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## Social systems: Complex adaptive loci of cognition

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**Abstract:** *We argue the case that human social systems and social organizations in particular are concrete, non-metaphorical, cognitive agents operating in their own self-constructed environments.*

*Our point of departure is Luhmann's (1996) theory of social systems as self-organizing systems of communications. Integrating the Luhmannian theory with the enactive theory of cognition (Di Paolo et al., 2010) and Simondon's (1992) theory of individuation, results in a novel view of social systems as complex, individuating sequences of communicative interactions that together constitute distributed yet distinct cognitive agencies.*

*The relations of such agencies with their respective environments (involving other agencies of the same construction) is further clarified by discussing both the Hayek-Hebb (Hebb; 1949; Hayek, 1952; Edelman, 1987) and the perturbation-compensation (Maturana & Varela, 1980) perspectives on systems adaptiveness as each reveals different and complementary facets of the operation of social systems as loci of cognitive activity.*

*The major theoretical points of the argument are followed and demonstrated by an analysis of NASA's communications showing how a social organization undergoes a process of individuation from which it emerges as an autonomous cognitive agent with a distinct and adaptive identity. With this example we hope to invite a debate on how the presented approach could inform a transdisciplinary method of cognitive modeling applied to human social systems.*

**Keywords:** social systems, communication, individuation, self-organization, distributed cognition, cognitive modelling

### Introduction

The most widely accepted account of social systems today is that they are complex and adaptive -- and that they are *not* bearers of cognition. They are

*complex* in the sense that they are ‘made up of a large number of parts that interact in a non-simple way’ and that ‘given the properties of the parts and the laws of their interaction, it is not a trivial matter to infer the properties of the whole’ (Simon 1962:68). They are considered *adaptive* in as far as they operate in relation to their environment in such a manner that preserves a certain set of their characteristics invariant or within a limited range of variation. They are typically *not* associated with the concept of *cognition* for two reasons. One, even though a cognitive component --of a human mind-- is obviously involved, it is typically assumed that it can be treated in a black-box manner: it is enough to adequately capture the range of its possible inputs and outputs to model its role within an overall system. On the other hand, if the concept of cognition were to be attributed to the entire social system, there is a risk attached and a suspicion evoked of an eclectic and mystical use of the concept. Within the scientific discourse such attempts are rare. Nonetheless, a line of argumentation has been already established, which suggests that such application of the concept is not only due, but also rational (Hutchins, 1995; Tollefsen, 2006; Theiner & Sutton, 2014; Theiner, 2015; Lenartowicz, 2016; Heylighen & Beigi, 2016). Our aim in this paper is to support this claim.

We do that through a re-conceptualisation of the widely accepted notions of ‘complexity’ and ‘adaptiveness’ in a way that highlights and strengthens the view of social systems as proper, non-metaphorical, holders of cognition. To a large extent our re-conceptualisation follows Niklas Luhmann’s (1996, 2012, 2012a) approach to social systems. By integrating Luhmann’s thinking into the understanding of social complexity and linking it with Gilbert Simondon’s theory of individuation (Simondon, 2005) we offer a view on social systems as complex, individuating sequences of occurrences of communication. We further argue that operating of such individuating sequences within their complex environments can be approached from either one of the two prevailing theoretical perspectives on adaptiveness, that is: both Hayek-Hebb (Hebb; 1949; Hayek, 1952; Edelman, 1987) and perturbation-compensation (Maturana & Varela, 1980) views on systems adaptation. While both perspectives are applicable, each reveals a different, complementary facet of the operating of social systems. This leads to our final argument, in which we show that the resulting integrated view on social systems, if taking both facets into account, is in itself an abstracted model of individuating, autonomous, distributed cognition.

### **Concept 1. Components**

In the research paradigm of Complex Adaptive Systems it is typically taken for granted that, in the case of social systems, the basic components are human beings that interact in a ‘non-simple’, context-dependent, non-deterministic

manner that gives rise to complexity (e.g. Buckley, 1968; Miller & Page, 2007). We would like, however, to explore here the alternative view of Niklas Luhmann. Luhmann (1996, 2012, 2012a; Moeller, 2011), having developed a consistent sociological framework inspired by systems theory, second-order cybernetics, and evolution, has managed to re-describe all major contemporary social systems in a way which assumes basic components that are not people, but sense-making, meaning-processing *communications*. These are, naturally, communications among *people*, but any 'property' of an individual human, such as the 'contents' of her mind, starts to play a role in a social system only when it is socially expressed. If withheld, it remains in the system's environment. On the other hand, if conveyed -expressis verbis or otherwise- it becomes a *communication*, i.e. the basic processual component of a social system.

Luhmann's focus on communication, instead of communicating people, is part of a wider paradigm shift, which goes back to the Heraklitian view of reality as constituted of processes - instead of objects or agents. Our conventional system of thought is grounded in an ontology rooted in Greek philosophy and particularly in the metaphysics of Aristotle. It asserts a world made of entities with an identity that is a priori given as a set of stable properties and qualities. The Heraklitian shift from being to becoming enjoyed a revival during the 20th century in the writings of philosophers such as Nietzsche, Bergson, Simondon among others, and was further distilled in Gilles Deleuze's ontology of difference (1990, 1994; Weinbaum, 2015). It is also exemplified, to some degree by *action ontology* (Turchin, 1993; Metzinger & Gallese, 2003; Heylighen, 2011; Heylighen et al., 2015) and *process metaphysics* (Rescher, 1996; Whitehead, 1978) and translated into the systems theoretic terms by Manuel DeLanda (2005). It emphasises that even the most solid objects are in fact networks of processes, only temporarily stable (metastable). If this is so, we overlook most of the fabric of the reality when we approach it by delineating only stable entities -be it humans, systems, or any other objects- and only then look at what is happening *within* them and *among* them. We may get a fuller or even quite a different picture, if we try first to disregard the *agents*, typically attracting most of our attention, and instead focus solely on *actions*; whereas in action we mean anything that brings forth a difference in the state of affairs. In this sense, we may leave the agent outside the boundary of the observed arena, treating her not as a component, but a mere *catalyser*: 'an aspect or part of a state that is necessary for the action to occur' (Heylighen, 2011:8).

Thus, when approaching the notion of complexity on the grounds of such ontology, one needs to reframe the basic interacting components, whose interactions bring about complexity: it is actions - not agents. In Luhmann's approach, this shifts the focus from humans to processes of *communication*. A communication happens as a difference-making selection, or more precisely: 'a synthesis of three different selections, namely the selection of *information*, the

selection of the *utterance* [*Mitteilung*] of this information, and the selective *understanding* or *misunderstanding* of this utterance and its information' (Luhmann, 2002:157). This triad corresponds with the semiotics of Peirce (1931, 1977), offering a processual version of it. Out of all possible processes, some get distinguished to carry meaning, some - to be referred to, and yet others - to be a frame of reference, i.e. providing a context for understanding. Only if all three selections take place, a process called 'communication' occurs.

**Example 1: The triple distinction-making selection in a single communication (NASA)**

We can start the tracking and modelling of social systems with any randomly chosen single component: any occurrence of communication in the world. However, searching for an example that could be interesting for as wide international readership as possible, we have selected the utterance formulated during one of the most significant moments in the history of one of the best recognized organizations across the globe: NASA.

