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# ELEMENTS OF A CYBERNETIC EPISTEMOLOGY: CYBERNETIC REQUIREMENTS FOR THE 'SELF-ORGANIZATION' OF 'SELF-ORGANIZING' SYSTEMS

The paper combines Foersters definition of 'self-organization' as production of redundancy with Ashby's approach that 'self-organizing' systems require an organizing and an organized part. Based on that it is investigated if systems usually considered as 'self-organizing' have such an organizing part producing redundancy, i.e. reducing the number of states of an organized part. It is found that such organizing parts can be identified in almost all systems usually considered as 'self-organizing'. But the investigation shows that today several very different phenomena are subsumed under the notion of 'self-organization':

(1) What is called 'self-organization' in physics deals with the reaction of particles to external forces, which may result form occasional events or from goal-orientated systems striving for control.

(2) What is called 'self-organization' in chemistry deals the combination of particles leading to the emergence and evolutionary growth of goal-orientated systems.

(3) What is called 'self-organization' in biology and sociology deals with the intentional interaction of goal-orientated systems trying to achieve control, either individually as dominance or collectively in a cooperation.

It is concluded that identifying the organizing parts, and especially in social systems the goal-values determining their activities, seems the most important task to understand all the resulting phenomena of organization.

## 1. INTRODUCTION

This paper is part of a series called 'Elements of a Cybernetic Epistemology', in which we investigate how the cybernetics of goal-orientated systems determines the behavioral possibilities and necessities of all technical as well as living systems that can observe, decide and act. Here we want to investigate the relation between goal-orientated systems and 'self-organizing' systems.

'Self-organization' has become a widely used notion in many disciplines, dealing with questions how order emerges. It seems to originate from physics, where it refers to a 'spontaneous' building of a structure, i.e. a sudden interaction of some or many elements of a system that showed independent behavior before. But while 'self-organization' may even be celebrated as a new scientific paradigm (see e.g. Vec, 2006), for a reader striving for precise definitions it often remains unclear what is really meant by that term. And a reader looking for causes and explanations for any 'spontaneous' building of a structure, will find few, if any answers.

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Things become even more complicated since there are notions, with overlapping, if not competing meanings: 'Autopoiesis' (Varela, et al. 1974) is an equally celebrated term, with equally unclear meaning, and an equally large number of applications. And 'synergetics' is a less known term, coined by Haken (1983), originally derived from his study of lasers. Haken claims that the principles found there do apply exactly to the phenomena that are said to show 'self-organization'.

Well, in this paper we will focus on 'self-organization' raising the question if any order does really occur 'spontaneously'. We will ask if 'self-organization' does not require some sort of 'self' doing the job of organizing, and if we can find some necessary properties of this 'organizing self'. So we will try to find some common principle behind 'self-organization' - if there is any. We will refer to 'autopoiesis' and 'synergetics' where we consider it as relevant.

## 2. TWO STARTING POINTS

We suggest that a common denominator applying to most approaches to 'self-organization' can be found in Foerster (1960) defining it as a phenomenon of systems that produce redundancy, i.e. that show an internal realization of Shannon entropy below the theoretical maximum. Put in another way this means that a 'self-organizing' system according to Foerster has to be able to keep the number (or at least the probability) of states realized below the number of states theoretically possible. For reasons of simplicity we will speak in the following just of a reduction of the number of states, keeping in mind that the probability of states repressed need not be turned to zero.

This fundamental statement is our *first* starting point: It means that any understanding of 'self-organization' requires an explanation *how* a system can reduce the realized number of its states.

A *second* starting point for the analysis how this may happen we take from Ashby (1962), who suggested that any 'self-organizing system' has to consist of two parts, i.e. an organizing part carrying out the organization of an organized part.

## 3. THESIS ABOUT CYBERNETIC REQUIREMENTS FOR 'SELF-ORGANIZATION'

Now let us assume for this paper, that both, Foerster (1960) and Ashby (1962), are right. From that we can derive the following thesis about cybernetic requirements for 'self-organization':

(1) We should be able to identify in all 'self-organizing' systems an organizing part able to introduce and maintain some organization, understood just as a reduced number of states, in an organized part.

