A system theoretical paradigm of social interaction : towards a new approach to qualitative system dynamics

A SYSTEM THEORETICAL PARADIGM OF SOCIAL INTERACTION: TOWARDS A NEW APPROACH TO QUALITATIVE SYSTEM DYNAMICS

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Summary

Recent developments in information theory, cybernetics and general systems theory have inspired theoreticians in behavioral science to translate the general concepts into a language of social-behavioral relevance and to move to a process-oriented kind of social theory.

The best examples of such endeavours however, although well developed in the axiomatic sense, have not yet been formalized.

The social scientist in the field however, will only be able to put the newer theories to the test if all the basic concepts and their significance in the context of a social process are well defined. This article is written to this aim. It is mainly a paradigm – a set of related concepts – but takes, on the issue of the concept of "utility" or "value", the form of a theoretical model.

According to this model the value of an input is function of the degree in which various interaction cycles to which the input components refer sustain or impede each others completion.

Introduction

Systemtheoretical approaches in social science are still relatively scarce. As the term "system" belongs to the traditional vocabulary of sociology, systems theory may become confounded with structural-functional theory such as developed by Parsons a.o. [1].

Especially Silverman's polemic study has contributed to this confusion [2]. Consequently, systems theory has been made the object of criticism similar to the objections raised against structural-functional theory [3]. Thus, it is argued that in systems theory social systems are viewed as "reified", living entities equiped with unique goals, motivations etc. This objection originates from a misjudgement with regard to the difference in the levels of abstraction to which traditional sociological and system theoretical formulations refer.

According to the systemtheoretical view a system has a *dynamic* structure either repeating itself in time (stationary dynamics) or changing over time (non-stationary dynamics). In both cases, the phenomenon of structure implies that the system shows a certain degree of selectivity in response patterns, and it is always this selective phenomenon which is the object of explanation. In systems theory such a selective function may be called a "system norm" which of course does not imply that in the system there is some objective norm-element discernible, but simply that we need a term referring to a selective function. Depending on the specific case at hand this function in a social system may be produced by a single individual or by a number of interacting individuals involved in a political norm-setting process. As the basic concepts in systems theory do not refer to any specific entity or element nor to any class of elements in reality, their empirical content changes according to the level of aggregation to which any specific empirical analysis refers: a number of interacting organizations, one organization, a subsystem, a subset within a subsystem or an individual. Of course one cannot say – on a descriptive level – that a system comprising a number of individuals "has" a norm, but one can certainly state that it has produced a selective function. In systems theory all terms bear a functional, not a descriptive connotation. Even the term "system attribute" is conceived as effected by a dynamic function.

Therefore the "holism" of systems theory does not reduce man to a blind instrument of norms superimposed on him, a *homo sociologicus* acting according to the system norms as is certainly the case in the pure structural-functional framework [4].

Holism is indeed a central concept in systems theory but is does not imply that the individual members of a social system bear no independent qualities. However, it certainly does imply that the system output (its selective function) is a resultant function of an environmental input over a certain period of time, the system's state at the beginning of that period and a dynamic set of relations between all elements and element-attributes comprising that system.

Thus "holism" in systems theory contests the idea of subsystems producing autonomously specific system functions, such as technical, economic and political or any other arbitrary connection between a system function and an element or subsystem as is so typical for structural-functional sociology. A second important misinterpretation refers to the "functional revisionism" of systems theory. In modern social systems theory system properties are time-dependent functions of an interactive process between the system and its environment. Therefore no system attribute can be immanent to the system: all properties, norms and values included are a function of the systems interactive history.

The basic question is here how processes of change can be explained. The logic of systems theory is clear on this point: a theory in which the systems structure is at the same time regarded as a normative point of reference describing its preferred state must be a theory of homeostatic systems.

Luhmann, Weick, Buckley, Deutsch and others discard this possibility. According to Luhmann, the line of reasoning must be reversed: the theory is not structural-functional, but must be functional-structural instead [5].

That is: structures are temporal phenomenous, but structural changes do not happen in any arbitrary sense but according to a basic functional principle to which he refers with the term "reduction of complexity". The systems basic existential problem is to reduce the multitude of possible "meanings" (Sinn) the system could ascribe to its environment. The endless plurality of possible meaning must be bounded by reduction of this complexity, otherwise no meaningful (selective that is) interaction is conceivable nor possible [6].

Weick points to the same functional problem to which he refers with the term "equivocality", and Ashby's well-known law of requisite variety, points to the same direction when applied to systems of social interaction [7].

These formulations may still be too vague and abstract, but on the other hand we must acknowledge the fact that systems theory (re)introduces a central but much neglected problem in the theory of social systems, i.e. what is the basic principle that lies at the root of structural change, and accordingly, of changing social norms? In psychology this was the need-hierarchy of man, axiomatically assumed, in the structural-functional model a given value system, in economics the ultimate selective force is the "utility" concept either assumed axiomatically or just regarded as empirically given. The same goes for economic game theory and bargaining theory in this respect as well as for the Forrester-type models of the Club of Rome. In the "critical theory" of the "Frankfurter Schule" a humanistic principle figures as the basic principle immanent to man, and in neo-marxism it is described as the "logic of capitalism". Thus, in spite of great differences in ideological background and notwithstanding their opposing interests and irreconcilable views, such models are actually similar because the selective principle is either chosen on purely teleological grounds and consequently excludes any non-tautological deduction, or is purely historically chosen. In the latter case the historical *context* of the selective principle-at-work at a given point in time is at the same time regarded as the basic unchanging criterion that governs the dynamics of the system in the future.

Once such a *nominal* basic selective principle is formulated there is only room for building models of strategic behaviour, given the basic values to which the strategies are related. The basic norm or principle, for example the postulate of the maximalization of surplus value, or of the cashflow or the realization of the "self", or conforming to given values, or to immanent humanism etc., is in such concepts a *constant* dimension, but the system develops with changing environmental conditions new strategies selected with reference to this constant basic criterion.

In this sense the mixed collection of humanistic, positivistic, bourgeois, economic, game-theoretic, critical, structural-functional, psycho-analytical, neo-marxist, administrative models are just of one kind. From the point of view of systems theory their axiomatic character as such is of course no problem, but their *static* nature certainly is.

Because of its mathematical orientation and degree of abstractness, systems theory is able to formulate in a strictly mathematical (or logical) sense what is meant by "holism", allows for a systematic construction of a conceptual apparatus fitted to the description of dynamic relations and creates by its own logic the need to distinguish between levels of decision. In this way it unveils gaps in current theory which otherwise go relatively unnoticed. Thus, the basic norms in the above mentioned theories refer to preferences of a *nominal* character. System decisions based on such norms refer only to changes in the "syntaxis"; the technical-strategic norms selected and learned with reference to the constant basic norm.

Luhmann and Weick are examples of theorists who search for an answer to the question what must be the basic logical and general type of function on which selective self organizing systems must base their selection in order to demonstrate the characteristics we observe in reality.

It would therefore be fundamentally wrong to rise objections against the functionalism in modern system theory because it uses a functional concept for explaining social behaviour.

The problem is not functionalism as such, but the type of function postulated and built into the theory. In the same vein it would be wrong to assume that theories on social reality differ fundamentally from each other because they differ with respect to the postulated nominal selective principle that governs the behavioural laws in reality. Such theories do not differ, only the types of social reality projected do so.

Many disagreements in sociology earmarked as theoretical in nature differ in fact only in a cognitive semantic respect, i.e. with regard to the question which cultural component in a social interaction network is dominant and should therefore be regarded as the selective principle to be "fed" into the model. In Popper's terms [8] one could say that the disagreement focuses on the "initial conditions" to be defined. For example: is this system functioning according to capitalistic or socialistic principles?, whereas the underlying theory contained in a set of universal propositions is left undiscussed or is even only vaguely existent.

