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MANUFACTURING COMPANY AS A CYBERNETIC AND COMMUNICATION SYSTEM

Summary

The aim of this paper is to show production company as a purposeful system, characterized by goal-seeking behaviour, complexity, probabilistic, with sequential states, and the ability of self-regulation. These features cause that the company may be considered in the context of the cybernetic approach - as a cybernetic system. As the result the company is seen as communication system (network information), where information reduces the indeterminacy and uncertainty of the system.

1. Introduction

Continuous economic and political changes have influenced the way in which economic entities such as manufacturing companies operate in the market. Economic crisis, natural disasters, competition and tremendous dynamics of environment changes all influence the operational results of companies which are increasingly difficult to manage. Therefore new methods, tools and approaches supporting management are sought so as to meet the challenge posed by contemporary changes. One of such approaches, developing strongly in Poland in 1960s and 1970s and now experiencing a revival of interest is a cybernetic approach. It assumes that there are certain laws which govern the regulating and steering processes in natural systems (living organisms) and can be applied to regulating and steering artificial systems, such as enterprises. The condition here is the existence of common features for both types of systems.

This article aims at systematizing and presenting such features of a manufacturing company which would favor the opinion that we can treat this company as a cybernetic or communication system. The understanding of this approach allows us to model industrial systems as cybernetic systems. The designed cybernetic models of companies constitute a starting point in determining solutions optimizing the way these companies function [Gomółka 2000, p. 8].

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2. Basic features of a manufacturing company treated as a cybernetic system

The company is an economic subject economically, organizationally and legally separated from its surroundings [Encyklopedia PWN 1996, p. 361]. Kortan defines the company as an economic, social and technical unit singled out from the whole national economy, established in order to satisfy the needs of third parties in the market in a permanent and profitable way. The management of the company takes independent decisions at their own risk [Kortan 1997, p. 72].

A manufacturing company consists of the following subsystems [Flakiewicz, Oleński 1989, pp. 319-320]:

- a) production subsystem,
- b) management subsystem,
- c) information subsystem,
- d) economic subsystem,
- e) employment and social subsystem.

All the above systems, cooperating and interrelating with one another, constitute one comprehensive system which is called a company.

Gościński defines a cybernetic system as a coherent and purposeful complex system, which is probabilistic and self-regulating [1968, p. 34]. Beer provides a simpler definition of a system as a group of various elements joined together in one entity [1966, p. 13], which are interconnected by means of feedback or in series and create a network.

These connections carry certain amount of information^[1] which flows between particular elements of the system and which is responsible for all dynamic changes taking place both within the whole system and in its particular parts. The type of connections and the kind of these changes are the main subject of research on systems. Analyzing the manufacturing company from the material and attributive point of view [Kožmiński, Piotrowski 2005, p. 29] we can treat it as a system consisting a certain number of connected subsystems^[2].

The typologies of cybernetic systems may vary a lot. Taking into account the criteria of system complexity we can single out simple, complex and extremely complex systems. Analyzing the behavior of the system, that is the way a particular system undergoes successive states^[3], we can differentiate

1 Information is certain content being for example a description, request, order or prohibition passed by the sender to the receiver, see [Gościński 1968, p. 15] or any organizational (non-material) factor which may be used to make the activity more efficient or purposeful (by people, living organisms or machines), see [Müller 1974, p. 36].

