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Janusz W. Gościński*

DESIGNING OF SOCIO-ECONOMIC SYSTEMS

Designing is one of the oldest human being activities but on the other hand the theory of designing remains one of the youngest scientific disciplines. Well, but any time somebody uses the term: design or project or designing he is faced with a multi-aspect problem at the same moment. Usually, three aspects of the same problem arrive when we take into consideration the question of designing, namely:

- the subject being designed (what has to be done and changed)
- somebody who performes the process of designing (the methodological attitude),
- the method applied to solve the designed task.

Does the term designing relate to technical subjects only or could it be extended to all socio-economic systems? It is a fundamental question which relates to the first aspect of designing. We answer that question rather positively taking into account that such subjects like machines, plants, buildings, etc as well as companies, institutions, and also decision-making procedures are all artificial things generated by human beings. They are- what we call-artifacts. For these reasons Prof. W. Gasparski[1] suggests that we should tackle each designing task as a system. G. Nadler[2]

* Professor, Institute of Economics of Light Industry, University of Łódź, Poland.

[1] W. G a s p a r s k i, Projektowanie - koncepcyjne przygotowanie działań. Designing - The Conceptual Preparation of Actions, Warszawa 1978.

[2] G. N a d l e r, Work-Design. A System Concept, R. Irwin, Inc. Ill. 1970.

describes in his Work Design the first three phases of a classical procedure of designing and points out the similarities between them and the strategy of research approach.

These three steps are as follows:

1. Identification of the problem under consideration.

2. Analysis or division of the whole system into elements and the analysis of each particular component.

3. Identification of failures and their sources.

The fourth phase being, in contrary, a creative one is called by Nadler the phase of reconfiguration of old and new elements to obtain the desired system.

The information needs and requirements

In general, the process of designing starts, independently upon the characteristics of the subject, with the formulation of the task and the diagnosis of the operational way the system works. It is important to recognize at this point the significance of data a designer needs while entering this phase of the designing process. He has to know all the facts how the system operates as well as the ideas how the leadership intends to modify the behaviour of the system in the near future. The information needs could be specified as follows:

evaluation of the system and its performance	the need for change
- what is the structure now?	- description of the need for change?
- what is the actual performance?	- time in which modifications should be introduced?
- in what way does the system operate?	- conditions under which the system will operate in the future?
- sources of failures and unsatisfactory results?	

There are many methods to tackle the process of designing (e.g. Nadler's Ideals, or remind the endless discussions about the advantages and disadvantages of top-down vs. down-top approaches). What is, however, more important for the purpose of

this paper is the positive answer to the fundamental question. Yes. All aspects of designing are absolutely valid and relevant for socio-economic systems. Professor Herbert Simon puts his answer in such a way: indeed, we always design when we develop the means used to convert a given situation to another, more suitable one. This intelectual activity which supports the creation of artificial material subjects does not differ essentially from such an activity as medical prescription by a doctor or of an economist developing a plan of sale or by a politician preparing a program of social changes. The main task and goal of any type of higher school like engineering, law, medicine or administration is to teach desingning[3] Simon.

So, the elaboration of an economic system or a modification of the performance of an existing system means just designing. The question is, however, that economic systems differ by nature from all other types of systems in structure, performance and growth. The special characteristics of socio-economic systems require special approach to solve problems such systems create.

Designing of economic systems deals, in general, with two kinds of subjects:

a) material artifacts (machine, building, factory etc.) being under consideration in the social and economic context because some of their elements (components) are people; individuals, teams, and groups but on the other side devoted to serve people in the systems environment (groups or the whole society) in many aspects (employment, increase of professional qualifications, increase of salaries, changes in the social structure or infrastructure, etc.),

b) real processes, for example, consumption, production etc. to meet the material and spiritual needs, standard of living and social aspirations.

It seems to me, however, one more type of subjects should by added to those two. I mean here the regulation and control processes including planning (central planning or just planning within each particular institution), motivation mechanisms etc.

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[3] H. S i m o n, The Sciences of the Artificial, MIT Cambridge 1969.

