

The Joker in the Box or The Theory Form of the System

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ABSTRACT: Compared with traditional theories, systems theory presents a deviation. It replaces causal explanation by functional explanation. This paper shows what scandalon is inherent in this substitution and elucidates some models (self-organization, dance, non-triviality, structural coupling) which put the explanatory principle to work. The paper concludes by showing how systems theory aims at a general concept of communication that not only means a passing on of knowledge but above all the tracing of ignorance. Overall, systems theory is presented as a joker dealing with the paradox that the system is never identical to itself as soon as it is considered as a function of itself and its environment. The system has to withdraw into the function it is a function of in order to enfold this paradox.

Introduction

Systems theory belongs to the jokers of interdisciplinary and transdisciplinary debate in the sciences of the twentieth century. Having just exhausted its possibilities in one discipline, systems theory reappears in another one. Although it can always be depended on for a surprising, promising, and liberating beginning, it loses its powers of persuasion the more seriously it is taken as the one and only option. That is one of the characteristics it shares with constructivism, which is its epistemology. The philosopher Hannes Böhringer (1990, p. 48) once said about the latter that it develops its charm as a drawing, sketch or model, but loses it again when it tries to reach a state of completion and perfection. We thus have to consider systems theory being just one option in dealing with a theory problem that perhaps aptly may be described as the problem of understanding, in general terms, the singularity of any system (Strub 1998).

We may this accept as a disclaimer to the following paper. It is an attempt to take a look at 'general systems theory' as if we were in a position to think it afresh. It does not want to settle arguments between different branches of specialized systems theory as, say, between engineering, physical, biological, epistemological, and sociological versions of it. It has a certain inclination towards epistemology and, to be sure, towards sociology, since 'the observer' seems to be as social a figure as any general kind of theory or, indeed, science, may get. Yet the general idea is rather to cut across the jungle of competing schools and notions and to take another look at systems theory as an epistemological revolution. As we seem to go through,

say, the history of the physical universe or the history of a foetus from time to time anew just to get amazed in wonder, we should try, I think, to look anew from time to time at the concepts of systems theory, cybernetics, and informatics. There is nothing to be taken for sure or for granted. It is all in a state of a reconfiguration of scientific thinking still under its way.

Thus I will try to be very explicit in concepts, yet shy on their definition. I will try to show how they work, not how they struggle for their self-evidence. Here, you cannot look at the cake without eating it. One has to follow the notions and concepts as their own recipes to direct and guide observations in order to get a glimpse of how they may be understood.

From time to time I will even not restrain from the temptation to relate systems theoretical notions to notions or ideas from different intellectual endeavors such as post-structuralism and deconstruction. I am convinced, for instance, that Shannon's intriguing definition of a 'message' being a selection from of a set of possible messages, for instance, is not the Fall of any 'communication' theory from the paradise of meaningful semantics (Hayles 1999), but the very core concept of Lacan's 'real', Bateson's 'information', Derrida's 'différance', von Foerster's 'order from noise', Serres' 'parasite', Luhmann's 'meaning', and Spencer-Brown's 'form'. They are all up to the inclusion of exclusion. And they are all looking at how anything might be informed by something accompanying it without being it. Think of Buddhist co-dependence. Shannon designed his communication model in terms of well-defined, that is 'technical', sets of possible messages. There is no necessity to stick to that and to avoid introducing non-defined or ill-defined, that is 'social', sets of possibility. This seems to be what 'Western' thinking is going to rediscover at certain pains with respect to its well-received scientific tradition of objectivity and causality. If there is such an undercurrent of post Second World War thinking to most of its intellectual adventures, why hide it behind a respect for self-stylized schools that serve academic more than scientific aims?

This section is called an 'introduction'. The rest of the paper is not. Please, feel free to introduce and to add other concepts, as you feel fit in order to emphasize the epistemological thread of systems theory. The concepts and models I use are a selection. They do not attempt to be 'basic notions' but rather to reveal the at times idiosyncratic ways that I used to access systems theory. That is why I call the paper 'The Theory Form of the System'. I do not only want to pay tribute to Niklas Luhmann's Husserl lecture (Luhmann 1996), which he used to flesh out his interest in a theory that is informed by philosophy, social sciences, and mathematics alike, but I would like to emphasize the notion of 'form' even with respect to 'theory'. 'Form' is George Spencer-Brown's (1969) term that he used in his calculus of indications to show that there are always *three* values to the *two* sides of *one* distinction: inside, outside, and the dividing, and deferring, line 'itself'. This means that there is always another side to what

you, what we are doing. We don't know what we exclude by including what we focus on. Yet we may be aware of that form of exclusive inclusion and call that awareness 'systems theory'.

The Joker

The joker is the principle of non-linearity. Wherever we expect certain things to happen, a joker may be responsible for producing a bifurcation or a deviation, a singularity, that not only runs counter these expectations but creates new ones. The joker interrupts by creating a new link. It seems natural, yet it is art. It establishes a parasitic relationship to an already existing relation (Fig. 1):

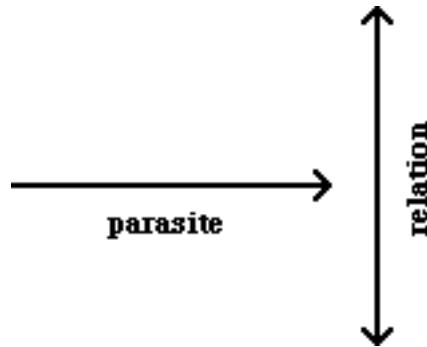


Fig. 1: The parasite

Thereby it creates a new possibility at a place where everybody else has come to terms with existing relationships. Like Maxwell's demon creating negentropy out of its ability to tell faster als slower molecules apart (Baecker 1985), the joker interferes by exploiting distinctions that otherwise almost disappear. In that he is exactly acting like the Chinese sage and strategist who is waiting for small ruptures, breaks, that is, bifurcations to appear in order to almost unnoticeably give the course of things and events a new twist (Jullien 1996). Look at Fig. 2 for a further demonstration:

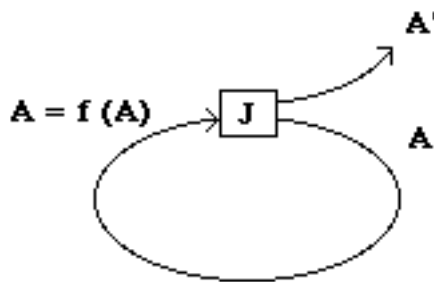


Fig. 2: The joker is creating a new bifurcation

Perhaps a theory always has that quality of a joker mixing things up by creating bifurcations when nobody expects them. But you lose sight of a joker when you follow it up the bifurcation – until it suddenly creates a new one (see Serres 1980; cf. Derrida 1990).