(2) From that assumption follows we should expect that whenever this organizing part ends its activities, any organization that emerged in the organized part should break down and the 'self-organization' should perish.

(3) We propose furthermore that such organizing part exhibits control, by limiting the behavioral options and the number of states of the organized part.

(4) From this follows according to Ashby's law (Ashby, 1957), that such control can only happen if the organizing part has more power and / or variety of behavior than the organized part.

(5) These four assumptions follow directly from our two starting points. We want to add here another point. Since the focus of our work is on goal-orientated systems, as stated in the introduction, we will additionally ask what role goal-orientated system can play in 'self-organization'. That means, we will ask if any system involved has the basic properties of a goal-orientated system (Nechansky, 2006), i.e. (1) an internally defined goal, (2) the ability to observe

the actual state of its environment and (3) the ability to act on that part of its environment to change it towards the goal. Particularly we will check for the following possibilities:

(5a) There may be *occasional* 'self-organization', when an occasionally directed force has an *implicitly* goal-orientated effect on another system, i.e. a force happens just by chance, but long and strongly enough to enforce and maintain certain states there.

(5b) Or there may be *intentional* 'self-organization', when the organizing part is a goal-orientated system able to decide for *explicitly* goal-orientated actions to control another system.

(5c) Finally there may be 'self-organization' resulting from the directed interaction of two (or more) goal-orientated systems. Then the interesting question arises which goal-orientated systems becomes the organizing part and therefore which goal prevails.

Let us summarize our thesis:

Based on our two starting points we propose that the change from unorganized behavior to 'self-organization' requires the occurrence or emergence of a higher level system that can exhibit control of one (or some) previously unorganized systems, that become subordinated. To achieve that the higher level system, i.e. the organizing part, has to have sufficient variety of behavior to control and to limit the number of states of the subordinated system, i.e. the organized part. And we expect that taking apart the organizing part and the organized part should lead to the break down of 'self-organization'. Finally we will ask what role goal-orientated systems can play in this process.

In the following we investigate how we can support our thesis by studying phenomena in physics, chemistry, biology and human society that are usually considered as 'self-organizing'.

## 4. PHYSICAL 'SELF-ORGANIZING' SYSTEMS

### 4.1. EXAMPLES OF PHYSICAL 'SELF-ORGANIZING' SYSTEMS

Let us start to consider a few examples of physical 'self-organizing' systems:

(1) *Boiling liquids* are often presented as a simple example of 'self-organization', because they develop circulating movements: When enough heat is induced by some source, vapor bubbles emerge and cause a strong upward force in the liquid. Friction and gravity cause cooler parts of the liquid to move downwards. This 'self-organized' circulation ends, when no more heat is supplied. So here we can easily identify the source of heat as Ashby's (1962) organizing part.

(2) *Laser light* can be obtained by stimulating electrons of a gas tube or a semiconductor with strong electrical currents and keeping the emitted light widely within the device by adding reflecting layers. Turning on the current causes, after a short phase of stabilization, the emission of light of a specific wavelength. Haken (1991) calls the states leading to the prevailing light an 'order' mode that eliminates states in 'slave' modes emitting other wavelengths. Haken (1983) calls the process 'synergetics' and sees it as a form of 'self-organization'. Haken (1983) shows that the overall process is determined by the current and the distance between the reflecting layers, plus the energy levels available to the atoms within the device. So this 'self-organization' is determined primarily by external control parameters. And, of course, it is over, when the current is turned off.

(3) *Temperature control*, as usually applied to a room, has surprisingly never been considered as 'self-organization'. Yet it is easy to show that it can be viewed that way:

If a temperature controller turns on a heater, slow moving gas molecules touching the heater get a higher velocity. This local warming leads to a local upward movement. We suggest this is Haken's 'order' mode. It introduces a slow circulation in the room. So more molecules touch the heater and get higher velocities. This reinforces the development. The circulation and collisions of molecules equalize the locally enhanced room temperature, till slow velocities - Haken's 'slave' modes - vanish. Of course, the phenomenon is over, when the controller turns off the heater. We see here not any difference to the 'self-organized' circulation of boiling water.