As system theory is still in its first stage of development we cannot speak of a mature theory yet. The literature is primarily of a very general theoretical polemic or partial character, and the best theoretical endeavours although well developed in an axiomatic sense, have not yet been formalized.

The social scientist in the field will however only be able to put the newer theories to the test if all the basic concepts and their significance in the context of a social process are well defined. This article is written to this aim. It is mainly a paradigm – a set of related concepts – but takes, on the issue of the concept of "utility" or "value" the form of a theory. A theory of social interaction must cover three theoretical fields: i.e. value theory, regulation theory and power theory.

In the following paragraphs we shall make an attempt to integrate a number of essential segments of these into a theory of qualitative system dynamics.

A paradigm

A paradigm is primarily a set of concepts. The relations between those concepts in a pure paradigm are of a semantic nature. It is therefore a system of concepts or a nominal system.

By formulating rules of correspondence between concepts and observed phenomena in reality it becomes possible to translate a set of observed phenomena in the language of our paradigm. By adding an axiom concerning some universal propositions with regard to functional relations between those concepts existing in reality, we can try to falsify these propositions by applying the rules of correspondence. Moreover we may – by using our axiom as a starting point – deduce a broad set of secondary propositions and put them to an empirical test.

The design of a conceptual apparatus presupposes a problem field for the solution of which the paradigm must serve and implies therefore at least a vague idea in which direction the solution must be found. It is clear then, that a scientific paradigm can never be developed without a perhaps vague and implicit theory in mind. Therefore the transition between paradigm and theory is – as a real problem solving process – always diffuse. As semantic concepts the difference between the two is however clear enough; the relations in a paradigm refer to semantic relations or symbolic meaning, whereas relations in a theory refer to functional relations in reality.

In the sections 1 and 2 we shall start our discussion with some primitive statements. The statements function as a starting point to formulate a set of concepts: a paradigm. Next we shall introduce an axiom with regard to the concept of value or utility. In the sections 16 to 23 some basic dynamic qualities of social processes will be deduced in terms of the conceptual apparatus.

1. Some definitions

We shall start our discussion with some definitions of primitive terms that can be used as stepping stones for the definition of more complex ones.

1. An attribute is a quality ascribed to an observed phenomenon.
2. A functional relation is a variation in one or more values of attributes which cause in the course of time a variation in one or more other attribute values.
3. An element is a set of related attributes.
4. An event is a variation of one or more attribute values in the attribute sets of one or more elements or in the variation of the attribute sets of elements in the course of time.
5. A process is a sequence of related events.
6. A system is a set of elements with an internal and external structure, the internal structure being the set of relations between elements where all elements are related, and the external structure that set of relations with the environment which is a function of the internal structure and the attribute set of the environment.
7. An open system is a system in which variation in its external structure is always related to variation in its internal structure.
8. A system state is the set of elements, attributes and attribute values of a system on a given point in time.
9. A normative open system is a system the external structure of which is a function of a set of environmental attributes, the system state and a set of system norms, the latter being independent of each separate environmental attribute and state attribute of the system.
10. A social system is a normative open system with a variable norm or norm set.
11. The environment of a social system is the set of relations between elements and attributes that may vary independent of the system norm.

2. On the nature of the system norm

Suppose the internal structure is constant under changing environmental conditions. This structure would be "impermeable" (closed) and the variation in the relation between system and environment is a function of the set of all changes between t_0 and t in the environment $O_{S(t_0,t)}$, like a ball in a football game. If the external structure at time t_0 is $E_S(t_0)$, then the change in the external structure of such a closed system will be:

$$E_{S(t_0,t)} = f[O_{S(t_0,t)}, E_{S(t_0)}] \tag{1}$$

This system does not correspond to our definition of a social system.

Suppose the internal structure (I_S) is variable and all change of relations between its elements is a direct function of environmental change. In that case there cannot be a system norm (N) and accordingly the external structure is again a function exclusively of environmental variation.

$$E_{S(t_0,t)} = f[O_{S(t_0,t)}, I_{S(t_0)}] \tag{2}$$

Should the internal structure of one or a number of elements in such a system show a relative independent variation, than the internal structure of the system as such would have an independent variable as well. This however implies the existence of a norm (N): a possibility which we just excluded. The system described corresponds therefore to an aggregate: a loose assembly like a heap of sand and in fact not a system according to definition 9. Suppose, however, that the system does contain a norm. In that case the external structure would also depend on the nature of that norm:

$$E_{S(t_0,t)} = f[O_{S(t_0,t)}, I_{S(t_0)}, N_{(t_0,t)}] \tag{3}$$

This description meets the requirements as formulated in the definitions. According to definition 9 a system norm is independent of each separate environmental attribute, or combination and each separate state variable of the system or composition of state variables. This norm corresponds to the factor (N) in our discussion and (N) is a variable according to definition 10.

This postulate is among the other generalizations already mentioned by far the most problematic. If such a norm is conceived as a criterion describing a preference for a system state, which can be defined in terms of its observable internal structure (attribute values and relations) and if such a norm is assumed to be autonomous and unchanging, then the system is called a homeostat. A homeostatic system is by way of illustration comparable with a rope-dancer: there is plenty of change and unpredictable and stochastic at that, nevertheless a certain subset of nominal attributes is constant or "steady": the dancer remains on his rope and coördinates his dynamics on this criterion.

A system is called stationary if it does not change its reaction pattern on certain environmental stimuli. Homeostatic systems should not be confounded with stationary ones. Homeostats may, for example, develop new reaction patterns in changing environments by way of a learning process and thus manage to maintain their preferred state. Examples of such static homeostatic models can be found in all branches of social science. In sociology it is the structural-functional model in which it is assumed that the system's preference criterion is defined in its own structure and its corresponding values, or in the neo-marxistic model where basic human values are taken as a static point of reference. In psychology we recognize the same statics in the notion of a basic nominal need-hierarchy, in economic theory in the assumption of nominal preference or utility functions and in game and decision theory in assumptions with regard to the transitivity of ordered preferences of the players, the stability of outcome probabilities per decision, the number of available decisions, etc.

However, reality tells us that the norms of social systems are variable, and the question is how to deal with this fact.

Theories in psychology, sociology and economy may be distinguished by taking this issue as a criterion.

It seems that at least four distinct types can be distinguished.

1. The question is not regarded as important. Such theories are restricted to the problem which strategy of action a system will follow, given its nominal norms (preferences defined in terms of attributes), state, alternatives, norms of partners, outcome probabilities, knowledge about the environment, experience etc.

   Game theory, econometry, decision theory and the larger part of behavioural science in general belongs to this type. Norms are in such cases introduced as non-historic static data and are therefore often called positivistic.

2. The relevance of the question is acknowledged but is regarded as inaccessible to scientific enquiry. Man is viewed as equiped with an immanent unchanging or changing norm or "leading principle", that governs his selection of choices. In the latter case creative purposive traits are thus ascribed to man and this creative ability to shape and select new leading principles is regarded as autonomous, given unexplainable and immanent.

   The so-called critical sociology of the Frankfurter Schule and – for that matter – all humanistic idealistic and individualistic theories in social science are related to the creative immanent conception.

