Research Paper

The Control of Intransparency¹

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General systems theory shows that the combination of self-referential operations and operational closure (or the re-entry of output as input) generates a surplus of possible operations and therefore intransparency of the system for its own operation. The system cannot produce a complete description of itself. It has to cope with its own unresolvable indeterminacy. To be able to operate under such conditions the system has to introduce time. It has to distinguish between its past and its future. It has to use a memory function that includes both remembering and forgetting. And it needs an oscillator function to represent its future. This means, for example, that the future has to be imagined as achieving or not achieving the goals of the system. Even the distinction of past and future is submitted to oscillation in the sense that the future can be similar to the past or not. In this sense the unresolvable indeterminacy or the intransparency of the system for itself can find a temporal solution. But this means that the past cannot be changed (although selectively remembered) and the future cannot be known (although structured by distinctions open for oscillation). © 1997 John Wiley & Sons, Ltd.

Syst. Res., Vol. 15, 359-371 (1997)

No. of Figures: 0 No. of Tables: 0 No. of References: 0 self-reference; operational closure; time; memory; oscillation

I

In classical epistemologies the observer brings in knowledge himself. He might find himself against a highly complex, partly intransparent universe. There might be religious grounds that put limits to his curiosity. This was still the way of reasoning in the seventeenth century. At the same time, techniques of mathematical idealizing came about, which guaranteed for themselves the solvability of their tasks, but in any case ignored the problem that the real world differed from the world of mathematics or idealtypical constructions. Real people, for example, don't act according to the principles which theories of rational choice assume for them, and the actual economical development does not necessarily follow the equation systems of neoclassical theory. Nevertheless this provocation, this self-irritation of the observer through the deviating behaviour of reality, could be brought back into theory and can be seen as a stimulus towards a continuous improvement of the theories and instruments. The invention of the electronic calculating machine again led to an enormous improvement in this technique of

 $^{^{\}rm 1}$ The paper is translated from German into English by M. P. van der Marel and A. Zÿlstra

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CCC 1092–7026/97/060359–13 \$17.50 © 1997 John Wiley & Sons, Ltd.

knowledge. Above all, it has enabled the simulation of temporal processes; and, in the theory of dynamic systems, it has led to the result that the investigator can even surprise himself by his own models. In simulation, the systems already behave in a way which the maker of these models cannot always foresee. The unpredictability is taken into account, as it were. Consequently, it should no longer surprise us that real systems also behave unpredictably. Model calculation and reality now converge, it seems, in the prediction of unpredictability.

One may guess that at the end of the twentieth century this symphony of intransparency reflects a widespread mood. One may think of the difficulties of a development policy in the direction of modernizing, as it was conceived after the Second World War. One may think of the influences of worldwide financial speculation based on prognosis of prognoses on all important parameters of the economy and thus also on politics. One may think of the withdrawal of the therapeutical profession towards constructivistic concepts and instructions, which are guided into unknown territory, in the expectation to see better afterwards why it has not worked. One may think of the demotivating experiences with reform politics, e.g. in education. The examples can easily be extended. The question is, to what degree may we accommodate our cognitive instruments and especially our epistemologies to this?

As we know, public opinion reacts with ethics and scandals. That certainly is a well-balanced duality, which meets the needs of the mass media, but for the rest promises little help. Religious fundamentalists may make their own distinctions. What was once the venerable, limiting mystery of God is ever more replaced by polemic: one knows what one is opposed to, and that suffices. In comparison, the specifically scientific scheme of idealization and deviation has many advantages. It should, however, be noticed that this is also a distinction, just like that of ethics and scandals or of local and global, or of orthodox and opponents. Further, one may ask: why is one distinction preferred over the other? If one cannot do without distinctions, because without distinctions nothing may be observed at

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all, what testifies for choosing one definite distinction?

A modern theory, which today is already classical, put forward by thinkers such as Francis Bacon or Giambattista Vico, has worked with the distinction of knowing and acting and has presumed that man can only know what he can make himself.¹ The world itself may be and remains intransparent, but for man in his own sphere there is hope that he may improve his circumstances, and as a condition for this, as a side effect as it were, that he may attain knowledge of the world. Because the world itself has been created by God, within creation created man has received the possibility, within his own limits, to repeat creation, to acknowledge and utilize regularities and to design of his own accord; and not only artefacts, but since Vico also with regard to symbols. The construction of ever more knowledge about construction is no longer forbidden curiosity (curiositas), but at the same time admiration of creation and adoration of God. This reference to the superagent God, however, is only an argument. It could pacify theologians and keep them from intervening; but it does not betray anything about the structure of this theory, about the meaning of its 'only this way', or about the advantage of this detour via construction towards knowing.

Perhaps we get further if we replace the causal concepts of cause/effect by the more abstract concept of conditioning. In doing so, that knowledge which provides difference remains intact in another form: that which conditions and that which is conditioned are to be distinguished. Their relationship should be thought of asymmetrically, and this requires, as one would say today, a breach of symmetry. It does not exclude, if time may be presumed, the possibility that what is conditioned in its turn serves as condition for further conditionings. Such sequences, however, cannot be understood as repetition, if one should presume the nonidentity of that which conditions and that which is conditioned. The evolution theory offers a good example of a construction of order as a result of that.