In accordance with prof. Gasparski' interpretation there exist two developments of modification to achieve a desired change:

- standard approach which consists in replacement of one element or any combination of elements through the same type of elements or the same combination of elements. This means that the process is a repetitive one and is typical for massproduction or large batch production, some types of service activities, maintenance etc.

- unique approach where the change requires the replacement of one element or any combination of elements through another element or any type of new combination of elements. Such approach can be called an innovative one.

The concept of a standard and unique decision was introduced to economic considerations by J. Kornai[4]. These types of decisions are connected with two types of adaptation of economic systems to significant external and internal changes. For this reason they are closely connected with different goals of both types of adaptation, with different managerial functions and with - what is very important - different patterns of behaviour of a system. Kornai thinks that the majority of decisions made in an average company are standard decisions in the field of purchasing, selling, manufacturing, etc. He also says that standard decisions are connected with the primary adaptation ability and through it with the strategy of survival of the system. The other type of adaptation is called higher order adaptation and relates to the strategy of development.

Now, generally speaking we could make the final statement that the process of designing fully covers the area of socio-economic systems. The question is and still remains how to design the modifications of socio-economic systems in the most effective way. This means the problem is of greatest relevance and the answers, we have to search for, should be given in all three aspects of the process of designing.

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[4] J. K o r n a i, Anti-Equilibrium, Amsterdam 1971.

Main characteristics of socio-economic systems

The economic systems are by nature complex, probabilistic, and selfregulated. For these reasons a designer is getting into trouble having difficulties with the first stage of the designing process, with the static analysis and the first draft of diagnosis. Things are becoming more complicated when one moves from this stage to the dynamic analysis of the systems performance and effectiveness. Nevertheless, we have to extent the characteristics to take into account in the designing process all important factors and circumstances under which an economic system usually operates.

The presentation starts with the background R. Ackoff created by his contribution to the semantics of the General Systems Theory. In respect to this approach and, in particular, to the behaviour of systems we can distinquish many classes of systems. But by an organization we mean a system:

- which is an intentional one,
- contains at least two intentional subsystems,
- has a set of purposes for the whole system,
- purposes can be expressed in social and economic terms,
- its structure is based on the criterion of job specialization,
- provides such a communication system which enables interactions among subsystems being relatively autonomous,
- at least one of the subsystems performes the function of regulation and control devices J. Gościński[5].

There are three fundamental questions a designer has to answer if he were able to design a modification of a given system. The answers, we are searching for, are connected with:

1) degree of identifiability of the system,
2) degree of observability of the system,
3) degree of controlability of the system.

This means we have to answer the question to which extent a system being under consideration is identifiable because each com-

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[5] J. G o ś c i ń s k i, Combined Technological and Economic Control Process "Control and Cybernetics" 1974, vol. 3, nr 1/2.

plex system is identifiable only partly. Moreover, we have to answer the question to which extent a system can be observed (what means the observations of input and output). The first case is related to the description of the structure of the system (elements, their characteristics, relations between pairs of elements, etc.) In the second case we do not care to much about the transition functions because the system as a whole is treated as a black box and we use induction as an approach to conclude by observations of both in- and outputs what the transition (or conversion) programme really is. Yes, but in both cases we usually intend to change the state of the system knowing that probabilistic systems with selfregulation mechanisms can be only partly controlled. The answer should be given to the designer because otherwise he could assume the system (or a particular process) is fully controlable. Wrong assumptions can not be repaired in a model. The only possibility is to cancel the model and to start modelling from the beginning.

