Method Of Modeling Of The Control Systems Adapted To The Skills Production Systems

Abderrahman Rhouzali
Department of Physics Faculty of Sciences Ain-Chock
Hassan II University
Casablanca, Morocco
a.rhouzali@ieee.org

Benayad Nsiri
Research Center STIS, M2CS, Higher School of Technical Education of Rabat (ENSET)
Mohammed V University
Rabat, Morocco
b.nsiri@um5s.net.ma

Mounia Miyara
Department of Mathematics and Computer Science Faculty of Sciences Ain-Chock
Hassan II University
Casablanca, Moroc
miyara12@gmail.com

Mohamed Abid
Department of Physics Faculty of Sciences Ain-Chock
Hassan II University
Casablanca, Moroc
m.abidkamy@gmail.com

***Abstract*— Nowadays, the production systems of skills are considered as quality goods and services production systems at the level of all the practice, rules, tools and methods that constitute the industrial culture of the company. In this perspective, our work aims to show that the methods and tools of systems engineering commonly used in industrial production systems are applicable in the field of skills production systems.**

The present paper focuses on the study, the understanding and modeling the process of skills production system. Through this work, we seek to use a generic GRAI grid to propose a mapping process for the skills production systems and aims at formalizing a reference model for a control system adapted to the skills production systems, based on coordinated piloting structures.

Keywords: Skills Production systems, Modeling, GRAI, Control system, Mapping Process.

I. Introduction

Over the past decades, industrial organizations must respond to: the changing significant and exponential growth and evolution of technologies, the customer demand that requires a diversification in products and services and the competitive pressure that necessitates flexibility both in terms of product design and in the provided services. For industrial organizations to follow this evolution, several researchers and practitioners put in place performance measurement and evaluation tools. The role of these tools should not be underestimated, as they affect the strategic, tactical and operational control and planning.

Today, production systems of skills (SPS) (training centers, educational system Institutions, Universities, Schools …) are regarded as production systems for goods and services, in terms of the practices, rules, tools and methods that form the company's industrial culture.

Moreover, the SPS in the broadest sense in business administration is open to the outside world. Its socio-economic environment and its administrative tasks are its natural space during and after the deadlines of its production cycles; as well as all the inherent difficulties that go with it. But a SPS is not just that. It also has an internal life and special problems that guide and influence its operation and determine its performance.

In this context and in order to ensure a better organization of management for a global control of a skills production systems. Through this work, we seek to use a generic GRAI grid as an approach of modeling to propose a mapping process for the system studied based on models of industrial production systems. This mapping process in order to give an overview of the processes of skills production system and describe the essential and the meaning that we wish to give to it. It represents, at the high level, the main processes of the SPS, called macro-processes, and is at the basis of its performance. Moreover, aims at presenting a method of modeling of the control systems adapted to the skills production systems, based on coordinated piloting structures.

II. Concept of a Production System

Before starting the study of the control systems for the skills production systems, it is paramount to present and to analyze the system that we are seeking to improve: the production system (PS).

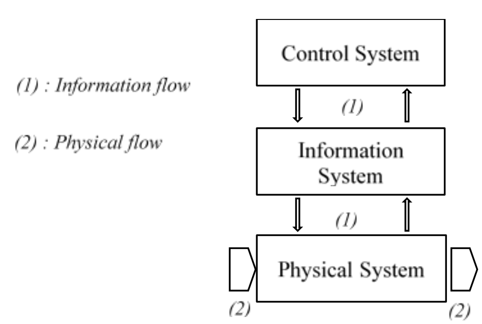

Figure. 1. The Production System [4]

Below, we will introduce it in an abbreviated form. Based on the fact that the majority of the views can be analyzed from a systemic view [4], it is common to break down the production system into three operating sub-systems Fig. 1:

- The physical sub-system representing the operating system;
- The information sub-system that enables the acquisition, the processing and the data management of the system and its environment;
- The decision sub-system which controls (identifies, analyzes and rectifies the derivatives by suggesting corrective or preventive measures) the physical system.

