PRODUCTION SYSTEMS AS COMPLEX SYSTEMS

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Abstract*: This article presents the production systems, bringing arguments that there are big (complex) systems, including technical, economic and social aspects, operationally integrated. The paper explains what a complex system is and which its most important characteristics are. There is emphasized the relation with the environment that represents an important side of the complexity of the production systems.*

Keywords*: environment, subsystem, relation, cybernetic, non – linear.*

A **production system** represents an **organized functional group** (in a unit or in a reunion of units) which fundamental purpose is **the production of goods (products**). Essentially, the production systems represent production lines, assembling lines, workshops, sections, enterprises or holdings, having as objective the production of products or groups of products, in interacting with their environment, with their varieties of inputs and with their performances of output.

The system structuring approach of the production allows emphasizing the **functional group** integrated as producer of value (synergy), of its objectives, with parameters referring to information, processes, results, control, constraints, as well as of the **attributes** as objective properties by which the process is manifested outside (in the environment). The system structuring approach allows also an analytic vision upon the integrating elements, components of the subsystems and the relations between these and between these and the system.

Emphasizing the group of relations (internal and external) in a production system highlights the importance of the connections **required to operation** (ranking first), of those with implementation (ranking second) which do not express although a direct functional relation contribute to the quality of its deploying, as well as of those **regained** or **of contradiction** (ranking third).

Another requirement of the system structuring approach of the production is represented by the **accurate definition of the production group** (the total) with its frontiers (margins, limits), with the relations of supervision and internal dependence, with the tendency of keeping the technological and organizational identities, as well as the attributes of each element essential component, sometimes also complementary or redundant.

The production systems, as the other systems, are also studied in relation with time and towards the neighboring systems.

In relation with time but also in relation with the other systems, the production systems have elements of self-regulation having the property of reacting with own means to various disturbances and of keeping, during certain periods, the entire parameters set or of a part of this, the self-control during operation and reaching the fundamental objective established (sometimes per sub objectives).

Besides the technological or process self-regulation, the production processes – as mixed elements man-machine – have integrated in their structure subsystems of human management, fulfilling also operative functions of self-regulation. In other words, the production systems have a **complex mechanism of self-regulation**: technological

and human, per group of parameters or per parameter, with positive or negative reactions, continuous or discreet etc.

The self-regulation characteristics impose to production systems their cybernetic character. Starting from the fact that economic cybernetics represents the science of the dynamic, self-regulating systems behavior, from economy; the production systems may be called **economic-social cybernetic systems.**

Describing in detail the production system, one may emphasize several subsystems, of which at least five have a special importance:

– **Planning** subsystem for:

- labour force;
- consume of materials;
- costs;
- research-development activities;
- production;
- sales.

– **Production** subsystem (processing) achieving:

- launching in production;
- scheduling operations;
- materials procurement;
- manufacturing products;
- testing products;
- their transportation and sale.

– **Controlling** subsystem upon:

- labour costs;
- consume of materials;
- expenses with production;
- quality;
- number of products;
- sales of products;
- self-regulation of products.

– **Financial** subsystem achieving:

- salary payment;
- payment of materials and technological costs, transportation and sales;
- incomes from sales;
- profit calculation;
- reinvestments;
- financial self-regulation.

– **Informational** subsystem providing:

- computerizing the production process;
- processing information;
- informational relations between subsystems and between the system and the environment;
- management information;
- documenting information;
- labour information;
- personnel information;
- assessment information;
- information for locating within the environment and information for the relation towards the proposed objectives;
- self-regulation information.

If **the production** (manufacturing) **subsystem** represents a sequence of technological operations meant to transform the inputs (object of work) by labour means in finished products, **the controlling and informational subsystems** provide the quality of the process development, its operability and the fluidity as well as the relations and strategies of self-regulation, and their management is relatively difficult.

Generally, the systems, as simple as they would be, include technical, economic, and/or social aspects, operationally integrated, which make each system to represent, in fact, a complex product.

The difficulties of analysis, synthesis and management enhance as increase the size, density and number of subsystems components of the systems; from the above-mentioned reasons, they become more complex and hence difficult to achieve, as the number of relations, objectives and sub objectives, functions and functional procedures, structural, relational, aggregating or cooperating uncertainties, dynamic and random or vague processes uncertainties increase.

Supplementary to these aspects, the optimization uncertainties of the systems behavior is added, making the real evolution to be sometimes far from being optimum, because it is difficult to emphasize both the multitude of states and the states of nonlinear operation. Finally, complications and uncertainties occur also in the area of establishing with accuracy the inputs, outputs, commands and functional parameters as well as the relations of determination between the variety of inputs and outputs, respectively. These uncertainties and non-determinations imply difficulties in establishing the regulation and self-regulation conditions and under

disturbances conditions they lead to malfunctions, mistakes, errors, and exceptions and, in a totally exceptional way, to offences.

