Relevance of systems theory for management science

RELEVANCE OF SYSTEMS THEORY FOR MANAGEMENT SCIENCE*

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Abstract

Systems theory has developed out of the established inability to deal with certain phenomena of the traditional analytical methods of research. So it is also felt in management science. Because of peculiar parallels between management science and systems theory in the emphasis on the dependence of the constituent parts and on control a confrontation of both seems fruitful. After the development of an empirically empty system of system's concepts the way is discussed by which it can lead to modelling the empirical world. Also attention is given to several approaches, particulary important to the study and control of organizations. In the second part criticisms on systems theory are discussed, that has been raised against systems theory, especially from action theory. It will be shown that they are based on a misunderstanding of the nature of systems theory. Our conclusion is, that although a lot of work still has to be done, concepts and paradigms of systems theory are at this very moment of practical value for the manager and management scientist.

Introduction

Systems theory has developed in consequence of the grown dissension with traditionally used analytic methods of science. This dissension manifested itself explicitly in technology, biology and psychology [1]). In those sciences the said methods did not lead anymore to satisfactory results. Especially complexity of matters of control in technology [1], inadequacy of description of certain biological processes [2], and the unsatisfactory results of the mechanistic stimulus-response model (robot-model) in psychology [3] were the reasons for this fact. More and more one came to the conclusion that behaviour of a system cannot be explained from the behaviour of parts of that system. Birth of the systems approach had taken place.

Nevertheless it lasted several years before systems theory had come to growth. The development ran mainly along the three sciences named earlier; in technology by means of the theory of information and control, in psychology via the Gestalt-psychology and in biology by the organismic biology.

* Lecture delivered at the summercourse 1974 of the Systeemgroep Nederland. With permission of the editors of *Bedrijfskunde*. Dutch version in *Bedrijfskunde*, 47 (1975) no. 1, p. 22–33.

Important progress has been made during the crisis-situation in world-war II, when the development of automatic gunfiring systems was necessary and with the foundation of the Society for General Systems Research in 1954. In this society for the first time contributions to (general) systems theory from different sciences were brought together. It was especially Von Bertalanffy, who, lead by his belief in the idea of the unity of science, has stimulated the development of this society. A similar initiative has been taken in the Netherlands in 1970 by the Foundation of the "Systeemgroep Nederland" (Netherlands Society for Systems Research), that wants to stimulate in the Netherlands the development and application of systems theory in all kinds of sciences.

Systems theory for management science

A similar development has taken place in the thinking about organizations. The growing complexity of organizations and the environment of organizations has forced managers to develop new ways of thinking and expedients to be able to cope with this development. Therefore more and more one calls in the aid of science; first the economic sciences, afterwards also the humanities. Given the fact that contributions from those different sciences cannot be brought together – results from one science can often not be compared with results from another science, among others because of the use of different units – and that specialisation within science progresses still further, the need of an integrating science arises.

As such systems theory announces itself. For systems theory approaches a system as a whole. It emphasizes the mutual interdependence of the parts and concentrates furthermore on problems of control in systems. So she is not emphasizing certain discipline-bound aspects. This fits wonderfully with the subject matter of management science that can be described as control of organizations in the widest sense. Application of systems theory to management science should lead therefore to the integration of all sorts of aspect-approaches to organizations. Whether this leads to a real integration of the subject matter, should still be questioned. Rather we will look for integration of theories about aspects and the development of a theory for an aspect by searching for structural isomorphisms then for the development of a Grand Theory about organizations or the behaviour of organizations.

Because of the need for aspect-integration and the increasing specialization in science, together with increasing communication difficulties between specialisms because of specific use of notions, I attach to systems theory and systems thinking in first instance two functions [5]:

1. Providing insight into the methodology [2]), that is inherent to systems theory, the approach of the whole.
2. The development of a common language, that makes it possible for scientists and practitioners, from different scientific background, to communicate with each other: so in fact a multidisciplinary means of communication.