2 It should be noticed that in cybernetics a system is defined analogically to the system in systemic thinking.

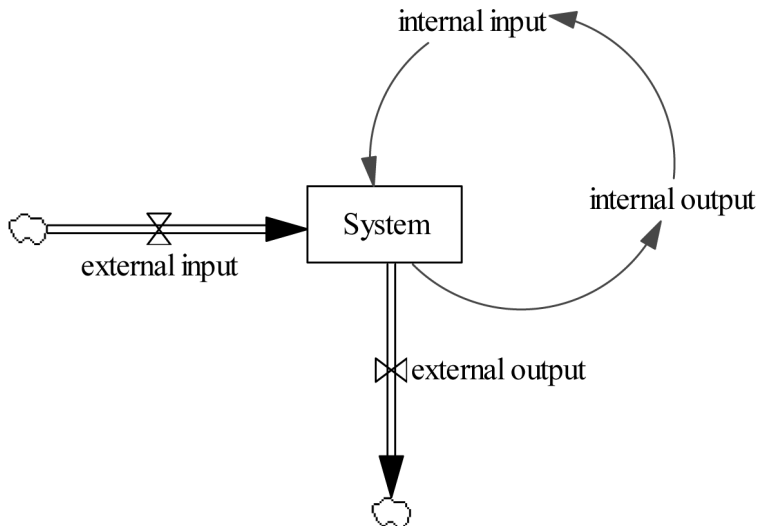
3 The state of the system should be understood as a value of the selected parameter or parameters.

deterministic and probabilistic systems. Deterministic systems are characterized by the behavior that can be predicted in advance (for example a computer), in case of probabilistic systems we are unable to determine the direction of changes to their behavior. A manufacturing company should be treated as a probabilistic, extremely complex system [Beer 1966, p. 21]. Beer emphasizes that while probabilistic complex systems may be examined by means of operational research, in case of probabilistic, extremely complex systems, they require a cybernetic approach.

Yet another typology of systems is presented by Gościński, who differentiates absolutely and relatively isolated systems, that is systems separated from the environment⁴. Absolutely separated systems are devoid of inputs and outputs beyond the system. Relatively isolated systems have at least one input from outside and at least one output outside as well as internal inputs and outputs (Figure 1).

Each external and internal input and output consists of two elements: supply and information. Supply is a material factor which may be the carrier of information, material to be transformed by the system or serving as a means to transform other supplies. A manufacturing company as well as any of its parts, may be treated as a relatively isolated system, in which supply can be: orders coming from customers, raw materials necessary for the production and machines, for example for metalworking.

Figure 1. The scheme of a relatively isolated system

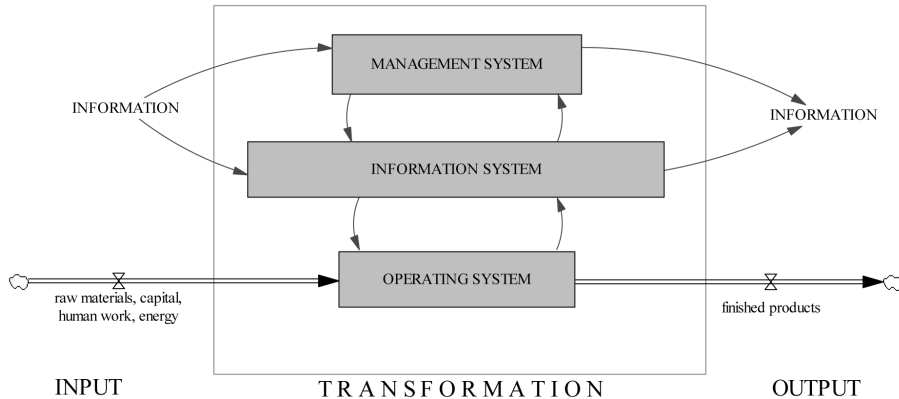


Source: own elaboration.

4 This type of systems was first defined by Greniewski, see [Greniewski 1955, p. 55].

Each supply and information may undergo the transformation process in systems. The word transformation comes from Latin ‘transformatio’ and means change, metamorphosis, change of form or substance [Flakiewicz, Oleński 1989, p. 47]. In a system such as a company, the output, for example in form of a finished product may be the result of transformation of such supplies as: raw materials, labor, etc. Transformation takes place due to coexisting, interrelated and cooperating systems of management, information and labor (Figure 2).

Figure 2. Transformation in a company



Source: own elaboration.