Let us then start here with the '*A-OK full go*' neologism, uttered by Commander Alan Shepard Jr.' during the NASA launch, which made him the first American astronaut in space on the 5th of May 1961. Seen as a triple selection, this communication combines three processes of distinction-making:

<p><b>Selection 1: information</b></p>	<p>Several processes are being selected (by the Commander) to be rendered by the following communication:</p> <ul style="list-style-type: none"> <li>- the mental and physical processes of the astronaut <b>having reached</b> the state of optimal readiness for the blastoff;</li> <li>- the technological processes running the operation of the spaceship <b>having reached</b> the state of optimal readiness for the blastoff;</li> <li>- the current technological, social, and political processes (realised in the form of the spaceship blast-off) <b>being</b> as yet unprecedented in the techno-socio-political context, which is selected as relevant.</li> </ul>
<p><b>Selection 2: utterance</b></p>	<p style="text-align: center;"><i>A-OK full go</i></p>
<p><b>Selection 3:</b></p>	<p>Selection of understanding happens within the</p>

<p><b>understanding</b></p>	<p>dimension of time: it happened for the first time at a certain moment during the blastoff and, after the utterance has been transformed into a text, it continues to happen each time the 'A-OK full go' utterance is being encountered. One of the current selections of understanding of that phrase is:  <i>'Defined as an engineering term for 'double OK' or perfect, it became a U.S. idiom for 'everything is going smoothly'.</i>            Source:  <a href="http://www.spacequotations.com/orbit.html">http://www.spacequotations.com/orbit.html</a></p>
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It may appear important to point out that all three communication-constituting selections are made *by* human minds and, as minds are subjective and changeable, to emphasise therefore that the selections cannot be considered irrespectively of their source. In most cases, as in the example above, it is certainly so: all selections have been made by the operations of subjective and changeable human minds. However, it does not *have to* be necessarily so: the materialistic branch of the humanities already extends social agency to objects, technologies, and 'things' (e.g. Latour, 2007; 2007a) and the AI branch of computer science makes it clear that this will be increasingly apparent in the future. But, again, in the process-oriented perspective what is most important is that a triple selection *is being made*. Whatever mental, technological, physical, or other kind of processing is prompting it, when a selection of information takes place, when it gets combined with a selection of an utterance, and when a selection of understanding follows, in addition to all the processes involved, a new process becomes apparent with this event: a process of communication. Should that utterance be multiplied in writing, print, audio recording, or any other technology, a new occurrence of communication takes place whenever it is understood. And whenever an understanding of an utterance happens, a new selection of information may follow to be uttered in response --or in relation-- to that understanding, the sequence of communications continues. Even if it were solely the human mental activity what made all the selecting of information happen in the first place, the triple combination constituting an occurrence of communication bounds these selections out of that mental process and couples it with two other selections, which now constrain it and anchor it in a specific point in time. 'Nothing is transferred.' --Luhmann claims-- 'Redundancy is produced in the sense that communication generates a memory to which many people can lay claim in many different ways' (2002:160). There is

no better way of witnessing how that bounding out actually happens other than by 'paying but little attention to what we ourselves say' (ibid.:166). If we do that, Luhmann explains, 'we already become aware of how imprecisely we must select in order to say what one can say, how greatly the emitted word is already no longer what was thought and meant, and how greatly one's own consciousness dances about upon the words like a will-o'-the-wisp, uses and mocks them, at once means and does not mean them, has them surface and dive, does not have them ready at the right moment, genuinely wants to say them but, for no good reason, does not' (ibid.).

Redefining the elements of social systems and reconsidering the complexity resulting from their non-simple interactions, yields profound consequences for the way in which social complexity can be studied and modelled. If the interactions constitutive to the systems of our interest, happen between instances of communication, rather than individuals, then the properties relevant for tracing and modelling of such interactions are bound to be quite different from the properties of human agents. While interconnections between humans may be explained as a result of their proximity (Cohen et al., 2012), similarity (Akkora et al., 2013), trust (Adali et al., 2010), etc., the interconnections between various occurrences of communication extend from the triple selections they are constituted by. Thus, for example, (1.) the selection of understanding in one communicative occurrence will *constrain and be conserved in* the selection of information and utterance in the following ones; (2.) the selection of a form (the utterance) in one will be *retained, refined, or refused*, in another; (3.) by adhering to a shared form, several otherwise unrelated communications will *prompt* a selection of understanding which bundles them all together, etc. While the combinatorial possibilities are multiple, as observed in the dimension of time they result in the production of *sequences* of intertwined communicative occurrences which are, this way or another, adhered to some other communicative occurrences as their predecessors, frames of reference, genre models, etc. Such sequences in turn constitute various patterns, of which some are completely unique while others are more or less frequent. The most frequent and recognizable ones include: conversations, narratives, discourses, languages, organizations, groups, projects, governments, states, economies, religions, and social movements.

## **Concept 2. Individuation**

The Aristotelian focus on objects and individuals also conditions the way one accounts for their genesis. To put it briefly, if individuals are the primary ontological elements of anything existing, the genesis of individuals is merely the transition of certain individuals into other individuals. Everything starts and ends therefore with individuals. The Copernican shift to a process-oriented

ontology, moves away from individuals as the primary given ontological elements whereas all transformations are secondary, to *individuation* (Simondon, 1992; Weinbaum & Veitas, 2014, 2015) -- a primary formative activity whereas individuals are always intermediate, only temporarily stable entities, undergoing a continuous process of change. Individuation is a process where boundaries and distinctions that define individuals arise without assuming any individual(s) that precede(s) them. The nature of distinctions and boundaries is subtle; inasmuch as they separate subject from object, figure from background, and one individual from another, they must also connect that which they separate. A boundary, therefore, is not only known by the separation it establishes but also by the interactions and relations it facilitates.

Gilbert Simondon, the father of the theory of individuation (Simondon, 2005) encourages us to understand the individual from the perspective of the process of individuation. For him, the individual is a metastable phase within a continuous process of transformation and is always impregnated with not yet actualized and not yet known potentialities of being. According to Simondon, an individual is not anymore the rigid well defined Aristotelian element endowed with ultimately given properties, but rather a plastic entity, an on-going *becoming*.

How can an entangled network of meaning-shaping distinctions (*information*), meaning-carrying forms (*utterances*), and meaning-making selections (*understanding*) breed an autonomous, individuated social system? How can a particular human organization, a research project, a nation state, a social movement, a language, form a distinguishable, coherent assemblage (Delanda, 2006) of interacting components? It is easy to see the relevance and advantage of applying the concept of individuation to communication constituted social systems. Clearly, communication is a formative activity in regards to the social systems they constitute. The theory of individuation provides an important conceptual bridge between the distributed dynamism of communication and individuated entities such as teams, corporates, organizations, communities. In (Weinbaum & Veitas, 2015) the authors discuss in length the mechanisms of individuation and specifically how local and contingent interactions progressively achieve higher degrees of coordination among initially disparate elements and by that bring forth complex individuated entities with agential capabilities as products.

Moreover, the very nature of communication as explicated above seems to be in full agreement with the concept of individuation. Happening as a triple selection, a communicative occurrence marks the fluid, processual reality with several temporary boundaries:

- the Spencer-Brownian (1969) boundary between the marked and unmarked sides of a distinction, delineating and linking together the



selected information, which is intended to be conveyed, and the non-selected one, which thus becomes apparent as the one that could have been selected, but was not;

- the Yuri Lotman's (1990) *semiotic boundary*, delineating and linking together the *signified* and the particular *signifier* (Saussure, 1916; Peirce, 1931), the utterance which has been selected to carry the meaning;
- and the 'sense-making boundary' between the *sign* and the *context*, brought about by selecting of *understanding*, delineating and linking together the conveying of an information and the context in which it occurs.

It may be that all these boundaries are brought about just temporarily, by a single communicative occurrence, and never recreated. Not all communications need to originate from preceding communications. It is always possible to communicate something novel in a way that was not determined by any pre-existing *signifier* (a word, a form, a medium). However, typically, communications do connect to one another, by either elaborating on the predecessor's *signified*, making a novel use of its *signifiers*, or by preserving the *context* of its occurrence. In the first case, some information distinguished by a communication is inherited from a preceding communication and thus preserved, confirmed, and reinforced in a novel form. In the second case, a communication uses the same forms, the same pre-existing code, to convey something that has not been communicated with these forms before. It produces new distinctions, charts new shapes, while still maintaining links with already established (stabilized, recurrent) usages and other meanings of the borrowed form. Adhering to the form of previous communications, the new one serves both as a repetition (conservation) and a difference (innovation) in relation to it. In the third case, a communication brings new information and employs new forms, but preserves the selection of understanding, made in a preceding communication: and thus responds to it. Most typically, such combinations multiply simultaneously: a communication conserves information from one communication, borrows a form from another, and reinforces the context of a third one. And it may happen that the *signifier*, the *signified*, and the *context* are all inherited simultaneously from a single predecessor as the same communication is repeated again and again, to convey just the same meaning, with the same form, in the same circumstances.