Principles of systems theory

Systems theory starts from the premise: everything depends on everything. This gives us still nothing to go by. For if we perceive phenomena in the empirical world, we always have to consider these in relation with others. To make this contemplation or inquiry possible, we should be able to discern the concerning phenomena. We should be able to cut something out of reality. If we make such a distinction, we create a system. At first instance we could describe a system as a set of interrelated phenomena. More precisely I want to define it as:

a system is a set of entities, among which there exist mutual relations [5]

With this definition we have to realize very thoroughly, that we have constructed an artefact. At last it is us who make the distinction. This presupposes a choice criterion with the investigator; he considers something as a system, whether or not being in interaction with an environment [3]).

A very important notion in this definition of a system is the notion of relation, together with the notion of structure of a system. Intuitively the content of the notion of relation is clear. Practically it gives quite a lot of problems. The notion of relation can be defined as:

the way two or more entities are interdependent [5].

The establishment of a certain relation between two entities or properties of entities is however something different, the given definition does not provide. For this matter, I want to describe the notion of relation more precise as: there exists a relation if a change in a property of one entity causes a change in a property of another entity. The behaviour of both entities is thereby not independent any longer. It also means a restriction in the number of possibilities of behaviour or degrees of freedom of a system.

By means of the notion of structure we give content to the pattern of relations, that together with the entities forms the structure of the system. We can describe the structure of a system by:

the set of relations together with a dimensional domain and a frame of reference [6] [4]).

Let us consider as a system for instance the topography of the Netherlands.

The cities and villages can then be seen as entities and the water, air and overland routes in between as relations.

The dimensional domain, that accounts for the relative position of the towns, is then given by statements as: the distance between Amsterdam and the Hague is 5 and the Hague is at the left side under Amsterdam. The frame of reference gives a scale and a reference to north.

The last notion minimally to be defined is the notion of environment. It can be defined as:

Everything that does not belong to a system [5].

More useful for the sake of easiness of contemplation, because this definition includes the total universe, is to speak of the relevant environment. This can be described as: the set of entities, not belonging to the system but influencing or being influenced by the system.

With the aid of those notions: system, relation, structure and environment, we are in principle able to describe systems. Mostly this is nevertheless not simple. Especially the choice of a systemboundary, that is narrowly connected with the discern that has to be made between the considered phenomena, as mentioned before, is often problematic and indeterminate.

Nevertheless we still are not able to describe the behaviour of systems. For this purpose two methods are designed in systems theory, named the *I/O* (Input/Output) representation and one where the notion of state is used. In the *I/O* representation one tries to find a function, the transferfunction or transmissionratio, that carries the input of a system straight over into the output. This method is applied in the black-box approach, on which I will return further on. What a description of the behaviour of a system by means of the notion of state holds, becomes clear as soon as possible by the following definition of the notion:

> the state of a system contains that information about the history and present condition of the system, which is necessary and sufficient to predict given a certain input the output or the probability of a certain output of the system [5] [5]).

Curiously this description of the notion covers exactly the common use of the notion in ordinary language. This is illustrated well by the following example from the banking business. The payments done by a bank will not only depend on the charges for payment given by the client, but also on the balance. The state of the system is in this case the balance and that is indeed a sort of abstract of the relevant history (deposits, payments, interest, up and off writings).

The behaviour of a system can now logically be described as simple as: the course of the state in time [5].

The task is now to investigate the empirical world with those notions and to describe in these terms the phenomena observed. As is said before, this is not a simple matter. A distinction between the perceived phenomena in the sense of belonging or not belonging to the system, is arbitrary and supposes a choice criterion with the investigator.

This means that the notion of model and modelcycle or empirical cycle are part of systems theory inbreakably. For we construct a model of empirical reality, that we describe in notions of systems theory. So we use this model to gain information about these phenomena. Apostel has therefore defined a model as:

if a system M, that is independent [6]) of a system S, is used to gain information about that system S, than we say that M is a model of S [7].

I want to emphasize the pragmatic or usage value of a model. That means, one constructs a model of something with a purpose. A model has to be considered operationally. It is interesting in so far as it is purposeful. This aspect of the notion of model has recently been treated very extensively by De Zeeuw [8].