With that example we want to suggest that *physical* 'self-organization' deals with the other side of control, i.e. the reaction of the physical particles of a controlled system (the organized part) to the actions of a controller (the organizing part). It complements control theory, which usually focuses only on the overall achievement of controllers, ignoring how these exactly realize their goals in other systems. In Haken's 'order' mode we see the direct response of the controlled system to the impact of the controller, in his 'slave' mode the previous state overcome by control.

Here we contradict Haken (1991, p 153) that a laser would be fundamentally different from feedback control, because external influence cannot reach all electrons causing the light emission. The same holds for temperature control: The heater does not get in contact with every gas particle either. It just causes by *heat transfer* an increased Brownian movement of some particles in the room. This causes *heat conduction* within the gas, without further contact with the heater.

(4) *Natural temperature control* and other natural control mechanisms can lead to similar phenomena, when interacting forces can maintain certain patterns of physical states. Examples are the stabilization of the surface temperature of the earth caused by the sun and moderated by the rotation of the earth, or the cycles of water transport in the atmosphere of the earth.

These examples suggest that physical 'self-organization' seems more or less completely dependent on the occurrence of external systems - i.e. organizing parts - exerting strong directed forces within constraints. This can be quickly illustrated, when we consider a heating plate put on the bottom of an ocean, a laser insufficiently supplied with current or a temperature controller in open air. In all these cases there will be some minor effects, but 'self-organizing' will not show. All that are examples of Ashby's (1957) law: if the organizing part has not enough variety and / or power in its behavior it cannot control an organized part and determine the states emerging there.

## 4.2. SUMMARY: PRINCIPLES OF PHYSICAL 'SELF-ORGANIZATION'

The emergence of physical 'self-organization' seems primarily to depend on directed forces from external systems, then on their relations to constraints, while the properties of the 'self-organizing' elements seem to play the least role. Yet we can discern two phenomena:

**(P1) One-side change towards some constraint, i.e. positive feedback:** The action of just one (or one dominating) force on a system with constraints may lead to some stable rearrangement of that system, determined by the interaction of the force and the constraints, or to the break down of a structure involved (called a phase change in physics).

**(P2) Approaching a steady state within constraints, i.e. negative feedback control:** When two (or more) similarly strong opposing forces apply, they may establish a steady state determined by the interaction of the forces within the constraints, with the strongest force having a prevailing influence.

So concerning physics we can confirm our thesis of section 3: (1) We can identify organizing systems on the verge of all 'spontaneous' 'self-organizing' behavior. (2) As expected 'self-organization' breaks down, whenever these organizing systems stop to exert their directed forces. (3) The organized behavior is the result of control. (4) This control requires accordance with Ashby's law.

Concerning the role of goal-orientation we have to say that physical 'self-organization' may occur occasionally (5a: implicit goal-orientation of the organizing part as in natural control phenomena) or intentionally (5b: explicit goal-orientation as in technical control). Yet we do not find goal-orientated systems as organized parts (5c).

## 5. CHEMICAL ‘SELF-ORGANIZING’ SYSTEMS

### 5.1. EXAMPLES OF CHEMICAL ‘SELF-ORGANIZING’ SYSTEMS

Let us continue with examples of chemical ‘self-organizing’ systems:

(1) *Oscillating reactions* like the “Brusselator” investigated by Prigogine (1985), can be seen as determined by certain external conditions (energy and material supply by an organizing part) and the properties of the components involved, much like the phenomena in physics.