Transformation is connected with the process in which the cybernetic system strives at reaching the final state, in which all system parameters reach desired values. The system undergoes the so-called distinguished states or stage states until reaching the set goal. It is connected with the time factor and from the cybernetic point of view constitutes an orderly set of states distinguished in time. Stage transformation occurs to supplies and information, but, as Greniewski points out, the aim of the information stream is to direct supply streams [1967, pp. 14-15].

The features allowing us to consider a manufacturing company as a cybernetic system are also [Gościński 1968, pp. 27-34]:

- a) purposefulness,
- b) complexity,
- c) probabilistic type of distinguished states of the system,
- d) equifinality,
- e) self-regulation ability.

Purposefulness means that the system exists and is dedicated to realize a certain aim through particular actions. The company realizes internal aims serving the purpose of survival and development and external aims – imposed by

the environment. The most frequently mentioned main aims of manufacturing companies include [Skowronek, Sarjusz – Wolski 2008, p. 43]:

- a) maximization of financial result in the long period of time,
- b) consolidating its market position and obtaining competitive advantage,
- c) increasing economic potential,
- d) increasing the company value for shareholders.

The complexity of the system cannot be understood here as a number of all elements of the system, but as a number of distinguished states of this system [Ashby 1961, p. 96]. There are systems composed of numerous elements which may be presented by joining basic groups in simple entities differentiated by a couple of distinguished states.

Probabilistic type of distinguished states of a system is related to the existence of countless factors influencing processes realized in the company (for example production, storage, employment, sales, etc.) and causing random stochastic result of a reaction. In this case, knowing the initial state of the system and the program of transforming supplies and information, we can only with some probability determine the new state adopted by the system. Two identical companies with the same supplies and information provided in the input will not obtain the same number of finished products in the same time.

The above feature is also related to equifinality. It means that the aim can be achieved following different ways. For example, a company which has to produce a certain number of finished products may use a different combination of subjects, production means and labor. It is also connected with available technology and existing information flow channel.

The final, essential feature of cybernetic systems is self-regulation. It is connected with the notion of homeostat. Homeostat can be defined as a regulatory system, maintaining the value of any variable of this system within desired limits [Beer 1966, p. 26]. A company is a system of homeostat type, as through regulation it preserves desired states within determined limits (for example the state of raw materials necessary for production or the amount of necessary labor). It is, however, threatened with constant changes of economic, financial, social and political conditions as well as external environment. It adapts to them through self-regulation, whose main tool is feedback^[5].

To present and analyze the networks of analyzed systems cybernetics uses complete directed graphs^[6]. Such a graph consists of knots (in our case knots are particular subsystems in a system represented by the company) and the lines connecting knots along which information flows (see Figure 3). A complete graph is one that has a complete (definite) number of knots and information

5 See also [Gościński 1982, pp. 56-57; Kornai 1977, p. 255].

6 The basics of the graph theory can be found in [Wilson 2007].

lines. If all information lines appearing in the graph have the flow direction from one knot to the next one, then we have a directed graph.

3. The company as a communication system

One of the processes analyzed by cybernetics is the already mentioned transformation of information. Each piece of information decreases the so-called indeterminacy of the system which results from diversity, that is a large number of elements of the set of possible distinguished states of the system [Czerniak 1978, p. 76]. Information introduces certain limitations to this set, decreasing the number of distinguished states which prevent the system from being undetermined and give it some order. Taking into account the significance of information transformation in a system created by each company, we can present this company as an information network or as a communication system in which information is stored, processed and sent inside the system as well as from the environment to the system and vice versa. This is illustrated by an example^[7] presented in Figure 3 and discussed below.

The analyzed construction company was presented as a system consisting of eight subsystems presented below:

- a) P1 – leadership;
- b) P2 – subsystem responsible for managing production;
- c) P3 – production preparation;
- d) P4 – production supplies;
- e) P5 – planning and analysis;
- f) P6 – records and control;
- g) P7 – auxiliary production and services;
- h) P8 – construction production.

The above presentation of subsystems results from the functional division adopted by the company, using the service criteria rather than organizational division according to organizational units.

