information and Communication Technologies (CHILECON), 2017, pp. 1 - 6.

[6] AGCD, Manuel pour l'application de la «Planification des Interventions Par Objectifs (PIPO)», 2ème Edition, Bruxelles, 1991.

[7] The Logical Framework Approach (LFA): Handbook for objectives-oriented planning, Norad, Norway, Fourth edition, 1999.

[8] L. Guangshu ,W. Songjiang, Application of ZOPP theory on TOT project financing mode—A case study on NBJ Water Plant of Zunyi, Guizhou Province, The 2nd International Conference on Information Science and Engineering, 2010, pp. 2655 - 2658.

[9] M. Annabi, PIPO étendue : Méthode Intégrée de Spécification, de Développement et d'Implémentation de Projet (MISDIP), International conference on Sciences and Techniques of Automatic control and computer engineering STA'2003, Sousse, 2003.

[10] M.N. Lakhoua, Systemic analysis of a supervisory control and data acquisition system, Journal of Electrical Engineering, (www.jee.ro), vol.11, N°1, 2011.

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

[12] M.N. Lakhoua and T. Ben Jouida, Refining the OOPP into Method of Representation of the Information by Objectives, International Transactions on Systems Science and Applications, Vol. 7, No. 3/4, December 2011, pp. 295-303.

[13] M.N. Lakhoua, Refining the objectives oriented project planning (OOPP) into method of informational analysis by objectives, International Journal of the Physical Sciences, ISSN: 1992-1950, Academic Journals, Vol. 6(33), pp. 7550 - 7556, 2011

[14] G. Cattani, S. Ferriani, L.Frederiksen and T. Florian, Project-Based Organizing and Strategic Management. Advances in Strategic Management. 28. Emerald, 2011.

[15] A. Azzabi, K.Nouri, Path planning for autonomous mobile robot using the Potential Field method, Proceedings of International Conference on Advanced Systems and Electric Technologies, IC_ASET 2017.

[16] M.F. Karoui, M.N. Lakhoua, Methodology of Modeling and Supervision for Mechatronic Systems, Journal of Computer Science and Control Systems, Vol.12, N°1, 2019.