This inner distinction of conditioning has been expressed most sharply by Kant. The conditions

of the possibility of empirical knowledge may not, according to Kant, be derived from this knowledge itself. They are not empirical, but transcendental in nature. One should distinguish between the realm of causality and the realm of freedom controlled by reason.² The point is: the victory of freedom over gravity, or, as one would perhaps say today (shifting the problem from space into time), over entropy.

Such a sharp distinction, forming the basis of the transcendental theory and sustaining the expression of 'conditions of possibility', makes it impossible to envisage a crossing of the borderline between transcendental and empirical. However, this problem only arises if you ascribe to the conditionings the function of foundation, because only then does one need to avoid circular structures. In this way the issue of the unity of empirical *and* transcendental is shifted into the 'subject' and the fact of his consciousness, where it potters about like a ghost, without finding its way out.

Here we need not be concerned about the further history of the transcendental theory. With cybernetics, a new phase in thinking about conditionings begins. The first innovation was the rediscovery of the circle as, at the same moment, a natural and technical form. At first the feedback loop was thought of as a structure, but as far as *time* is concerned it was adjusted to a sequence of operations and *repetition*, just as, as far as environment is concerned, to unpredictable changes. In this way one could explain how a system can maintain itself without 'requisite variety' in an extremely complex, and for the system, intransparent environment. However: hold onto what, when the world has lost its old supporting function (in the sense of the Greek periechon)? May we say now: hold onto the difference?

For this cybernetic theory, the concept of conditioning was recovered.³ A system distinguishes itself from its environment by its kind of conditionings (and one has to add, by conditionings of conditionings, by inhibition and disinhibition). This no longer presupposes that somewhere in the universe or outside the universe there must be something unconditioned—a God or an I. One sees already,

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too, how time is utilized in this way and replaces as it were that which before had to function as unconditioned, as origin, as ultimate foundation. Conditionings don't always work, especially if further conditionings interfere, whereby they are enabled and disabled. In this way a system may react in an orderly, self-organized way to unpredictable things. It produces 'order from noise'.⁴ After all these considerations, however, intransparency remains a property of the environment which the system may oppose by winning information from the environment and learning to handle this.

The thesis that a system maintains itself by a difference (and not only notwithstanding by differing) from the environment gains plausibility if you take into account Von Bertalanffy's proposals for a general system theory. According to this theory, a system maintains and reproduces itself in its environment by (always highly selective) exchange relations. This insight may be disconnected from its original model in the living organism, and be formulated more abstractly in terms of 'input' and 'output'. In this way, a general theory arose, which is applicable also to human beings and social systems. Many, including Talcott Parsons, have been influenced by it. On closer inspection, one recognizes that there are now two different distinctions involved: that of system and environment and that of input and output. This takes us to the point where further development has led to a radical break with all former assumptions-not only within cybernetics, but also in constructionoriented epistemology. For now one may ask: what happens when a system reinputs its own output as input? Or, more radical still: are there systems that are their own output, their own product?

Π

In a first approach, one may start with the concept of conditioning and apply it in a reflective way. One describes systems that condition their conditionings. Whether conditions then trigger off consequences depends on further conditions. Possibilities are blocked or released

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depending on the blockade or release of other possibilities. The system then disposes of a latent potentiality which is not always but only incidentally utilized. This already destroys the simple, causal-technical system models with their linear concept and which presuppose the possibility of hierarchical steering. With reflective conditioning the role of time changes. The operations are no longer ordered as successions, but depend on situations in which multiple conditionings come together. Decisions then have to be made according to the actual state of the system and take into account that further decisions will be required which are not forseeable from the present point in time. Especially noteworthy is that precisely complex technical systems have a tendency in this direction. Although technology intends a tight coupling of causal factors, the system becomes intransparent to itself, because it cannot foresee at what time which factors will be blocked, respectively released. Unpredictabilities are not prevented but precisely fostered by increased precision in detail.

This unexpected reversal of determined processes into decisive situations under conditions of intransparency has increasingly occupied recent research, especially in view of the occurrence and spread of risks.⁵ This may concern rare failures, improbable coincidences with possible catastrophic consequences,⁶ but also more or less everyday situations, e.g. military operations or serious medical interventions. The transitions are fluent, but the problem always lies in the reversal from tight causal coupling into intransparency. The system generates indeterminacy through an overload of determinations, and through tight technical coupling time pressure, because technology requires immediate decisions.

Of sociological interest here is that such systems require resources which in classical organization theory were not or only marginally taken into account, e.g. observation of 'critical' objects or modes of behaviour, problem-oriented construction of alternatives, an experience of many years, and especially quick, communication and independent understanding of what others plan simultaneously. Planning beforehand

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fails, as well as recourse to hierarchical instruction. Howard Becker calls a similar state of affairs, which is spontaneously available, 'culture'.⁷

In these types of research it remains initially open whether the failures, which require immediate reaction, come from the environment or are to be located in the system itself. That might be a pseudo-problem, however. For environmental events can only lead to failures or possibly to catastrophes, because the system is built for technical couplings and it conditions these couplings in a complex manner. Here too, the pivotal point is already the problem of our concern, namely the control of self-generated intransparency. In more theoretically if not mathematically oriented considerations, however, this point of view becomes more clear.

In the 1970s and 1980s the ensuing considerations were protracted in several ways. In Heinz von Foerster one finds analyses of machines which calculate their own calculations, are connected with the environment by 'double closure', and thus produce such a great, practically unlimited numer of possibilities for further operation that they become unpredictable (for themselves and for others).8 Von Foerster's distinction between trivial (reliable) and non-trivial (unreliable) machines⁹ is now a frequent quote. All higher forms of life, consciousness and social communication systems are non-trivial machines. This led to a second-order cybernetics, which is based on observing observations and has been introduced in epistemological discussion as 'radical constructivism'. Ethical consequences too are indicated by, education towards unpredictability and decision-decision with respect to what is basically undecidable in view of an increase in possibilities of decision.

