A Note on Composition

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ABSTRACT: It is characteristic of Heinz von Foerster's approach to the cybernetics of cybernetics that it combines a sense of tight reasoning with the acknowledgment of fundamental ignorance. The article attempts to uncover an epistemological relationship between the reasoning and the ignorance. The relationship is provided for by a razor which reads: What can be described in relation to its composition, is described in vain in relation to its substance. The razor asks for second-order terms instead of first-order terms, or for ontogenetics instead of ontology.

1. Parameters and Variables

When the Center for Interdisciplinary Research at the University of Bielefeld celebrated the sixty-fifth birthday of Niklas Luhmann, then professor and now professor emeritus of sociology at the University of Bielefeld, Heinz von Foerster gave a speech in which he proposed two research programs, one in recursive functors (functions of functions), the other in composition systems for non-trivial, self-referential, autopoietic systems (see von Foerster 1993a).

In what follows I will recall the program in composition systems and comment upon some of its consequences for an understanding of Heinz von Foerster's thinking. Like him I am interested in what happens when two systems begin to go together. We will see that there is no answer yet to the question of how to compose two systems. Whatever you are doing you produce—in following the steps of von Foerster's experiment—a new system for which it is difficult to imagine it once having been two. I will propose to call 'Von Foerster's razor' what turns out to be a device to enhance our research into the dynamics of combination and composition rather than of separation and analysis. The issues most dear to von Foerster—

second order observation, recursivity, undecidability, and inclusion—are issues which relate to his interest in composition. His thinking indeed is an invitation to join. Consequently it is an invitation which does not offer knowledge but a knowledge how to gain knowledge together. Afterwards, it is difficult to remember where you come from.

The question allegedly developed by the research program in composition systems is, how it might be possible to combine two or more autopoietic systems into a new autopoietical system without forcing the systems one starts with to loose their autopoietic status and to become allopoietic (see Maturana/Varela 1980, pp. 107-111). That, of course, is also a question for sociology, which, as von Foerster (1993a, p. 77) rather ambivalently called it, is the "science of the 'socius', of the comrade and companion, and of the 'secundus', the one who follows, who is second."

Let us accept the lure of the question and follow its lead. Niklas Luhmann (1981) once recommended that, before answering the question of *composition*, one should decide how to *decompose* social complexity, that is, decide which elementary components one thinks appropriate to start with when describing social phenomena. Luhmann (1984/1995) went on to propose a social systems theory which does not take human beings but communications as the 'socius' and 'secundus'. To single out communication, and neither intrapersonal nor interpersonal nor cultural aspects of events, is a concept that was originally advanced by Jurgen Ruesch and Gregory Bateson (1951) in order to connect psychiatry with all other sciences that deal with human behavior. Since then it underwent considerable development (most notably the introduction of the concept of operational closure which relieves the concept of information transmission). Yet it still means that the 'dance' society is performing (see von Foerster 1993b, p. 82) is a dance of communications, not necessarily of people.[1]

Luhmann lets people's action, acting and orientation to situations all depend on communication. Communication, however, is not a process relating sender and receiver, as information theory would have it. It is an event constitutive of a social system, and it is triggered by an understanding which distinguishes information from utterance. This understanding is the "sharp-valued event" (Pask 1981, p. 270) which cannot be attributed either to a person talking or to a person listening (or to computers, for that matter, as one has to add nowadays) but only to the social system enabling these understandings to come about (see Baecker forthcoming).

Decomposing social complexity thus brings us to communications as elementary components, and composing these components builds social systems. Human beings are observers of these and other systems. They are conceived as being able to *think*, that is to stay ambiguous when attributing what they mean to either communication or consciousness or corporeality.[2] It is not just the bodies they experience nor the sounds they utter nor the ideas they have in their minds which may be composed in a way such as to build social systems. Social systems are built of communication. And communication is constituted by social systems producing and reproducing themselves by means of communication. These communications are the components and the boundaries of social systems.

Since there are no systems without their environments, human beings, their ambiguous thinking, their remembering and forgetting, their feeling and meaning and withdrawals are indispensable for the constitution of social systems. But what they are (whatever they are) is delayed by social systems, these systems establishing themselves inside these delays (see MacKay 1964, p. 177); and only thereby it is contextualized, offering human beings meanings they may accept or reject in terms of individual idiosyncrasies, or in terms of possible acceptances and rejections tendered by society.