The modelcycle describes the process of modelconstruction and consists of three phases: abstraction, deduction and realisation, that can possibly be reiterated for the sake of refinement of the model. During the phase of abstraction the relevant magnitudes are selected and brought together in the model. To these magnitudes content is given by measurement.

After construction of the model comes an analysis that leads to conclusions, this is called deduction.

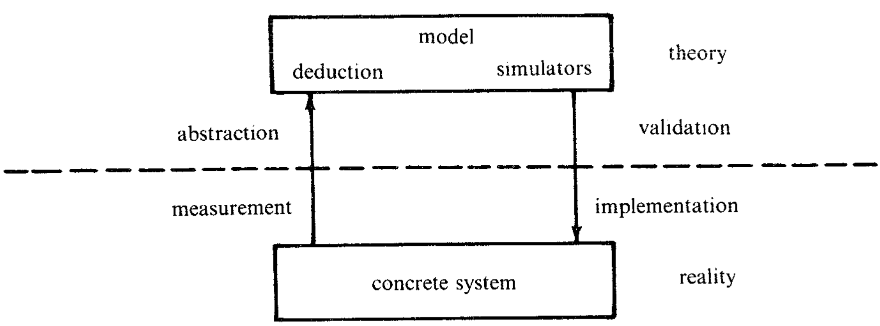

Fig. 1. The modelcycle [9].

These conclusions are translated into testable statements about the original system: realisation.

The phase of realisation consists of two parts: validation and implementation. In the phase of validation we test the conclusions from the phase of deduction at their validity and examine thereby whether the model is valid. If this is the case, we can implement conclusions from the model into the concrete system. If the results do not match the fixed criteria, we can again start the model cycle. It can be useful then to use information gained during the preceding modelcycles.

Hanken and Reuver are offering in this process of modelconstruction an important aid, by means of designing a system-based model of models, a metamodel. It is a formal model, starting from the fact that one can describe the behaviour of systems with four sorts of variables and relations between them [7]). Those are successively:

1. Input variables $x(t)$; these are images of magnitudes [8]), which operate upon the system from the environment and which are considered as nonmanipulative. For instance, weathercircumstances and political situations.
2. Desision variables $u(t)$; these are internal variables that can be influenced or manipulated. With them we can control the system, because they determine the choice from possible alternatives by means of the criteria. They determine more or less the reaction of the system to the input. For instance: height of taxes.
3. Statevariables $s(t)$; these are images of state magnitudes. They record the relevant history of the system and are influenced by input and decision variables. They can't be manipulated directly, but together with input and decisionvariables they determine the output of the system. For instance bankbalance.
4. Output variables $y(t)$; are determined by input and internal system variables. What one considers as output variables is dependent on the problem-definition. For instance, renumerativeness, generated energy or work satisfaction.

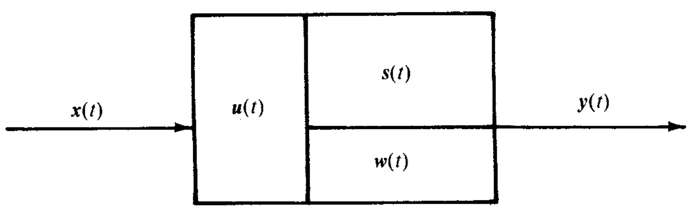

Fig. 2. Metamodel or Systemcell [9].

Also are being considered: auxiliary variables $w(t)$ and parameters. Auxiliary variables are dependent variables, that are brought into the model to facilitate the description. They can always be eliminated. Parameters are systems magnitudes that do not belong to any of the five categories. One calls them sometimes images of characteristic magnitudes. Voltage and type of current (*AC* or *DC*), to which an electromotor should be connected, are examples of parameters.

We can take the metamodel as guide for the process of modelconstruction, to arrive at systems theoretical models. They fit narrowly with the state-space approach of Zadeh and Desoer [10]. Research in management science has led to the development of an integral corporate model [9]. Starting point in this model is a financial-economic problem definition. The model is built in a modular way and contains among others a marketmodel, forecasting model, investing/financing model, model of personel, productionmodel and book-keeping model. Nevertheless one should consider the fact that the discerned variables are of mere financial-economic character and throw only light on a specific aspect of what occurs in organisations. This is caused by the fact that behavioral aspects can still not be described satisfactorily in a formal way.