(2) *Cyclic reactions* mark a departure from physical ‘self-organization’: (a) Unlike the patterns discussed above, here *all* components involved have to show restricted behavior. The emergence, closing and continuous reoccurrence of the cycle requires always a 100 % yield of all reactions involved, whereas other phenomena of ‘self-organization’ can be observed even if there is a lower percentage of participation. But even 99 % closure still gives no cycle. (b) The emergence or at least the reoccurrence of cycles seems not to be a result directly induced by external forces, i.e. the organizing parts we are looking for. (c) The repeated reoccurrence of the sequence of components and reactions making the cycle requires stable conditions in time, to allow cycles to continue and not just to be short lived phenomena resulting from strong local forces (like boiling liquids, lasers or temperature control). So this phenomenon seems to depend on a stable environment maintained by physical control (P2), allowing occasionally given particles to develop patterns of continuous interaction. (d) Since all components involved have to contribute to maintain the cycle, their behavior gets a ‘purpose’, because they have to be working towards what we call an *existential goal-value*, i.e. a certain physical state necessary for closing the cycle.

We suggest that we can speak here of the emergence of the core of goal-orientated systems i.e. an *internal goal-orientation* towards an existential goal-value. This becomes the characteristic of all living systems, which built on such cycles.

We suggest that this formation of a goal-orientated system out of components that show now goal-orientated behavior by themselves might be called ‘*autopoiesis*’. We think we come here close to the meaning of the term when it was originally coined by Varela et.al. (1974).

(3) *Catalytic cycles* mark a next step, when cycles occur that can catalyze the production of certain components. Here two extreme cases are possible: (a) The components produced can inhibit the reactions of the cycle. Then the phenomenon is a short lived one. (b) The components produced can serve the maintenance of the cycle, e.g. may be a product necessary or favorable for the formation or closure of the cycle. We suggest that we can speak in the second case of a first form of goal-orientated systems with a structurally enabled *external goal-orientation*, which can introduce directed change in the environment serving its internal existential goal-value.

In both cases we find an influence on the environment of the cycle, causing one-sided change (P1). We suggest that we find here for the first time what in biology is called ‘coevolution’.

(4) *Autocatalytic cycles* may start to promote their own reproduction as next stage. This may be seen as an even stronger form of external goal-orientation causing one-sided change (P1).

(5) *Hypercycles* may emerge from the combination and interaction of cycles. While catalytic cycles can introduce one-sided chance in the environment, hypercycles may turn on and off such internal catalytic cycles. We find here a first form of structurally enabled ‘decision making’. If all the ‘decisions’ to turn an and off catalytic cycles lead towards the existential goal-value of the system, i.e. that particular physical state that allows a closing of the hypercycle, such external goal-orientated activity marks the beginning of control of the environment (P2).

5.2. SUMMARY: PRINCIPLES OF CHEMICAL 'SELF-ORGANIZATION'

So chemical 'self-organization' starts with something new:

**(C1) Reaction cycles and internal goal-orientation.** We see the emergence of cycles as core of goal-orientated systems, because they require the unequivocal interaction of components towards a certain physical state necessary for closing the cycle, i.e. an 'existential goal-value'.

**(C2) Catalytic cycles causing one-sided change.** Catalytic cycles may evolve out of simple cycles (C1). They produce components causing (P1) one-side change in the environment. If that change improves the conditions of the existence of the cycle we speak of external goal-orientation.

**(C3) Hypercycles causing control.** Further evolution of cycles (C1) may lead to (C3) hypercycles. If they contain catalytic cycles (C2), turning on and off such cycles can cause local control of the environment (P2).

Concerning our thesis formulated in section 3 we find here primarily a change of the regime: We do not know the causes for the emergence of cycles. But once emerged, their goal-orientation has to be maintained for their continuous existence and determines that all further 'self-organizing' phenomena based on them have to be goal-orientated (Our thesis 5b in section 3: explicit goal-orientation of the organizing part).

For all resulting phenomena of 'self-organization', or better *control of the environment*, we can apply our other thesis of section 3: (1) In catalytic cycles we find the emergence of systems that can change their environment in one direction, in hypercycles we find the beginning of control. (2) When such cycles cannot ensure repeated closure, all external change breaks down. (3) External change follows the scheme of physical 'self-organization' (P1) or (P2) and (4) requires a variety and / or power of behavior according to Ashby's law to have any impact.