We may therefore be allowed to think of von Foerster's two non-trivial machines not as human beings but as communications. Thereby we gain insight into a trail of composition which leaves human beings as intact as they want, even forces and teaches them to go along alone, yet composes them the more inevitable by communication, story, and discourse.

Von Foerster on this day in early February, 1993, needed two steps to compose two non-trivial machines. The first step he called *orientation*, the second step *composition*. Take two non-trivial machines *S* and *D*, one working on the variable *u* and obeying the parameter *x*, the other one working on the variable *x* and obeying the parameter *u* (Fig. 1):

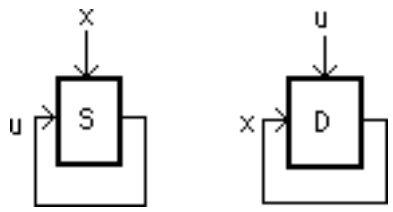

Fig. 1: Two non-trivial machines

Say *S* ('*S*' honours the 'state function' of early cybernetics) is a machine computing information *u* by dint of asking who (*x*) uttered it; think of a business firm working (*u*) on the communicational premises of hierarchy (*x*). Say *D* ('*D*' because of the 'drive function' of early cybernetics) is a machine computing utterances *x* by dint of having already decided which information *u* they contain; think of the same business firm counting how many (*x*) items of a certain product for a certain price (*u*) it is selling.[3] In both cases we deal with communication consisting of three selections: information, utterance and understanding, the last one establishing and feeding on the distinction between information and utterance.

Machine *S* is a machine maintaining the 'inner' organization of the business firm. It is able to process information as long as this information is coded in terms of hierarchy. It does not understand anything else. Machine *D* is a machine observing the structural coupling of this

business firm to a market in which it is marketing its products. It is able to relate to the market only in terms of price information taking into account whether any goods are sold at all, and if so, how many. Since x_D is the price information which should be communicated inside the firm in order to re-orient production when new opportunities appear or old ones vanish, any 'real' business firm looks for a way to combine drive function and state function (only then this distinction applies) by translating market behaviour x_D into internal communication u_S and thus relating hierarchical information x_S back to price information u_D. The system consisting of both machine *S* and machine *D* has to combine the understanding of a distinction between the need to obey hierarchical orders on one hand, and the meaning these orders take on on the other, with an understanding of a distinction between the possibility to set prices on one hand, and the market response to these prices on the other. The composition problem is a problem of composing understandings which relate to informations and utterances of different languages, namely an organization language (decisions) and a market language (payments).

The first step Heinz von Foerster proposes in order to combine these two machines he calls 'orientation'. He rotates machine *S* (but it could equally well be *D*, could it not?) by 90 degrees and thereby lines up parameters and variables in the same register (Fig. 2):

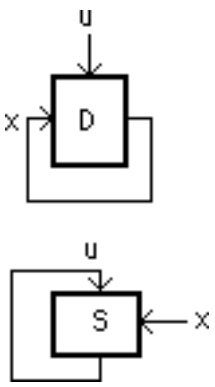

Fig. 2: Orientation

'Orientation' means two things. First, x and u are said to be translatable, if not 'the same'. Second, x and u are entirely distinct, u being a parameter in D and variable in S, x being a variable in D and parameter in S. One can translate u_D into u_S and x_D into x_S, and vice versa in both cases, only when taking the distinction between parameter and variable into account, that is when taking into account that they cannot be translated. Thus an orientation by a rotation of 90 degrees means rendering possible a translation which is not possible. Both systems, starting with the system that is willing to rotate, will have to give up something in order to gain something else. Yet they will have to maintain their respective distinctions between parameter and variable lest they relinquish their possibility to perform at all.

What then is given up to permit this change in orientation? Both machines give up their insistence on x and u being either variable or parameter, respectively. Each concedes its own parameter to be the variable of the other, its variable to be the parameter of the other. And what is gained?—insight into the *distinction* between parameter and variable. It is not the fact that one factor is the parameter and the other the variable, but the distinction between parameter and variable that enables a machine to work at all.