This fits the concept of autopoiesis, which was introduced by Humberto Maturana as a definition of the concept of life.¹⁰ In autopoietical systems, the conditions of reproduction of the system are products of the system itself. This is of course not true for all elements within the borders of a cell, like for example minerals. And as a matter of fact one should take the concept of production in a classical, that is a narrow sense, and not apply it to all causes that have to be

present in the environment in order to make the continuation of autopoiesis possible. Therefore here too it will be useful to side-step towards the concept of conditioning, for causally speaking the environment always participates. Creation is not the main intent, but only production through availability of the necessary conditionings.

The concept of reproduction explains in its biological context the concept of the circular structure of the chemistry of the cell and gives it a new temporal sense. In another terminology, introduced by Francisco Varela, one also speaks 'operational closure'.¹¹ Both authors, of Maturana and Varela, as neurobiologists, include cognitive processes: for in the end cognition has also to be produced and reproduced (produced from its own products) in the brain-or it doesn't take place. On this road too, one arrives at a constructivistic epistemology, which understands knowledge no longer as representation of environmental states of affairs (in any symbolic form whatsoever), but as 'Eigenbehaviour' of a self-referential system. Reality then is no longer the result of a resistance of the environment against knowledge attempts of the system,¹² but the result of the successful solution of inconsistencies, i.e. the result of a resistance of operations of the system against operations of the same system.

A third attempt, this time not conceived in terms of system theory (system theory would in this case be only an application of a much more general mathematical theory), is found in the calculus of forms of George Spencer Brown.¹³ He is concerned with the processing of distinctions that are used for the indication of something (whatever) and to mark this something from an unmarked space, because otherwise nothing may be indicated and nothing may be observed either. This runs smoothly as long as the normal calculations of arithmetic and the (Boolean) system are concerned, which in their part have absolutely no need of the apparatus developed by Spencer Brown. With it, however, one is not able to explain how one arrives at stable entities, with which one is able to reckon, at all; they would have to be prepared, isolated, for it beforehand. In order to make up for these conditions, which have to be put at the beginning, Spencer Brown eventually crosses the borders of arithmetical–algebraic calculus *by introducing self-reference*, namely in the form of the re-entry of a distinction into that which is distinguished *by itself*, or, more briefly, by re-entry of the form into the form.

The outcome is that same explosion of possibilities which was observed by Heinz von Foerster. Spencer Brown talks about 'unresolvable indeterminacy'¹⁴ and underlines expressly that this is not conditioned by the fact that the calculation is dependent on independent variables. Translated into system-theoretical terminology, the result of such a re-entry into the system of the distinction between system and environment is that such systems operate in the mode of *self-produced indeterminacy*. As such they reproduce this mode in all they do—as it were as a medium which they have to presume and reproduce in order to have the possibility to be able to indicate something special at all. This may sound extravagent for the moment, but for systems of consciousness as well as for social systems it is unavoidably normal, and even the self-produced condition of the possibility of meaningful operation.

Self-produced indeterminacy should only mean that the system operates recursively, and in doing so has to fall back upon past states which it cannot fully remember, and has to anticipate future states about which decisions may be taken only in future presents. Put otherwise, it is not able to bind its own will¹⁵ and yet has to take it into account. Intransparency, then, is the cognitive result of this situation which is produced by self-reference. Therefore, this indeterminacy is not to be evaded by means of improved cognitions, but may only create starting points for uncertain prognoses by its own operations.

Now we have arrived at the theme of the control of intransparency. Before we take the next step, we want to insert an interjection to mark the distance from the modern philosophical tradition. The discovered dualism of logical and causal form, i.e. the dualism of the distinction between true and false sentences on one hand and of causes and effects on the other, was already overcome by Leibniz, in the form of a theory of possibility. He had divided possibilities

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in compossible and incompossible, and he had left the control of this disjunction to God. The warranty of the compossibility of the created world as the best of all possible worlds and the exclusion of all incompossibilities-that was God's remaining function in an otherwise selfrunning, Newtonian universe.¹⁶ This problem, however, had soon become superfluous, as Kant and afterwards Hegel related incompossibilities to the world and to time, and gave the process by which they were now to be treated the old name of dialectics. Within the new mathematical cybernetics this form too is dropped. One reason for this might be that dialectics had given time too strict a form, oriented towards the concept of process. It might be that for problems dealing with self-produced indeterminacy, such as have become actual today, one needs a very different understanding of time.

III

This supposition we will work out in what follows. It seems that for the solution of the problem of self-produced indeterminacy and intransparency a *temporalization* of the situation of the system is required, like the other way round intransparency is produced in order to make it possible to handle time without being caught in inconsistencies. This does not mean that the treatment of intransparency has to take place *in time*, i.e. at datable moments. That is obvious. Our supposition is rather that the solution lies in *the way time differences are utilized*.¹⁷

Temporalization means here generating a difference consisting of past and future. If the system only knew the past, or if the present of the actual operation were only a repetition of the past, it would reproduce itself as it is. If there were only the future, the system would have to understand itself as constant deviation from its own state, e.g. as goal, and it would fall into deviation from deviation from deviation. The system only requires a self-organization which is able to stay and to learn, if it orients itself to a *difference* of past and future and produces time just in this way.