The principle of the joker introduced by modern theories of self-organization (Prigogine/Sengers 1979) talks of noise and distinction where the occidental philosophical tradition talks of corruption and error in opposition to identity. The joker disturbs the expected course of events and presents a new, an unexpected possibility. The noise he is making is already part of an argument. We listen to him, invite him to our table, and read his noise in terms of information. We do so because we know that we need deviations if we want to expand, and contract, the range and reference of our observations. The joker, as Claude E. Shannon (1949) might have said, is not just noise but the ability to relink an information to the set of possibilities it is a selection from. It is difficult to watch possibilities because there is, at any instant, too many of them. That is why we need somebody joking with them.

Traditionally scientific knowledge seems to insist on the principle of causality and to reserve irrational and mystical assumptions for all deviations to which that principle does not apply. Any critique of the principle therefore risks being suspected of irrational mysticism as well, since the tradition does not know of any other exterior of scientific knowledge. On the interior of scientific knowledge tradition has always opted for a coalition of causality and rationality in order to be able to assume not only the common sense of the world but also its ability to be its own cause.

Systems theory is a critique of the principle of causality. It takes on the mathematical conception of function, which does not accept any variable without a reference to an argument (see Korzybski 1958, pp. 133 ff.). It converts the explanatory principle of science from causal explanation to explanation by variables, which determine or rather constrain each other as part of their very argument. Gregory Bateson (1972, pp. 399-410) spoke of the principle of „cybernetic explanation“. Phenomena are not explained with reference to causes that are external to them,¹ but with reference to constraints that constitute them internally in distinction to their environment. No system without an environment being its argument.

¹ But how can causes that are meant to *cause* effects be „external“ to these effects? – The closing of the world seems to be a matter already agreed upon in the explanatory principle of causality, well before one is looking for causes „outside“ the phenomena, or for effects, which in the same way do not arise in the phenomena but „somewhere else“. In short, the causal principle of causality demands a *distinction* between cause and effect (Bateson 1979) without being able to tell who is drawing that distinction if that person is not an observer who must then equally be understood as the cause of an effect or the effect of a cause.

Systems theory thus extends on the classical world theory by using the cybernetic principle of explanation and describing any system as a function of itself and its environment:

$$\mathbf{S} = \mathbf{f}(\mathbf{S}, \mathbf{E}).$$

The system \mathbf{S} is a function \mathbf{f} of itself, \mathbf{S} , and its environment, \mathbf{E} . Since there is no „function” different from the „system” itself, the equation condenses to (see von Foerster 1973 and 1974):

$$\mathbf{S} = \mathbf{S}'(\mathbf{S}, \mathbf{E})$$

In order to be able, as an observer, to distinguish the system from the function, we denote the former \mathbf{S} and the latter \mathbf{S}' . It should be obvious, however, that this is an observer’s distinction.

Yet this is only the setting. We haven’t yet lost any word about how a ‘system’ might possibly be understood, knowing that there has been fierce debate on the questions of ‘elements’, ‘relations’, ‘distinctions’ and ‘operations’. We take the ‘system’ as consisting of events operating on each other such that the distinction between the system and its environment is rather maintained.

The first ‘scandalon’ of systems theory therefore is its basic notion of *a distinction constituting an entity*. How is that possible if a distinction, as Bateson (1979) was insisting, is devoid of any visible and touchable existence? How can something that ‘is not’, as for example the distinction between a red and a blue strike of chalk on the black board, constitute redness and blueness? The distinction somehow ‘is’ in time. OK, that’s fine. But what distinction does that make? The answer, of course, is the distinction of an observer. Systems theory is including, and necessarily so, the observer among the subjects it is observing.

The second ‘scandalon’ or deviation which systems theory as a joker produces in the edifice of old-European world theory is the splitting of causality into a *closed causality*, on the one hand, and an *indeterminate causality*, on the other. First, the system is postulated as the cause and effect of itself – which accepts the world theory as a world *theory*, since it interprets it as an *alternative* description of the world. At the same time,² second, the concept takes into account that further causes may appear in the environment of the system whose effect in the system is indeterminate since the system fundamentally relies on its distinction from its environment. The system relies on its ability to interrupt causality – with the exceptions of a causality that destroys the system and a causality that goes unnoticed. It is called

² Note that simultaneity alone is enough to set causality apart, since cause and effect at least demand a temporal differentiation. See Whitehead 1929, p. 123.

„turbulence“ (Emery/Trist 1965, p. 26) when the system is the cause of external effects, which for their part indeterminately exert an influence on the system. There is no causal influence of the environment on the system but only perturbation: the observation by an observer that the system, as Piaget (1947) would have said, accommodates to itself while ‘adapting’ to its environment. We will come back to this idea when speaking about the concept of the ‘dance’.

The discovery of systems theory is thus not the systems character of the world. Such an interpretation would reduce it to a world theory. No, its important discovery is the environment. That is an almost paradoxical notion since it denotes the outside of systems inside the world and thus denies any outside of the world inside the world – which, then, is the place occupied by God alone. The world, here, is not to be considered as the overall system of all systems (like Lovelock’s ‘gaia’, see Jantsch 1982), but as the term that describes the unity of the distinction between system and environment (Luhmann 1984, p. 208). The notion of the world describes that the relation between system and environment is not a systematical one, but an ecological one. If the ‘systema’, as the Greek word has it, ‘arranges’ and ‘articulates’ elements and relations, or, as later versions of systems theory will have it, ‘arranges’ and ‘articulates’ operations, the world does not arrange and articulate system and environment. That is difficult to think in our occidental frame of thinking. But it is the reason we talk of ‘distinctions’ at all. They arrange and articulate system and environment on behalf of the world. And they are nothing but systems reproducing themselves in the world. Systems theory is thus complementary to evolution theory of 19th century (Darwin 1859) which also profits from the discovery of ‘milieu’, ‘environment’, ‘Umwelt’, while localizing it to play its role not inside but outside the ‘organism’ or ‘system’. That is why recent attempts to integrate systems theory and evolution theory are difficult and demanding in terms of theory (Kauffman 1993). Systems theory replaces the notion of ‘adaptation’ to ‘natural selection’ by the notion of ‘drift’ (Varela/Thompson/Rosch 1991), precisely because there is no agency acting outside the system selecting its course but only the ‘form’ of the system (consisting of its two sides, inside and outside) succeeding to realize itself, or not. The outside outside this form can only kill it, but not in-form it.