This system breaking down might be relevant for companies by enabling its analysis, but it is less suitable for the industrial PS and its modeling. In the industrial PS, the information and decision sub-systems cannot exist if alone. Together, they make what we call the control system Fig. 2, the information and decision system or the director system [9][5]. Thus, it is truer to consider the PS as the association of a manufacturing system and a control system.

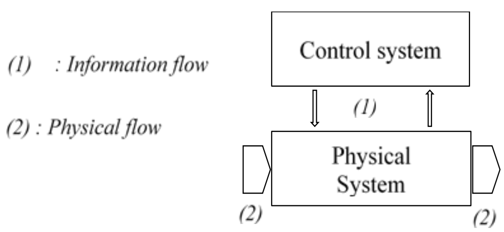

Figure. 2. The Industrial Production System

III. Concept Of A Control System And Piloting Structures

The evolution of production systems has led to the emergence of the production systems control functions. Regarding this topic, many definitions can be found in various books on this subject. For instance, C. Berchet and D.Trentesaux have suggested an interesting synthesis of this notion in their research thesis [1];[10].

According to J. Mélèse [6] "flying a device implies choosing a goal, determining the best trajectory, launching the device and permanently correcting its deviations from its trajectory and, eventually, changing the trajectory, or even the goal itself, when the outside state of the universe, or that of the device show that the initial plan cannot be maintained". Based on this definition, it can be inferred that Mélèse qualifies the physical system by key variables (indicators) which are defined as indicators that enable the evaluation of specific objectives. The control system has action variables that define the rules of the functioning system. Three main control system functions could also be deduced Fig. 1.:

- Measurement Function: Operation that consists in detecting the deviations between the key variables and the objectives set out;
- Monitoring Function: Operation that consists in determining the values of action variables according to the key variables values;
- Regulatory Function: Operation that consists in reducing the gaps between the targeted values and those implemented by modifying some of the key variables features.

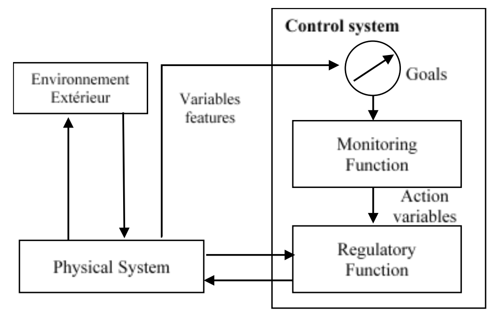

Figure. 3. The Control system model (Mélèse, 1991)

There are now several models to define the organization of piloting a production system. For our work, among the five piloting structures proposed by Théroude [10], we favor the coordinated structure Fig. 2. because this structure based on the hierarchical approach, allows communication between decision centers of the same level. The notion of communication, coupled with that of subordination on more than one level enables to increase the decision-making capacity of each level and to have a decision-maker that has an overall vision of its system's progress.

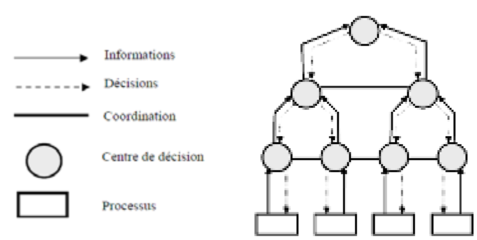

Figure. 4. Coordinated Piloting Structures

IV. The Concept Of Skills Production Systems

The definition of skills production systems, as adopted by Clementz [2] in his works, is based on the coherent way we can define SPS and any production system as it is usually defined in a company.

Indeed, in the case of the SPSs, competence constitutes the intangible product of the SPSs, since it constitutes the added value provided to the learner.

According to the works of Renauld [8] on the observation of the situation of training systems, three types of actors have been identified:

- The learner
- Recruiting organization
- The paying agency

It is essential to identify these actors in order to be able to manage them and to meet their expectations. Fig. 3. presents the layout of actors in the SPS with:

- Cn-1 = Learner's competence prior to system integration
- Cn = Learner's Competence After system integration.