Both machines—maybe one tentatively taking the first step, the other one initially refusing but giving in eventually—give up *necessity* (of regarding parameters as parameters, and variables as variables) and gain *contingency* (of a parameter being able to be a variable, and of a variable being able to be a parameter). Both machines now see a *distinction* at work that they never saw before. They still have to use this distinction but they know its items to be interchangeable. It is no longer a certain variable and a certain parameter, but the distinction between parameter and variable that is the token for the operations of the machine.

Orientation thus means a translation which by discarding a distinction lets a distinction be observed. Orientation is an event which can be attributed neither to the one machine nor to

the other but only to the communication being the 'interpretant' (Peirce 1960) both machines refer to when checking their situation. Their situation is their operating in an environment where other machines are operating as well. Orientation means allowing the situation take over—without forgetting, however, that there is a moment of *letting* it take over. At some point the machines will even discover that this letting the situation take over was already (and well-beforehand) offered by socialization. And now they search for the 'source' this discovery may be attributed to. Is it their individual discovery, or a discovery once again triggered by the situation they created, and were created by, when orienting towards each other?

The second step Heinz von Foerster proposes draws on the first one. It is the *composition* enabled by the orientation. The two machines are slipped into each other (Fig. 3):

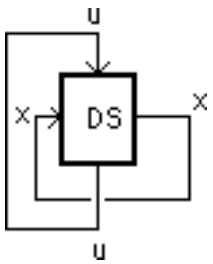

Fig. 3: Composition

We are now dealing with a *DS*-machine working on a translation of parameters into variables with the help of a translation of variables into parameters. That is, the machine computes its own reality as a contingent one by means of transforming its own reality into the structure it has to rely on. It is transforming operators into operands, and vice versa. The result is a structure-determined system (see Maturana 1976) exhibiting double closure (von Foerster 1993a, p. 78).

Think again of the example of the business firm. It is now *one* system consisting of *two* machines[4] translating market behaviour (the variable of machine *D*) into hierarchical instructions (the parameter of machine *S*) by the means of a translation of production and investment decisions (the variable of machine *S*) into price information (the parameter of machine *D*). One translation enables the other one. That is called orientation. The new system, composed as it is of two machines, develops a new mode of communication that couples hierarchical communication to the observation of market behaviour by coupling production decisions to price information. That, of course, is a model of a business firm that is neither the black-box-production-function of the neoclassical economic theory nor the white-box-power-brokering system entertained by some sociological approaches. It is a model which shows that parameters (hierarchical instructions, price information) are translated into variables (market behaviour, production decisions), and vice versa.

Translations are brought about by orientation, and the orientation is entertained by translations. That means that the business firm is now relying on communications able to observe production decisions with respect to hierarchical instructions and to ask, with respect to market behaviour and price information, how instructions constrain possible decisions, and, with respect to instructions and decisions, how prices constrain possible marketing strategies. The hierarchical order of the firm and its mode of making decisions become contingent on its marketing performance. And the marketing performance becomes contingent on different possibilities of organizing production. Suddenly, it becomes possible both to re-enter the market into the firm, and to re-organize, relying on networks, the market (see Peters 1987 and 1992). However, that presupposes the reconsideration and reorganization of the firm as a device of translating parameters into variables, and vice versa (see Baecker 1993 and 1994b).

2. *A Kidnapping Epistemology*

In order to model any organic, mental or social system biologists, psychologists and sociologists may possibly be interested in, there is an indefinite number of non-trivial machines one would have to compose in the manner described. Of course, there is a cybernetics which attempts to do that and identifies, adds and combines feedback mechanisms in any way that seems appropriate. However, such a procedure of cataloging feedback mechanisms hits on one problem which is an empirical problem proved by mathematics. A complex system consisting of only four interdependent components already can no longer be completely described by a listing of the feedback mechanisms at work (see Ashby 1956 and von Foerster 1993a, p. 71). To rely on the description of feedback mechanisms at all then becomes a didactic device (used, for instance, by Weick 1979) giving people an idea of the complex interdependencies they are dealing with (and which are dealing with them) when working in organizations, teaching in schools, intervening in economies, providing help in family therapy, and so on. It is an invitation to dance certain communications. But it is not a device to model complex systems. One would end up with trivializations that may serve as reminders of complexity but cannot claim to picture it.