The split of causality makes the asymmetry of causality („the cause *is not* the effect“) impossible since it links cause and effect recursively back to each other (see ‘feedback’ and ‘deviation amplification’ in Maruyama 1963). It assumes indeterminateness exactly where the principle of causality insisted on determinateness: in the relation of effect to cause, and vice versa. This scandalon indeed is all the more disturbing as it in no way rules out speaking further of causality. Yet causality now is the special case of an explanation by constraint. It ex-

plains the self-constraint of an observer (see Günther's 1979, p. 214, „image-induced causality“) who believes to be able to select the one or the other cause from among a multitude of possible causes and selects this one or that one effect in order to explain a phenomenon. The observer thereby demonstrates his own 'freedom' of choice, which is the freedom to select other causes or effects and to thereby „commit“ oneself in one way or another as well to the causes and effects actually selected. Assuming the viewpoint of systems theory, it is easy to see that an observer who uses causality as an explanation selects his own relation to the world and insists on 'freedom' because he notices that he is able to select it this way or that way. Yet he must face up to the problem that he is expected to restrict at least socially, if not materially, the possibilities of choice among an indefinite number of possible causes and effects. He cannot just watch what he is pleased to do so. We have come to call 'science' our special way of integrating social and material (or 'real') restrictions on the possible selection of causes and effects.

But the deviation produced by systems theory with respect to the classical world theory is not exhausted by its introduction of the observer and its critique of causality. The question how to describe the circularity which was accepted by traditional world theory only behind its own back, is equally important. How can one understand a system as a function of itself *and* its environment? What is systems theory up to when combining the two types of new causality into a notion of *indeterminate self-determination*?

Systems theory changes perspective in order to answer these questions. That change of perspective is decisive for everything that follows; yet at the same time it hides the difference to the world theory, as we will see soon. That means it looks like the classical world theory, and yet it is completely different. The change of perspective is nothing less than a re-interpretation of the joker. The joker – just like Maxwell's demon in theories of self-organization – is no longer condemned or idolized but is engaged as a virtuoso in distinction. The box where it hid and produced corruption, seduction and error is placed under observation and made responsible for that kind of (externally) indeterminate (internal) self-determinateness that systems theory tries to describe. The puzzle of indeterminate self-determination, however, means to require the joker not to produce the deviations but to react to them or even handle them.³ The assumption is that nobody is in a better position to do just this than the joker whose observations do not stick to objects but address themselves to relations. That exactly is the riddle of systems theory: How are the self-determination of the sys-

³ This seems to be one of the reasons why Michel Serres who had very early a strong interest in systems theory now rather retreats from it: He does not want the joker to be obliged to do anything but to play its game. Compare Serres 1997 to Serres 1968.

tem and the indeterminateness of the system through its environment to be *related* to each other? With respect to systems theory's founding function, $S = S'(S, E)$, the appropriate figure is the following (Fig. 3)

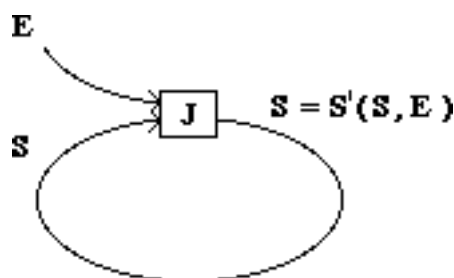


Fig. 3: Perturbed recursion

The joker **J** is sitting in its box, looking at system **S** and environment **E**, and knowing that, if at all, it can only reproduce the system. It is responsible for the function **S'**, which turns the system **S** into a function of itself, **S**, and its environment **E**. Sitting in the box the joker **J** is itself a function of the system **S** and the environment **E** it is able to 'see', that is, to distinguish: $J = J(S, E)$. In the end, it is not to be distinguished from the system since the joker's function turns out to be the same as the system's function. The joker is our eighteenth camel Heinz von Foerster is talking about (Segal 1986), which we introduce to the system in order to make it run and only get returned in form of an epistemological riddle (Luhmann 2000; Baecker 2000). We may denote the function of the system being a function of the joker (being a function of the system) by saying $S = S(S, E(S, E))$, turning the system into an operation on its own distinction from its environment. Systems theory thus is a theory of functors, of functions on functions (von Foerster 1993; Baecker 1996a). The joker is given the duty of de-
tautologizing (von Foerster 1960) the system by introducing its distinction from the environment.

Looking at the figure (3) it is easy to see why systems theory can be suspected of paying for its own scandalon of split causality by having to accept the same kind of tautology as the world theory. Like the world theory where the world had to appear from behind as a function of itself, so systems theory now describes the system *as a function of itself*. Thus it seems to pay tribute to aspects of unity just as the world theory did.

This first impression is deceptive. It underestimates the joker. The joker did not turn into an industrious official on behalf of systems dynamics but administers that difference between system and environment which 'is' the system without necessarily being known by the system. The joker administers the relation between self-determination and indeterminateness.

That is the very mechanism which an observer „can only watch, but not understand“ (Kornwachs/von Lucadou 1994). For the price one has to pay if one recruits the joker to serve the system, is to concede that the joker may reproduce *the system as a deviation of itself*. In other words, any coupling of the system as a cause of itself with an indeterminate cause outside the system in the environment of the system turns the system as a cause of itself into a different cause of a system unlike itself. The acknowledgment of the ‘drift’ of the system pays for the reproduction of the system inside its environment. One may describe the drift as ‘evolutionary’ if one wants to assume that the system has a chance to co-select the environment whose ‘natural selection’ it is exposed to. In that case, however, it holds once again that the system is not reproduced as identical but as different (Glanville 1981).

Systems theory therefore distinguishes between recursive or iterative feedback on one hand, and perturbation/irritation/disturbance on the other. Perturbations are handled in an indeterminate way by iterations of the system determined by the joker. They vary the iterations. Consequently systems theory relies on the assumption that

$$\mathbf{S} \neq \mathbf{S}, \text{ if } \mathbf{S} = \mathbf{S} (\mathbf{S}, \mathbf{E})$$

Looking at the equation sign one may notice that the system „is“ nothing else but the distinction of the system from its environment.