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Thus time is not gained through copying external movements or their measurement into the system, e.g. in the form of clocks. We do not at all deny that this is *also* possible, but the need for it already presupposes time. Nor should time, as in the occidental tradition,¹⁸ be described as the difference of moved and unmoved, for in this way one would not arrive at a universal concept of time. Time, however, comes into being through a purely temporal equipping of the present with infinite horizons, which meet and are linked together in the present: that of the past and that of the future. And we speak about infinite horizons because one cannot think of an origin with nothing existing before it, nor of an ultimate goal with nothing following after it.¹⁹ Limits, time limits also, always point beyond themselves.

Here, too, we may first fall back upon Spencer Brown's calculus of forms. At an early stage Heinz von Foerster had already noted his innovative introduction of time into mathematics.²⁰ Time functions here not only as a scheme of the sequence of operations or as time for the gradual construction of complexity of meaning. After the introduction of the re-entry of the distinction into itself, the system, in order to be able to carry on, has to dispose of a memory function and an oscillator function. For purely mathematical operations in the imaginary space of secondorder functions a limited interpretation suffices. The system has to identify the state into which it has brought itself, to be able to start from there; and it has to oscillate its indications between marked and unmarked space because it must allow for indeterminacy. However, one already senses that time comes into play here in a new way. If one wants to take this way out from selfproduced indeterminacy into an empirical systems theory, one should interpret both functions, memory and oscillation, in more detail and work out more clearly their connection with time. This will also clarify the importance of their separation. Memory represents the system's presence of the past and oscillation the system's presence of the future.

As far as actualization of the past is concerned, memory has a double function with which it accompanies all (!) actual operations, and thus is

always at work, namely forgetting and remembering.²¹ Its main function is forgetting, the release of the capacities of the system (as it were a parallel of the continuing evacuation of space through the expansion of the universe). However, this inhibition of fixations must also to a certain degree be undone in order to enable the system to construct identities, to build redundancies, to fix Eigenvalues. In this sense memory discriminates continuously between forgetting and remembering, and in this way it is in a position to condition itself, namely its remembering. This may raise the impression of knowledge or ability (how does one ride a bicycle, how does one swim, how does one speak a language?), but apart from that, with the same mechanism inconsistencies may be solved because memory localizes happenings which could not occur simultaneously in different temporal locations, for example the Chernobyl catastrophe. For the rest memory functions in no way necessarily (typically not even at all) in the form of universalizing rules for more than only one situation. The re-use in new situations of what is known may take place very concretely, through familiar details, analogies or impressions of similarity or difference. To learn rules, one almost needs a school or an artificial memory acquired by training.

The temporal horizon 'past' indicates *unchangeability*, which is its obvious character and its relief function. Nevertheless memory constantly *modifies* the past to connect it with a possible future in the present. Modification notwithstanding unchangeability?—even that is possible because memory discriminates between forgetting and remembering, and it is able to rearrange within this space of discrimination. All of a sudden you may remember something which you had previously forgotten, or it may be regenerated as 'had been forgotten', and what you remember may gradually be forgotten because it has become unimportant and has not been evoked again.

Only when one notices this continuous discrimination of forgetting and remembering and when one takes into account how memory solves inconsistencies by temporal and spatial distribution, may one recognize how memory creates

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reality by computing. Reality results from the successful processing of a resistance by operations of the system against operations of the same system. To do so, the system first has to generate internal indeterminacy, internal confusion, in order to be able to assign a task to its own memory. Without self-generated intransparency memory would be neither needed nor possible.

The memory may, in case of an uncertainty which internally is traceable to external causes, work on with known forms and give these a new sense in new situations. After an earthquake in southern Italy the inhabitants first took care of an espresso bar in the open. In doing so, they organized a meeting point where they could collect and exchange experiences. (The government, less successful, sent soldiers with guns and ammunition.)²² That may suffice for a theory of sociocultural evolution, but it ignores the temporal horizon of the future. However, one may only speak of self-produced indeterminacy if one also takes the future into account and puts it against the past, explicitly and in another form. This difference of past and future we shall, loosely following Spencer Brown, describe in terms of the distinction between memory function and oscillator function.

Spencer Brown needs the concept of oscillating only to build the distinction 'marked / unmarked space' into his system. In the system-theoretical context it is recommended to relate the concept of oscillation to any distinction which is used by the system for observations. A condition of use is that only one side and not the other side is indicated and used as a starting point for successive operations. Just for that reason every distinction which is used for observation enables the system to cross its internal border and in this sense enables an oscillation of the system. It may concern distinctions like talking and eating, selfreference and non-self-reference, to be and not to be, true and false, good and bad, more and less, sick and healthy, normal and pathological, in short any distinction. The only condition that holds here is that the moment the distinction is used, the reference itself stays unilateral and the distinction itself, like the perspective through which one sees, stays invisible. That of course does not exclude the distinguishing of distinc-

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tions and oscillation between them; nor does it exclude the introduction of cross-gauges, e.g. to cross-gauge good/bad and normal/pathological in order to be able to indicate bad as normal and good as pathological also. But then it is true also that the distinction of distinctions remains unobserved and that the theory behind the chosen distinctions for cross-gauging remains unrecognizable.²³

If we say every distinction is ready for oscillation in view of the future, this is also true for the distinction past/future and for the distinction memory and oscillation respectively. The system is, if it observes temporally at all, inevitably bistable. So the universal character of the time schedule, which is indeed very special, is warranted by a re-entry of the time distinction into itself.²⁴ If understood in this way, time can no longer be captured as movement, not even in ontological concepts. Neither may the future any longer be seen as something which comes towards us. Every projection of future states of affairs is a projection of a distinction capable of oscillation and not only, for example, the still uncertain expectation of future facts, whose conception could in turn oscillate between occurrence and non-occurrence. Therefore a future without oscillation is impossible. Just as the past is marked by unchangeability, so the future is marked by oscillation. That does not change when one thinks of future presents, which 'will be as they will be' and in which 'will be acted as will be acted'; for these are only formulations which cover up that this 'as', seen from today, may happen in this or that way.