Another important concept from systems theory is the black-box. We use this concept to find a description of the system with abstraction from the real content of the system. The system is described in terms of input $x(t)$/ output $y(t)$. The system is then characterised by a transfer function or ratio H that transfers input into output.

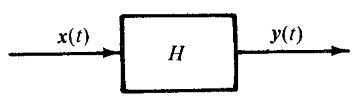

Fig. 3. The black-box.

The black-box is defined as:

> a system of which the content is unknown to us or does not interest us and the relation with the environment runs according to known paths [5].

The advantage of examination of systems by a blackbox approach is, that we examine systems thereby in a purposeful and clear way, without damaging or influencing the system eventually by opening it.

For certain kinds of researches as neurological research etc, this is of crucial importance. To determine the transferfunction we shall generally try to vary the input in a clever way and then observe the resulting output. From these observations we try to design a function that transfers the used input into the observed output.

In the different sciences more or less refined techniques as frequency response and correlation are designed for this purpose. In management science they are applied among others in communication research within organizations [11].

Also concerning models of structures systems theory offers what is necessary. Two important examples from management science are the research into patterns of communication in organizations, based on the concept 'liaison communication roles' [12] and Mesarovic's theory about 'hierarchical, multilevel systems' [13]. There is every appearance that this theory can bear fruitful results in formal research of complicated, stratified organizations, although a phenomenon as conflict cannot be described satisfactorily with this theory.

Two, in my opinion promising, developments in systems theory concerning applications on matters of organizations, are the theory of purposeful systems, laid down in the book of the same name [14] by Ackoff and Emery and De Leeuw's paradigm of control [15]. In the next section I will discuss them both briefly.

The study of Ackoff and Emery is concerned with the development of what they call: 'a way of looking at human behaviour as systems of purposeful events'. They start from a holistic view of human behaviour, that according to them is necessarily a functional, teleological or purposeful view. With this view they leave the mechanistic, extremely-behavioristic approach (a.o. Tolman) of human behaviour, although their functional concepts concerning objectivity, measurableness and usefulness for experiments, should satisfy the same requirements as those of the structural concepts derived from the behaviouristic approach.

To explain the human behaviour with a functional approach they develop a model of decision or choice, based on a more extended but similar set of concepts as is introduced at the beginning of this paper. This model produces insight in the behaviour of the individual in his situation. In the behavioral sciences one has long attempted to design such models. This model is, in my opinion, compared with other models a substantial step ahead. This is due to the fact that Ackoff and Emery consistently have tried to define their concepts in an objective, measurable (although sometimes rather naive) and for experiments accessible way.

All problems are thereby still not solved, nevertheless results of experiments carried out by them, among others into the human behaviour of drinking alcoholic beverages and buying by consumers, show the promise of this approach.

Beside the explanation of behaviour on micro-level, especially exacerbated on the individual behaviour of choice or decision, De Leeuw [15] has developed a paradigm of control. This paradigm can be used on micro-, meso- and macro-level of control of organizations. It is formulated as follows: within the input of a system a distinction is being made between magnitudes that can or cannot be manipulated. By means of the magnitudes that can be manipulated we try to control the system. Control is executed according to a defined goal or set of goals. For a few of the magnitudes that cannot be controlled, it turns out that no adequate internal controlling measures are at stake. Nevertheless by influencing the environment of the system one can prohibit that no such input reaches the system or that this input changes.

We can depict the paradigm of control therefore as:

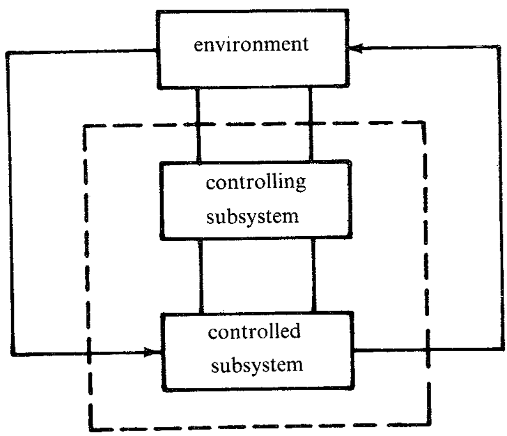

Fig. 4. Paradigm of control [15].