3. The norm is viewed as a variable, changing as a function of a dialectic process in such a way that actual behaviour is always a function of both actual stimuli and the system's state which itself is a function of past interactions, including its experience, cognitive capacity etc. stored in its memory. According to this view normative systems change is not autonomous but on the contrary a function of a state at time t_0 developed in the course of its interactive history, the changes inflicted by environmental changes in the period (t_0, t) and a general reduction-factor (I) signifying a kind of code or rule determining how the system will eventually develop a new norm given its state (S_{t_0}) including its normative orientation at t_0 and the dynamics of environmental relations during a given period $O_{S(t_0,t)}$

   $$N_{(t_0,t)} = f[S_{t_0}, O_{S(t_0,t)}, I] \tag{4}$$

   Usually however this reduction factor is conceived as a constant nominal code. It is for example assumed that the individual or an organization will (sub)maximize towards some preferred state in terms of preferred attributes, attribute values and their relations. A constant code or rule in this sense may for example refer to an assumed fixed proportion between state variables such as is the case in indifference curves in economic theory, or in some cyclical alternation between preferred states, or an assumed unsatiable need for "surplus value" or what not. Completely adaptive a system would be that tends to maintain each induced state; a kind of two-stroke engine: during the first stroke it tends to maintain a given state whereas in the following stroke the outcome of the first is the reference point for the next. Completely negative adaptive a system would be if it tends to change each induced state into its reverse.

The assumption or postulate however referring to such a fixed code implies that the system is regarded as a *nominal programmed system.* That is, such a system will show a preference for a specific state which can be defined in terms of attributes. Such systems are the prisoner of their own program. Of course such systems are deprived of the possibility to reflect upon their own choice; i.e. to compare alternative programs, norms and choices as this would imply a new choice and consequently a new selection based on an even more basic "superimposed" criterion.

As this criterion was always conceived in a nominal sense or in other words, as a preference for a specific state or change of state, or proportioned relation between state variables always defined in attributes, it was (implicitly) assumed that social systems are indeed nominal programmed systems. In sociology we find this assumption in the postulated preference for a certain internal structure (structural functionalism), in economy in the concept of utility and in psychology in one or another postulated needhierarchy. To be sure, needs can of course be "learned" and thus change in the nominal preference of attributes is perfectly possible, but the criterion on which man selects its learning is either left out of consideration, regarded as given or postulated as a fixed nominal preference.

On second reflection then, it seems justified to place the models of this "dialectical" kind into the categories 1 or 2.

4. Finally a systemic viewpoint can be distinguished, where the nominal change of system norms is regarded as non-programmed. However, the changes are governed by a code which is not put in nominal terms but in functional terms (referring to the existential effect of relations and not to attributes or attribute values as such). This code refers therefore to the selective "leading principle" or the "reduction-factor (I)", which governs in the course of time the change of the nominal choice-criterions or norms $N_{(t_0,t)}$. It would bring us too far away from our subject to discuss the matter into detail and we shall therefore present the argument in a short-hand way. The only constant quality of a social system thus far observed is the fact that it interacts selectively with its environment.

Therefore in the class of systems bearing this quality the "reduction factor (I)" must be based on a functional principle which in any case does not reduce the chances of selective interaction. Thus the basic cybernetic principle in social interaction must be in accord with this functional requirement. Of course it need not be assumed or postulated that social systems will always be able to meet this requirement, nor should we accept a teleological axiom to the effect that social systems will always be oriented towards this norm. The principle is however a logical condition for the continuity in selective interaction.

The theory should therefore be restricted to the formulation of those objective conditions in which such continuity is logically possible. In order to formulate such a theory we must be able to describe the process of interaction in sufficiently precise terms. We shall therefore turn our attention to some basic concepts in the vocabulary of systems theory.

3. Interaction and interactioncycle

The external structure is a function of the internal structure and the dynamic properties of the environment (section 1).

If two systems S_1 and S_2 function as each others environment and their common environment is empty their external structure will be a function of both internal structures.

$$E_S = f(I_{S_1}, I_{S_2}).$$

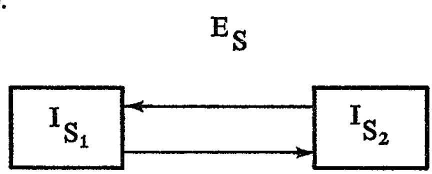


Figure 1

Definition: An interaction cycle is a process in which a given event in the internal structure of a social system S (start of a cycle) is followed by a related sequence of events in the internal structure of a social system S_2 in its environment and a resulting event in the internal structure of S_1 (closure of the cycle).

4. Interaction network

Two systems in an empty environment is a rather unrealistic picture. In such a closed configuration both systems determine each others state and their complete interdependence would make it impossible to see how their internal and external structures could ever change. Therefore it would be more realistic to take at least three social systems placed in a non-stationary environment as the basic elements of analysis.

Definition: An interaction network is a set of at least three social systems in a non-stationary environment where each system is in direct interaction with at least two others (see also section 13 and further).

5. Input

Suppose a social system S_1 is an element in an interaction network. An attribute change in the internal structure of an interaction partner S_2 can now bring about a change of attributes in S_1. In that case the (environmental) change in S_2 is an *input function* on S_1, and the directly related change in the internal structure of S_1 is called an *input* of S_1.

Definition: An input is a variation in a system state being a direct function of environmental variation.

Inputs are often defined as a relation between environment and a system, or as an environmental sector. This is of course a matter of choice and preference. However, in the case of social systems there are some strong arguments against such a definition.
First, social systems are only able to reach on those environmental impacts which have been perceived and evaluated. Thus, such an input can only be understood as a *perceived* change in the internal structure by the system itself. In other words, in empirical theory *not the observer but the system defines* the inputs and its qualities. Secondly, social systems may be able to discern an input according to our definition, but may be quite at a loss with regard to the question of which external relation the input is a function.

6. Regulation activities

System elements will at any moment in time show a certain reaction structure signifying a specific dynamic quality to react in a specific way on specific environmental change.
By varying the sequence, duration and attribute properties of relations between such elements, a system may at each time, depending on the specific "connec-

tion pattern" chosen, influence its own internal structure and thus its own output. As the system norms guide the selection process, they have an influence on the changes in the system's internal structure.
Definition: A regulation activity is a change in one or more system attributes selected on the basis of a norm which influence the ordering and properties of the relations between all other elements and attributes contained in the internal structure.

7. Output

Just as is the case with a system input, the output is conceived as a change in the system's internal structure. We define it as such because social systems are usually not able to identify their own output function, i.e. the exact nature of the relation between internal structural change and changes in the environment. The effect of such a relation is called an output function (environmental change as a function of change of the system's internal structure).

Definition: An output is a change in a system state as a function of an input and a regulation activity.

It follows then, that in the theory of social systems outputs are never identical to inputs as the mediating function of a regulation activity is postulated by definition.

8. Transformations

The production of an output implies a transformation: an input has been transformed into an output.

Though transformations imply changes in matter and energy, such physical processes are from the point of view of social interaction conceived as potential bearers of information with a cognitive as well as normative "loading". This is why we can only understand social system behaviour on the basis of that part of the physical input which has been perceived (section 3) and to which a value function has been attached (see section 10). The same comment applies of course to the output.

Definition: A transformation is an input – output combination being a function of an input and a regulation activity selected on the basis of a system norm. Thus, in social systems tranformations are normative (the system's norm that is, not the observers).

The system cognition of the actual physical transformation and its semantic content and normative impact on the environment will of course be bounded by its own perceptual capacity. In other words, we shall have to distinguish between manifest and latent transformations.

9. Operations

Transformations are produced by a process being a function of an input and a regulation activity.
The output is therefore a temporal end-state in a complex chain of a causal sequence of relations between elements and attributes, activated by regulation activities and selected on the basis of a norm or set of norms.

Definition: An operation is the set of relations ordered in a time-sequence between elements or attributes belonging to a transformation.

10. Norms

As norms have a selective function with regard to transformations which bear a certain meaning to the system producing them, it is useful to start our discussion with some concepts pertaining to the concept of information.

