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Technology and Global Change

The Illusion of Control

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Why are societies (partly) adopting the scientific, Western intellectual perspective so little inclined to accept that their vision of the world is much more uncertain than they assume? This paper views the illusion of control as the result of a long-term coevolution in which, in Euro-American society, the basic categories of thinking have shifted from "open" to "closed," from a focus on exploration of the unknown to the exploitation of the known. Such closed categories are to a large extent anchored in technologies, because in the interaction with technologies, human actions are routinized and adapted to the technology, so that it is difficult to deal with changing circumstances. Thus, as part of the technology explosion of the last two centuries, Euro-American societies have undergone a massive shift from exploration and comprehension of the changing world they deal with to competently repeating known responses to known challenges without understanding the underlying dynamic. This shift makes them (wrongly) assume that they control their world. Any attempt to break this illusion of control must consider how categories are formed and assembled into narratives, and in particular the nature of the relationship between information (cognized signals and categories) and noise (signals excluded from cognition). That relationship has been fundamental to the dynamic of niche construction that has shaped both our thinking and the environment to which it relates.

INTRODUCTION

One of the most vexing questions of the day is *why, while our societies have had increasingly detailed information on the state of the climate and the environment for the last forty years, it is proving so very difficult to actually respond adequately to the sustainability conundrum*. This year, again, the Intergovernmental Panel on Climate Change (IPCC) has raised its alarm, more pressingly every time, while the annual Conference of the Parties (COP) meetings (now twenty-two years old and still going strong) promise, but do not deliver, the measures needed to deal with this emergency. There is a wide range of efforts – in the media as well as in academic publications that highlight political, economic, or energetic obstacles to delivery of appropriate solutions (for a recent example, see Vasbinder and Lim 2021) or that encourage other disciplines, in particular the social sciences, to come up with solutions – to deal with this issue (Gupta et al. 2021). The issue is fundamentally a societal rather than an environmental one. But none of these efforts have enabled our societies to implement the necessary measures. Time and again, scientists as well as many citizens have blamed an absence of sufficient political will, or the power balance between parts of societies that favor action and parts that prefer inaction. The last few years have therefore seen at best a kind of slow-moving dance around the hot topics of climate and environmental change.

Among an increasing number of scientific and engaged civil organizations, we argue that the issue is actually a much more encompassing one, involving not only politics, economics, technology, and such themes individually, but also the way in which Western thinking is everywhere transforming human interaction with the Earth system. Most people concerned identify proximate causes such as the Western capitalist or democratic systems. We argue that dealing with those proximate causes will not bring us closer to solving the problems involved. Instead, we ask: *Are there maybe dynamics that have been, and are, going on at a deeper cognitive level as part of the evolution of our Western thinking?* Dynamics that operate in all domains of human interaction with the environment.

We assume that an "illusion of control" hinders effective responses to the conundrum. If so, what are the dynamics responsible for it? How might the Western worldview have shifted from an appreciation of the unknowns and uncertainties of the dynamics of its socio-environmental context to a sense that our societies control most of those dynam-

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ics? Has that shift also occurred in other societies, independent of the Western perspective? What might we need to do to break that illusion? In this paper, we will offer some suggestions in response to those questions. But that clearly is a work in progress—suggesting substantive research areas for the coming years.

The expression "illusion of control" was first coined, and extensively studied, by the psychologist Langer (1975; Langer and Roth 1975). It referred to the observation that, quite often, people have a sense that the solutions they have conceived for certain challenges will allow them to meet further challenges, but do not include in their calculations that such solutions always have unintended consequences that undermine the control of events. Examples abound. The most famous synthesis of this phenomenon is attributed to Einstein: "We cannot solve the problems we have by applying the thinking that was responsible for creating them." The continued use of nuclear energy, for example, is promoted by some, even though nuclear accidents are among the worst kinds of disasters that can, and will, occur. Another example is the illusion among certain interest groups that the fossil energy system can in its current state be maintained in the face of environmental change. The current COVID-19 pandemic is due to maintaining for a long time the illusion that Western medicine has such control over human health that there is nothing to fear, even though at the same time many countries dismantled substantive parts of their health systems. And maybe the largest illusion of all is the idea that the "developed," ex-colonial nations can maintain their global supremacy "forever." The fallacy of that illusion is, as we write, being highlighted in international politics across the globe, including the Russian invasion of Ukraine.

Among many early references about what is behind such illusions of control, one of the most important ones is chapter 16 in Kahneman et al.'s foundational book *Judgment under Uncertainty: Heuristics and Biases* (1982, 231–38). More recently, Kahneman (2021) summarized his perspective on this issue as follows: "*The power of reason* [in making someone change their mind] *is an illusion. The belief will not change when the reasons* [for the belief] *are defeated. The causality is reversed. People believe the reasons because they believe in the conclusions*" (Workshop "Real Patterns in Science and Cognition," Santa Fe Institute, February 28–March 4, 2022).

Established beliefs come first; reasons for them are secondary in importance. This provides an interesting lead into the role of narratives in the very complex dynamics of human cognition, which we will pursue further down.