The company is centralized so the power of decisions lies in the hands of the company management. The system input is affected by external information (from the environment – the cloud picture in the scheme which comes from principals, suppliers, subcontractors, superior units and controlling bodies. They all constitute the so-called stimulus - information.

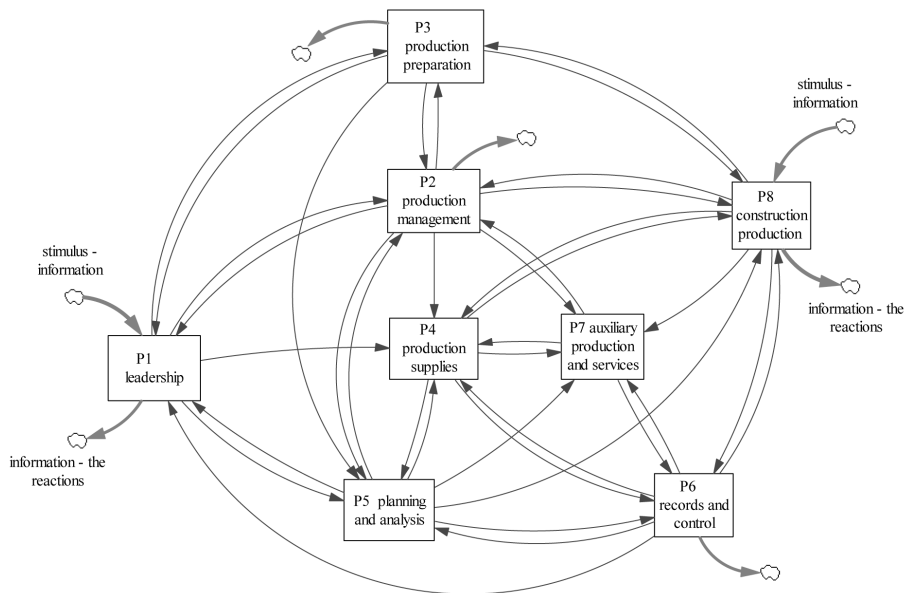
Information flows between subsystems mainly as a result of feedback and series connections.

⁷ The example was taken from research conducted in a construction company. The presented scheme is simplified, omitting physical supply, see [Gościński 1968, pp. 126-131].

From P1 subsystem (leadership) the following information flows:

- to the environment – concerning production and technical arrangements, payment, raw materials orders and products, complaints directed at suppliers, etc.;
- to P3, as guidelines and orders related to production organization, valid or new technology, etc.;
- to P2, related to production, products, quality, flaws and health and safety regulations;
- to P4 – concerning material supplies, equipment and labor, etc.;
- to P5, concerning programs of company activity comprising technical and economic plans and operational plans.

Figure 3. A company as a communication system



Source: own elaboration.

P2 subsystem (production management) sends information to:

- the environment, concerning the realization of construction production and instructions to subcontractors in a construction project, etc.;
- to P7, instructions for auxiliary production and services units;
- to P8, instructions for construction production units;
- to P5, essential to draw up production plans, technical progress plans and period plans;

- e) to P4, instructions related to provision of production units with necessary production resources;
- f) to P1 – concerning realization of approved production plans and all problems that appeared during the realization;
- g) to P2, connected with the guidelines for production preparation.

P3 subsystem (production preparation) has information essential for:

- a) the environment, directed at the designers offices and customers, related to proposed design solutions, construction organization solutions, technical conditions, etc.;
- b) P8, in form of verified documentation for production units;
- c) P5, defining the technical conditions of contracts with customers;
- d) P2, generally referring to production preparation and updating original technical and organizational assumptions;
- e) P1, connected with all production arrangements – to be approved by management.

From P4 subsystem (production supplies) information flows to:

- a) P7, in form of instructions concerning shifting production resources between production units and renovation operations;
- b) P8, concerning management of production resources and power supply;
- c) P6, as data related to use of materials, employment and production equipment work;
- d) P5, in form of information essential for technical and economic planning and operational planning.