Definition: Semantic information is information with the function to establish a picture about the state of affairs in reality.

Definition: Pragmatic information is information with the function to define the value to be attached to semantic information.

Definition: Syntactic information is information with the function to relate pragmatic information to an operation with an expected output function.

The elementary process of information processing can now be conceived as a sequence of partial transformations which may be represented as follows:

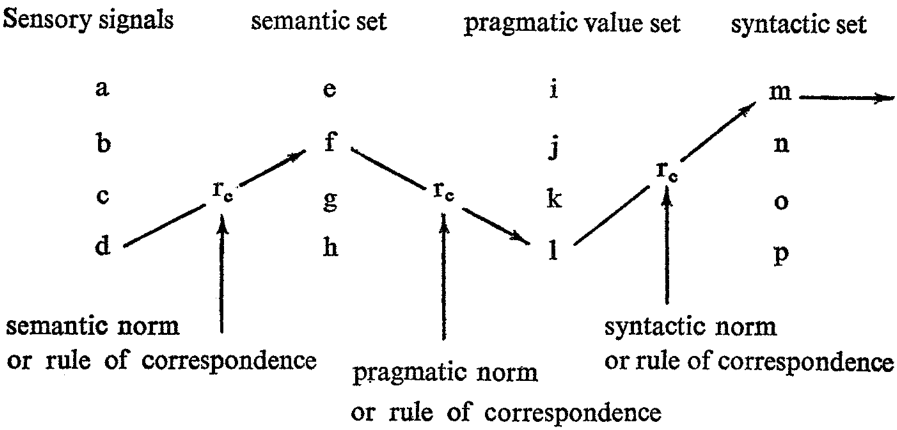


Figure 2

According to the scheme a rule of correspondence (r_c) or norm will determine how the relation between two domains of information will be. Rules of correspondence may be complex and may vary in their degree of precision. They may be stationary (the pragmatic norm for example) while the system is nevertheless non-stationary: see for example our remarks on the possible non-stationary character of a homeostatic system, learning itself new (syntactic) strategies in a varying environment on the basis of a fixed set of pragmatic norms.

If all r_c's are stationary, the system's internal structure will be stationary as well because the independent dynamic qualties of the system are constant in that case.

Norms may be conceptualized (as is often the case in sociology and psychology) as refering to a preferred system state or proportioned change of state-variables. Now, a system state or change of state can only be defined in terms of attributes or attribute changes or events, but not in terms of relations (section 1). In a process oriented kind of theory this manner of defining norms is not very useful. Instead we shall use the term norm as a concept identical to "rule of correspondence".

Definition: A norm is a rule of correspondence which relates either physical information to semantic (cognitive norm), semantic to pragmatic (pragmatic norm) or pragmatic to syntactic information (syntactic norm).

These norms constitute the building stones out of which the system constructs in the course of time its input norms, output norms, transformational norms and operational norms. The paradigm contains no further catagories in this respect, with the exception of the concept of "relative rule of correspondence" (R_{r_c}) being a superimposed selective principle (the reduction factor I mentioned in section 2) which controls the relation between a norm at t_n and t_{n+1} or the relation between the norm types mentioned.

It may be useful to continue our discussion a little further with regard to this relative r_c. Suppose that an indivudual P ascribes to this input several attributes on the basis of his semantic norms. In addition, we assume that P has pragmatic norms corresponding to each perceived attribute component of his input. In order to select his reaction on this event, P must have a relative pragmatic rule of correspondence at his disposal, which determines the value of the components relative to each other. In the absence of such a relative rule, P would notwithstanding his particular pragmatic norms with regard to each component not be able to react in any selective manner. Under such circumstances P would only be able to make "random choices" and P would be a *non-selective system*. On the other hand, should such an R_{r_c} in fact exist then P would be able to consider alternative components of input components, and he could order the combinations in a weak or transitive order and determine his preference. This is of course a requisite condition for the selection of behaviour on a evaluative pragmatic criterion.

But, though in this case P's behaviour would indeed be selective it would certainly not be a selection by choice.

This is so because the existence of only one rule of correspondence excludes a choice among alternative pragmatic orderings. Consequently P would in this case be a *programmed system;* the prisoner of his own norm upon which he cannot reflect.

If P would be able to apply more than one R_{r_c}, the problem would repeat itself. In that case P would indeed be able to generate alternative orderings of preference depending on the R_{r_c} which he applies. But in the absence of a norm or rule providing a criterion which R_{r_c} to choose P would again be a non selective system and his behaviour would show a random character.

The paradox is that if we would assume that P would indeed have a "relative rule of correspondence of relative rules of correspondence"; a super $R(R_{r_c})$ so to say, P would again be a programmed system. It looks as if man as a non-programmed but still selective system is not possible!

This is why in decision theory the assumption that the decider has only one transitive ordering is always taken for granted, in this way reducing man rather implicity to a programmed system.

The error is that the relative rule or norm is always understood in the *nominal* sense. But we need not assume the relative criterion to be a nominal one in order to realize transitivity, we may put a functional criterion in its place. In that case the non-programmed system is constantly "switching" between intransitive and transitive states, where the intransitive state in transformed into a transitive by way of a functional principle. We postulate that this functional criterion is as follows:

"the nominal rules of correspondence are a function of the degree in which the use of these rules reduce the probability of interference, where the probability of interference is defined as the probability that interaction based on transformational norms in a subset of interaction cycles impedes such interactions in another subset "(see section 16).

11. Transformational structure

Given its cognitive, pragmatic and syntactic rules of correspondence a system will at any moment in time have a predisposition to react on a specific input with a specific operation. This predisposition is of course a function of the system history and experience. In the following section we shall describe a system model containing a formulation of the criterion on which a system evaluates its experience and may change its norms in the course of time.

Definition. The transformational structure of a system is the set of transformations implied in the system's transformational norms.

12. Operational structure

Of course more than one operation may produce the same transformation. In other words: it is perfectly possible to reach the same goal (output) along different roads. Perhaps the number of alternative possibilities is actually greater than "perceived" by the system, or better (to avoid reifying language) than contained in its operational structure.

The operational structure defines that part of potential manifest system operations which the system actually may select on the basis of its syntactical norms. A system with a stationary operational structure does not innovate or renew its "technical" knowledge (syntactical information) and functions like a bureaucracy.

Definition: The operational structure of a system is the set of operations corresponding to its transformational structure.

13. Interaction network in equilibrium: contingency

Definition: An input is contingent, if its attributes conform to input norms and the system's state is such that it can produce outputs in accordance with the transformational norms.

If this condition holds for all systems in a network within a certain period all outputs will have contingent input functions on the members of the network in that period.

Definition: A social interaction network is in *equilibrium* if for each system in the network the inputs are contingent.

Such a network is stationary by definition. However, it need not be "harmonious". Stress may occur in abundance but they will be controlled and kept within commonly accepted boundaries according to the set of transformational norms defining the network during that period (secondary regulation, see section 21).

14. Input and output components

According to our definition the input of a system in an interaction network is a function of at least two interaction cycles. In social process theory we cannot (and should not) decompose an input into possibly interesting nominal aspects according to an observers opinion, but according to input and output components belonging to each particular cycle. Therefore the concept of transformation already defined needs an important specification: a transformation refers always to *one and only one cycle.* Thus, a system in an interaction network is involved in as many transformations as there are partners with which he interacts.

A system produces therefore a total transformation composed of other transformations. The latter define together the total input and output as a composition of components where each component refers to the input or output function by which it is related to one interaction partner. The distinction is rather important *because the model postulates that social systems have no norms for total inputs nor outputs, but deduce such norms from the specific composition of components.*

15. The law of complementarity

The relations between the elements of a system are a function of the environment, system state and system norms. The system boundaries are therefore determined by the set of transformations produced by a structure of elements constituting a domain that lies within the reach of control by system norms.