#### **Example 2: Interrelations between communications (NASA)**

Let us consider the interrelations of the following four communications related to NASA:

<b>Communication</b>	<i>It is the policy of the United States that activities in space</i>
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<p><b>a</b></p>	<p><i>should be devoted to peaceful purposes for the benefit of all mankind.</i></p> <p>Public Law# 85-568, U.S. National Aeronautics and Space Act of 1958</p>
<p><b>Communication b</b></p>	<p><i>When I first started working at NASA more than twenty years ago, the motto at the time was "For the benefit of all Mankind". It came under severe criticism of the extreme nationalists who wanted to change the word "Mankind" to "Americans", and of the extreme feminists who questioned why "Man" and not "Woman". In fact, it even got criticized by the animal rights groups and environmentalists for the exclusionist implication of "Mankind" towards animals and plants. And hence, NASA settled on "For the benefit of all.</i></p> <p>Süleyman Gokglu, Senior scientist at NASA; source: Tayla &amp; Bingül, 2007</p>
<p><b>Communication c</b></p>	<p><i>"For the benefit of all"</i></p> <p>NASA motto; source: Wikipedia citing Tayla &amp; Bingül, 2007</p>
<p><b>Communication d</b></p>	<p><i>I have observed people outside NASA saying that NASA's motto is "For the benefit of all." I don't recall ever seeing NASA state that as the motto, in fact, I don't recall the word motto ever being used at the agency level. NASA does have a vision statement, and that is somewhat analogous to a motto. The official vision statement of NASA is: "To reach for new heights and reveal the unknown so that what we do and learn will benefit all humankind."</i></p> <p>Robert Frost, Instructor and Flight Controller in the Flight Operations Directorate; source: <a href="https://www.quora.com/What-is-NASAs-motto">https://www.quora.com/What-is-NASAs-motto</a></p>

Taking into account the consecutive occurrence of these communications in time, we can plot the following interrelations among the three selections made in each communication:

<b>Interrelations</b>	boundary between the signified and non-signified (information-making)	boundary between the signified and the signifier (sign-making)	boundary between the sign and the context (sense-making)
<b>a → b</b>	conserved and innovated	conserved and innovated	---
<b>a → c</b>	conserved and innovated	conserved and innovated	---
<b>a → d</b>	---	conserved and innovated	---
<b>b → c</b>	conserved	conserved	conserved
<b>b → d</b>	---	conserved	conserved
<b>c → d</b>	---	conserved	conserved

Once a novel semiotic distinction appears, it also reflects on all previous communications that are somehow implicated by it as well. Whether that 'form' is a single word, it employs its previous denotations to render a novel one. If it is a yearly report, it renders new data and events, making them replace the previously displayed ones. If it is a new motto of an organization, it introduces new distinctions and leaves out those that ceased to be relevant. Remarkably, communications often perform both conservation and innovation simultaneously: they conserve in some new way a number of distinctions made previously by other communications while employing some pre-existing communication templates to introduce distinctions which are new. These two modalities of continuity and discontinuity between communications are thus usually mingled, contributing to the complexity of their interrelations. This dynamism of communication brings forth *fluid identities* (Weinbaum & Veitas, 2015: 22-23); these are metastable entities in the course of individuation whose defining characteristics change over time but without losing their longer term intrinsic coherence and distinctiveness from their milieu.

For a social system to persist as an individuating entity, however, not everything goes; while the nature of each communication is open-ended in principle

(hence the potential for novelty), a certain critical mass of recurrence, and coherence grounded in the historical record of communications is necessary. Then, when observing such a metastable 'entity' we discover that it is not a constant pattern but rather an *emergent* dynamics which results in *adaptability*. But this concept requires the notion of the 'environment' to be addressed first: what it actually means when related to a bundle of intertwined communications.

### Concept 3. Environment

Luhmann's theory has made it apparent how much the meaning of the concept of the system's environment shifts when we adjust our lenses to see communications-constituted systems, instead of agents-constituted ones. Whereas an environment of interacting people would normally be understood topologically, the environment of interacting communications is much less so. It is to a large extent semiotic. Having identified the three selections which forge a single communication is a good basis for an initial tentative definition of the environment of such a single occurrence: it includes, simply, *whatever the communication refers to and is being referred to*. This encompasses not so much the actual surroundings of the process of communication, but the semiotic space delineated by the three meaning-creating selections: the *context* delineated by the selection of understanding, the *signifier* delineated by the selection of the utterance, and the *marked side* delineated by the selection of information. The environment of the simple single communication 'For the benefit of all mankind', for example, encompasses the 'mankind', as constructed by the combination of the three selections. Even if the object of this denotation existed only as fluid processes in a realm where nothing has individuated yet, or did not exist at all, such communication would chart a temporary boundary rendering the 'mankind' as its environment - it would call it to a temporary existence. And since this communication did not happen as a first one to use that particular form, it was conserving and reinforcing the boundary that already had been brought forth many times before in entirely different contexts. Most probably, when initially used in the NASA context it was not intended nor understood as excluding women: according to the Merriam-Webster dictionary the notion of 'mankind' used to refer to the entire human species since the 13th century. But once *understood* as excluding, it started to do exactly this. Once this understanding happened once, the already unsuccessful communication had to thus be replaced by a new one if the previously rendered environment was to be maintained. Then, a new selection of the utterance ('For the benefit of all') allowed the selection of information and the selection of understanding to re-converge in the previously rendered space. Yet another shift has happened with the initial exclusion of animals and plants. This one was intended, uttered,

and understood: the environment rendered by the first motto simply did not include species other than humans. Interestingly however, they *were* somehow present: the indication of the human species as the marked side of information was bringing forth the Spencer-Brownian *unmarked side* of the selection, i.e. all other species, as well. They were selected to remain just outside the environment and, thus, they could have been observed as excluded. This reminds of David Seidl's (2005) explanation of self-transformation of social systems as being enabled and constrained by the unchosen alternatives.

**Example 3.1: The environment of a single communication (NASA)**

The simplest computational way for charting of the environment temporarily constructed by a communication may be to identify the nouns which have been used in the utterance:

Communication	Environment
<p><i>To understand and protect our home planet; To explore the Universe and search for life; To inspire the next generation of explorers ...as only NASA can.</i></p> <p>NASA mission statement 2002; source: <a href="http://www.hq.nasa.gov/office/cod ez/plans/Vision02.pdf">http://www.hq.nasa.gov/office/cod ez/plans/Vision02.pdf</a></p>	<p>Home planet Universe Life Next generation of explorers NASA</p>

Such a landscape portrait of the environment, however, is not the only product of communication. Another one is the portrait of the communication itself. While an instance of communication may or may not select itself to be an object of itself, once it happens, it becomes *available* to be rendered as the environment of another communication. Hence, even when the communication 'A-OK full go' does not refer to itself in a way in which the communication 'This sentence is short' does, once it has taken place, it can be referred to as an environment by any other communication which follows it in time. Thus, the environment of a communication expands: *it encompasses not only what it refers to, or is being referred to, but also all the communications that perform the referring.* In the era of spoken word, a communication was available to become an environment of only a limited number of other communications in its space-time neighbourhood. In the era of written word and print - once written,

a communication was made available for all consecutive communications in time that happened to neighbour the instances of its recurrence in every new reading. In the era when the Internet is taking over an ever-increasing share of all human communications, both the number of communications immortalised in this way and the spatiotemporal scope of their reach expands dramatically again<sup>1</sup>. Today, a digitalised communication transmitted over the Internet is available to become an environment of any other consecutive communication in the world. Therefore, even if a communication does not implicitly refer to itself and thus position itself in a relation to its own environment, it has an endless potential for being referred to - and for being thus positioned.