Of course, one may manipulate this contemplated oscillation by a choice of the distinction which is taken as a basis for the oscillation. One may take the ethical distinction 'good/bad' or the technical distinction 'it works/it does not work', and by choosing a distinction one may divert from another one. Among the most interesting forms of intervention in future oscillation are attempts at communicating advice or prescriptions for future conduct. The context of oscillation is then concentrated on the distinction following/not-following and covers up the basic intransparencies. For us the paradigm of this diversion is the biblical prohibition to eat from

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the tree of knowledge. In the meantime there are, however, numerous other cases which have slipped from the control of theologians. For example, should one follow a medical recommendation if this is unattractive or urges one to change daily habits?²⁵ To repeat once more, the future cannot be constituted without opening possibilities of oscillation, just as little as the past without unchangeability. However, it seems, as a compensation of this compulsion of form, there are enough forms for it, so that the presence of the future may be adapted to a great many different needs, and, historically speaking, very different institutional situations.²⁶

As a bi-stable determination of the future the oscillation reacts upon the memory of the system too, and in different ways, depending on the distinctions which are used. This leads to a constant redescription of the past.²⁷ The global effect is that what before was necessary and natural, now becomes contingent, artificially introduced and in need of legitimation and can no longer be made necessary again. In the sentimental age, to give an example from Schiller, former poetry seems naive, which previously was not the case.

Just as the intransparency of the system regarding the past is controlled by memory, so the intransparency regarding the future is controlled by the distinctions which in every case are used as a framework of observation. Thereby the future has become binary, it is left to a flip/ flop; but one has to choose distinctions to reach this effect, and numerous other distinctions are and remain possible as well. The oscillation understood in this way is therefore based upon, if one wants a logical reconstruction, 'transjunctional operations' in the sense of Gotthard Günther, i.e. operations that oscillate between acceptance and rejection of distinctions.²⁸ Thus the transjunctional binarization of binarity seems to be the form in which the not-yet-determined future gains form and its being unknown may be exploited.29

This leads, finally, to the question as to which system chooses which distinctions on the basis of its memory to form its future. Only within this framework may the small, sharp spirits of rational choice begin their work. The intrans-

parency does not disappear, it remains like the 'occultum' of Augustine, from which time springs and in which it disappears again.³⁰ But we may formulate this more precisely now: it remains such that self-forgetting and with it the discrimination of forgetting and remembering are forgotten and that every distinction at the moment of its use does not observe its own unity but has to presuppose it as a blind spot.

At the base of the integration of past and future into the unity of time there necessarily lies a selection which can only be made in the present—in a present which in turn is only present by marking the difference of past and future. That also is not possible without another side, namely that the thing which is excluded by the selection is not seen. The summation of past and future excludes, according to Jean Paul, the happiness of the soul because in this deal one has to refrain from leaving past and future to themselves.³¹

IV

It is still possible, in view of such a complex (but therefore hopefully somewhat realistic)³² theory, to speak about control or self-steering or at least self-control? Does control more than face or come to terms with self-produced intransparency? Is it different from 'exploitation of unknowledge' (Shackle) or 'capacità negativa' (Lanzara)?

In the context of the theory of self-referential, autopoietic systems which we developed here, concepts like control and steering lose their normal outlines and are in need of definitions. Apparently 'control' cannot mean that the overall future state of a system is already defined today; not even, if one wants to make concessions, that details stay open initially and that one has to take into account unpredicted side effects. The problem is no longer solvable along the lines of decision and execution. When the system creates its own history, and does that with ever new selective operations, it is already for this reason indeterminate for itself. Then even the modal descriptions for steering and control, which might be pursued, are lacking. The system

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itself is, one should now say, the unforeseen side effect of its own operations. These only make possible connecting operations which are to be determined always anew. In consequence that difference from the environment emerges, which is exploited by the system in order to stabilize itself (with any structures whatsoever). Steering therefore cannot be understood as orientation to a model of the system within the system.³³

As an alternative one might think of defining steering as trivializing. This would mean treating non-trivial machines as trivial machines, i.e. technically. That also, however, cannot satisfy us, for it would lead to the definition of steering as an error, even as a category mistake. Such an error may well work as a practical motive and for example be indispensable for the political rhetoric of 'being able to design'. A scientifically convincing theory might, however, no longer be grounded on it. One would only fall back on the general denunciation of 'systems theory' as technical-instrumental, as was usual around 1970.

This reservation against widespread ideas (especially in the political sciences) need not lead to abandoning the concept of steering altogether; one should only define it more precisely and consistent with theory. With this goal in mind, one may define the concept of steering as *intention for change of specific differences*.³⁴ This may, depending on how one treats positive and negative evaluations, concern an increase or a decrease of the intended differences.