The Box

We are, I hope, still working on the sketch and have not yet started the implementation. For everything else it is important to see how systems theory puts the joker, the idea of a split causality, the problem of indeterminate self-determination and the paradox of $\mathbf{S} \neq \mathbf{S}, \text{ if } \mathbf{S} = \mathbf{S} (\mathbf{S}, \mathbf{E})$ to work.

A systems theory can be recognized by its inclination not to be dismayed by problems and paradoxes but to look for a solution to these problems and paradoxes *in the object*. In other words, it attributes the problems and paradoxes to itself, the observer, and identifies them as the characteristics of the knowledge possible when taking the current scientific conditions of possible self-reference, for instance, into account. And it assumes that the object is ahead of its observer, above all of its scientific observer, with respect to the solution of its problems. Thus, the problem of the observer is that he cannot know to which problem the object is already the solution.

In a certain way, such a procedure is different from the deconstructive one which lures the observer into the dilemma of recognizing his problems and paradoxes and holds him right there until he makes the ‘mistake’ of turning into an ‘object’ himself by presenting a solution to these problems and paradoxes, i.e. by introducing a distinction. Evidently, such a ‘mistake’ is not a mistake at all, but the condition of getting active, or even for becoming alive. Perhaps deconstruction is to be understood as a wager on the possibility of such a mistake. It lures the observer into the temptation to become real, taking with him everything he experienced when looking at the paradox of all distinction being a distinction only we can draw.

We will come back to the question of how systems theory manages its own form of knowledge in the following section. Here it is only important to say that systems theory relies on the assumption that the problems mentioned are solved in the object (which thereby turns into the ‘subject’ of systems theory, if ‘subject’ still means to ‘underlie’ itself and the possibility to observe it). One might even say that an ‘object’ for systems theory is defined exactly by such an ability to solve its problems. The object is not a problem, but the solution to a problem. Systems theory directs its distinctions in an attempt to discover how these object solutions come about.

That interest in objects being their own solution to systems problems explains why in the early systems theory few notions are more important than the notion of *steady state* or *Fliessgleichgewicht*. As Ludwig von Bertalanffy (1968, p. 142) wrote: „Under certain conditions, open systems approach a time-independent state, the so-called steady state (*Fließgleichgewicht*). The steady state is maintained at a distance from true equilibrium and therefore is capable of doing work; as it is the case in living systems, in contrast to systems in equilibrium. The system remains constant in its composition, in spite of continuous irreversible processes, import and export, building-up and breaking-down, taking place.“ A steady state denotes the phenomenon of the continuity of the discontinuous or rather the reproduction of identity from the heterogeneous (and ‘order from noise’). The observer then has the choice of using the concept of steady state either with respect to an entity and unity maintaining itself (Bateson 1976) or rather with respect to an ever new variety of possibilities (Deleuze/Guattari 1980). Yet he has to be aware that these are both sides of one medal.

What ever happens in a system and to a system: it exists as long as it can be observed (and: as long as it maintains its observations, since all these statements are valid for the observer as well, who is a ‘system’ himself in the sense explained). It maintains itself, it reproduces itself, any ‘it’ and ‘itself’ being spelled out under the condition of $S \neq S$, if $S = S(S, E)$. This condition is often expressed by sentences like „the system is in disequilibrium“; yet this only makes sense with a systems notion which stems from thermodynamics, since thermody-

namics must speak of ‘open’ systems or else the system would be absorbed by the higher probability of an entropic state.

Just after the introduction of the concept of the steady state Ludwig von Bertalanffy mentions a second notion which proved to be helpful for the re-interpretation of the concept of causality. He (von Bertalanffy 1968, p. 142) speaks of „equifinality“ in order to state that systems in their steady state are independent of their starting conditions and are indifferent towards perturbations in the sense that they succeed in turning perturbations of almost all kinds (depending on the restrictions of the system and the „domain“ it is reproducing itself in) „equifinally“ into the reproduction of the iterations of the system. „If a steady state is reached in an open system, it is independent of the initial conditions, and determined only by the system parameters, i.e. rates of reaction and transport. This is called *equifinality* as found in many organismic processes, e.g. in growth.“ That is how Bertalanffy conceptionally responds to the problem of indeterminate self-determination and to the paradox of $S \neq S$, if $S = S(S, E)$, since he is well aware that „living organisms maintain themselves in a fantastically improbable state, preserve their order in spite of continuous irreversible processes (...)“ (von Bertalanffy 1968, p. 159).

A different phrasing of the concept of equifinality is developed by Niklas Luhmann’s (1970a; 1970b; 1984, pp. 299 ff.) *notion of function*. This notion had been developed above all in critical examination of the American brand of social sciences’ functionalism (from Bronislaw Malinowski up to Talcott Parsons) which tries to save the concept of causality by a notion of function based on the assumption of a final causality (in an Aristotelian sense), i.e. tries to claim the effect of a cause for the cause of the cause as well (thus closing the world over itself, as shown above). Luhmann - by contrast - takes the joker inside the system seriously and interprets its work as the work of a self-confident Maxwell’s demon. That joker is able to examine all kinds of happenings occurring with respect to the question how they might fit in with the reproduction of the system. The function S' of the equation $S = S'(S, E)$ is considered as a point of reference for comparisons. That point of reference underlies the examination of both environmental happenings with regard to the question as to whether they may serve system reproduction, and of system happenings with regard to the question as to whether they may prove capable of taking on environmental events and of introducing them into the system reproduction.

The peculiarity of this interpretation of the notion of function is that the system ‘is’ nothing else than this kind of a function. It must realize itself as such a function in order to be able to distinguish itself from its environment. That is why the condition of system maintenance or steady state as well as the production of boundaries (or ‘interfaces’) differentiating the system

and re-embedding it into its environment all become objects of the system operations themselves. It becomes impossible to explain the system as the fulfillment of a proceeding (for instance societal) function. Thus the notion of function in systems theory does not just state that systems ‘function’. Instead it maintains that systems ‘function’ by exploring, comparing, and realizing ‘functional equivalents’ (Luhmann) with respect to the problems to be solved in reproducing the system. The function is not a substitute for good old causality but a device used by the system itself in searching its solution space (Rosenblueth/Wiener/Bigelow 1943).