Since all communications are endlessly available to be referred to, also the environments that they delineate become available endlessly. Each such an environment has a potential of becoming evoked by a following occurrence of communication and thus, by the means of repetition of such occurrences, has a potential of becoming more or less *stabilised*.

Once communications interact and individuate into more entangled and interrelated sequences, the stabilization of their mutually fashioned environment increases. The more such a shared environment is referred to (and every communication may add another instance of such reference), the more opportunities arise for the following communications to anchor there as well. Furthermore, mutual referring and self-referring of the communications themselves include them as part of that increasingly stabilised environment. As a result, specific sequences of communication become bundled more or less tightly with their respective environments and turn into patterns of communication that are increasingly likely to be further referred to as 'belonging' to that specific environment/context. Thus, the whole socially constructed reality (Berger & Luckmann, 2011) comes into existence. On one hand, the description of the environment may grow and thicken into a fully operational worldview (Aerts et al., 2007; Vidal, 2008), while on the other, some occurrences of communication that are shaping that worldview, may become increasingly labeled as the ones, that are part of it. The consolidating worldview is accompanied with specific language games, which are expected and accepted in its context (Wittgenstein, 2009). This very process has been well captured in Anthony Giddens' (1986) theory of structuration.

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<sup>1</sup> Especially thanks to search engines.

### Example 3.2: Construction of the environment of communication (NASA)

When we say:

<b>Communication x</b>	<i>This is the new motto of NASA</i>
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and point to a specific communication, we render both that communication and the interrelated sequence of communications referred to as 'NASA' to forge an environment for our own utterance, and we link them all together.

Then, another communication may occur, which points to ours, saying:

<b>Communication y</b>	<i>NASA has just announced its new motto</i>
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While this second communication has a quite similar environment to our own (consisting of one occurrence of communication and the sequence called 'NASA'), it constructs it differently: it presents one as being sourced within the other.

But, even more interestingly, a third communication may follow stating:

<b>Communication z</b>	<i>No no, NASA does not have an official motto it has only a mission statement</i>
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While discussing the concept of social system's components, we have adopted Luhmann's assumption of communication processes as diverging from mental processing by the means of their triple combination. This combination binds communications together and externalises them from the human mind. While, as Luhmann has put it, a 'redundancy is produced' in the sense that an original mental processing becomes accompanied by an additional sort of processing via communication, this does not mean, of course, that the former becomes irrelevant or idle. We can easily observe the interrelation between the two modes of processing, when communications like [y.] and [z.] collide. Within our 'mental environment' of the above three occurrences of communication, we -most likely- instantly need to *clarify* whether the motto was indeed 'sourced within NASA', or perhaps the communication [z.] was. The lack of coherence observed between the three witnessed occurrences of communication mobilizes our attention to *search for* or to *initiate* additional occurrences, until coherence is established. This urge reveals a third layer of the environment of

communication as its source: *mental (and possibly technological) processes on the basis of which communication emerges*. It also reveals the important role of this layer of environment in the individuation of entangled sequences of communication into more and more consolidated ones. Just like wind and water support the consolidation of rocks, by either washing out or gluing dust to their surface, the mental processing of the occurrences of communication actively engages to determine how they are anchored into larger bundles. Once a certain degree of coherence is achieved, the mental environment of communication actively facilitates its further individuation by *searching for* and/or *initiating* new instances of communication that promote clarity, coherence and the determination of yet undetermined details in previous communications.

In fact, all three conceptual 'layers' of the environment of communication, as described above --i.e.: (1.) the selections rendered by each communication, (2.) other related communications, and (3.) the mental processing mobilized for the relation-making-- can be seen as both constructing that communication and being constructed by it. While whatever communication refers to and is being referred to (layer 1) is in Luhmann's constructivist tradition seen as constructs of communication, not constructors of it, at the third layer, *human thought* has a tendency to attribute all the agency to itself. Of course, the exclusivity of both attributions may be (and have been) questioned, but even if they were not, the dynamics of the mutual co-construction would still be fully revealed at the middle conceptual layer: of the environment of communication as consisting of *other occurrences of communication*. While an initial occurrence may refer to a completely fluid sequence of non-stabilised processes, a following communication is already confronted with this selection: its space is, thus, partially constructed before it occurs. And, equally importantly, by referring to its predecessor and positioning it within its environment, the following communication completes and refines its construction.

Returning to the three occurrences of communication, presented in Example 3.2., we can ask: what is being (co-)constructed there? While at the first, 'landscape' layer, one of the selections being delineated is clearly the selection called 'NASA', at the second, 'inter-communication' layer, that selection is related (and un-related) to a single occurrence of communication. This oscillation creates a tension at the third, 'mental' layer of the environment, which becomes motivated to either confirm or disconfirm that relationship. What is, then, being constructed by the three occurrences of communication [ $x$ ,  $y$ ,  $x$ ] is not only the selection of NASA and its communication-constituted environment, but a tension within the environment, an *action window* (Lenartowicz, 2016), which elicits a dynamic geared towards an increased clarification of the relationship between the two.



If we choose to draw the boundary of the observed system in a way which positions this particular source of action outside it (since after all drawing of boundaries is mostly the observer's choice), we can consider the mental tensions elicited by particular patterns of communication, and absorbed by them, to play a role similar to the one played by wind for the technical system of a windmill, or the role of oxygen for a plant. For the system to function, it is crucial that this particular agency of the environment is present. Systems are built, self-organize and evolve with the assumption that this the case. While for some purposes it is more useful to treat such sources of action as belonging to the system, for others it is better to consider them as part of the environment. In our case, the investigation of the hypothesised autonomous cognition located in social systems, obviously sets the boundary of our observation between humans and the processes that are argued to bring about cognition. And this apparently goes right against the common sense. In the modern western worldview the only agency lies firmly within the processing performed by a human mind: it is a human who feels compelled to *clarify* and who seem to be in the position for an arbitrary filling in the gaps. But by inspecting of *how* such filling-in might actually happen, we will notice that it has to take the form of either *locating of an already existing communication* or the *initiating of a new one*. Thus, markedly, the precise locus of agency shifts back to the process of *communication*. Moreover, a peculiar constraint is reached as to the kind of communication capable of resolving the dilemma. It starts to be apparent that the dilemma whether an occurrence of communication (e.g. the motto) does or does not 'belong' to an individuating interrelated sequence of communication (e.g. NASA) cannot be settled through *any* occurrence of communication. Being experienced participants of the social reality, the readers and us know it already: our exemplary dilemma can be clarified only by either searching for a communication that is clearly positioned '*within* NASA' (an official NASA publication, the NASA website, an official speech, etc.), or by *uttering* a communication which is both *meant* and *understood* as a communication originating *within* NASA. What that 'within' actually means, and how is that positioning of the locus has come about, remains as yet to be explicated in the following. For now let us note that while any communication is free to position the selection called 'NASA' in relation to any selection of the environment, not all communications are capable of selecting where (in the web of various instances of communication) does NASA end and its environment start. At some stage of the process of individuation, the locus of control over the *boundary* between the environment and the individuating sequence of communications (which at this point can be called a *system*) has started to be positioned *within* it<sup>2</sup>. This way the Luhmannian *social systems* arise, which 'have the ability to

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<sup>2</sup> Though clearly no social system has a complete control over its boundary. Other environmental factors and other social systems in particular are relevant to such boundary setting as well.

establish relations with themselves and to differentiate these relations from relations with their environment' (Luhmann 1995: 13).