Against this theoretical background, one may first redefine the concept of goal as a double, temporal and objective distinction.³⁵ Goals arise when a system, remembering the past, anticipates a future which the system does not want to accept. In the specification of goals the system abstracts in a certain degree from itself. Seen this way, self-preservation is not a possible goal, and that is already so, because it contains no information as to whether the difference of system and environment should be increased or decreased. In this constellation of concepts the system is then the other, unmarked side of its goals. In other words, when one pursues goals, one must be able to distinguish them from the system which pursues them. Hereby also the counter

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concept to goal rationality shifts by a kind of 'antonym substitution': we are no longer concerned about reason, for which one only might find criteria that depend on society,³⁶ but about systems rationality.

That steering in this goal-rational sense is possible cannot be challenged at all. By means of vaccinations chances of certain diseases decline. By means of subsidy from the government for industries that lack enough markets, unemployment may sometimes be decreased. Steering in this sense works future oriented, it effects the oscillators of the system. It does not fix the system upon a future overall state of affairs, but changes only some of its conditionings. This makes it probable that the system reacts to steering (from the outside or from the inside) with transjunctional operations³⁷ and jumps from one distinction to the other. Vaccinations raise questions of law (liability to vaccination, responsibility for vaccination harm), and fighting unemployment may foster inflation tendencies and shift attention in that direction. Steering thus always has the effect of conditioning something which happens elsewhere in the system.

Thus the future is not entered into the system as a final state of affairs (telos), nor as a decision tree, the structure of which would be surveyable if one takes decisions at the nodal points. Only differences (of which there may be several simultaneously) are projected, i.e. fixed as conditions of possible oscillation. The differences that function like goals may be measured afresh from situation to situation. There may be shifts of focus from goal towards means, but goals may also lose their value or prove to be unattainable. The goal itself, one might say, does not justify the adherence to the goal. The most important planning resource which is supplied by the future is its being unknown.³⁸ Only for this reason can one imagine several possible courses of events at all, and opt for one of them. The overall behaviour, which tries to follow a steering impulse, may well make a rather goal-rational impression, if one could observe it from above with a bird's eye view. But above all, every new situation renews, with the then newly organized information, the difference of past and

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future as well: and that at least one may know beforehand.

Therefore it makes sense to distinguish between steering and control. Insofar as steering attempts become past and, limited as they may be, are remembered, control starts. Every new present puts the steering under strains of consistency. The possibilities of continuation or of discontinuation enforce the making of decisions. 'Control' therefore is not to be thought of as a discovery of errors, which would only make sense with trivial machines, but is the retrospective self-observation of a system which follows upon steering attempts. Control is not merely success control either. It may exist too when the system tries to divert or to eliminate external steering attempts or steering attempts from above. Instead of putting on a safety belt, one paints a dark strip on one's T-shirt. Control may mean too, however, that the narrowing of the field of vision to specific differences is resolved or at least loosened and one starts to describe the steering impulse in a more complex way. Thus control is almost always connected with a redescription of the steering, which exposes the system to a constant self-correction. Just as steering belongs to the context of oscillation, control belongs to the context of memory.

The relation between steering and control may therefore, if one wants to describe it from the viewpoint of a possible systems rationality, be seen as a special case of concurrence of past and future, i.e. as a temporal self-integration of the system. This is at any rate neither a case of goal rationality nor of value rationality.

V

Finally some brief remarks regarding the epistemological and ethical consequences.

In epistemology, the thesis that one may only know what is able to make should be abandoned; at least if one takes self-knowledge into accounts. For without reflection upon itself, knowledge is hardly imaginable. Self-reproduction (autopoiesis) is exactly the process which overdetermines a system and thereby exposes it to that 'unresolvable indeterminacy'. One will

have to refrain from representational epistemology at all, if one acknowledges that systems do not operate outside their borders in their environment, and therefore cannot communicate their states at all.³⁹ Operationally closed systems can only operate within their borders, even if the meaning of border suggests to them that there has to be another side. With their own operations they are unable to pierce their borders and therefore they are unable to compare internal and external states of affairs.

However, operationally closed systems also experience at their borders an external world. This compels them to distinguish self-reference and external reference and to force this distinction upon all internal operations.⁴⁰ Cognition therefore is generated by an oscillation in this internal distinction and inevitably is temporarily as well as reflexively constituted. There is no cognition that could not shift back and forth between external reference and self-reference, that works with this certainty of the future of the possible shift and therefore reflects itself as cognition.

Ethics also originates by oscillation and, as knowledge, by sedimentation of connected memories. And just as the two-value logic in epistemology, which has to distinguish true and false statements and has to presuppose this distinction as given, now only has a restricted meaning, so ethics also no longer can assume naturally that its task is to distinguish good and bad (respectively evil) conduct. In their classical two-valued forms, epistemology and ethics necessarily have to apply their respective codes to themselves with the help of just these codes, i.e. they have to acknowledge the distinction true/ false itself as true and the distinction good/bad itself as good.⁴¹ These, however, are hardly hidden paradoxes, which apply the same value-now with and then without counter value. At any rate ethics, given so many harmful moral quarrels, can no longer naturally assume that it is good to distinguish between good and bad, and good and evil respectively, and that in doing so there are only problems of rational foundation to be solved. The biblical prohibition not to eat from this tree of knowledge made good sense at the time. After the fall, we are left only

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with a politics of limiting the damage—e.g. under mottos like tactics, humour and irony.