Luckily, there is a way out of the dilemma of having, and not being able, to rely on a collection of feedback mechanisms. One may call this way "von Foerster's razor". Just think of what we did when we composed the non-trivial machines. We turned parameters into variables, and vice versa, and thereby we closed these machines by feeding the results of their computation back into them. There are no parameters any more which the machines, or at least one of them, are not able to treat as variables. And there are no variables any more which could turn into parameters regulating the machines, or some of them, without being computed by the machines themselves. Both sentences are valid, adding up to the paradox of a system regulating its own regulation. A sociologist delights in this concept, since it not

only translates the distinction between a system's manifest and latent features but shows as well that this distinction only makes sense if one considers the possibility of the latent becoming manifest, and the manifest becoming latent.

Von Foerster's razor consists of adding closure. "While at first one would think that the introduction of closure adds richness to the arguments, it does in fact do the opposite. It removes one degree of freedom. This is so, for whatever we may consider the 'end' in any domain, it must coincide with the 'beginning', otherwise the system is not closed" (von Foerster 1984, p. 6). Von Foerster is well aware of the abundance of ideas, concepts and models there are at hand when trying to understand, describe and intervene in the world we call our own. He does not want to add to this abundance, since "the gigantic problem-solving conceptual apparatus that evolved in our Western culture is counterproductive not only for solving but essentially for perceiving social problems" (von Foerster 1979, p. 6). Instead he wants to add one idea which almost imperceptibly gives our thinking another spin.

Closure of course means (at least) double closure. There are 'operations' that do what they do, that is they compute a reality, and there are 'programs' that operate on the operations, or regulate how the system regulates itself (von Foerster 1981, pp. 304-306). Removing one degree of freedom almost as a matter of course leads to removing (at least) one other degree of freedom. This removing, though, is not done by the cybernetician modeling a system but by systems regulating their own operations.[5] The idea now is that these moves of adding closure, that is of adding recursivity—the one and only credo cyberneticians believe in (see von Foerster 1987)— means regaining computability, which is tantamount to decidability (see Löfgren 1987). However, that computability is not at the disposal of an external observer. And the decidability is not handed over to parametric interventions from the outside. Computability is acquired by the system itself in terms of its own operations, and decidability is deployed by the system itself in terms of its own regulations. An external

observer can only infer both computability and decidability; an external observer can only compute or decide his or her own operations and regulations.

Peirce's (1960) term 'abduction' has to be taken literally here. It is a kidnapping that lets the abductor (observer) acquire something he did not have before, namely an insight into the working of a system, and that makes the system dependent on the observer refraining from destroying what he gained. Were he to destroy the insight, he would lose his coupling to the system, and the system would lose the observation of its own mode of working. The abduction is a peculiar non-zero-sum game entertained by a Catch 22 situation of a system liberated by being drawn into the observer's distinction of closure. The constraint both the system and the observer now have to obey is their relation to each other, and "the properties of any particular constraint will depend on both the real thing and on *the observer*" (Ashby 1981, p. 54). 'Cybernetic explanation' (as termed by Bateson 1972, pp. 399-410) almost naturally becomes an explanation with reference not to *causality* relating cause and effect but to *constraints* relating systems and observers.

The kidnapper is already working inside the system. The system is the relation between 'the real thing' and 'the observer', or rather it becomes this relation by enabling the real thing to be a real thing for the observer, and the observer to become an observer of the real thing. The system is a white box that consists of Glanville's (1982) "two black boxes trying to get out", i.e., of the real thing and the observer. However, as soon as they succeed in getting out, they would turn into two white boxes, in turn each consisting of two black boxes trying to get out. The abduction works only at the expense of agreeing to both of constructivism's postulates, the postulate of 'autonomy' or operational closure of the system, and the postulate of 'inclusion' or participation of the observer (see von Foerster 1985). These two postulates contradict each other, and that is the paradox constructivism enfolds. What the kidnapper abducted is the insight into his own state of being abducted, into his own being kidnapped by

the system (see the story "Circular Ruins" in Borges 1964). That is the Catch 22 situation: you cannot get 'out' if you do not accept being 'in'. But then what is the meaning of 'getting out'?