We hope to have shown so far that, once social *complexity* is approached as constituted of instances of distinction-making communications, at some point of the ongoing reflexive referencing among various instances of communication, an emergent complex dynamic can be observed. While, as we have discussed, the environment of a single instance of communication can be rendered arbitrarily by any other communication to follow, sooner or later a point is reached where it becomes obvious that the delineation of sequences of interrelated communications within their respective environments is no longer arbitrary. It turns out that it is no longer up to *any* communication to follow, to position a motto as either 'belonging to the sequence' called 'NASA' or only 'relating to that sequence' from within the environment. Of course, we *may* formulate any communication we wish in that respect, but we can also expect that a confirmation or denial of such an attribution may follow in a form of communication which is meant, formed, and understood *as* a communication sourced *within* the sequence. Thus, the positioning of the *boundary* of this sequence becomes a function of its *internal* dynamics, and it no longer can be easily shaped by a communication sourced 'outside'. This brings forth the second notion widely accepted today as describing social systems: the notion of *adaptability*.

#### **Concept 4. Adaptability**

Social systems widely considered as complex adaptive systems (CAS), are not mere aggregates of interacting components delineated by external observers. These are aggregates which self-maintain their own coherence/identity through their own dynamics. Thus, whenever a change happens in the system's environment, it adapts. The interactions of the system's components adjust and change in a way that best supports the continuity and coherence of the whole - as if the whole 'consciously' mediated the risk, 'knowing' that its further existence in the changed environment would otherwise be compromised. Such adaptive capability may seem obvious in living systems, but quite mysterious if attributed to other systems. There are, however, several theoretical explanations of how this happens even in systems that are not living (such as cities, markets, etc.) or not self-conscious (such as insect colonies, ecosystems, etc.) Existing explanations typically fall into one of two broad categories: the system is either seen as *responding* to the changing environment (Hebb, 1949; Hayek, 1999; McQuade & Butos, 2009; Heylighen, 2014), or *reacting* to it (Maturana & Varela, 1980; Dittrich & Fenizio, 2007; Heylighen et al., 2015):

- The 'responsive adaptation' approaches describe the way, in which a system develops a *model* of its environment: a model that dynamically reflects external changes, adjusting accordingly. The concept of how that happens was independently developed by Donald Hebb (1949) and Friederich August von Hayek (1952) as a model of learning and memory. The central idea is that external stimuli generate interactions within the system's internal network of components - and a pattern of such interactions becomes a map of the environment, as experienced by the system. Since interactions are reinforced by the repetition of the stimuli, or weakened by lack of thereof, the resulting map gets continuously updated. This way the system remains flexibly responsive to its environment. This explanation fits well into the cybernetic paradigm, which refers to living organisms as cybernetic systems (Ashby, 1962).
- The 'reactive adaptation' approaches draw quite a different picture; sketched for the first time by Humberto Maturana and Francesco Varela (1980). Maturana and Varela tackled the fundamental difference which sets apart the system-environment relations maintained by living systems from those held by man-created machines. They posit that while living systems are *open* in the von Bertalanffy's (1968) sense, i.e. they do interact with their respective environments, they are also *operationally closed*. This basically means that all the operational responses to external changes or perturbations a system may display, only depend on the inner structure and the state of the system at the time of change and can only induce further changes to its inner structure and state (in cases when that the system does not disintegrate). Therefore, the so-called external stimuli is not instructive in regards to the system's options of operation. It follows, that the system-environment interactions take place only in a way that allows just that: the system's recursive production of *its own* identity pattern under ever-changing conditions. Whenever a change in the environment forces an internal shift in the system, the shift is *compensated* by some other internal changes.

Whereas Luhmann's own choice in understanding the adaptability of communication-constituted social systems notably favours the 'reactive' path of explanation, it seems that the dominant way of applying the concept of adaptation to social systems follows the model of the 'responsive' one. The so called 'Hayek-Hebb model' (Edelman, 1987) has been found relevant in a diverse array of applications within the social sciences. E.g. it has been used to explain adaptability of markets and scientific projects (McQuade & Butos, 2009), employed to explain global learning arising from local decisions prompted by agents' individual self-interest (Watson et al., 2011), and applied to a model of the evolution of collective intelligence (Heylighen, 2014). On the other hand the controversy whether or not the concept of autopoiesis can be extended from biology to social systems, which would unquestionably justify the application of

the 'reactive' model of adaptation, has not been settled. The idea was refuted at first (e.g. Mingers, 2007), following Maturana's and Varela's own argument that social systems are not self-producing in a sense that they do not produce, but only co-ordinate people - considered to be the components. While after Luhmann's 'communicative turn' this particular argument is no longer valid, and while -as it has been recently argued Hugo Cadenas and Marcelo Arnold (2015)- the concept of autopoiesis does prove to be productive in social sciences, its status remains controversial. This, however, does not prevent the model of 'reactive adaptation' from being explored. To that end the concept of systems autonomy (DiPaulo, Rohde & De Jaegher 2010) provides a sufficient theoretical justification for the perturbation-compensation mode of adaptation to be derived from a dynamics weaker than biological autopoiesis. What is needed for such an application is merely understanding the dynamic of systems as structurally defined i.e. that they will not be able to produce any consequent behavior which is not encoded already in their current structure and state. And there are already numerous examples of how such adaptation may be modelled and observed in social systems (e.g. Seidl, 2006; Holdschlag & Ratter, 2013; Lenartowicz, 2015; Shaw & Lenartowicz, 2016).

To find out which explanation of systems adaptability can be in fact more useful for our framework, let us consider how each of these two theories might shape on its own terms our observations of the boundary of our exemplary social system.

#### Concept 4.1. Responsive adaptation

The example below explores the application of the 'responsive adaptation' approach.

<b>Example 4.1: Responsive adaptation of a mission statement (NASA)</b>		
<b>Communication a →</b>	<b>Communication b →</b>	<b>Communication c</b>
<i>To understand and protect our home planet; To explore the Universe and search for life; To inspire the next generation of explorers ...as only NASA can</i>	<i>To pioneer the future in space exploration, scientific discovery, and aeronautics research</i>  NASA mission statement 2006; source:	<i>Drive advances in science, technology, and exploration to enhance knowledge, education, innovation, economic vitality, and stewardship of Earth</i>  NASA mission statement 2011; source:

NASA mission statement 2002; source: <a href="http://www.hq.nasa.gov/office/codez/plans/Vision02.pdf">http://www.hq.nasa.gov/office/codez/plans/Vision02.pdf</a>	<a href="http://www.nasa.gov/pdf/142302main_2006_NASA_Strategic_Plan.pdf">http://www.nasa.gov/pdf/142302main_2006_NASA_Strategic_Plan.pdf</a>	<a href="http://www.nasa.gov/pdf/516579main_NASA2011StrategicPlan.pdf">http://www.nasa.gov/pdf/516579main_NASA2011StrategicPlan.pdf</a>
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As proposed in the Example 3.1., the simplest computational way for charting of the system's environment is to identify the nouns which have been used:

Communication a →	Communication b →	Communication c
Home planet Universe Life Next generation of explorers	Future Space exploration Scientific discovery Aeronautics research	Advances Science Technology Exploration Knowledge Education Innovation Economic vitality Stewardship of Earth

Now, let us observe the adaptive changes that are noteworthy. Especially between the year 2002 and 2006 the system's Hayek-Hebbian *model of its environment* (i.e. the pattern which emerges through repetitive interactions with the environment and gets updated through *responsive* adaptation) has become very different. First, the 'home planet' as a part of NASA's environment, has disappeared altogether. This change has been noticed, debated, and criticized by many at that time, e.g.:

**Communication d**  
*[.] the change comes as an unwelcome surprise to many NASA scientists [...] Without it, these scientists say, there will be far less incentive to pursue projects to improve understanding of terrestrial problems like climate change caused by greenhouse gas emissions. (Revkin, 2006)*

Explained in the cybernetic terms, the Hayek-Hebb responsive adaptation happens because the system's map of the environment gets updated as a

result of a particular pattern of system-environment interactions getting weakened and another - strengthened. It suggests that, prior to the shift within the model, there must have been a weakening in NASA's everyday interactions with the 'home planet', as an object of its investigations. The author of the newspaper analysis quoted above seems to have observed this very process:

**Communication e**

*The shift in language echoes a shift in the agency's budgets toward space projects and away from earth missions, a shift that began in 2004, the year Mr. Bush announced his vision of human missions to the Moon and beyond. (Ibid.)*