In this context, we assimilate the definition according to which the **big (complex) systems are those systems including more non-linear, negative or positive relations and interactions, characteristic determining a large diversity of ways of behavior**, completing with the following aspects that can underline the big or complex character of the systems:

- complicated structures, both as number of subsystems as well as the relations between them;
- uncertainties in complete defining the technologies and the direct relations;
- difficulties in establishing inputs, outputs and the direct relations between the variety of inputs and those of outputs;
- heterogeneity of the objective relations;
- multitude, quality and manifestation of some properties determined by the energetic and informational intrinsic exchanges of the system;
- large geographic extension and the impossibility of defining with accuracy of the distribution of the subsystems and elements;
- concentrated functions and with cumulative effects, with dynamic and difficult to control interaction;
- complex conditions of regulation both as variety of shapes and directions and releasing stimuli;
- an accentuated dynamics of the states and stability thresholds;
- interdependences with different relations degree;
- multiple strategies of becoming and development, of evaluation and control of parameters;
- parametric dynamics accentuated both per stages or at different stimuli and during the life time of the system;
- behavioral complexity as consequence also of the mixed structure type man-machine;
- a fast rhythm of transformations not only of states but also of functions;
- the cybernetic character, self-regulating and informational-decision making, to which the energetic-informational relations during the systems functioning are added;
- the vague character of determining a stratification in time and space of the subsystems and, hence, of their function as well as of the weigh of their contribution to attaining the objectives.

The living systems may be a first example of a big system; they are formed by a multitude of quasiordered subsystems and elements, which together with their relations and connections generate a substantial behavior different from these, the **rational behavior**. Among the living systems, the **man** represents a complex super developed system.

Social integration of humans (by labour, language and thinking) generated the constitution of big social, scientific, economic, administrative, educational, military etc systems, with hierarchy generated due to the differentiation of significance of the component subsystems, as well as of their mixed character, man –machine, (integration of energetic resources and technological means in these systems represents no longer a novelty).

The globalization phenomenon trend of the human kind is also manifested in the field of the production systems, by their complex integration in social-economic hierarchy, holdings, state unions, military alliances, etc. as well as in multidiscipline sciences or researches. The large seizure of objectives, the expanded geographic distribution, the simultaneous belonging of some subsystems to several systems give a special character of complexity to these big systems and complicates more their analysis and the optimization of their management and even of their operation.

Their relation with the environment, as well as the energetic and information exchanges with it, represents another side of the complexity of the production systems.

All these systems with many vague elements, with multiple dynamic and nonlinear relations and must be governed, under the conditions their intrinsic properties and their specific factors are well understood and the cycle of the structural engineering, the relations between the variety of inputs and

outputs, the influence of the disturbances and their dynamic behavior can be deduced.

A particular place within the production systems occupies the military and security systems, following the same engineering cycle of becoming, except checking the operation behavior for which special conditions are needed. On the theatre of operations or on the criminality one, the respective systems are subject not only to functional or disturbances tests but also to attacks and offences which may affect their structure, components, consistence, performance, resources, and may verify the range of performances, from the potential integrally designed to the potential intermediate during the action and until the potential „survival", crisis or preserving.

Although it is logical, „the non operational potential" is not taken into consideration, because in this case the system is not operational, being abandoned or replaced with the same type system or with other available types, but which can and must reach the fundamental objectives established by their strategy of use.

Another category of production systems is represented by the technical or technological systems (production lines and aggregates, communications networks, computer sciences systems, armament systems, etc.). In this case also, the general principles of structure and operation are kept, but the character man-machine has other valences, meaning that the man becomes simple operator, deciding upon the operation only within the limits of the operation and regulation strategies pre-calculated and implemented accordingly in the system.

Regardless the objectives, structure or category, the production systems represent the support of two types of processes: **real processes**, which may be monitored and governed by a set of indicators and **regulation processes**, by means of which directing, research and change of becoming are provided.

Far from being discouraging, the system complexity is however an objective property, deriving from the multitude of components, relations, factors, properties and intrinsic behaviors specific to big systems, imposing the need of studying these systems not only towards an operational dynamics in time but also towards the quality, optimum, and stability changes and transformations. The characteristics of the production systems, from this viewpoint – of structure, operation and security (fundamental manifestation of quality in safety and stability) – become fundamental features. At the same time, the analysis, synthesis and hierarchy management must be studied in interaction and movement, while the complexity must not only be defined but also quantified as well evaluated

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