## 6. BIOLOGICAL 'SELF-ORGANIZATION'

The evolutionary steps leading from these chemical processes to biological systems are not known to us. But all biological systems definitely build on chemical cycles. So they are all goal-orientated systems that have to act towards their existential goal-values (C1).

There are a lot of biological developments allowing improved goal-orientated interaction with the environment. These behavioral possibilities result from an increasing complexity of biochemistry (C3). Here we can name just some of the principles of biological 'self-organization':

**(B1) Goal-orientated actions and movements** are enabled by the combination of sensors with a structure that allows the evaluation of sensor data in relation to existential goal-values and to use the results for decisions to trigger goal-orientated actions of effectors. We suggest that we find here explicitly all the basic properties of goal-orientated systems (Nechansky, 2006), we mentioned in section 3. (Implicitly these may already be found in hypercycles.) That development allows controlled interaction (P2) with the environment. That eases to maintain existential goals (C1).

**(B2) Flocking** is enabled by (B1), i.e. the movement of some individuals towards an environment favorable for the maintenance of existential goals (C1).

**(B3) Leaders** become a cybernetic necessity (Nechansky, 2008a) with flocking (B2) to end conflicts, i.e. to control the behavior within a group.

We find here a new form of 'self-organization' emerging at the latest with flocking, i.e. the interaction of two or more goal-oriented systems (our thesis 5c in section 3: explicit goal-orientation of all systems involved). Yet this interaction has to fulfill the requirements for control of the environment as already formulated for chemical systems at the end of section 5 (i.e. it has to follow our thesis (1) to (4) of section 3).

## 7. 'SELF-ORGANIZATION' WITHIN SOCIETY

Humans, as result of the line of chemical and biological systems, have to follow, too, (C1) as core 'self-organizing' principle, i.e. they are 'goal-orientated systems' that have to maintain an internal goal-orientation towards an existential goal-value, and an according external goal-orientation in their actions. Let us introduce here three specific human abilities, available to men additionally to all principles of biological 'self-organization':

**(H1) The ability to make decisions to set individual goals.** Unlike biological 'systems', which can just decide for given acts leading towards their existential goal-values, humans can decide to pursue individual goals within their range of existence.

**(H2) The ability to make decisions for speech-acts and for actions to pursue them.** The ability to speak allows humans to announce actions that may be realized later on.

**(H3) The ability to cooperate towards mutually stipulated goals.** Using speech acts humans can stipulate mutual goals, and can initiate long-term cooperation towards such goals.

In the following we want to analyze the emergence of cooperation in more detail. We focus on that, because we want to show, that (a) it, too, requires the organizing part according to Ashby (1962), we are looking for; (b) It can make explicit a process that implicitly has to happen in other biological systems, too; And finally, (c) it stands at the beginning of a hierarchical process of organization that may lead to ever higher levels of goal-orientated systems exhibiting control.

### 7.1. THE EMERGENCE OF COOPERATION

Human 'self-organization' becomes explicit when mutual goals are stipulated using speech acts. The decisive point here is, that speech acts, like any other action, require before a decision, i.e. a here decision what to say. And since decisions are goal-orientated (Nechansky, 2006, 2008a), speech acts are a form of goal-orientated actions, too. To analyze this process at the verge of cooperation, we apply that elementary decisions of feedback systems having the form

if {(data) (relation) (goal-value)}, then {trigger for a goal-orientated action}

provide a first approximation to describe all decisions (Nechansky, 2006, 2008a).

Now the first question is, which goal-values enter such decisions for the mutual goal-values to be pursued in a cooperation. We suggest that any individual has to apply primarily existential goal-values (C1), i.e. interests concerning its survival, health, long-term wellbeing, etc. And secondarily it will apply individual goals (H1). This leads to the following series of decisions:

1. if {(possible mutual goal-values) (positive relation) (existential goal-values C1)}, then {trigger a further consideration concerning individual goal-values}.
2. if {(possible mutual goal-values) (positive relation) (individual goal-values H1)}, then {trigger subordination of individual goal-values to mutual goal-values}.