Since the kidnapper is already working inside the system, he assumes the roles of the kidnapper, the blackmailed and the hostage all at once. It is the threat to his own autonomy that makes him pay the ransom which consists in acknowledging the epistemological paradoxes of cybernetics.

3. Ontological Jokes, Ontogenetic Necessities

A certain uneasiness, however, remains. Did we not just buy all the preceding arguments by calling the parameters and variables in machines *S* and *D* *u* and *x* respectively? What if we had spoken of parameter *x* and variable *u* with respect to machine *S*, but of parameter *y* and variable *v* with respect to machine *D*? Would not that have killed our argument of translations of parameter *x* into variable *x* and of variable *u* into parameter *u*? In any case, we would have a new situation. With $u \neq v$ and $x \neq y$, the composition system would look much more complicated:

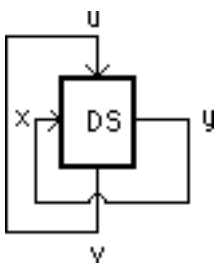

Fig. 6: Complicated composition

But does it make a difference if we give the variables and parameters different names? Did we not in any case acknowledge that $x \neq x$ and $u \neq u$ by saying that x seems to be x (and u seems to be u) but is at one time a variable and at another a parameter? We did in any case acknowledge that the same is different (as did Glanville 1981). And, moreover, we know from Spencer Brown's calculus (1972, p. 69) that the sign "=" stands anyway just for "is confused with"—that is, for "is different from". Thus "≠" stands for "is not confused with" (if we believe in a symmetrical logic of negation, but that in fact we do not). So what difference is there between calling x variable or parameter and calling x x or y? We know there is a difference at work in both cases. And that is what is important. We are not looking for variables and parameters, since we know they slip through our fingers and turn into each other. We are looking for distinctions at work. We are looking for operations able to turn operators into operands, and vice versa.

Thus, introducing v and y does not really complicate things any further, but mirrors the difficulties we are evoking when discussing problems at the level of first-order terms. If instead we discuss things at the level of second-order terms (without, however, forgetting about the distinction between first-order and second-order terms), we avoid the difficulty of not knowing what to call what, that is, we avoid having to give names. Lyotard (1983) once said that giving names is in any case just a tribute to the metaphysical illusion that things respond to the signs that denote them.[6]

When theorizing we apply von Foerster's razor together with Ruesch/Bateson's (1951) and Luhmann's (1981 and 1984/1995) recommendation of decomposition. We know we are operating recursively in iterations of operations, keeping track and knowing how to jump, being moved and knowing when to delay—thereby building 'operative complexity', as Willke 1993, p. 103, would have it—projecting our selective memories into cautious expectations. We start with recursivity since everything that interests us is already operating, that is, it

knows already what it is. And we know what it is as well, since 'we' operate inside 'it', be it organic systems, mental systems or social systems. All we have to do is find out which questions we will accept that will deliver the answers we already know (see Maturana 1994, pp. 56-58).

The question von Foerster accepts is the question that delivers the answer of closure. He knows that the difference between parameter and variable, or between *x* and *y*, *u* and *v*, is not at issue the moment the *DS*-machine operates recursively, since at that point first arguments vanish and eigen-values appear which we may identify and even predict (see von Foerster 1993a, pp. 76-77). Objects we may speak about are endlessly different, as phenomenology had to find out, to its delight and disappointment. But the fact that we speak about them proves that they are 'the same' with respect to their being "tokens for (eigen-)behaviors" (von Foerster 1981, pp. 273-285). They emerge out of communications hinting at them, employing them and in turn hinting at them and employing them. That is their way of making sense (see Luhmann 1990, pp. 103-111). These objects may come about due to their own self-referential closure (see Glanville 1981 and 1988) and that certainly is one of the questions which deliver the answers we are prepared to accept after so many attempts at reification (see Baecker 1985). But even this abduction of self-referential closure delivers objects that are constituted *in communication* and nowhere else.