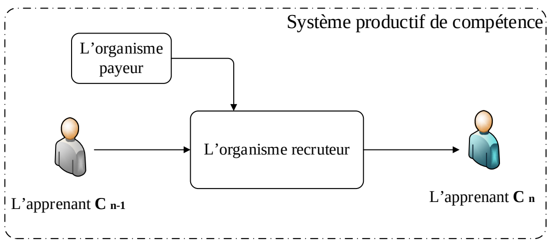

Figure. 5. Actors in skills production systems

A. Comparison between the Industrial Production Systems and the Skills Production Systems

According to Clementz's research studies, [2] on skills production systems, where he compared industrial production systems with skills production systems, the study highlights a number of similarities:

- Both systems have a complex organization of different and coordinated activities; The links between each of the activities do not provide information on the causes and effects of activities but rather on the logic of the flow path and, thus, determine the transformation processes;
- The activities of the two systems ensure the transformation of inputs into outputs by consuming allocated resources (human resources, technological resources, software resources);
- Both systems have controlled activities controlled and ordered between them;
- Both systems complete cycles (loops of activities) to reprocess the output or information.

Clementz also found a certain functional analogy between a production system and a competence production system "Table I.", particularly in its general organization structured into transformation processes composed of several activities. The table below illustrates the relationship that can be made between industrial production systems and the competence production system.

TABLE I. SUMMARIZING THE COMPARISON BETWEEN THE INDUSTRIAL PRODUCTION SYSTEMS / SKILLS PRODUCTION SYSTEM (CLEMENTZ, 2000).

	Industrial production systems	**Skills production systems**
Production	Production of products	Productions of skills
Operational processes	Supply process Transformation process	Recruitment process Skills production process
Production program	Production plans	Training plans
Scheduling	Supply scheduling Production scheduling	Recruitment scheduling Skills production scheduling
Design of objects	Design office	Board of directors
Design process / methods	Methods Office	Teaching staff
Performance indicators: **Costs** **Deadlines** **Quality**	cost of products; Deadlines of manufacturing orders Satisfaction of the need.	Training / learner costs; Training program Constance of flows.

B. Adaptation of the Typology of Engineering Projects to the Skills Production System.

The production systems have many aspects [8]. We can, to try to draw up a typology, we press on the model of the system operating, the information system - store and the system of decision [5] which is one of the basic principles of some modeling methods. The typology of engineering projects proposed is therefore [7]:

- The engineering of the object produced by the operating system. In our particular case, the object can be considered as an increase in skills,
- The engineering of the system operating in conjunction with the engineering of the object. It consists in the specification of tasks, actors and processes responsible for the transformation of the technical object. In some cases, we also develop the process of support (logistics, maintenance, etc.),
- The engineering of the information system which focuses on the identification of information flow,
- The engineering of the system of management or of control in which one finds the concerns relating to the management of resources, skills and knowledge. The axis control included, as to him, the definition of the strategy and the satisfaction of the requirements of the system,

- The engineering of the system of measures/evaluation whose goal is to deploy the strategy by the specification of the operational objectives of the constraints and performance indicators.

TABLE II. TABLE 2. COMPARISON OF ENGINEERING PROJECTS OF PRODUCTION SYSTEMS OF OBJECTS AND PRODUCTION OF SKILLS (POURCEL, CLEMENTZ, 2005)

Type de projet d'ingénierie	**Système de production de compétences**
Ingénierie de l'objet	Spécification des formations proposées pour l'obtention des compétences visées
Ingénierie du système opérant	Spécifications des tâches, des acteurs et des processus de recrutement, de formation et de soutien
Ingénierie du système d'information	Spécifications des tâches, des acteurs et des processus de traitements et gestion des informations, des données et des connaissances
Ingénierie du système de management, control	Spécification des procédures de gestion des ressources, des compétences et des connaissances et de définition de la stratégie
Ingénierie du système de mesure et d'évaluation des performances	Spécification des objectifs et des indicateurs de performances ; Spécifications des tâches, des acteurs et des processus de mesure et d'évaluation des performances.