P5 subsystem (planning and analysis) sends information to:

- a) P4, constituting directive indicators and plan parameters;
- b) P2, connected with periodical plans of particular production subsystems;
- c) P7, concerning planned tasks of particular auxiliary production and services units;
- d) P8, as plan tasks for all construction production units;
- e) P6, as data on realization of approved plans and changes to long-term and operational plans;
- f) P1, in form of reports, analyses and progress reports from realization of planned tasks as well as contracts on performance of construction work together with attachments and necessary supplements resulting from changing contract conditions.

Information from P6 subsystem (records and controlling) goes directly to:

- a) The environment and concerns production results, its quantity, quality, etc.;
- b) P7 and is related to production, own costs of realized orders, expenditure, labor, remuneration fund management and other information connected with auxiliary and service operations of the company;

- c) P8, constituting a similar type of information as in P7, but related directly to construction production;
- d) P1, in form of financial reports and analyses, balance sheets and profit and loss accounts and information on the management of remuneration and operational funds;
- e) P5 and is connected with execution of production plan, costs, sales and general financial standing of the company;
- f) P4 and concerns production resources, labor and remuneration fund, etc.

P7 subsystem (auxiliary production and services) sends information to:

- a) P4 as data resulting from the volume of auxiliary production and necessary resources;
- b) P2 on auxiliary production state;
- c) P6 on use of resources and labor in order to verify and record it.

Finally P8 subsystem (construction production) shares information with:

- a) the environment, especially with production purchasers;
- b) P7, concerning breakdowns, stoppages and other disturbances which can be eliminated only with help of auxiliary personnel, transportation base, etc.;
- c) P3, connected with the project estimate documentation and with projects of construction work organization in production units;
- d) P6, as data on used production resources, labor and construction equipment;
- e) P4, in form of information on production means, disturbances in deliveries, unexpected changes in the production program which lead to changes in production means and workforce;
- f) P2, on core production, technologies and technical issues, health and safety of work at particular production posts.

In the above example we presented information connections between particular subsystems which connect the network into one entity. Subsystems are both receivers and senders of processed information. Information flows in the system through communication channels. The types of flowing information vary. There is information on information, information – operational orders, information on supplies connected with production and information coming from outside the system (stimulus – information) or going beyond the system (information – reactions). All these information items constitute tools limiting the diversity of the above system.

We should also draw our attention to the quality of received and sent information. It is desirable that the information coming into the company, flowing inside it and going outside is:

- a) true,
- b) valid,
- c) comprehensible,
- d) unambiguous,
- e) complete,
- f) comparable,
- g) available to interested parties at a particular time.

It is important as there might be various types of disturbances and information overload which result in information which is wrong, false or even misinforms. Wrong information results mainly from the use of wrong methods and measure or observation tools. Therefore it only gives us some approximation of reality. Usually it results from the features of the information system used in a given company. False information is untrue information intentionally sent in circulation in order to disturb the decision process. Misinformation happens when, apart from formal information connected with the main aim of the company, there is incomplete or wrong information which serves the purposes of particular units and often collide with the main and superior aim of the company.

4. Conclusions

The article presented a manufacturing company as a relatively isolated system, characterized by purposefulness, complexity, probabilistic character of distinguished states, equifinality and ability to self-regulate. The above-mentioned features allow us to analyze the company in the context of cybernetic approach – as a cybernetic system. The company was also presented as a communication system and the importance of information as a factor limiting indeterminacy of the system was emphasized.

To sum up, a manufacturing company in light of cybernetics is above all a “machine” to transform physical supply under the influence of information. We can clearly see the supremacy of information from physical supply which is derivative of information.

Looking at the company from the point of view of cybernetics also emphasizes the importance of the whole system which constitutes the company and the role of each part in this entity. Mutual connections between these parts (subsystems) account for the fact that a change in one part causes adaptive changes in other parts. The understanding of these processes may therefore lead to effective steering and regulation of the system constituting each manufacturing company.

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