Moreover, in 2002 NASA appears to be interacting with and building representations of the very objects of its explorations (the home planet, universe, life) and those in the future who will carry the activity on (future explorers). However, in 2006 it is interacting with and building representations of much more abstract phenomena: the future, exploration, discovery, and research. It seems as if the exploratory activities, which were previously placed within the boundaries of the system, have now been exported outside, to the environment which is being mapped. We could speculate that this particular shift may be attributed to the spectacular increase of the NASA's 'self-awareness' which started after Columbia disaster in 2003. Not only NASA's organization, with 'the very essence of what the NASA family holds so dear' (O'Keefe, 2005:xviii), has been found then to be blamed, but it was also claimed to have demonstrated a failure 'to learn from its previous mistakes', which caused the Challenger catastrophe in 1986 (Hall, 2003). The dramatic increase in the number of interactions addressing the system's own operating has most probably led to a 'rewiring' of its Hayek-Hebb model of the environment, making the NASA's exploratory activities a central part of it. Interestingly, the 2006 shift to a second-order auto-observation did not reverse. It has become even more apparent in the next time-step presented above, co-occurring with the progressing privatisation of NASA's missions and the public debate on outsourcing of NASA's task (Pasztor, 2010).

While concepts employed in the analysis presented above -such as interactions and mapping- do not easily fit as yet to our line of argument, the analysis seems to be a good example of how the modelling of social systems' adaptation might be performed when based on the Hayek-Hebb approach. The vocabulary may

be adjusted, but there is an already apparent flaw that will not be easily overcome: the map-making system, which is interacting with its environment, is clearly being approached here with an object-based Aristotelian manner, not the process-based Heraklitian one. The resulting analysis of the adaptive shifts in NASA mission statements takes the existence of the system-environment boundary, whose emergence we wanted to observe, already as a given: the relation between the map and the mapped territory, as well as the interaction between the mapped and the mapping, would be impossible without a clear *a priori* delineation between the two. Once we will adjust the vocabulary in the following, the limitation of the Aristotelian point of departure of this analysis will become even more apparent.

This is not to say that such modelling cannot be useful. In fact, the example 4.1. presents a simplified, potentially computable variant of one of the most prominent approaches to the social reality which is extensively used in the humanities: analysing it as constituted of texts, discourses, or stories. Such an analysis may be particularly helpful for capturing the relationships between the investigated fraction of the social reality (delineated *a priori* as the organization of interest) and what we have identified as 'the first layer' of its environment: the 'whatever communication refers to or is being referred to', which can be understood as Hayek-Hebb's *mapping*. In that sense a social system, such as an organization, can be seen as a story, a narrative about how the world is to be approached, as seen through the lenses of that system. But it is apparent that approaching the adaptability of sequences of communication in the Hayek-Hebb manner, necessarily reduces our three-layered environment (referred - communications - humans) to the single aspect of the 'referred' only. Consequently, since the map-making is considered to be an outcome of *interactions* between the system and its environment, this approach to adaptation requires an identification of an agent of such actions on the system's side. That is, agents that participate in occurrences of communication in such way that their manner of participation in future occurrences changes as a result. The third human layer of our environment is thus necessarily called upon to be the agent, while the agency of the construct called 'NASA' remains only a metaphorical, *totum pro parte*, rhetorical figure. This particular result also does not have to be necessarily problematic: in fact, locating of all agency in this way reflects a cherished cornerstone assumption of the western worldview in general. What is most problematic, however, is that such positioning of the first (referred) and the third (human) layers necessarily flattens and instrumentalises the middle one: the one that consists of other occurrences of communication. As a result, a large part of the environment in which the individuation of communication happens, encompassing all intertwined triple-selection-making instances of communication that relate to the individuating sequence, disappears from our sight and get clearly cut into two distinct sets. The first is a set of instances considered to be external to the system, which may potentially

become the 'referred' parts of the environment (e.g. the new vision announced by Mr. Bush in the example above). The second set of internal instances are employed by the system in its interaction with the environment (e.g. the mission statement). The former set merges with the environment, which is being mapped, and the latter become the mapmaking tools: extensions of human agents. Our 'middle layer' of the environment - the fabric of occurrences of communication, out of which social systems individuals as such - disappears from our sight.

The above effect (of the 'middle layer' being lost, as an environment) is not an error of perception, but a consequence of the fact that, when the Hayek-Hebb 'interacting - mapping' vocabulary is applied to explain the adaptability of social systems, the system-environment boundary is assumed to exist *a priori*, separating the mapmaking interior from what is being mapped. If only one aspect of the environment (i.e. whatever can be mapped) is selected to be considered an environment, another aspect of the environment (i.e. human agents) gets to be granted the agency of the mapmaking. As a result, the entire domain fashioned out of occurrences of communication becomes a mediator between the two, a transparent lens, cropped to fit the arbitrary contour of the agents' group - and used by them as a means of engagement with their exterior. The notion of adaptability of a social system, in relation to its milieu, gets equated with an adaptability of a group of agents, who use communication to capture and update their own shared or merged worldview. Thus, approaching social systems adaptability by highlighting one (referred), downplaying second (communication) and super-powering the third (human) of the three crucial layers of the environment, in relation to which adaptation takes place, necessarily positions the adaptability of social systems as a function of the adaptability of humans. While such an approach may help to investigate cognition and behaviour of human beings, when grouped, it fails to encourage the investigation of social complexity as the realm in which not only individuation of humans, but also an individuation of communication-constituted assemblages might be taking place. By failing to address the full complexity of the social realm, it reduces our conceptual capacity to account for emergent phenomena, which to a large extent might be actually shaping the human condition.

We conclude therefore that the Hayek-Hebb theoretical approach, however useful it might be for certain purposes, does not allow us to track the emergence of the boundary between an individuating sequence of occurrences of communication and its multi-layered environment, let us test how the other, 'reactive' account of adaptation could be used to reveal this dynamics.



## Concept 4.2. Reactive adaptation

The 'reactive adaptation' approach posits that operational responses of a system in relation to external changes (perturbations) depend only on the inner structure and the state of the system and can only induce further changes to its inner structure and state. To observe reactive adaptability in sequences of communication, we should therefore look for instances in which an occurrence of communication (X) points to some other –previous– occurrences (Y), using their selections as a rationale for the way it refers/responds to a change (a perturbation). It is important to note that the criterion of the selection of Y, as an orientation point to be used by X, already indicates that both occurrences 'belong' to the same sequence of communications. Finally, the resulting way in which X refers to its changing environment gets to be addressed by consequent occurrences of communication (Z), which clearly refer to changes that have been indicated by X *within the entire sequence* by the manner it has referred to the external change. And, again, the later occurrence of communications Z is justified on the grounds of the X's and Z's mutual 'belonging' to the same sequence.

Generally speaking, when a reactive adaptation is taking place, we can expect that a change happening in the environment of a sequence will lead to the occurrence of a number of communications within this sequence, which refer to the composition of the sequence itself. Let us see if we can detect such a pattern in the NASA case:

### Example 4.2: Reactive adaptation of a mission statement (NASA)

In contrast to the attempt described in the Example 4.1, this time there is no need to arbitrarily delineate any foundational set of communications (like the organization's mission statements) and treat them as the focal window through which the system's interactions with its environment and the mapping operations are happening. It is enough to start with *any* communication that appears to be performing either the function of the communication X, or Z, as described in the general pattern above, and to follow back and forth in time the mutual co-referring in which the specific chosen communication is participating.

We start, then, with a communication, which seems to display the characteristic of the Z type:

#### Communication a

*"We refer to the mission statement in all our research proposals that go out for peer review, whenever we have strategy meetings," said Philip B. Russell, a 25-year NASA*

veteran [...]. "As civil servants, we're paid to carry out NASA's mission. When there was that very easy-to-understand statement that our job is to protect the planet, that made it much easier to justify this kind of work." (Revkin, 2006)

If we attribute the characteristics of Z to this entire occurrence of communication, we can see the proposals "that go out for peer review" as communications X and, then, the NASA mission statement as Y. Selections apparent within the Y (here: the 2006 version of the mission statement) are explicitly described as constraining the possible ways in which NASA project proposals are allowed to relate to various calls and emerging research opportunities. Should there be a different Y, like the mission statement from 2002, the relating would be "much easier".