V. CONTROL SYSTEM MODELING RELATED TO THE SKILLS PRODUCTION SYSTEM USING A GENERIC GRAI GRID

Based on what has already been studied on the skills production system and their analogies with the industrial PS, we have introduced a method of modeling of the control systems adapted to the skills production systems, based on coordinated piloting structures. First, we tried to preset a mapping process for the system develop a general structure for the skills production system.

The skills production systems are composed of a complex structure and operation. However, the analogy is strong with the production systems [2] and, in this sense; the models presented in the preceding paragraphs inspire us. The Fig. 4. illustrates its architecture.

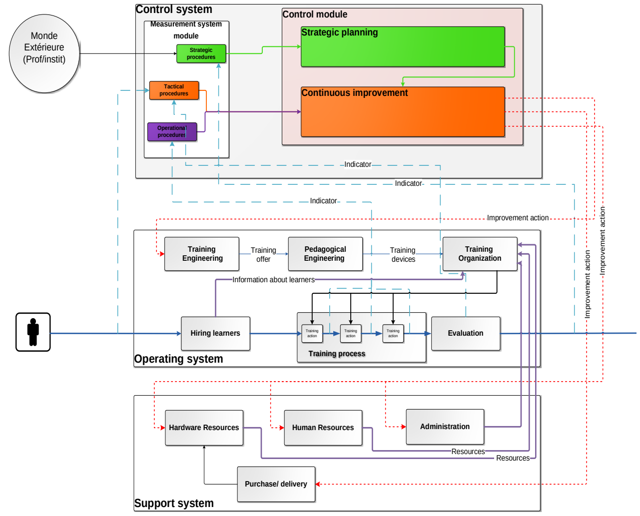

Figure. 6. Our Mapping Process of the Skills Production Systems

From the Fig. 4. above, we can distinguish four general systems:

- Operating system;
- Support system;
- Control system.

1) Operating system :

It is the set of all the processes1 that give the added value to our system's products. In this case, for instance, we can define six operational processes Fig. 5.:

- Training Engineering;
- Pedagogical Engineering;
- Training Organization;
- Training process;
- Evaluation of the training process;
- Hiring learners.

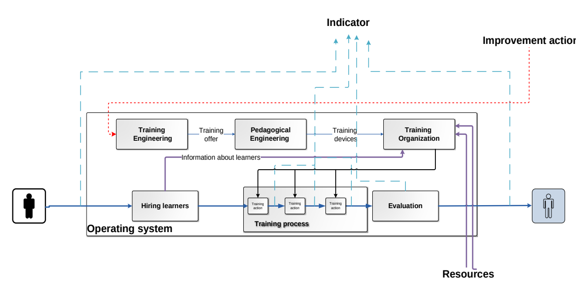

Figure. 7. The Operating System's Internal Architecture

2) Support System :

It is the set of processes that ensure the processing of the resources necessary to the conduct of the operational processes Fig. 6. The support process can be defined as follows:

- Hardware Resources;
- Human Resources;
- Administration;
- Purchase/ delivery.

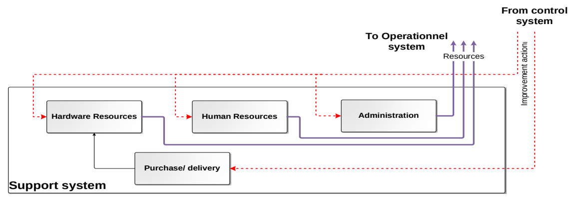

Figure. 8. The support process's Internal Architecture

3) Control system :

We can consider that, from an internal point of view Renauld [8] a control system must fulfill two main missions: first, to measure the behavior of the system on a regular and precise basis in order to provide performance indicators relevant to the command part. Second, to control the functioning, i.e to provide levers of action to influence the operating part in order to correct deviations and to react effectively to disturbances.