The interaction cycles of a system meet each other in a common material and normative domain constituting the system as a whole. By consequence, system transformations are interdependent.

The analysis of one transformation for example, can only give us a description of a partial process (partial system) whereas it can only be explained by an analysis of the interdependent nature of the total set of transformations in the context of the system's environment and transformational structure.

With these considerations in mind the concept of complementarity can now be formulated:

a. the set of all input components at t_n is contingent if the components are complementary
b. components are complementary only if each single component as well as the set components are contingent.

Consider for example a case where all input components correspond *separately* with their respective transformational norms, but the combination is such that the system lacks the socio-technical capacity to transform this combination according to the respective transformational norms. In this case the input is not contingent because the specific composition of components is non-complementary. The paradigm furnishes possibilities to formulate rather precise hypotheses with regard to the question under what conditions a system will probably change transformational and/or operational norms under the pressure of incomplementarity.

16. Interference

Suppose an interaction network in equilibrium and a member-system (S) at time t_0 where the input X_{t_0} is complementary and the regulation-function according to the corresponding operational structure is R_{t_0}. Now, if the input changes to incomplementarity during the period (t_0, t_n), the output will become incontingent if the regulation-function is kept constant ($R_{t_0} = R_{t_n}$). In other words, the output function will deviate from the interactionpartners' input norms. If the partners fail to reduce the deviation they will in the same manner feed back the deviation to S. This implies that the input deviation would increase after one cycle period, and so on. Thus the *degree* of incomplementarity would under such circumstances tend to increase with each cycle period, and

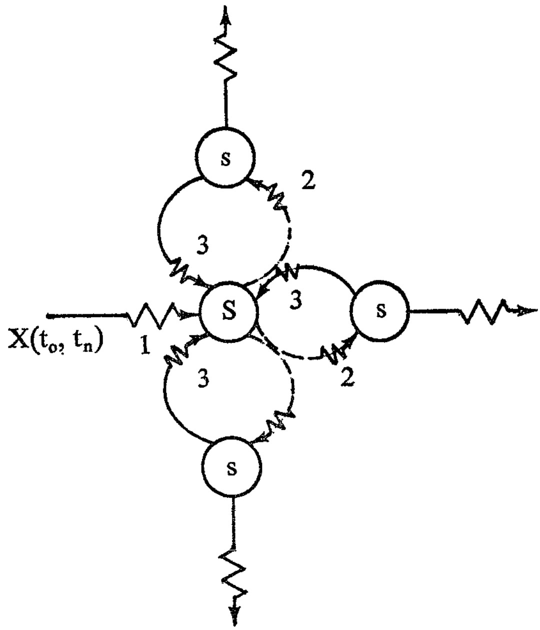


Figure 3

the network as a whole would progressively move to an increasing degree of non-stationarity and consequently, to a decreasing degree of selectivity or "organization".

In other words, the entropy would increase, or the *anomy* as the sociologist would say.

This anomic upswing of deviations is illustrated in fig. 3 and will tend to develop if partners in a social interaction network fail to reduce interference.

This term, a core-concept in our paradigm, refers to the fact that incontingency can only be understood as a condition where two or more interaction-cycles interfere and consequently impede each others normative completion.

Definition: The probability of interference is the probability that a non-complementary input will occur.

The reduction of interference is important because the predictability of the transformational structures of interaction partners is a necessary condition for selective interaction, and it is precisely this quality that will tend to diminish if interference is not kept under control. Now let us suppose that an incontingent input at t_0 will *not* (via interaction) be followed by any additional "deviation" at the "closure" of one or more cycleperiods t_{n+k}, if the system takes no regulative action. In that case the deviation at t_0 does not generate any future incomplementarity and we may conclude (just as the system itself would) that the input was actually *not* incontingent after all (under certain conditions adaptation of input and transformational norms may follow).

For this reason we are now able to improve our definition of interference.

Definition: The probability of interference is the probability ($1/i$, $i \geqslant 1$) that an input will become non-complementary during (t_n, t_{n+k}) as a function of one or more input components that have changed to incontingency during a preceding period (t_0, t_n) (see fig. 4).

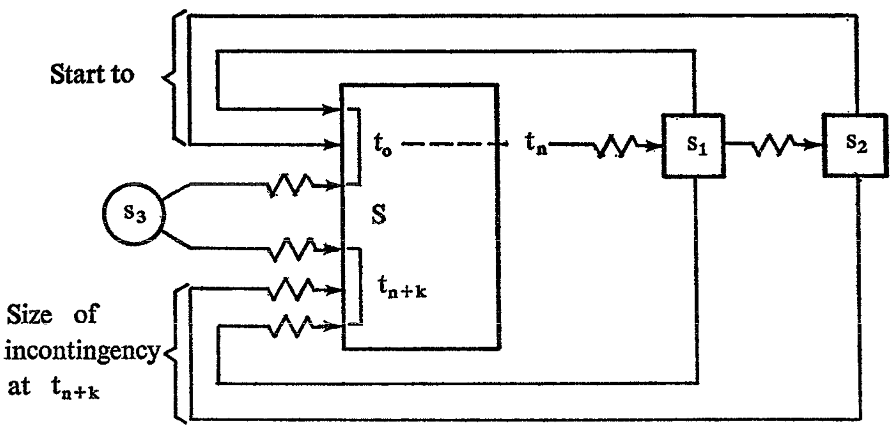


Figure 4

17. Functional equivalence

a) Transformational equivalence.

1) *Definition:* Transformations are internally equivalent, if a changing input component at each time is followed by an unchanging and contingent output component belonging to the same cycle.
2) *Definition:* Transformations are externally equivalent if a changing output component (conforming to an outputnorm) at each change is followed by an unchanging input component at the closure of that cycle.

   In case 1 the system is able to keep outputs within the normative boundaries because it reduces input variety by a selection of equivalent transformations (fig. 6, 1). In case 2 the system produces variation or transfers variation, but the interaction partner reduces the variety or in any case, he does not feed back the variety into the cycle considered. Consequently the systems input function is kept constant (fig. 6, 2). The first type refers to equivalence in a single transformation, the second involves a complete cycle and refers therefore to what might be called the "double transformation".

b) Operational equivalence.

Definition: Operation O_1, is equivalent to operation O_2 if they belong to the same transformation.

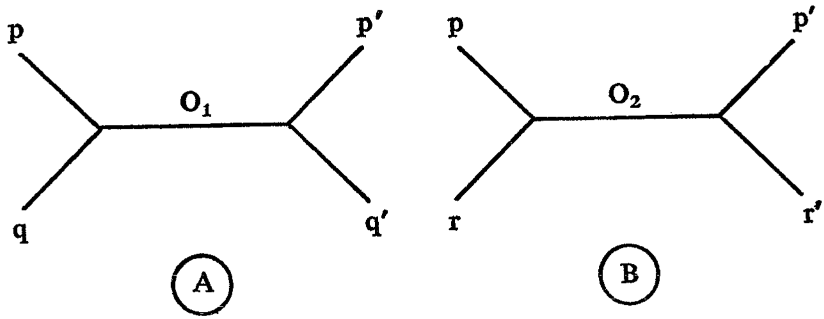


Figure 5

In case (A), the system has the inputcomponents (p, q), and produces the transformations $(p \rightarrow p')$, $(q \rightarrow q')$.

In case (B) one transformation has changed. The trajectors or operations are therefore different but functional equivalent with respect to $(p \rightarrow p')$. This possibility provides S with internal latitude with respect to the transformation $(p \rightarrow p')$.