Many concepts of systems theory may be understood as attempts to trace the work of the joker; i.e. to describe the working of the box in which it is pursuing its business. Just as important as the idea of steady states, which states that the problem of the reproduction of organic systems, mental systems, social systems, and perhaps even physical systems is always already solved when observers set out to investigate into it, is the idea of the *black box*. This idea is used to state that systems theory assumes *that* the reproduction succeeds but that it does not know *how* it succeeds. This distinction between the fact of reproduction, on one hand, and the ignorance of the mechanisms of that reproduction marks systems theory *as a theory*, that is as a way to ask questions with respect to a way to discriminate between possible answers. And the working off of that difference marks it *as a science*, that is as an empirical endeavor adding to our empirical knowledge of the world we live in.

The idea of the *black box* (Ashby 1956; Glanville 1979; Glanville 1982) makes clear (‘white’) that mechanisms may not be acknowledged and deciphered ‘from outside’ although ‘inside’ they are certainly present (von Foerster 1984). Therefore the observer has no choice but to relate himself to the box as an observer, for instance by experimenting on different variations of input and output and by trying to describe a rule for the transformation of input into output. One then has to acknowledge, however, that one did not ‘whiten’ or ‘enlighten’ the box but *one's own relationship to the box*. Considered in the light of day, one has no possibility of describing *how* but only *that* one succeeded in doing so. That is, one is back to the starting position of the distinction between fact and ignorance, yet one has gained an insight into a further black box, which is one's own cognitive procedure. That is why in successful ‘enlightenment’ it is always true that „inside every white box there are two black boxes trying to get out“ (Glanville 1982). If you make the world transparent to yourself, you at some point have to obscure how you succeed in doing this. This is Wittgenstein’s (1921) # 6.54 in any second-order cybernetics (von Foerster 1993b). Describing the obscurity, then, fulfills the enlightenment. But at that point it is not called enlightenment any more, but romanticism (Fuchs 1993).

Systems theory, thus, describes systems maintaining their steady states as black boxes to be whitened only by an interaction with the observer. This sums up to one of the most per-

taining puzzles of this theory. It forces it, as it seems, into the alternative of consisting either of a first-order cybernetics stating assumptions about things ‘out there’ or of a second-order cybernetics calling these very objects by their feature of being observing systems like the observer himself and herself is one. This epistemologically unsatisfying alternative seems to be necessary because there seems to be no way to introduce the interaction between observer and black box into the steady states of the system. Yet this is exactly what the most fascinating concepts of systems theory try to do. They combine fact (steady state) with ignorance (interaction). Several ideas have been developed, four of which I would like to name:

(1) The first and perhaps the most important idea is the idea of *self-organization* (Ashby 1961; von Foerster 1960; and many others). Central to this idea is the conditioning of a difference by mutual observation and observation of mutual observation (‘communication’). The difference, or distinction, not just happens but has to accept the conditions of its happening when happening. Self-organization is possible as soon as we do not deal with one joker alone but with two jokers, whose interaction de-trivializes and thereby enfolds the system. The first joker is observing what the other joker does, and decides on his next actions by taking the actions of the other as the point of reference (Fig. 4).



Fig. 4: Self-organization

In other words, indeterminateness is introduced (without indeterminateness no *self-organization*) and the means for *self-conditioning* is provided and at a certain point it will be noticed that the self needs to find triggers of self-conditioning in the other side of its distinction and runs idle without these.

(2) The second idea is the idea of the *dance*, which was put forward by Gregory Bateson (1979) when he thought about his question which pattern connects all patterns: „What is the pattern that connects the crab with the lobster and the orchid with the primrose and these four

with me? And me with you? And all of us six with the amoebae in one direction and the intimidated schizophrenic in the other?” Ever since Warren Weaver (1948), complexity research has started with the idea of such a pattern, a kind of steady state, and linked the observation of steady states to the assumption that these states are *self-similar*. On all levels of analysis they exhibit the same characteristics of structure. That is, an assumption which generates theory and science is to be considered as an observation; as a system; as a steady state; as a function of itself; as a phenomenon that is what it is since it iterates its own deviations... (Brockman 1995).

Bateson believes that self-similarity is due to the fact that there is a dance going on in the box where the joker is sitting in, which reproduces the system. The dance interweaves the iterations of the system with the perturbations/disturbances from the environment. We should think of the connecting pattern as a dance of interlinking parts and only secondarily as determined by different physical boundaries and by the kind of constraints typically exhibited by organisms (Bateson 1979). That means quite simply that you must be dancing yourself if you want to dance with somebody.



Fig. 5: The dance

This is another instance of self-conditioning on the basis of indeterminateness. Yet in addition there is the premise that everything that happens is under the control not of a causal (that is, ‘technical’) but of an ‘aesthetic’ monitoring looking out for the ‘matching’ of occurrences with a pattern that can only be ‘recognized’ and maintained internally (Fig. 5). That is how Nietzsche (1969) already distinguished between causality and aesthetics, obviously well informed on the neurophysiological research of his time.

(3) The third idea deals with the problem of the indeterminate self-determination of a system in the model of a *non-trivial machine* (von Foerster 1984). Here the starting point of systems

theory, which consists in the spelling out of a systems reference and in the distinction of system and environment, is smuggled into a world theory. The world theory believes to be able to assume a linear, homogenous, and continuous world (whatever the perturbations, breaks, and interruptions that only prove the reality of the world) and to postulate the existence of transformation functions of inputs into outputs whether as physical laws of nature, as psychological sets of characters (or drives), or as behavioristic hypotheses on stimuli and responses.

Imagine, or so Heinz von Foerster addresses such a world theory, that you have to deal with a machine which not only recognizes inputs and transforms them into outputs but is able to check on its own conditions during such a transformation (*self-motivation!*). The situation then is not only $\mathbf{O} = \mathbf{f}(\mathbf{I})$, for \mathbf{O} = Output, \mathbf{f} = function, and \mathbf{I} = Input, but moreover is $\mathbf{O} = \mathbf{f}(\mathbf{I}, \mathbf{M})$, where \mathbf{M} denotes the individual-state of the machine. The simplest possibility for \mathbf{M} is that the machine either works or is out of order. If it is out of order it will not be able to do the desired transformation. The situation gets more complicated as soon as the machine is able to refuse input, to desire more of it or to vary on it depending on its mood, that ‘mood’ moreover possibly depending on the number of times the machine has already produced a certain output. The machine acts on its own states and changes them to produce a different output (Fig. 6).