That means the criteria in stipulating mutual goals for a cooperation are (1) if these mutual goals serve the existential goal-values (C1) of the individuals involved and (2) if they serve their individual goals (H1), too. Only if all these goals are accordingly *aligned*, the individuals will accept the mutual goals and establish an individual internal hierarchy of goal-values:

Existential goal-values (C1)
↓
Mutual goal-values (H3)
↓
Individual goal-values (H1)

This is the core of *individual* ‘self-organization’ on which any society depends. To be precise, this is a *control* process initiated by that highest level goal-orientated system (the highest organizing part) that decides, if mutual goals (H3) serve existential goal-values (C1). If so, this can lead to the establishment and maintenance of a hierarchy of goal-values, and a new intermediate level of control we will analyze below. Before that let us say explicitly, if mutual goals (H3) stop serving existential goal-values (C1) the highest level goal-orientated system can reverse the decision any time: Then pursuing mutual goal-values may be skipped, reduced or at least delayed, giving precedence to individual goals (C1 or H1) again.

Let us add that stipulating mutual goal-values can be studied in its most pure form in contract negotiations. Here goal-values are made explicit, e.g. in describing certain products a partner has to deliver. In everyday life we find such explicit goal-values only seldom, but mutual goal-values tend to be defined as ranges. Individuals are told or punished when passing limits of an allowed range of behavior and thus violate goal-values that may remain unspoken. Then the individuals do not act towards explicit goal-values, but in relation to limits. Accordingly individuals tend to be only aware of the limits of these ranges, defined by the group, society and / or culture they belong to, and may even have difficulties to express the goal-values used to define these ranges.

The decisive point is, when individuals decide for new goal-values, their behavior will get a new direction, i.e. a new goal-orientation. And when individuals accept changes of the limits of allowed ranges around goal-values their behavior will gradually change.

## 7.2. THE MAITENANCE OF A SOCIAL UNIT

Now let us analyze how this hierarchy of goal-values (and limits) determines the *societal* ‘self-organization’, which is primarily an *individual control process*. This hierarchy of goals has to lead to a hierarchy of decisions determining the behavior of individuals. To describe this hierarchy we can again apply the formula for elementary decisions (Nechansky, 2006, 2008a):

1. if {(observational data of actual situation) (relation) (mutual goal-value)},
   then {trigger for an action directed towards the mutual goal-value}.
2. if {(observational data of actual situation) (no relation) (mutual goal-value)},
   then {trigger for a decision for an individual goal-value}.
3. if {(observational data of actual situation) (relation) (individual goal-value)},
   then {trigger for an action directed towards the individual goal-value}.

The hierarchy of goal-values has to applied by all individuals involved (1) to determine if a current situation is relevant for mutual goal-values, and if so, to decide for an action towards them. (2) If a current situation is irrelevant to mutual goal-values, then the individual may decide for any individual goal-value, and (3) may decide for any action towards that individual goal. (An example may illustrate this process: in a developed society a person has to check on any income, (1) if it is taxable, and if so to pay the according taxes. Only if the income (2) is not taxable, the person may decide to use all of it for a personal goal, and (3) that in any way.) Only such a hierarchy of decisions giving priority to mutual goal-values over individual ones enables that *controlled* behavior that differs a civilized ‘self-organized’ society from anarchy.

As claimed in section 3 societal ‘self-organization’ will break down, too, whenever this internalized control system - i.e. the organizing part - breaks down. This starts, whenever some persons put their individual goal-values (H1) above the mutual ones (H3). And when all individuals abandon the mutual goal-values the social unit perishes - then there is no organizing part left. (Continuing our example above, we can say, if some persons stop paying taxes, they may be forced. Then the society has to spend more money of a declining budget on enforcing. This can initiate a process of break down. And if all individuals refuse to pay taxes the society will perish.)

So societal 'self-organization' depends on an individual hierarchical *control* process, goal-orientated on every level involved. This approach brings us in contradiction to Luhmann (1987), who claimed that societies are 'autopoietic' (whatever that may mean) communication systems independent of the speakers. Quite on the contrary, we suggest that existential (C1) and individual (H1) goal-values primarily determine the decisions (H2) for of all speech acts. And the resulting communication will only lead to a society, when stipulations lead to mutual goal-values (H3) aligned with individual ones (C1 and H1). Then these mutual goal-values (H3) can be pursued, too, in any further communication.