The circumstance that each input component may vary independently of the other (which is always the case in the theory of open systems) implies that under the absence of external transformational equivalence (external latitude) the use of operational equivalence is a necessary condition for the reduction of interference.

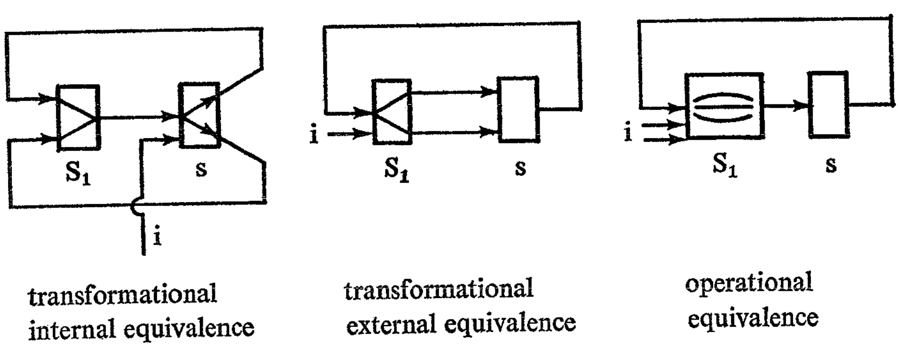


Figure 6

On the other hand transformational equivalence must be found if no operational equivalents are available.

In an earlier empirical study on leadership it was shown that instrumental leadership prevails when the first condition is met and social leadership tends to develop under the second condition.

18. Reduced interference

In the preceding section it was shown that transformational and operational equivalents are the means by which the probability of interference can be reduced. We are now able to regard the *degree of interference* as a measure of the number of interactioncycles that probably will be blocked by an incontingent input component.

Definition: The probability of interference reduction is the probability ($1/r$, $r \geqslant 1$) of a complete reduction of interference as a function of an equivalent operation and/or transformation selected by means of a regulation activity.

Definition: The reduced probability of interference for a probability of interference ($1/i$) and a probability of reduction ($1/r$) is $[1/i - 1/ir]$.

Definition: The degree or centrality of the probability of interference is the probability of the number of input components that would switch to incontingency over the period (t_n, t_{n+k}) as a function of one or more input components that change to incontingency during the preceding period (t_0, t_n) (fig. 4).

Definition: The reduced centrality of a centrality (C) and a reduction probability ($1/r$) is given by

$$C_g = C - \frac{C}{r}$$

It follows from the definitions that the reduced centrality will approach zero as the reduction probability approaches 1.

In other words: the relative "threat" of an input deviation tends to decrease in proportion to the system's capacity to reduce the probability of interference by means of alternative courses of regulative action.

It will be clear that the principle of interference refers to the hypotheses formulated with regard to the function of the "reduction factor I" in section 2. According to the model norms have no independent, and ultimate nominal point of reference, such as is the case in models of a teleological, idealistic or positivistic signature.

Changes in norms can only be understood relative to other norms. The norms refer to specific interaction cycles in which they fulfil a selective function. The change of norms with respect to one cycle or a subset of cycles will therefore always be related to the maintenance of norms with respect to at least one other cycle.

This is why social systems have according to the model no norms with regard to total inputs (section 14).

By consequence, a complete change of norms is impossible in one cycle period. Only in a dialectic process the complete set of norms may change step by step in the course of a number of cycle periods. Total "revolutions" conceived as a sudden complete change do not exist.

19. The centrality of an input component

According to section 16 additional deviations of input components may be expected in the double transformation (closure of the cycle) at t_n if an input changes to incomplementarity at t_0 and no regulative action is taken. On the other hand, the probability of interference will diminish if incontingency switches to contingency and the blocking of interaction cycles is dissolved. Should however an input component produce no interference of any kind whatever its change in time and numerical value, then the component will be irrelevant by definition. For in social systems "meaning" or "value" will always imply selectivity. Variation in input without any observable function or effect in the remaining interaction network lacks a point of reference on which basis the system could evaluate such variation in any selective interactive sense.

For this reason the centrality of an input component can be expressed in terms of the "effect of its negation", i.e. in terms of the number of interaction cycles that would become blocked with its disappearance.

Definition: The centrality of an input component is the centrality of interference that would be generated if this component would disappear during the period (t_0, t_n).

Definition: The centrality of an input component deviation is the centrality of interference that would be generated if this component becomes numerically incontingent during the period (t_0, t_n).

20. The value function of an input and output component

According to the preceding arguments the value of an input must be understood in terms of its centrality. Thus, the various concepts of value in social science as expressed in the term "valence" in social-psychology, "value" in sociology, "utility" in economy, and as "exchange" and "use" value in marxistic economy, may all be redefined in terms of centrality. Something has value in as far as it either reduces interference and fosters the probabilities of selective interaction, or induces interference and threatens the probabilities of selective interaction.

In principle then, we are in the position to measure a value and to explain value changes.

The lower the anomy or entropy in the interaction network the higher the probability of selectivity in the behaviour of the member systems and the higher the probability that value is produced in interaction, either positive or negative.

However, in assessing the value function of an input we must consider an important correction, because the system's reduction capacity influences the actual probability of interference emanating from incontingency. Therefore the value of an input will increase with the proportion of its *increasing centrality* and *decreasing reduction capacity*. Suppose for example that a highly central input component does not appear at t_0 but the systems reduction capacity levels to 1, then the reduced probability of interference will approach zero.

In such a case the system apparently disposes of an equivalent substitute; an alternative interaction partner furnishing the system with an equivalent input for example.

The value V_i of an input component is therefore equal to the product of its centrality and the inverse of the corresponding reduction capacity:

$$V_i = C_i \cdot r_i$$

The production of outputs involves of course some kind of cost. Usually such costs are conceived as opportunity costs, or the expected nominal value of the value forgone by choosing among alternative actions and expected outcomes.

According to the principle of interference these costs are now conceived as the centrality of probable interference that could probably come into being in the remaining network as a function of the production of the output component chosen.

The argument is, that the production of a contingent output with respect to one interaction cycle may cause incontingent outputs with regard to some or all cycles in the remainder of the network.

Therefore the concept of centrality is relevant for assessing input as well as output value, and the value function of an output component can thus in the same manner be expressed in terms of the centrality of the output component chosen, C_0, corrected with the inverse of the systems reduction capacity r_0 to reduce the probability of interference as a function of the production of such an output:

$$V_0 = C_0 \cdot r_0$$

21. Process regulation

The regulation of the transformation process involves the use of transformational and operational equivalents. Some useful distinctions may be given in this context.

1) *Intercyclical and intracyclical regulation*
   a. Intercyclical regulation refers to external transformational regulation. The system alters or modifies one or more output components. This implies a regulation of normative relations between systems, and is therefore identical to what is usually called political behaviour.
   b. Intracyclical regulation refers to alteration in operational procedures. Seen from the "outside" nothing seems to happen: the transformational programs are executed according to the current norms, but internally this requires an alternating choice between operational and (internal) transformational equivalents (see fig. 6).
2. *Primary and secondary regulation*
   Primary regulation refers to the design and execution of an interference reducing strategy by way of a change in the transformational and/or operational structure. Primary regulation involves accordingly a change of norms either with regard to the transformational (and by consequence) operational structure, or with regard to the operational structure only.
   Secondary regulation refers to the alternating choice pattern with regard to regulation activities within the boundaries of a given transformational and operational structure.
3) *Regulation by first and second order decisions.*
   First order decisions refer to the change of a pragmatic norm. Pragmatic norms determine the value a system attaches to its state. According to the principle of interference the value determination will be a function of the relation between the probability of interference and the system's state.
   First order decisions are therefore a special instance of primary intercyclical regulation, but not of the homeostatic type of course because first order

decisions require a change of the criterion defined in the "reductionfactor (I)".
Second order decisions refer to the choice of an operational syntactical norm, given one or a set of pragmatic norms. Second order decisions may be of the primary or secondary kind as well as of the inter- and intracyclical kind.