Therefore, the difference between *x* and *y*, or *u* and *v*, is no objection to von Foerster's concept of composition. We are dealing in ontogenetics, not in ontology. And that makes a difference: "Ontological inexplicables may turn out ontogenetic necessities. The navel is an ontological joke, a curlicue, a baroque riddle on one's belly. Ontogenetically, however, we would not be without it," as von Foerster brought this point home in a lecture on 'Epistemology and Cybernetics' in Milan on February 18, 1985 (translated into German and published in von Foerster 1993b, pp. 92-108). However, we still want to be able to play with

these jokes, to kiss the navel on the belly of our loved ones. We will never agree to enter any realm of pure necessity. Instead we re-enter the jokes into the necessary recursions that let them come about.[7]

Expressed in the terms that were used for Ockham's razor ('What can be done with fewer assumptions is done in vain with more') Von Foerster's razor reads: What can be described in relation to its composition, is described in vain in relation to its substance. The razor consists in an economy of first-order terms in favour of second, and higher, order terms. Composition is a second-order affair. It relies on observations fed back into operations thereby proved to be contingent, yet necessary.

Acknowledgment

Comments of an anonymous referee enabled me to improve on the argument. All remaining vagueness is not only mine but intentional. Thanks to Fiona Greenwood for her English language editing of the manuscript.

Notes

1 Luhmann's sociological approach is foreshadowed by Talcott Parsons' and Edward Shils' (1951, pp. 53-109) idea of understanding 'social actions' as 'social systems' and to view orientations of actors to situations as the stuff these systems consist of. The handicap built into sociological theory is that these orientations are to be interpreted as offered by society. They are not developed and maintained by solitary individuals who only afterwards enter social traffic. It is fascinating to read the classics of sociology like Emile Durkheim, Georg Simmel and Max Weber with respect to their handling the switch from psychic references (acting individuals) to social references (individuals acting in situations). Alfred Schütz (1974) for instance makes a distinction between 'acting' and 'action' and conceives of 'action' as the artefact of social interpretation whereas 'acting' relates back to a subject's awareness of its own behaviour; but even 'acting' he considers as constituted by meaning and as featuring retentional and protentional (Edmund Husserl's terms) aspects which date back, so to speak, to social orientation. There is no way for a sociologist to avoid the problem that as soon as one asks any specific question about individual behaviour, let alone individual intentions, desires and needs, the only possible answers one can get are answers relating to social meaning selected by customs of communication. Already the question is, of course,

one of certain communicational customs. That is, asking about individual behaviour one ends up watching selections provided by communication, that is with social systems providing orientations to situations.

2 In Baecker 1992 and 1994a I only emphasized the ambiguity of attribution to communication and consciousness; but see Varela/Thompson/Rosch 1991 for attributions to corporeality.

3 Note that we already argue with respect to the non-trivial machine emerging, i.e., the business firm. Whether there are non-trivial machines able to compute hierarchy or price independently from another would be a matter of much dispute. The example thus is inappropriate in a certain way. Yet it is useful nevertheless since in modern business firms different aspects of its organization not rarely are treated like independent machine. We will see that this treatment exactly divests the business firm of its social, or discoursive, quality.

4 But of course there could be, and there are, still more of them. Remember that the whole procedure is not one of engineering, but of epistemology. The composition indeed should be read backwards: as an operation of remembering the constituents of a system taken as self-evident. They are not self-evident, but they turned into self-evidence by forgetting how they came about. The composition re-members its own improbability. See Goldratt/Cox 1992 for a narrative of the difficulties of the retranslation of the business firm once established into the translations it is performing.

5 One of these systems is the cybernetician's working in his or her 'scientific community'.

6 At least since Kant there has been an uneasiness with giving names in theoretical reasoning; that uneasiness, however, is today answered by the feeling of having an almost moral obligation if not to give, then to respect names. The Holocaust, which erased millions of names, is one of the reasons for this feeling. A good starting point when trying to accommodate the difference between moral and theoretical practice is to remember the distinction between first-order and second-order terms. To make and remember this distinction allows the possibility of theory to emerge and is at the same time of utmost moral importance to cyberneticians. It is a lesson they never cease to teach us.

7 See, for instance, North American Indians' narratives about Old Man Coyote collected in Lopez 1977.

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