It shows that, looking upon the problems of control more closely, we can list a number of conditions, so that the system can function in a satisfactory way (De Leeuw [15], Conant and Ashby [16], Ashby [17] and Kramer and De Smit [5]:

1. There should be defined a criterion or set of goals, from which a criterion can be derived, to be able to make a selection from the available measures of control.
2. The controlling subsystem must have available information about the environment.
3. The controlling subsystem has information about the controlled subsystem at her disposal. Formally is shown [16], that it should then contain a model of the controlled subsystem and environment.

4. The controlling subsystem should have at her disposal a sufficient number of adequate measures of control ('Law of the requisite variety' [17]).
5. The controllability [9]) can be changed by a change of goals.
6. The time period, an optimal controlling subsystem looks ahead, is connected with the controllability.
7. The amount of information that should be coped with, depends on the uncertainty of the future behaviour of the system during the timeperiod mentioned above.
8. If the system cannot be controlled satisfactorily enough, the controlling subsystem will not only try to improve this by means of measures of control and changing of goals, but also by means of influencing the environment.
9. The rational controller will use external and internal control dependent of the relative sensitiveness of the state to input magnitudes that can or cannot be manipulated and the degree to which the environment can be influenced.

Summarizing we can state that the possibilities of control can be characterised by the 6-tuple [15]:

$\langle IR, IA, IG, ER, EA, EG \rangle$.

IR: means internal routine control. It exists of choosing measures of control in a clever way. Many of the results of operations research can be useful on this level.

IA: internal adaptive control. One adapts the structure of the controlled system in such a way that the function fits better to the goal. Results of re-organization can contribute to this level.

IG: internal goalchanging control. By adaptation of goals one tries to fit the wished behaviour to the real behaviour. This concerns mostly management decisions, taken high in the organization, as change of product.

ER: external routine control: for instance by advertising trying to sell more products.

EA: external adaptive control. By adaptation of the structure of the environment one attempts to let the system function in a better way. For example movement of the organization and influencing local political structures.

EG: external goalchanging control. By changing the goal of the environment one tries to reach its own goal better. Often it concerns attempts to change public values and norms.

It turns out that the introduced concepts of control can be formulated and manipulated in a formal way. A lot of formal theories are ready for application varying from linear differential equations to the theory of dynamic games with several deciders and several, changeable goals (see o.a. Hanken and Reuver [9] and Kwakernaak [18]). Underneath this theory often lies a number of assumptions, as linearity, continuity, differentiability, measurability etc, that restrict the direct modes of application in the investigation of complex organizations.

To my opinion should also be mentioned that there exists a certain shiver in application, coming forth among others from a (misplaced) aversion of formulas and formal descriptions. At this moment though the value of the offered concepts of control is more in the guide they provide indirectly for empirical research and action.

Criticisms on systems theory

The last few years criticisms are emerging from the behavioural sciences on systems theory, especially from the actiontheory [19], but also from management science based on an action approach. Mainly the book of Silverman [20] has contributed to those criticisms. The origin of this criticism is to be found in two fundamentally different approaches of social reality. The crux of the difference can be described briefly by 'Society makes man' (systems theory) and 'Man makes society' (action theory) [19]. Both theses are sensible in one way or another as starting point for research. Also it is very hard to see them independently.

The question is now, if theories coming from those approaches have a complementary or a conflicting character. For this purpose I want to look upon the fundamentals of both.

Concerning systems theory I refer to the preceding part. The result of application of systems theory on the description of the behaviour in social systems is, that systems theory considers behaviour as a deposit of the characteristics of a social system, that contains a series of unpersonal processes, outside the individual, that restrict his behaviour and in fact makes his behaviour dependent on these characteristics.

Action theory describes the behaviour of individuals, called actors, from the meanings they attach to their own and another man's actions. Furthermore it asserts, that the individual is restricted in his behaviour by the way he constructs socially the reality surrounding him.