And, naturally, the above attributions of our X/Y/Z functions are by no means permanent. The 2006 mission statement, playing the role of Y for our current X (research proposals), have also had the function of X, when it was relating to a change (e.g. the Mr. Bush's announcement made in 2004, mentioned in the communication e, Example 4.1.) and using the previous version of the NASA mission statement as its own constraining Y. At that moment, however, a *perturbation* appears to have happened: the 2006 mission statement has rather 'responded' than 'reacted' to the new vision and funding ideas announced by the Bush administration. It has enforced coherence with the political vision and loosened the coherence with other communications already present in the NASA sequence. By this, the new mission statement has *perturbed* the sequence. It is exactly at such moments, when patterns of the reactive adaptation may be observed in sequences which operate as already individuated, autonomous social systems. The perturbation induced the production of new occurrences of communication, *compensatory* ones, seeking to re-establish the coherence of the entire sequence. The 'NASA veteran's' criticism publicized in the mass media is one example of such communications and, as we already know, in this particular case there were many more communications like this one. In fact, the counterbalance continued until the home planet concept was reintroduced in the 2011 'stewardship of Earth' phrase and the internal coherence of the system was restored.

What still remains to be addressed, is the identification problem: how do various occurrences of communication 'identify' each other, as belonging, or not belonging, to the same sequence? Why the vision announced by Mr.

Bush could not be accepted as a valid communication of the Y type? Why did adhering to this particular communication work as an external perturbation, while adhering to the NASA mission statement by research proposals did not? Taking this back to the triple selection structure, that each communication is made of, we can see that it is impossible to equate this identification making with only one type of selection: it seems to be present in *all* of them. Communications that are most likely to be considered as unambiguously sourced within the NASA system are both meant (selection 1) and understood (selection 3) as exactly that: communications of NASA. And, while there are many subtler ways in which this can be manifested in their form (selection 2), one of the most common forms of manifestation of such belonging is their labelling with a name, which signifies the social system they belong to. Thus, the name of NASA is used as a *signifier*, which *selects* the entire sequence of NASA communications.

We can see that the above method of observing social systems adaptiveness does not require the definite assumption of the prior existence of an already individuated NASA, as it was the case in the 'responsive adaptation' attempt discussed in example 4.1. Such an assumption is in fact much weaker here: it is rather an hypothesis being explored, not a presupposition. For this reason the 'reactive adaptation' framework seems to be much better aligned with the process ontology perspective of social systems as it accommodates varying levels of coherency and dynamic becomings with various degrees of individuation. Should a pattern of reactive adaptation be detected in such a fluid realm, this may imply (prove) a temporary existence of an individuated sequence, coherent enough to display an adaptive behaviour. Therefore, while the 'responsive adaptation' approach appears to require such existence to be assumed a priori, the 'reactive adaptation' approach may indeed become useful for its verification. Providing a sound operationalisation of the above method, the 'reactive adaptation' approach has thus a potential of forming the methodological basis for tracking and delineating the dynamics of social systems (organizations, movements, groups, etc.) within big unstructured and unordered datasets of various occurrences of communication, such as abundantly found on the Internet.

Another significant difference between the two discussed methods of understanding systems' adaptation lies in how each approach influences our perspective of the environment of communication. While in the responsive adaptation approach the middle layer of the environment, i.e. the one constituted of all other instances of communication, was remarkably lost from our sight, the reactive approach renders this layer as the key one. It becomes clear that this layer is the environment within which the individuation of

communication-constituted systems actually takes place. The fluid, processual milieu populated by various occurrences of communication is exactly where the boundaries of the individuating assemblages are formed. It happens by distinguishing between the communications that belong to or owned by a specific system and those which do not.

In the reactive approach, the other two layers of the environment of communication -- the referred reality and the human minds involved in the process -- could be to some extent disregarded as we focus on the individuating process. This time, it seems that these layers are becoming 'flattened and instrumentalised', just as the middle layer of the environment turned out to be in the responsive adaptation approach. If we consider the adaptability of communication-constituted sequences to be happening in a reaction to the selection-making 'behaviour' of the surrounding occurrences of communication, we may conclude that the worldviews -- the Hayek-Hebb's 'maps' of reality being 'interacted with' via symbolic communication -- are ultimately mere by-products of the self-organizing activity taking place in the domain of communicative occurrences. Human minds, as the cognitive agencies necessary for selection-making, are involved quite instrumentally: they monitor the coherencies and incoherencies in particular sequences of communicative occurrences and perform selections that increase the former and decrease the latter. The map of the environment presented to them is an outcome of previous operations. The minds involved are guided not so much by the actual 'territory of reality' and its dynamics, as by the internal composition and coherence of particular sequences of communication, that fold and unfold with various degrees of arbitrariness. Whether or not employees of NASA will ultimately relate to the 'home planet' in the communications that constitute their work, does not depend, then, on whether the planet *is* actually there, in their environment. It depends solely on the internal structure of the communication-constituted social system which orients, mediates, and guides such activities. The social system may enable or disable certain activities, make them irrelevant, undesirable, etc. All these based only on the unfolding over time of the sequence which constitutes it.

While not denying that the cognitive agency of human minds is instrumental for the operation of social systems (at least until sufficiently replaced by communicating machines as it is already happening), we can clearly see these human agencies as *mobilised in the environment of communication* by communication itself. Following this line of reasoning, we are in a position to address the question can the agency associated with communication systems, as clearly demonstrated by our approach, be designated as *cognitive*?

## Concept 5. Cognition

So far we have advocated three shifts in approaching social systems. First: focusing on becoming rather than being as what gives rise to their complexity. Second: a triple-layered understanding of the environment in which (more or less fluid) identities of social systems individuate and shape their own boundaries. And third: a reactive rather than responsive approach to their adaptiveness. Our final argument is that these shifts reveal social systems as *cognitive* systems. This position does not stretch Luhmann's own thinking too far. He frequently described a social system's activity in its environment using terms such as 'observing' and 'coding' (Luhmann, 1996, 2012, 2012a). We wish, however, to address this more explicitly and argue that this is in no way merely a metaphor: a communication-constituted social system *is* a cognitive system and its on-going constitution is a process of *cognitive development*. We will make the argument in two steps. First, we argue that all individuating processes, inasmuch as they are boundary and distinction forming processes, can be considered as processes of cognitive development. With that we generalize the concept of cognition following the enactive cognition approach (Di Paolo et al., 2010). Second, we use this approach to explicate the intrinsic cognitive nature of communication-constituted social systems.

The phenomenon of cognition is definitely complex, multifaceted and gives itself to quite a few diverse definitions. Still, in a somewhat limiting approach, the activity of cognition is naturally associated with certain situations when there is an agent operating in its environment, and whose operation can be described as an on-going problem-solving activity. The question remains however how is it that this setup of agents, environments and their dynamic problematic relations emerge in the first place? Even while writing (or reading) these words, we make use of sensible objects that are already, at least partially, formed and related to each other. Perhaps they are vague and require further determination to become clearer; some may change the meaning (sense) in which they are understood; others may just emerge in the flow of thought or disappear; and yet others may merge or diverge. Crossing this, often unseen, boundary between the unknown and the known, the unformed and the formed is what we may call sense-making.