22. The transfer of interference

It is very important to study the processes of interference transfer in interaction networks.

By way of intercyclical regulation the system may transfer interference and – depending on its power position – may make a frequent use of it.

Latent forms of transfer can be expected in centrally regulated systems where the assessment of pragmatic value is unilaterally established by an organizational elite that occupies the power position in the systems internal structure.

The central theme of the socio-technical approach in organization theory is to study the location of interference transfer in the internal structure, to detect the reduction mechanism and to relate these patterns to the current division of labour and technical instrumentation of the system.

23. Power

Intercyclical regulation is one of the most important strategies of regulation. On the secondary level intercyclical regulation is based on *given* power relations, whereas on the primary level the power relation as such is at a stake. Though we shall not discuss the problem of power into detail, power forms an essential part in our model especially with regard to the analysis of normative changes.

We shall concentrate on this aspect and restrict our discussion to the question how estimates of power can be deduced by a strict application of the basic concepts and principles as contained in the paradigm described.

Suppose two systems S_1 and S_2. S_1 can only have an input function on S_2 and vice versa if: they share an environment or share elements.

Powerfunctions

If this condition is satisfied S_1 will have a selective influence on S_2 if:

1) There is a set of material inputs which, given its system state, enables S_1 to produce a set of transformations with an input function on S_2;

2) There is a set of transformational norms corresponding to these transformations;
3) There is a set of operational norms corresponding to these transformations (technical knowledge).

If these conditions are met, S_1 has a potential of influence on S_2. This potential however cannot be used because S_1 has as yet no information about the outcomes of his possible output functions. This requires that S_1:

4) knows the transformational structure of S_2;
5) knows the actual state of S_2;
6) knows the remaining input components on S_2;
7) knows the input components on S_2 to be expected in the (nearest) future.

These power functions may be reduced to a number of classes:

1) Material input and system state: Instrumental capacity I_c.
2) Input-output norms with respect to transformations with an input function on S_2: transformational information H_t.
3) Operational norms corresponding to the relevant transformations: operational information H_0.
4) Information with regard to the transformational structure of S_2, the state of S_2 and its remaining environment: market information H_m.

These power functions are system attributes constituting a necessary and sufficient condition for the production of a *selective* output function. On the other hand, they are all a potential function of an input. Thus, an unskilled worker may receive from his supervisor instruments and raw material (I_c), receive information what to do (H_t) and how (H_0). The worker's power function will be that he is able to produce a valuable input function on S_2, but the function is to a considerable degree dependent on S_2.

In fact, all outputs of social systems will – provided they have an input function on the social environment – be related to one or more of the four categories of power functions mentioned.

Our first step must be to determine the power functions $S_1 \rightarrow S_2$ and $S_2 \rightarrow S_1$. In this way a survey is obtained which may support a further analysis. If only a global estimate is needed it may inform us about the symmetry in number of functions and the degree of their interdependence as exemplified in the example given above.

With a more precise estimate, we must determine the value of the input and output components of S_1 and S_2 in a given network. According to Section 20 these values are a function of their respective centrality and the reduction capacity of S_1 and S_2. Moreover, the power of S_1 over S_2 and vice versa can only bear any meaning or value in as far as it fulfils a function relative to the remainder of their respective environments.

Consequently, the analysis must take into account the remaining environment of each respective system.

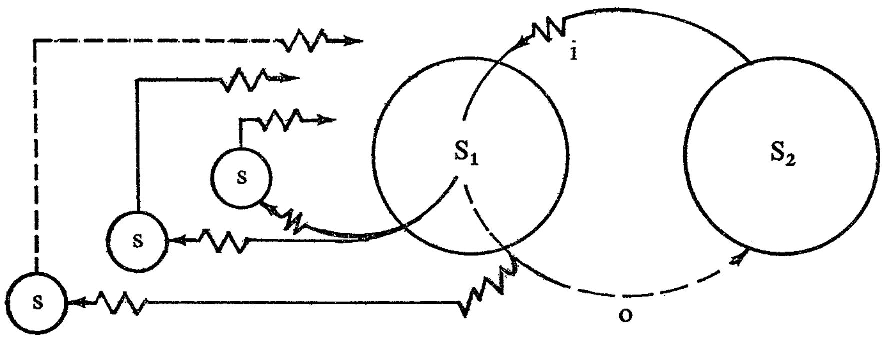


Figure 7

Thus, in figure 7 the input *i* has a certain centrality with respect to the remaining environment *s* of S_1. Furthermore S_1 commands a certain reduction capacity with regard to incontingent inputs from S_2. Finally, the production of a contingent output *o* on behalf of S_2 may cause interference in the remaining network as well and S_1 must employ his reduction capacity also to this effect.

Now inputs from S_2 imply a "supply" and "demand" combination. In order to keep the prediction of power reasonably accurate we must draw a matrix – given the transformational structure and environment of S_2 – containing the combinations of frequent occurrence and determine their values for S_1 as inputs and outputs respectively.

Reasonable accurate power estimates are therefore only possible in comparatively stationary networks, which is to be expected because in case of instability in interaction the power relations will be non-stationary as well.

Relative "fate control"

With the assessment of input values V_i the potential of influence by both partners is defined. This "fate control" (f_c) – a term introduced by Thibaut and Kelley – can be expressed as a relative influence potential toward each other (R_{f_c}): (10)

$$R_{f_c} = f\left[\frac{V_i, S_1}{V_i, S_2}\right]$$

Relative "usable control"

This term corresponds to what is generally understood by the concept of power: *the relative probability to obtain a usable input function by the production of an output.* In order to assess relative power two distinct factors must be taken into account:

a) the degree of mutual independence;
b) the value obtained by interaction.

Ad a) Of course the independence must be a function of the *independent* reduction capacity of the partners as described in the preceding section. This applies to reduction of input as well as output component incontingencies. If the difference between the independent reduction capacities of S_1 and S_2 is positive for S_1, this signifies that S_1 invests less costs in producing an output with a contingent input function on S_2 than *vice versa.* If the same advantage holds for the difference in reduction capacities on inputs, S_1 will be less sensitive than S_2 for possible "negative sanctions" (interference) induced by its partner. As it will be very difficult to assess precisely which partner will be the least dependent relative to the other if one scores higher on interference reduction capacity respective to incontingent inputs and the other on reduction capacity respective to incontingent outputs, we will assume that there will only be an outspoken and measurable difference in relative independence if the sums of the input/output interference reduction capacities of the partners are unequal. The independence (I_n) of a partner is therefore a function of this sum:

$$I_n = f\left[\left(\sum \frac{1}{r}\right), S_1\right]$$

The *relative* independence (R_n) is therefore:

$$R_{I_n} = f\left[\frac{\sum \frac{1}{r}, S_1}{\sum \frac{1}{r}, S_2}\right]$$

Ad b) The relative benefit; the "usability" of the production of power functions in an interaction cycle will be the difference in value between the input and output of a system ($V_i - V_0$).

According to the principle of interference reduction this difference must be positive ($Vi > V_0$), because a negative difference would mean that the production of an output *induces* a higher probability of interference than the following input would *reduce.* Thus, the greater the difference ($V_i - V_0$) the more the interaction will be valued.

If, moreover, the system disposes of a surplus reduction capacity relative to its partner, the latter will be the more dependent and is exposed to potential sanctions (interference) which he cannot evade.