So systems theory takes off from a holistic approach, action theory is based on an atomistic approach in which a much greater value is attached to the role of the parts (actors) in the social system. This is caused by the assumptions on which the action theory is founded. These provide a way of analysis for the explanation of actions of typical individuals in typical situations. Starting point is the actor (the individual), defined as in [19]: an actor has goals. These are mutually related. He possesses certain presuppositions concerning the nature and the possibility to attain these goals. Also he possesses certain norms and values that influence his selective perception of the situation, his emotional inclinations influence his perception of the situation and his choice of goals. To attain his goals, action will often consist of selection of means. This selection can be distinguished.

By means of the notion of this actor, action theory attempts to describe the behaviour of individuals. This leaves the question, whether action theory, based on these assumptions, and systems theory are complementary or conflicting. Cohen [19, p. 14] inclines to the first point of view, because of his distinction between a holistic and an atomistic approach. Silverman [20, p. 143] states on the other hand, that the approaches are conflicting and expresses his preference for the action approach. He gets his arguments from the research of Berger and Luckmann [21], who think that by examination of the way in which society makes man – precisely the thesis attributed to systems theory – the action theory can give an explanation of the nature of social systems, based on the interaction of actors, that not necessarily depends on the systems approach. The paradox in this case is, in their opinion, that man should be considered to be able to produce a world, that he does not experience as a product of man afterwards.

In my opinion this view is too restricted, because of two reasons. The first corresponds with the reasoning de Sitter has unfolded in a recent paper [22]. The second is based on the fact that in my opinion it is a misunderstanding that systems theory is not able to give explanations of phenomena on micro-level and that in the case of action theory even can be shown that she is a part of systems theory.

The argument of de Sitter is that the notion of system is part of the traditional vocabulary of sociology and that with this fact systems theory can be confounded with the structural functionalistic theory as Parson's theory of social systems [23].

Against systems theory are put up the same arguments as against structural-functionalism. This confusion is caused by a wrong judgement of the difference in the level of abstraction between traditional sociological theory and systems theoretical formulations. In systems theory the notions, to which the criticisms are pointing, as structure, norm and also attribute, should be conceived as dynamic not as static. They can be applied on different levels of aggregation from society to individual and carry a functional, not a descriptive, load. Therefore the holism of systems theory reduces man not to an instrument in the hand of norms, posited upon him: a *homo sociologicus* as happens in structural-functionalism.

More criticism on systems theory from action theory points at the fact that systems theory should not be able to explain processes of change. Systems theory gives for this purpose the explanation of the homeostatic system. Such a system is able to maintain a certain desired state notwithstanding influence of disturbances. The notion is not restricted to one specific state, but has the possibility to permit several desired states. If one specific state can not be maintained because of disturbances, then another can be chosen. The selected state should be stable with regard to the disturbances. (This is the choice criterion) [24]. With this systems theory introduces a central, but often neglected problem, in the theory of social systems, namely what is the basic principle of structural change c.q. the change of social norms [22]. For many sociological theories this is a postulated valuesystem of a static nature. It can be ascertained, that they change. Especially by its mathematical orientation systems theory is able to formulate in a strict logical way, what is meant with holism. She permits the construction of a conceptual terminology, by which dynamical relations can be described. The logic of systems theory forces at the same time a distinction in levels of decisions. Hereby systems theory is on a higher level of abstraction then structural-functionalism. Criticism on the deficiencies of structural-functionalism is met by the nature of systems theory.

The second reason why the criticism on systems theory from action theory is wrong, is the reproach that systems theory gives no explanations for behaviour on micro-level. Therefore action theory should be suitable pre-eminently. In the next section I want to show that this is not true, by showing that action-theory can be considered as a system theory. And more, that it gives an explanation and description of behaviour on micro level in a more objective, measurable and for experiments accessible way then action theory does, by means of the theory of purposeful systems [14].