Sense-making is the bringing forth of a world of distinctions, objects and entities and the relations among them. Even primary distinctions such as 'objective – subjective' or 'self – other' are part of sense-making. A relatively new appearance on the stage of cognitive science, the so called enactive cognition approach, regards sense-making as the primary activity of cognition. The term 'enactive', synonymous with 'actively bringing forth', makes its first appearance in the context of cognition in the book "The embodied Mind" (Varela, Thompson, and Rosch, 1992) and has been since then the subject of many

developments and debates (Stewart, Gapenne, and Di Paolo, 2010; Thompson, 2007; Di Paolo, 2006; De Jaegher and Di Paolo, 2007). A guiding idea of the enactive approach is that any adequate account of how the body (i.e. any embodied system) can either be or instantiate a cognitive system must take account of this fact that the body is self-individuating:

*[...] By saying that a system is self-constituted, we mean that its dynamics generate and sustain an identity. An identity is generated whenever a precarious network of dynamical processes becomes operationally closed. [...] Already implied in the notion of interactive autonomy is the realization that organisms cast a web of significance on their world. [...] This establishes a perspective on the world with its own normativity[.] (Di Paolo, Rohde, and De Jaegher, 2010, pp. 38-39,45)*

The enactive theory of cognition therefore incorporates the idea of individuation rather naturally as it asserts cognition to be an on-going formative process, sensible and meaningful (value related), taking place in the co-determining interactions (i.e. communications in our case) of agents and their environment (Di Paolo, Rohde, and De Jaegher, 2010).

We assert that the concept of sense-making captures two distinct meanings: the first is synonymous with cognition as a concrete capacity of an already individuated system, the second, with the individuation of cognition as *intrinsic to cognition itself*. The latter meaning of sense-making is the one corresponding to the acquisition and expansion of concrete cognitive capacities and it also generalizes the concept of cognitive development beyond its psychological context (Piaget, 2013) and make it applicable to general individuating systems (Weinbaum & Veitas, 2014). Furthermore, in the broadest sense, every individuation process where boundaries, distinctions and relations are progressively determined, is a sense-making process and therefore is cognitive.

Still, being based on the earlier works of Maturana and Varela on autopoiesis and the biological basis of cognition (Maturana and Varela, 1987; Maturana and Varela, 1980), the theory of enactive cognition asserts the necessity of an autonomous and relatively stable identity to sense-making. In contrast, we argue that the broader understanding of cognition as sense-making precedes the existence of systems as already individuated identities (cognitive agents) and is actually a necessary condition to their becoming. Only that at this pre-individuated stage *there is still no one for whom sense is being made*. It is only a habit of thought grounded in an ontology of fully defined individuals to assume the pre-existence of the sense-making agent to the emergence of the sensible.

By 'cognition of a social system' we do not imply the *experience* of the human 'ANTCOG', i.e. adult, normal, typical cognition (Von Eckardt, 1995), being

projected onto a distributed social phenomenon. Our understanding of cognition derives from the broader sense of social systems as individuating systems that *enact* sense-making via on-going communications. They make and manipulate distinctions which shape the system's unique perspective(s) of its environment, of itself in it and the resulting relations that are possible between the two (Heylighen, 1990). Since forging of a perspective of the environment, of an own identity, and of possible relations between the two are the core characteristics of the cognitive, at least according to the enactive approach, the operation of social systems is just that -- cognitive. Even more importantly, if cognitive development is intrinsic to cognition as argued by Weinbaum & Veitas (2014, 2015), cognizing is not only a core activity of social systems but also a vehicle for their evolution.

As a cognitive system, a social system is distributed yet embodied and situated once these designations are understood in the proper context. First, we need to release the associations of such designations from their narrow physical or topological interpretation. Embodiment can be understood as a combination of the 'raw material' constituents, in our case communication instances, and their coordinated organization, in our case the way communications are related and associated reflecting complex distinct structures. The situatedness of a social system can be understood as the totality of its immediate interactions over already established boundaries. In other words, the situation of the system is the immediate circumstances of enacting its sense-making. Of course for social systems both embodiment and situatedness are distributed and fluid.

In a communication-constituted operational domain, the process of individuation may be initiated by a difference of strength of association between a few contingent communications (see also (Weinbaum & Veitas, 2015, pp. 19-23)). A recurrent set of occurrences of communication which are more or less consistent and coherent constitutes a semiotic boundary or part of it. Associative relations among signifier-signified pairs may bring forth temporal patterns of interaction across the boundary where patterns may themselves become the object of further recursive significations. Such associations and significations may be dynamically reinforced or weakened depending on some fitness criteria that are encoded in communications as well.

An example might be a case of several scientific papers, published by different researchers in different parts of the world, using a similar set concepts to denote similar phenomena, which was rarely described before. Such a pattern may be strong enough to deserve a communication that encodes it with a *name* i.e. a new *signifier*. The *signifier*, selecting the entire group of these communications as its *signified*, may then become a frequent element of subsequent communications. It comes along with a network of associations that imply a more or less diverse and more or less stable set of meanings depending on the

phase of individuation of the system. Luhmann (2012a) refers to such progressive encoding of patterns into new signifiers as a process of 'self-description' but one should not read in that any kind of self-reflectivity or self-awareness in the experiential sense but rather spontaneous instances of compression of recurrent information patterns and the progressive consolidation of identity thereof.

With such individuating activities, by repeatedly linking *signifiers* and *signified* the social system maintains its own continuity and coherence even in the face of changing circumstances and values. Specifically, it can be said to possess (quasi-stable) *perceptions*, *actions* and *conceptions* (percept – action associations) that dynamically bind them. The system thus becomes a locus of identifiable cognitive activity, temporarily stabilized within the flux of communication.

## Conclusions

While the biologically embodied cognitive system of humans appears to be the most advanced one on Earth, it may be a mistake to reduce the collective cognitive processes performed by human societies to mere aggregations of the cognitive activities performed by human individuals. In this paper we made the case that human *social systems* are concrete, non-metaphorical, cognitive agencies in themselves and are operating within their own self-constructed environments. Furthermore, we make it visible that, though not biologically embodied, these cognitive agencies self-organize and operate in a way with characteristic similarities to many self-organizing processes of life and specifically the individuation of human cognitive competences.

Our explication of how this happens derives from Niklas Luhmann's theory of social systems. We find Luhmann's focus on communication, instead of communicating people, to be a close derivation of the ancient Heraklitian view of reality as ontologically constituted of processes and not objects. This is naturally integrated with Gilbert Simondon's theory of *individuation* and readily applied to the individuation of cognitive systems. This results in a novel view of social systems as *complex sequences* of occurrences of communication, which are capable of becoming consolidated to the degree in which they start to display an emergent *adaptive* dynamics characteristic to cognitive systems.

While adhering with the prevailing view of social systems as *complex adaptive systems* (CAS), we offer a novel re-interpretation of the applicability of both complexity and adaptability to social systems. The three major conceptual building blocks of CAS, namely, *components*, *environments*, and *adaptability* are



discussed and we demonstrate how they may be conceptualised in a manner consistent with our claims.

*Components:* We follow Luhmann's view on social systems as constituted of communications. We assume that an occurrence of communication happens as a combination of three difference-making selections: the selection of information, the selection of the utterance of this information, and the selection of understanding (meaning assignment) of this utterance.

*Environment:* We distinguish three conceptual layers of the environment of communication engaged by the occurrences of communication via the above selections: (1.) the selections of information rendered by each communication, i.e. 'whatever the communication refers to and is being referred to', (2.) the milieu consisting of other related occurrences of communication, and (3.) the mental (and possibly technological) agencies whose selections for coherency facilitate the emergence of communication instances.

*Adaptability:* We clarify the relations of social agencies with their respective multi-layered environments by examining two dominant perspectives on systems adaptiveness, which we refer to as 'responsive' and 'reactive'. Here, we discover that while each displays different and complementary facets of the operation of social systems, only the latter reveals social systems to be the loci of an autonomous agency.

The final argument affirms that this distributed social agency is indeed *cognitive*. The argument derives from a broader understanding of cognition as sense-making, *which precedes* the existence of a consolidated cognitive agent to whom we could conventionally attribute the activity of sense-making. Instead, we see the cognitive activity as a *formative process*, which actually brings forth actual agents. This brings us to conclude that though there is 'nobody there' in the conventional sense, human social systems constitute distributed yet coherent loci of an autonomous cognitive activity.

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