To model the control system of SPS, a generic model has been proposed based on two modules: control module, System Module of Measurement.

It seems to us that the coordinated structure is perfectly suited to the competence production system, and therefore, the model we proposed Fig. 7., perfectly fits this definition. And according to what we have seen previously, our behavior system will include: control module, System Module of Measurement.

Thus, the control system is specified by a set of module Fig. 7.:

a) System Module of Measurement.

This module assesses the performance of operational and support processes. These different measurements are combined and returned to the control process in the form of performance indicators through different dashboards resulting from the strategy's declination.

This module allows the different process pilots to have the performance indicators set already on the (strategic, tactical, operational) procedures of this system to ensure a reactive management of their activities. These indicators will enable actions to be taken in the very short term, but also for continuous improvement or re-engineering to be carried out.

b) control module

This module ensures the control of the operational and support processes. It also ensures compliance with instructions.

It is also in charge of defining the system's general strategy and its declination in Key Success Factors until the implementation of local operational objectives.

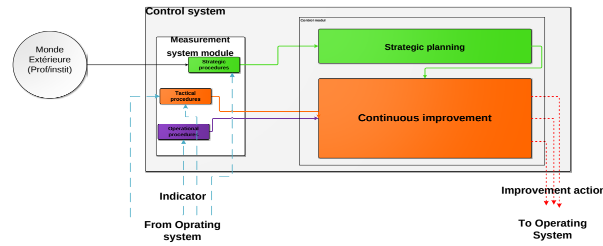

Figure. 9. The Control system's Internal Architecture

we relied on the GRAI grid as modeling an approach of the studied system for defining decision centers and the basic concepts and their relationships to define the reference conceptual structure [12] [13].

The Fig. 11. shows a functional grid established on the functions of the new plan based on the new mapping process of the Skills Production Systems:

- Columns: represent the functions;
- Lines: represent the decisions to achieve according to the various decision-making levels (strategic, tactical and operational). Every level is defined by period P and a horizon of time H. A horizon can be represented by one or several periods;
- A center of decision is the intersection between a function and a level of decision. Generally, a center of decision consists of an activity of decision, a relation of entrance and a relation of release;
- Arrows: the simple arrows represent the informative flow and the full arrows represent the decision-making flow between two centers of decision between a center of decision and the outside world.

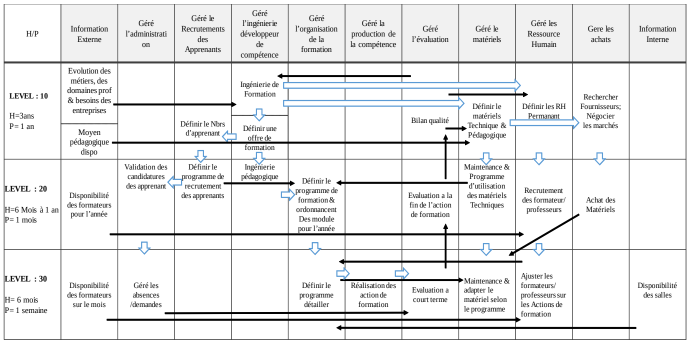

Figure. 10. Generic GRAI grid of the Skills Production Systems.

CONCLUSION

This paper's main objective is to formalize a reference model for a control system through the description of its components the development of its internal behavior that manages skills production systems.

The contribution of this paper is to use a generic GRAI grid in this method to have an overall view of the system functioning in order to find a reference model for Skills Production Systems. The implementation of this reference model is a necessary first step required to continue our study of control systems, because before we can measure the performance or optimize the functioning of a production system, it is important to know how it works by introducing its different processes: operational process, and support process.

Thus, this designed model is more suitable for an industrial production system, and could help us in our subsequent work on using the methods applied in the industry to better exploit the skills production systems.

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