Fig. 6: The non-trivial machine

Suddenly it turns out $\mathbf{O}' = \mathbf{f}(\mathbf{I}, \mathbf{M}, \mathbf{O})$. The idea of a non-trivial machine thus also introduces indeterminateness and deduces this indeterminateness technically, if one may say so, and in best systems theoretical thinking from the argument of the historical dependency of the machine on its own previously performed states.

(4) The fourth idea that I would like to mention perhaps encompasses the former three. Humberto R. Maturana (1970) introduced *structurally determined systems structurally coupled to its environment* as „autopoietic systems. Here also the basic idea is that systems have to fall back upon themselves that is on former system operations, if they are to reproduce themselves. For that they depend on an environment which so to speak plays along with that and contributes those unavailable factors of production, which are necessary in all reproduction. The idea of ‘poiesis’ (in distinction from a ‘praxis’ which satisfies itself) goes back to this overlapping of available and unavailable factors of production.

Maturana supplements these terms by the observation that systems are not only determined by their own structures, i.e. they can only do what is possible given these structures, but are determined also by *the history* of their structural coupling to their environment. That is a supplement which is obvious as soon as one looks at it, since every operation of a reproducing system is already the differentiation of an iteration from a disturbance or else the translation of a perturbation into an iteration, so that there is no history of a structurally determined system where these structures are not exactly the product of a working off of the system’s environment.

In this sense every system is already ‘individualized’ by the history of its differentiation with its environment (which is a differentiation with itself as well). Yet note that the indeterminate self-determination here is conceived as a determinably indeterminate self-determination since the environment is determined, or „enacted“ as Karl E. Weick (1985) would have it, by everything the system in its history up to now has more or less successfully dealt with.

Any system is a system in its niche (Fig. 7).



Fig. 7: structural coupling

And any system is the product of a co-evolution of system and environment, which implies a co-evolution of the system and systems in its environment. But such a co-evolution does not translate the indeterminateness of the perturbations coming in from the environment into determinations, for that would endanger the distinctness of the system and would put an end to the co-evolution as a co-evolution (of systems with scope for autonomy). Instead there is mutual irritation or that mutual offer of complexity which Luhmann (1984, pp. 213 ss.) subsequently to Parsons calls „interpenetration“.

Perhaps we should note in passing that all these ideas remain faithful to the scandalon of a split causality. Any observation informed by systems theory identifies a systems reference for the phenomenon it wants to analyze and takes into account that such a systems reference does not mark a unity but a distinction between system and environment. Only when using this distinction is there a chance to trace the joker's working method. For it is only in that distinction that iterations, just like information, are separated from perturbations, or noise. Yet both, - that is the trouble in systems theory - contribute to the reproduction of the system.

A system, then, is a form of controlling deviations by deviations, a principle that may be guided by the cybernetic law of *requisite variety* (Ashby 1958), which for its part is marked by never possibly being fulfilled (Glanville 1997). It is well known that positive feedback can ‘stabilize’ a system just as well as negative feedback can (Turner 1997). Industrial society in itself, as long as it runs properly, is the best demonstration of that (Sieferle 1997). Indeed, a system does not control itself by establishing an eigen-complexity to match the complexity of its environment. How should it measure the latter one, or, for that matter, its own? But it controls itself by sticking to its own limited complexity and by introducing, wherever it hits upon its own limits, that indeterminateness stemming from ambivalence (Weick 1969; March 1994) or that intransparency (Luhmann 1997a) that keeps it on its guard with respect to its self-determination. It might be possible to speak of the introduction of intelligence, if ‘intelligence’ can mean to attribute ignorance not to others but to oneself, thus calling on the knowledge of others, including on the knowledge contained in one’s situation, where one’s own knowledge fails or deceives (Baecker 1994).

Communication

We still, I hope, operate on the level of the sketch, not on the level of the completion of systems theory. We elaborate on the starting point of systems theory and try to figure out which concepts it uses to work off the improbability of starting by splitting and thereby bracketing causality. We operate on the level of the general theory; i.e. we do not take into account that

the applications of systems theory to questions of engineering science, natural science and social science differ depending on the style of the object (or subject). We know that systems theory, when applied, has to deal with very different kinds of problems, types of observation, and methodologies. That depends not so much on the respective object but on the knowledge received through these sciences whose scientific communities cherish and sanction very different images of that which is taken to be opportune, objective, and scientific. A lot of debate in and about systems theory is stimulated by the existence of different scientific cultures. Only recently have these debates calmed down a little and made room for a renewed reception of systems theory in natural sciences (disguised as ‘complexity research’, see Brockman 1995). It helps that the computer-based sciences of Artificial Life (Langton 1989; Langton/Taylor/Farmer/Rasmussen 1992; Bourguine/Varela 1992) treat the century-old problem of a distinction of soul from body with a certain lack of concern.

And still we find ourselves on the level of a reflection on terms. Carefully we try to avoid the „fallacy of misplaced concreteness“ which was identified by Alfred North Whitehead (1929, p. 20) and emphasized by Gregory Bateson (1958, pp. 280 ss.). That fallacy consists in the suggestion that where there is a word for something, that something must exist. We do not assume that there are systems. But we assume that it makes sense to venture into „considerations“ (Luhmann 1984, p. 12) that assume that there are systems. That means that we use a *second-order concept* whose performance consists in sorting out knowledge and questions differently than before – for instance, starting with a critique of the principle of causality and with the introduction of a notion of function. The notion of system describes what we are describing, and it describes how we are describing it. It results, when applied properly, in a knowledge of our own modes of description entertained in society (Luhmann 1997b, pp. 866-1149) and in experiments with new modes of description (Luhmann 1997b; Deleuze/Guattari 1980).

That is how systems theory turns into a „philosophical“ endeavor as Whitehead (1929, p. 20) wrote: „The explanatory purpose of philosophy is often misunderstood. Its business is to explain the emergence of the more abstract things from the more concrete things. It is a complete mistake to ask how concrete particular fact can be built up out of universals. The answer is, 'In no way.' The true philosophic question is, How can concrete fact exhibit entities abstract from itself and yet participated in by its own nature? In other words, philosophy is explanatory of abstraction, and not of concreteness.“ That is an understanding of philosophy which accommodates systems theory, for it deals in questions of constitution, the solution of which is not looked for in an ontology of substances and essences but in an ontology of rela-

tions and distinctions – the latter not having their place in time nor in space, as Bateson (1972) emphasized.