Of course this will only hold if the rule ($V_i > V_0$) also applies to him, otherwise more reduction of interference could be obtained from "disobedience" and withdrawal than from exposure to possible negative sanctions.

Relative power

The relative power (R_p) can now be expressed by combining both a) and b).

$$R_m = f\left\{\frac{\left[(V_i - V_0)\sum\frac{1}{r}\right], S_1}{\left[(V_i - V_0)\sum\frac{1}{r}\right], S_2}\right\}$$

Relative power is of course an "emergent property"; a system quality emanating from the properties of a network, not of a system by itself.

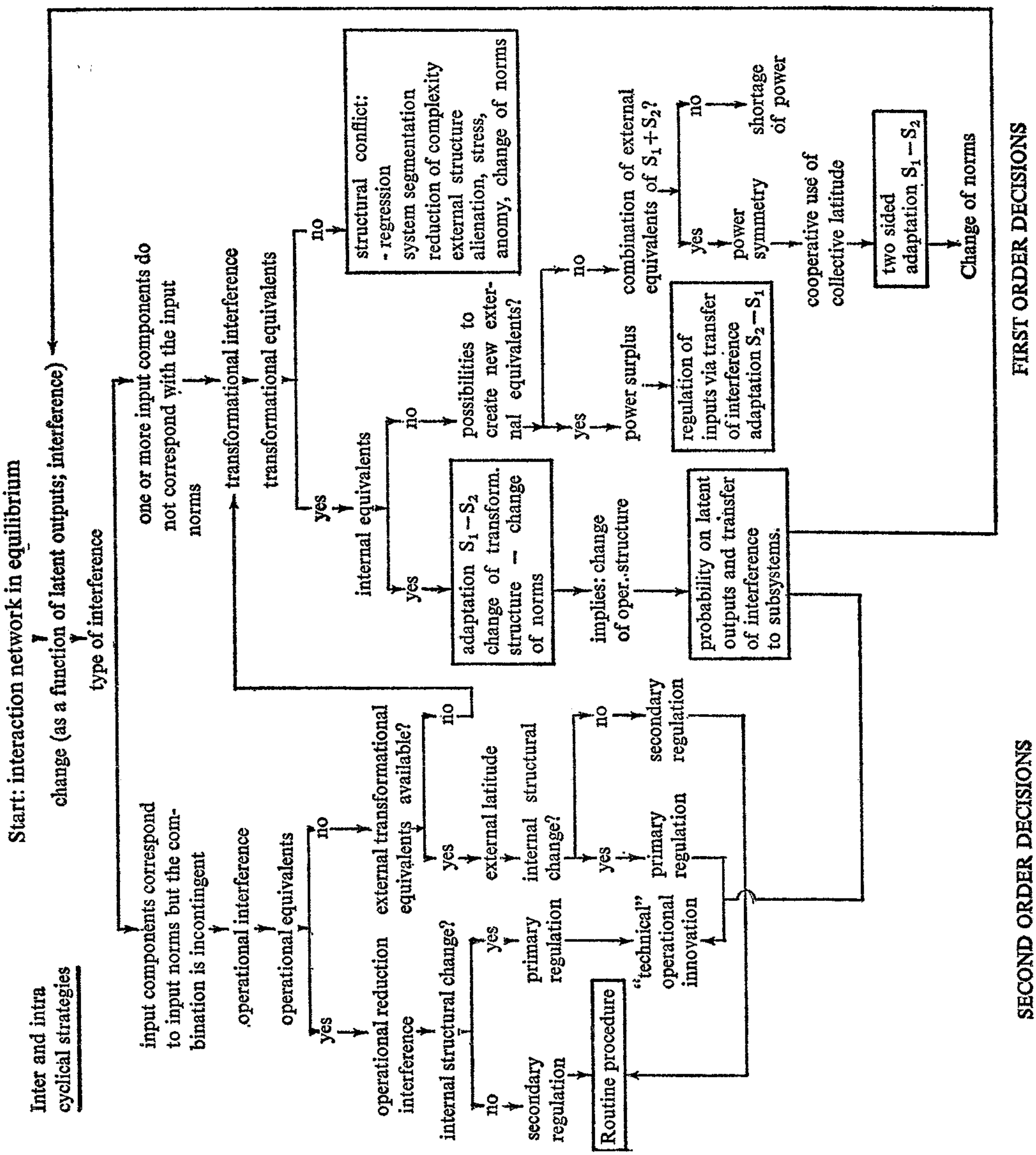
This property yields intercyclical (and therefore political) regulation capacity, as will be employed in the design of strategies aimed at the reduction of the probabilities of interference. The logic of our approach to the problem of power is to our opinion much in accord with the "contingency theory" of Hickson [11]. Both approaches have in common that power must be explained and deduced on the basis of structural analysis and not be dealed with as a property that can only be assessed in retrospect. The structural analysis of power opens the possibility to predict power relations and changes in power on the basis of an analysis of dynamical trends in an interaction network.

24. A scheme of interaction strategy

The scheme on the next page illustrates the theoretical relationship between a number of concepts discussed in this paper.

The probable trajectors along which a behavioural strategy is developed are presented. Real predictions however cannot be deduced from this scheme. In order to do so we should take into account such variables as the character of the remaining network, the centralities, the transformational structures, the time horizons chosen in order to assess the probabilities of interference, etc.

The most important restriction is that the scheme takes for granted the transformational and operational equivalents as they exist in a given network. No complete theory is yet presented as to which factors determine and limit their change potential.


Inter and intra cyclical strategies
Start: interaction network in equilibrium
change (as a function of latent outputs; interference)
type of interference
input components correspond to input norms but the combination is incontingent
operational interference
operational equivalents
yes
no
operational reduction interference
internal structural change?
yes
no
primary regulation
secondary regulation
Routine procedure
"technical" operational innovation
external transformational equivalents available?
yes
no
external latitude
internal structural change?
yes
no
primary regulation
secondary regulation
one or more input components do not correspond with the input norms
transformational interference
transformational equivalents
yes
no
internal equivalents
yes
no
adaptation S_1-S_2 change of transform. structure – change of norms
implies: change of oper. structure
probability on latent outputs and transfer of interference to subsystems.
possibilities to create new external equivalents?
yes
no
power surplus
regulation of inputs via transfer of interference adaptation S_2-S_1
combination of external equivalents of S_1+S_2?
yes
no
power symmetry
shortage of power
cooperative use of collective latitude
two sided adaptation S_1-S_2
Change of norms
structural conflict: - regression system segmentation reduction of complexity external structure alienation, stress, anomy, change of norms
FIRST ORDER DECISIONS
SECOND ORDER DECISIONS

Effective model applications will therefore only become possible if two problem areas are brought within the scope of analysis. These are to our opinion the limits caused by the *division of labour* between system elements as by far the most important quality of a systems internal structure, and – in close relation to this factor – the limits of the problem solving capacity of the individual.

With regard to this latter factor, we should bear in mind that the individual's capacity to make selections (choices) respective to interactive decisions requires that he has an internal normative structure (transformational structure on the level of the individual). The solution of an interactional problem (interference) may require a change in this structure (primary regulation, transformational norm). In technical language we could say that he is under pressure to reduce interference by a change of norms, which however may still have a problem solving function in the context of other interaction cycles. It will be clear that such situations pose a dilemma and may lead to severe intra-psychological conflicts. The more universal the norm is, the more important its problem solving function in an increasing number of interaction cycles. Intra-psychological structures therefore exercise an essential influence on the stability of an interaction network as well as on its flexibility to adapt to changing environmental conditions. The scheme should be interpreted against the background of the restrictions mentioned.

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