The control theory formulates very strong requirements in this matter. It says that by a system being observable such a system is meant which in a period t_o, t_k allows at a freely selected moment t_k - knowing the control function $u(t_o, t_k)$ and the response X for this period - to calculate the initial state of the system in this period. Economic systems however, are acting through sequential processes in which a state depends upon the transition function and the previous state go the process depart in time from the initial state of the system. It would be improper to call such systems as being observable. They are only partly observable. An economic system can be identified also only partly, because, complexity cannot be totally described. This leads us to the final conclusion, that economic systems are not controlable. What we should do to keep and exercise a little bit of control is to forecast the future conditions the system will be faced, secondly, to support the selfregulation processes going on within a system, and thirdly to plan tasks (desired future states of the system) and the resources the system will need to meet its objectives. The theory of control says that the state S_o of a system at a given moment t_o could be called a controlable if applying periodically continuous control-it were

possible to reach in a finite time (t_o, t_k) the planned or expected final state of the system. It is easy to see that all elements of this requirement are or not available or not reliable. This relates to the continuity of the control process, given period of time to reach the final state, the precisely distinguished final state (described usually in economic systems as a vector of partly contradictive objectives) etc.

Designing modifications of socio-economic systems is one of the most sophisticated processes. Each particular design is in the reality an unique procedure, an absolutely unique one what means in terms of Design Theory that the designer has to initiate a research to obtain new knowledge because the available knowledge is not sufficient enough to solve the designing problems.

Designing significant modification of an existing system or designing new system and the control functions $u(t_o, t_k)$ the following questions we have to solve and answer:

1) what is the real structure of the system and its dynamics or - in other words - variability of a number of elements in time, changes of their characteristics, and - what is extremely important - the changes of relations among elements,

2) the boundaries of the state space (vector S) of the system,

3) the vector of feasible inputs X and the subspace in which they can occur,

4) the boundaries of the subspace of the control vector $U_{o,k}$,

5) the multicriterial character of the control process what often causes that it is not possible to scalarize the criteria and to create relevant weights for the set of simultaneous criteria,

6) some kind of dualism which occurs when we try to confront things expressed in value and physical unit categories which often causes problems we are not able to overcome,

7) the boundaries of the feasible output state space (vector Y).

All state space problems show that we are discussing here questions from the point of view of the modern theory of control[6].

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[6] K. O g a t a, State Space Analysis of Control Systems, New Jersey 1967.

The multicritérial sets of goals (objectives), the state spaces and subspaces, the fact, that in more complex systems there exist two or more regulatory and control devices all these questions create an impact to search for now approaches and problem-solving generators. That is the background of new proposals such as L. Zadeh[7], dealing with the theory of fuzzy sets or the "Wattled Theory of Systems" by Wymore[8] which looks to be suitable to tackle the stochastic processes by applying measures of probability to inputs, spaces, transition functions etc. as well as to systems design supported by computers.

The role of planning in economic system control

Now we have to discuss the question what is the role of plans in an economic control process. Are planning and market as regulators (or control parameters) contradictive to each other or can they work together. Kornai has already presented his viewpoint based on the general assumption that both factors the plan and the market should be put together to increase the effectiveness of an operating system.

We could assume on this bases that there exists a theorem by Kornai which can be displayed in the following way: market or a planning system are separately and exclusivelly highly complex and stochastic by nature. Both market and planning systems are regulators operating in a way which is not enough complex (or on the lower level of variety). The control process requires, therefore, the joint action of the market and planning. They should operate on a basis of a multi-stage information system and multi-level control process to conduct the activities of an economic system and to respond correctly and quickly to all changes of environmental conditions[9].

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[7] L. A. Z a d e h, Toward a Theory of Fuzzy Systems [in:] Aspects of Network and Systems Theory, New York 1971.

[8] A. W. W y m o r e, Wattled Theory of Systems [in:] Trends on General Systems Theory, ed. G. K l i r, J. Wiley and Sons, Inc., 1972.

[9] J. G o ś c i ń s k i, Marketing Management Information Sys-

R. Ackoff assumed, considering the character and role of planning, that planning is a decision-making process but it is on the other hand the designing of the future. To be, however, more precise I would suggest to define a plan as a:

- set of decisions expressed in quantitative terms and
- dealing with economic activities in a given period of time.

It is easy to be seen that goals and/or objectives remain beyond this formulation. That's correct because I really think they are the components of the strategy of a firm or national economy or, respectively, of a tactics when we speak about a relatively short horizon of time. After the strategy is accepted and known a planner can start with preparation of the plan itself.

A plan self is not an action. It only creates the conditions to initiate a sequence of actions.