In order to reflect on knowledge and given ethical forms there is no need to go back to an ultimate thing (be it God, be it an I). Following the considerations outlined above, self-produced indeterminacy appears as the only ultimate reference of reflection. It may not be evaded, when one builds reflection loops and thus temporal differences into a system. The point is therefore a reflection of reflection in a form no longer surpassable, without an attempt at foundation and thus also without the problem of infinite regression. In epistemology this leads to a radical constructivism and to the generation of realities without obligation of consensus. That may be one of the reasons why the want of ethics is spreading today. Yet one meets here the structurally similar problem of a theory which is too simply constructed. In both areas, in knowledge and action, one runs into the problem of self-produced indeterminateness, which can only be treated further and changed into useful forms contingently. If in this situation one still wants to look at the Western tradition for models for a solution, one might perhaps think of the concept of the Stoa, which more than once has proven useful in times of unrest, namely of the advice to endure in tranquillity and dignity whatever the consequences of one's own or others' action.

NOTES

- 1. Exactly opposite is G.L.S. Shackle, *Imagination and the Nature of Choice*, Edinburgh 1979, p. 134: 'If history is made by men, it cannot be foreknown.'
- 2. This shows very clearly that the question of conditionings transcends causal concepts.
- Cf. W. Ross Ashby, Principles of the self-organizing system, in Heinz von Foerster, George W. Zopf (eds), Principles of Self-organization, New York 1962, pp. 255–278; reprinted in Walter Buckley (ed.), Modern Systems Research for the Behavioral Scientist: A Sourcebook, Chicago 1968, pp. 108–118.
- 4. Thus Heinz von Foerster, On self-organizing systems and their environments, in: Marschall C. Yovits, Scott Cameron (eds.), *Self-organizing Systems*. Proceedings on an Interdisciplinary Conference, 5–6 May 1959, London 1960, pp. 31–50.

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- Cf., for example, Gene I. Rochlin, Informal networking as a crisis-avoidance strategy: US naval flight operations as a case study, *Industrial Crisis Quarterly* 3 (1989), pp. 159–176; Karl E. Weick, Karlene H. Roberts, Collective mind in organizations: Heedful interrelations on flight desks, *Administrative Science Quarterly* 38 (1993), pp. 357–338.
- 6. See, for example, Karl E. Weick, The vulnerable system: An analysis of the Tenerife air disaster, *Journal of Management* 16 (1990), pp. 571–593.
- 7. See Howard S. Becker, Culture: A sociological view, *Yale Review* 71 (1982), pp. 513–527. His example consists of a group of musicians who, without knowing one another beforehand nor practising together, form a band. The *equivalent* of tight (technical) coupling is here the sequence of tones in the *pieces of music*.
- 8. See Heinz von Foerster, *Observing Systems*, Seaside, CA 1981.
- 9. See Heinz von Foerster, Principles of self-organization: In a socio-managerial context, in: Hans Ulrich, Gilbert J. B. Probst (eds), *Self-organization and Management of Social Systems: Insights, Promises, Doubts, and Questions, Berlin 1984, pp. 2–24.*
- See first of all Humberto R. Maturana, Francisco J. Varela, Autopoietic Systems: A Characterization of the Living Organization, Urbana 1975. An actual overview gives John Mingers, Self-Producing Systems: Implications and Applications of Autopoiesis, New York 1995.
- Francisco J. Varela, Principles of Biological Autonomy, New York 1979; Niklas Luhmann, Probleme mit operativer Schliessung, in idem, Soziologische Aufklärung, Vol. 6, Opladen 1995, pp. 12–24.
- 12. But see also N. Katherine Hayles, Constrained constructivism: Locating scientific inquiry in the theater of representation, in: George Levine (ed.), *Realism and Representation: Essays on the Problem of Realism in Relation to Science, Literature, and Culture,* Madison 1993, pp. 27–43.
- 13. See George Spencer Brown, *Laws of Form* (1969), reprint of 2nd edn, New York 1979.
- 14. Op. cit. p. 57.
- 15. Jean Paul, for example, formulates, Traum eines bösen Geistes vor seinem Abfalle, quoted from: *Werke, Auswahl in zwei Bänden*, Stuttgart 1924, Vol. 2, pp. 269–273 (269): 'no finite man may prophesy his will and state that he shall and will this or that next week. For even if he fulfills his prophecy, he does not act with his former will, but with his momentarty will,' and the consequences are, as one may see confirmed in social systems: 'Angels still may fall, and devils multiply.'
- 16. On this see Gilles Deleuze, *Logique du sens*, Paris 1969, esp. p. 200ff. and on Kant, p. 342ff.
- 17. For this important distinction see Giovan Francesco Lanzara, Capacità negativa: Competenza

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progettuale a modelli di intervento nelle organizzazioni, Bologna 1993, p. 293: 'mediante il tempo, non solo nel tempo.'