The origin of action theory is with Weber [25, p. 410]. According to Weber significant social action was the object of knowledge of sociology. For the purpose of analyzing social reality, he designed a typology of rational, evaluative, emotional and traditional types of action. To describe social structures he defined a notion of relation as: the patterns that can be discerned in recurrent actions. A social structure is then the pattern of social relations.

This point of view can without loss be translated into systems theoretical formulations. Analogous notions in systems theory are: entity, relation and structure. There is nothing against to load those empirically empty notions according to lines Weber has pointed out. To make it a system we just have to define the notion of state. This can be derived from 'significant' in significant social action, with which Weber describes the object of knowledge of sociology. In this way we show, that the principles of action theory can simply be translated in terms of systems theory.

A similar reasoning applies to Silverman's [20] action approach of organizations. The theory of purposeful systems, developed by Ackoff and Emery covers it in full extent.

Silverman [19, p. 154] states, that such an approach of organizations should be designed along the following lines. Six areas should be considered.

1. The nature of the role system and pattern of interaction, that has been built up in the organization.
2. The nature of involvement of the actors with the organizations and the characteristic hierarchy of ends they pursue.
3. The actor's present definition of their situation within the organization and their expectations of the likely behaviour of others with particular reference to the strategie resources they perceive to be at their own disposal and at the disposal of others.
4. The typical actions of different actors and the meaning which they attach to their action.
5. The nature and source of the intended and unintended consequences of action.
6. Changes in the involvement and ends of the actors and in the role-system, and their source both in the outcome of the interaction of actors and in the changing stock of knowledge outside the organization.

If we compare this with the model of a choice process developed by Ackoff and Emery [14, p. 59] then the 6 items can be conceived as successively: the structure of the system, the set of goals, the state at the beginning and the purposive state of the individual, the typical courses of action and the relative value attached to them, the set of outcomes and finally the influence of the environment. Again systems theory and action theory cover each other. Systems theory provides however a measurable and for experiments accessible frame, that is not reserved to action theory.

Concluding I think to be able to state, that criticism on systems theory can be traced back to a misunderstanding about the level of abstraction and the confusion of systems theory with structural-functionalism of Parson's theory of social systems [23].

This does not remove the fact, that theory formation in systems theory is to my opinion still of crumbled nature. Especially the application of the abstract concepts in real life should be examined further. Nevertheless the qualitative directives, as are shown for the purpose of organizational control, can be fruitful at this very moment in real life.

Notes

1. Systems theory has however also roots in economics, sociology and philosophy (Kant).
2. I attach at first instance two functions to systems theory, because I hold a broad opinion on methodology. In my opinion also heuristic, problem solving, methodical, praxeological, etc. aspects [8] fall under his heading.
3. Since the examiner makes the decision what he considers to be a system, he also makes this on the behalf of considering interaction with the environment. The distinction between open and closed systems becomes with this fact more arbitrarily. In the axiomatic branch of systems theory the distinction is anyway very difficult. Besides that I want to remark, that when considering organizations it is still more useful to start from the point of such an interaction. However one should avoid the pitfall of superficial analogies with living organisms.
4. A.o. de Leeuw [15] defines the structure of a system as: 'the set of relations'. The given definition in this paper and this definition are equivalent, because dimensional domain and 'frame or reference' can be defined as relations. The reason that they are taken up explicitly in the definition of structure is due to the fact that one abstracts in my opinion to much of the possible influence that choice of 'dimensional domain' and 'frame of reference' can have on the system's description. To much they are considered as given, as for instance time and space.
5. It is also possible to define the notion of state mathematically formally unambiguous. I refer to a.o. Zadeh and Desoer [10].
6. Independent in the sense of the theory of knowledge. That means popularly: information about *M* should not be information that one has gained through a backdoor from *S*.
7. This implicates that models of structures are not a subclass of this meta-model.

8. If one wants to speak about magnitudes, then the considered phenomèna should at least be measurable on an ordinal scale. With magnitudes I want also to consider in this paper phenomena measurable on a nominal scale because of the avoidance of a too artificial terminology.
9. Until now I have supposed that the system is controllable and the magnitudes observable. Determination of these facts is yet another problem, which I want not to elaborate more in this paper. (See a.o. [15]).

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