The question of emergence highlighted by Whitehead is a question for the (possibly self-similar) patterns that constitute phenomena and that are brought forward by the way elements refer to each other, i.e. dance with each other. The abstraction, on the one hand, is that which has been generalized according to traditional ways; on the other, it is the pattern whose acknowledgment demands a different schooling of vision. That does not mean that tradition and its insistence on normative order got it all wrong. But it means that the tradition focused on a kind of pattern recognition that devalued the unforeseeable, the individual, the event, and history, in sum: the concreteness, in a way that is not accepted any more in modern society and that moreover, thanks to the „new science of chaos and complexity“ (Turner 1997), is even not necessary any more.

The notion of system is to be taken seriously as a notion, that is as a second-order device organizing descriptions and explanations, not to be confused with notions calling things by names. Its notional, i.e. philosophical achievement consists in seeing and performing a new way of thinking. The notion is philosophical in the sense that it is necessary and strange in a way and that it by its form impedes the thinking to „become mere opinion, viewpoint, debate, i.e. prattle“, if we may here quote Deleuze (1990, p. 188). It is philosophical also in that it features not only a conceptual dimension relating to other notions (for instance, to causality and function) but perceptive and affective dimensions as well (see, with respect to the distinction between concept, percept, and affect, Deleuze 1990): The systems notion suggests not just a new way of thinking but new ways of perceiving and sensing as well. We quote Deleuze because he used the central notion of steady state, disguised as ‘plateau’, when organizing, with Félix Guattari, their book ‘Mille Plateaux’ (Deleuze/Guattari 1980).

Perhaps systems’s new ways of perceiving and sensing give the most trouble to its proponents as well as to its critics. Conceptually the notion of system seems to result in a „pre-adaptive advance“ which rushes on well ahead of our perceptions and sensations. However, we do perceive and sense that we do not have perceptions and sensations that correspond to the conceptual dimension of the notion. In this respect our nervous system is as outdated (Ashby 1967) as our institutions, above all our education (see the memorandum on universities in Bateson 1979).

On the other hand, all that should not mean that we are prepared to turn back the systems notion to ‘philosophy’. Systems theory is a ‘scientific’ endeavor and that means that the concept of system is of importance not because it is a notion but because it denotes a *function*. Gilles Deleuze (1990) says that the creative performance of philosophy consists in bringing

forth notions, that of art consists in bringing forth percepts, and that of science in bringing forth functions. Systems theory, with the help of mathematics, has not just discovered a new type of function, i.e. functions that exhibit self-referential and non-linear features like $\mathbf{S} = \mathbf{S}(\mathbf{S}, \mathbf{E})$. It moreover assumes that its object observes itself functionally, i.e. it situates itself in a set of alternatives, which may be, realized this way or that way. Systems theory uses its notion of system as a second-order notion which describes objects that are constituted on a second-order level and that coordinate at this level observations and operations of a first order. That is, systems theory speaks only about phenomena that organize and reproduce themselves by means of a double closure (von Foerster 1973).

One of the most important theoretical achievements of systems theory therefore consists in the introduction of a distinction between first-order operations and second-order operations. Of course, that is a distinction that is in itself a second-order operation (it organizes operations), yet is at the same time a first-order operation, which links the two levels. Here as elsewhere we deal in a heterarchy (McCulloch 1945) of notions and levels, not in a hierarchy. We might say as well that we deal in notions that ‘supplement’ each other, i.e. in a Girardian circle they require each other as necessary preconditions *and* keep each other at a distance in order to secure their respective autonomy (Girard 1972; Dupuy/Varela 1992).

Here systems theory is a sketch as well. It poses questions and gives answers, which pose new questions. It is itself one of those linking techniques via distinction, which it describes as its subject. It sets itself as a first-order operation, as the empirical experience of a theory, among those second-order operations to which its subjects owe their self-organization. Using still another notion we might say that this theory essentially, that is operationally, is a „communication“ which works out a new understanding of communication as well. It tries to spell out communication as a further indication of self-organization, dance, non-triviality, and structural coupling which goes on in that box which couples the perturbations of the environment to the iterations of the system (von Foerster 1980; 1993a; 1993b; Baecker 1997).

Communication, according to Claude E. Shannon (1949), is that process of an arrangement of observations with operations in which observations recognize operations by their deviation and maintain the process by feeding data into it that correct the process, as mentioned in the introduction. Fig. 8 shows how that is meant (Shannon 1949, p. 68):

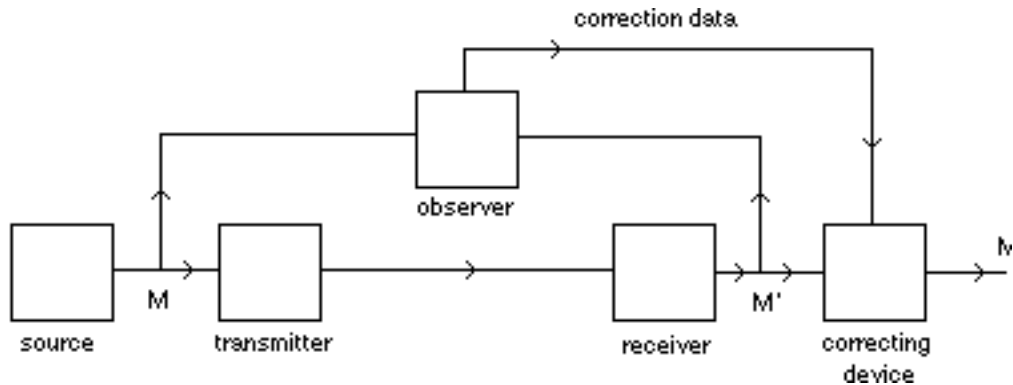


Fig. 8: Shannon's communication (a correction system with observer)

This is a schema of communication, which deviates from the usual picture of source, channel, and receiver by the introduction of an observer. It pays for this deviation by having to accept, or so it seems, an open (open to the right) understanding of communication, which does not answer the question who is doing what with the correction data. One may assume that the process will get closed recursively and that the observer will wait for the source or the receiver to produce new data. But exactly that is not shown! The only thing shown is that a communication occurs which produces a difference between \mathbf{M} and \mathbf{M}' which was noticed by the observer; the observer responds by feeding in the correction data which reduce the difference noticed by the observer, i.e. which reduce \mathbf{M}' to \mathbf{M} . One may imagine that the observer is a source by himself, which produces messages that are read and corrected by a further observer with respect to the deviations he distinguishes. The scheme therefore might apply repeatedly to itself. Repeatedly applied (or „folded“, see Turner 1997) to itself it produces the complexity we have to deal with as soon as we watch communication.