- A very specific achievement, in cultural history. Cf. Jan Assmann, Das Doppelgesicht der Zeit im altägyptischen Denken, in: Anton Peisl, Armin Mohler (eds), *Die Zeit*, München 1983, pp. 189–223.
- 19. See the 'solution' to this problem: it violates the meaning of God's eternal presence (aeternitas), in book 11 of the *Confessions* of St Augustine.
- 20. In a review of 'Laws of Form' in: *Whole Earth Catalogue* 1969, p. 14, German translation in: Dirk Baecker (ed.), *Kalkül der Form*, Frankfurt 1993, pp. 9–11.
- 21. See Heinz Foerster, Das Gedächtnis: Eine quantenphysikalische Untersuchung, Vienna 1948.
- 22. This example is in Lanzara *op. cit.* p. 9ff. Following Keats, Lanzara calls this memory-supported capacity for handling unknown situations *negative capability*.
- 23. Parsons of course tried to overcome this lack by analysing the concept of action. In this, however, the exclusive effects of this procedure and thus its inner cohesion could not be controlled.
- 24. A similar state of affairs has been taken into account by historians since the eighteenth century at least: in going from present to present the whole time schedule of past/present/future comes along. That is why past presents have to be distinguished from the presence of the past, and future presents from the presence of the future.
- 25. Modern medical research talks about 'compliance' problems.
- 26. This might be why the multiplicity of forms of possible destinations and the ensuing uncertainty have attracted more attention than oscillation itself.
- 27. 'Redescription' in the sense it is being used, for example, by the British Art and Language Group to indicate the continuous revaluation of past art during the development of a style. After the transition towards atonal music, tonal music still is tonal music, but it is no longer the natural way of composing, but only a historical form, identified by its limitations, in which serious composing nowadays no longer is possible. See Michael Baldwin, Charles Harison and Mel Ramsden, On Conceptual Art and Painting and Speaking and Seeing: Three Corrected Transcripts, Art-Language N.S. 1994, pp. 30–69.
- 28. See Gotthard Günther, Cybernetic ontology and transjunctional operations, in *idem., Beiträge zur Grundlegung einer operationsfähigen Dialektik*, Vol. 1, Hamburg 1976, pp. 249–328. The question whether this leads to the conclusion that a 'multivalue' logic is necessary may be left open.
- 29. G. L. S. Shackle also talks about 'exploitation of

unknowledge', *Imagination and the Nature of Choice*, Edinburgh 1979, pp. 74, 140.

- 30. 'ex aliquo procedit occulto, cum ex futuro fit praesens, et in aliquod recedit occultum, cum ex praesenti fit praeteritum' (*Confessions* 11, 17).
 31. Cf. Bruchstücke aus der Kunst, stets heiter zu sein,
- 31. Cf. Bruchstücke aus der Kunst, stets heiter zu sein, quoted after Jean Paul's Werke op. cit., Vol. 2, pp. 153–161. See also Rousseau's Cinquième Promenade on the isle of St. Pierre, in: Jean-Jacques Rousseau, Les Rêveries du Promeneur Solitaire, quoted after Oeuvres complètes (éd. de la Pléiade), Vol. 1, Paris 1959, pp. 993–1099 (1040ff).
- Of course 'somewhat realistic' here may only mean passing self-organized consistency tests.
- Thus Roger S. Conant and W. Ross Ashby, Every good regulator of a system must be a model of that system, *International Journal of Systems Science* 1 (1970), p. 89–97.
- 34. Following methodical models of empirical science one might also talk about 'variables'. I prefer 'differences' however, and, if an observer is referred to, 'distinctions', because the terminology of variables must take into account specific conditions, especially a 'ceteris paribus' clause, which we may avoid if we assume Spencer Brown's notion of an open distinction which excludes 'unmarked space' and by this includes it. The terminology of variables must take into account a false condition. On the other hand, the terminology observer/distinction/form tries to comprise the distinction true / false too, and this as a distinction among other distinctions that are equally possible. That might be the reason why Spencer Brown comprehends his calculus of form as mathematics, and not as logic.
- 35. The *social dimension* is added, if goals are seen as in need of legitimation, and if the concept of goal is distinguished from motives, interests and values. That, however, happens reflectively only in *modern times*.
- 36. Apel and Habermas would say 'diskursabhän-

gige' criteria; that, however, leads only to the question: which society values 'herrschaftsfreie Diskurse' in which communication contexts?

- 37. In the sense of Gotthard Günther, op. cit.
- 38. Also Shackle, *op. cit.*, who rightly wonders how the economical systems market succeeds in guaranteeing somewhat uniform prizes at any time (p. 65).
- 39. Extensively in Niklas Luhmann, Die Wissenschaft der Gesellschaft, Frankfurt 1990.
- 40. Exactly for this reason Husserl proposed a theory of conscience as phenomenology-with 'epoché' of the question whether the phenomena have an ontic quality. In Gotthard Günther one finds the insight that cognitive systems, exactly because they accept their cognition only passively, and control these only by distinguishing true and false, have to (not may) ascribe to themselves a will that makes a difference in their environment. See Cognition and volition, in: Gotthard Günther, Beiträge zur Grundlegung einer operationsfähigen Dialektik, Vol. 2, Hamburg 1979, pp. 203-210. Thus the same insight of a connection between operational closure and an internally unavoidable distinction between self-reference and external reference is found in highly different theoretical traditions.
- 41. The inversion, to regard it as bad (in Sade: contrary to nature) to distinguish between good and bad, ends with reversed premises at the same paradox. It is then more obvious, with Gilles Deleuze, to regard the use of moral concepts as the highest form of immorality, because it forces one (an argument of the Gödel type) to ask for motives for the use of moral concepts, and in doing this the limits of moral discourse are violated. See (without this argument) Gilles Deleuze, *Logique du sens*, Paris 1969, p. 175: 'Ce qui est vraiment immoral, c'est toute utilisation des notions morales, juste, injuste, mérite, faute.'

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