Let us consider three main types of plans: perspective, medium-range (usually 5-year plans), and short-term plans (annual or shorter). To make some comparisons and analyse the differences the following criteria will be used: goals, structure of the plan, obligation to achieve the final figures of a plan, degree of uncertainty, complexity, and the function of the plan.

Perspective planning goals are long-range strategic objectives of the growth of the unit preparing certain plan for national economy, corporation, company, etc. Those types of plans are usually geographically or subject-oriented (for example: innovations, development of new products, penetration of new markets etc). The figures are not obligatory. The uncertainty is relatively high and the prediction errors are often relatively great. Perspective plans are mostly not overall because they deal with certain carefully selected problems or areas of activity. The function of such a plan is the choice of strategy and the calculation of expected results 5, 10 or more years ahead.

Because of the characteristics and function of this type of plans it is easy to conclude that they cannot be used as a tool in control processes.

Middle-range planning deals usually with changes which will

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tems for Marketoriented Companies in Centrally Planned Economy, Brussels 1977.

be introduced into the system with the purpose to diversify its performance and to achieve the restructuring of the whole system. For this reason they are overall complex, and partly obligatory. The uncertainty is still relatively high. The major function of this kind of plans is to achieve desired structural changes in the system and to affect the environment to facilitate the operations and activities of the system. It seems that some elements of such a plan can play certain role in the regulation and control processes.

Short-term, operational planning does have a clear goal, namely, to keep the system going. The figures are obligatory and cover all areas of operations. Because of the horizon of time the uncertainty is relatively small. The main function of such plans is task-oriented. It helps to perform day by day and week by week operations of the system. For these reasons short-term planning could be considered as an element of the control process.

The control process in economic systems as well as in all complex social systems consists of:

1) vector of goals with periodically stable priorities,

2) standards of categories (resources, inventories, levels of saturation of something, etc),

3) trajectories to achieve desired or expected states (alternalives with sometimes optimization procedures),

4) measurement system to measure deviations and to process data connected with those deviations and tolerances,

5) correction activities to eliminate deviations or to compute new trajectory to achieve planned goals or to modify goals etc.

Analysing all five points of a typical control process we should be able to discuss the question what the role of planning in the control process really is.

First of all let me use a notion to demonstrate the control error e_t at the moment t as the difference between the norm standard N_t and the real output Y_t. What I want to formulate is the argument that a control process, where the standards are derived from a plan, can be called the planning and control process. In contrary, are the standards and variables taken not from a plan because they are set-up beyond the plan as a set of economic parameters (for example discount rates- custom tariffs, taxation

progressive rates etc.) we can distinguish another type of control process in economic systems which is called parameterized process of control. For a designer of a system this means he has to incorporate the planning procedures and plans themselves into the set of control loops (both positive and negative feed-back loops) to create an effective system of control without overlappings and empty subspaces.

It seems to be obvious that this part of a designing task is, in fact, one of the most sophisticated assignments.

Janusz W. Gościński

PROJEKTOWANIE SYSTEMÓW SPOŁECZNO-EKONOMICZNYCH

Projektowanie jest niewątpliwie jednym z najstarszych rodzajów ludzkiej działalności. Z drugiej strony teoria projektowania pozostaje najmłodszą dyscypliną naukową. Jednym z istotnych problemów dyskutowanych w teorii projektowania jest pytanie: czy określenie projektowania należy odnosić tylko do przedmiotów natury technicznej, czy też można je zastosować w odniesieniu do wszystkich systemów społeczno-ekonomicznych? Teoria projektowania odpowiada na to pytanie w zasadzie pozytywnie. Pozostaje jednak problem opisu faz projektowania, a szczególnie projektowania systemów społeczno-ekonomicznych.

W prezentowanym artykule zostały przedstawione różne podejścia do projektowania systemów społeczno-ekonomicznych, omówione zostały fazy tego procesu. Wiele uwagi poświęcono także procesom regulacji i sterowania oraz procesowi planowania i roli jaką spełnia w sterowaniu systemem społeczno-ekonomicznym.