This is an understanding of communication, which fits without further problems with the box that couples the perturbations of the environment to the iterations of the system. That is how we reach an understanding of the system that is compatible with a cybernetic understanding of control and regulation (Wiener 1948; von Bertalanffy 1968, pp. 21-22), yet regards that control as a communication with an unforeseeable outcome (Ashby 1956). Communication is that eigen-value, which indicates the reproduction of systems that use their own unforeseeability to produce those non-linearities that secure, and jeopardize, their autonomy. Communication thus is not information about knowledge wrought out of the noise, and secured against it, but it is the discovery of non-knowledge (Luhmann 1997a, pp. 36 ff.). The reason for that is that a message, according to Shannon (1949, p. 31; see Ashby 1956; Baecker 1999), is not understood by deciphering its contents but by comprehending the distinction

between the message selected and the overall set of possible messages (restricted by technical or social determination). We can only speak of communication when this set of possibilities (Husserl's 'horizon') is read at the same time as the message which is specific in communicating as well the set of possibilities out of which the message has been selected. This is why there is no in-formation without meaning, that is without the possibility to venture further into the set of possibilities it is selected out (Luhmann 1971).

Communication thus generally and fundamentally is observation of 'form' in the sense of George Spencer-Brown (1969). It is an exploration of the unmarked state in distinction from the marked state. It is only in this way that it may fulfil its function to couple the iterations of the system to the perturbations of the environment.

The achievement of Spencer-Brown's calculus, at least under the perspective of the sociological systems theory (Baecker 1999b), consists in offering an idea of how to conceive the precondition of a differentiation of communication into operation and observation. *One* operation has to fulfil *both* functions, i.e. it has to reproduce a system *and* it has to offer relays for the translation of perturbations into iterations. The basic idea for that is the differentiation between an operation of distinction on one hand, and the observation of the form of that operation of distinction on the other. The form includes the re-entry of that which is excluded by the distinction (its other side, or unmarked state), into the form of the distinction (fig. 9).

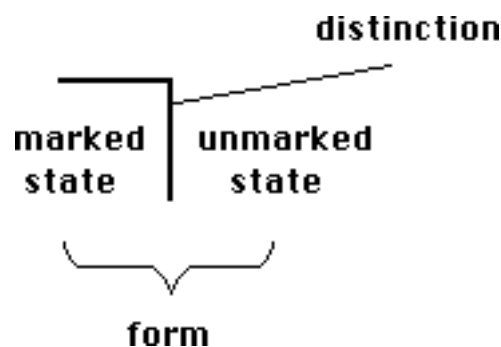


Fig. 9: The form of the distinction

The form of the distinction is the unity of the difference between marked state and unmarked state, including the possibility to watch the separating line between marked state and unmarked state – the latter, of course, leads to an observation of its withdrawal (or *différance* in the sense of Derrida 1968), since one can observe only the marked state in distinction from

the unmarked state and in distinction to the operation of distinction which separates the two states.

That is why any second-order observation is observation of form. It is an observation of any operation

- (1) with respect to the indication it shows for further operations,
- (2) with respect to anything the indication excludes by not indicating it (which is not identical to a ‘negation’)⁴, and
- (3) with respect to the operation being its own „third value“ which produces indication and exclusion all in one act and would not be possible otherwise.

Communication is second-order observation in this sense, namely distinction of the indication with respect to a set of possibilities out of which that particular indication has been selected, and not another. Communication thus above all is production and confirmation of redundancy (Bateson 1972, pp. 406 ss.; Luhmann 1992): Any communication, as specific as it ever it may be, communicates at the same time a set of possibilities whose destiny is not left to the discretion of the one who communicates. Instead it is socially pre-selected and may be ‘performed’ (or ‘re-entered’) relying on the usual means of wit, irony, or even seriousness (yet then usually without being aware of it) but will never be transcended.⁵

Yet the fact remains that second-order observation can occur only as a first-level operation. It must be done. Even reflection, as detached as it ever tries to be, must be done. That is why second-order observation confirms the closure even if it goes for ‘regulation’, and not ‘operation’ (von Foerster 1973). And in using that form it must be aware that second-order observers with respect to the observation may itself observe its uses and the exclusion it performs.

The theoretical achievement of systems theory consists in the introduction of the notion of communication (Wiener 1948; Baecker 1997). This achievement starts with the scandal of

⁴ That should accommodate Deleuze (1968) who as well searched for an understanding of difference without having to start with negation. Negation thereby becomes a second-order concept describing no primary operation but a secondary operation keeping at a distance what you discover to have excluded when drawing your first distinction. Thus the negation operates already on the level of the form, not the distinction, being a reflexion of the fact of the distinction being drawn (Baecker 1996b).

⁵ It is interesting that the level of relation is more sensitive to attempts to re-enter the communication than the level of content is, if we may follow the distinction between these two levels offered by Watzlawick/Beavin/Jackson 1967. Everything takes place as if the level of content is allowed to produce surprises, i.e. information, in order to use the level of relation to test inconspicuously whether the world one is in is still the familiar one.

a split of causality and thereby of a deconstruction of the unity of the world, and is mediated by a series of models from thermodynamics, biology, neurophysiology, cybernetics, theory of information, and sociology in order to enlighten the black box $S = S(S, E)$ under the condition of $S \neq S$, if $S = S(S, E)$. Systems theory is a sketch of communication. And that means that all executions of systems theory are disappointing if they do not live up to that understanding of communication and instead reduce to an identity of iterations that which, following the function of the theory, can only be understood as a difference between iteration and perturbation.

The theory form of the system consists in the insistence on an introduction of a function, which applies to itself as well. The function draws our attention to the fact that the theory is nothing else but a reproduction on the basis of perturbed recursion. And it tries to understand the theory all the better, the more promising the description of phenomena becomes under this viewpoint. The system becomes the „medium of enlightenment“ (Luhmann 1970c, p. 76; Baecker 1999c). Yet this presupposes that enlightenment does not consist in the establishment of a reason which then may be aspired to while putting everything else under the stress of contingency; instead it refers to the rather romantic insight into a dynamics of the self-organization and self-coordination of indeterminate self-determination systems which is not to be steered by reference to a overall systems reference.

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