That means there are simply no Luhmannian 'autopoietic' communication systems that may develop towards some societal goal-values neither pursued nor accepted by any of the individuals involved. What is pursued depends on individuals working towards goals, what may be achieved depends on limits defended by individuals. We consider Luhmann's theory insofar even as a misleadingly distorting approach as it ignores all the decisive goal-orientated intentions that drive the organization of any social unit. Any organization achieved will probably not reflect exactly the personal goal-values of any *single* individual involved, as Elias (1976) has shown. But it can only be explained as a result of the goal-values pursued by *all* individuals, which either try to enforce their goals to achieve control or are willing to compromise for a cooperation. Accordingly social change can be described as interaction of goal-orientated systems (Nechansky, 2008b).

### 7.3. THE GROWTH OF SOCIAL UNITS

When 'self-organization' continues from individuals via groups to larger social units, of course, the same principles repeatedly apply: The hierarchy of agreed on goal-values has to grow, adding at least one additional goal-value for every organizational level emerging. The hierarchy of decisions to be made by every individual has to grow accordingly. The difficulty to remember and consider all these goal-values of all levels and to decide appropriately increases accordingly, till making it impossible for men in a modern society to know and even less to apply them all.

This process is usually paralleled by the establishment of leaders, and growing hierarchical organizations, according to our principle of societal organization (Nechansky, 2008a, 2008b), that a hierarchy becomes a cybernetic necessity, whenever conflicting interests have to be settled or cooperating partners reach their maximum channel capacity for direct communication.

This process is continuously an interaction of individuals, acting on their own behalf or as representatives of social units. Anyway, they always pursue goal-orientated speech acts and actions, trying to introduce or even enforce their own goal-values in the formulation of mutual goal-values. Here our cybernetic analysis leads us directly to the crucial questions of the humanities: The political question: Which and who's goal-values? The epistemological question: Why the current goal-values? And the philosophical question: Are there best goal-values?

## 8. CONCLUSION

Our investigations lead us to the conclusion that the notion of 'self-organization' is currently applied to very distinct phenomena differing primarily in the role played by goal-orientated systems (our thesis 5a to 5c formulated in section 3):

(1) What is called 'self-organization' in physics deals with the reaction of particles to external forces, which may result form occasional events or from goal-orientated systems striving for control. So here the causes of these forces may be goal-orientated systems as organizing parts, while the organized parts show no goal-orientation by themselves.

(2) What is called ‘self-organization’ in chemistry deals with the combination of particles enabling the emergence and evolution of goal-orientated systems. So far we cannot identify any organizing parts initiating the formation chemical cycles. But once emerged their evolution requires the maintenance of the goal-orientation towards that physical state necessary for closing the cycle.

(3) What is called ‘self-organization’ in biology and sociology deals with the intentional interaction of independent goal-orientated systems trying to achieve control, either individually as dominance or collectively in a cooperation. This process may lead to higher levels of organizational control.

If these different phenomena have anything at all in common then our thesis 1 to 4 formulated in section 3: (1) Most of them (but the emergence of chemical cycles) require an organizing part for the organization of organized parts. (2) As expected these phenomena break down, whenever these organizing parts stop their activities. (3) These activities control the behavior of the organized parts. (4) This control requires accordance with Ashby’s law.

Therefore we suggest that the notion of a ‘self-organizing’ system is a valid description for systems showing continuously a number (or at least a probability) of states below the theoretical maximum, whenever their organizing parts responsible for this reduced number of states is not of interest or not yet identified.

But we suggest furthermore, that it is of prime scientific interest to make explicit that organizing parts that actively carry out control leading to most forms of organized behavior. And particularly in social science we consider it as crucial for any understanding of the formation and development of organizations, to make explicit the goal-values pursued by the individuals involved.

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