Our interest in this topic was raised by Nicholas Taleb's *Black Swan* ([2007] 2010), in which he observes that "overconfidence in our knowledge and judgment is fed by the illusory certainty of hindsight." That converges with Kahneman's (2011, 13) description of the illusion of control as "A puzzling limitation of our mind: "our excessive confidence in what we believe we know, and our apparent inability to acknowledge the full extent of our ignorance and the uncertainty of the world we live in." Both statements refer to a denial of the fact that whatever approach may be conceived or instantiated in solving a challenge, the outcome is always different and, in many ways, unexpected, so that control is lost. Our societies deny what Lane and Maxfield (2005) summarize in their work on invention and innovation as "There is always ontological uncertainty." We propose in this paper a model of these observations as a consequence of our Western societies' reductionist, more or less linear perspective on causality and history.

A MODEL OF KNOWLEDGE ACQUISITION

What is information? One evident way to define information is "that which humans pay attention to among all the impulses our senses receive."[1] The next question, evidently, is then, How do humans come to pay attention? This has been the subject of an important discussion in cognitive science. Wikipedia (https://en.wikipedia.org/wiki/Attention, consulted 7/11/2021) defines "paying attention [as] the behavioral and cognitive process of selectively ignoring other potentially perceivable information to concentrate on a discrete aspect of information." Humans pay attention, and define patterns, by ignoring noise rather than by identifying signals. Societies accumulate (path-dependently) the knowledge that enables their information processing by ignoring what they consider noise.

What is at the root of the illusion of control? We attribute it to the dynamics of human learning, and in particular to how that dynamic has evolved in Western societies over the last four or five centuries. Human individual and collective learning has transformed our societies from small bands roaming the Earth to huge societies involving millions if not billions of people. Such learning is driven by a positive feedback loop in information processing that creates order out of experiences of the—seemingly chaotic—unknown world. It does so by isolating patterns, characterizing them in terms of a limited number of dimensions, and using those patterns in the form of knowledge. It may be summarized in the figure 1a (van der Leeuw 2006).

Problems that exceed an individual's cognitive capacity also have an impact on the size and structure of the groups involved, leading to a second feedback loop (figure 1b).

This positive feedback loop results in the definition of ever-growing numbers of cognitive (knowledge) dimensions. And as more cognitive dimensions are distinguished,

1 The original information-theoretical definition proposed by Shannon (1948) applies only to a very restricted situation, the transfer of signals in a closed (telephone) communication system. There are, of course, many other definitions (e.g., https://en.wikipedia.org/wiki/Information, consulted 15/7/2021). Here, we have chosen a definition that directly relates the concept to the dynamics of human cognitive systems.

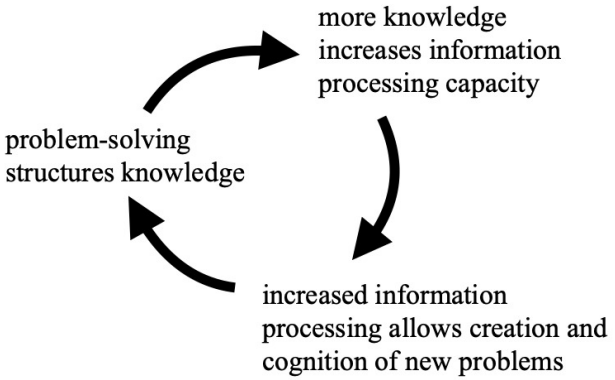

Figure 1a. The feedback between problem-solving and cognition

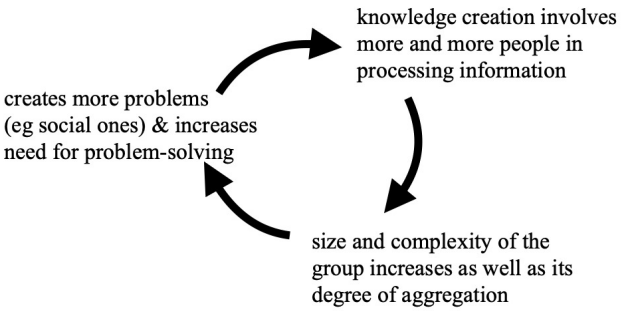

Figure 1b. The feedback between problem-solving and community size

more and more complex problems can be tackled, and the more quickly further knowledge, enabling more information processing, is accumulated.

The construction of the meteorological system from the mid-nineteenth century till today is an excellent example of such a positive information-processing feedback loop. Beginning with early attempts to understand what is responsible for sunshine, rain, mist, and clouds, scientists identified at each stage new (spatial, chemical, physical, etc.) dynamics, which led them to improved understanding of the weather and then to identification of new unknowns. Studying those led to the progressive constitution of new signals (temperature, humidity, static electricity), new dimensions of understanding (3D modeling of atmospheric dynamics), new scientific fields (climate science), and new technological capacities (use of supercomputers). Each cycle of this feedback loop involved the identification of new problem dimensions and appropriate metrics (Grumbach and van der Leeuw 2021).

We conceive of the interaction that is responsible for this process of knowledge accumulation as a combination of resonance and niche construction (Odling-Smee 1988; Odling-Smee et al. 2013; Laubichler and Renn 2015; Iriki 2019; Vieira Bretas, Yamazaki, and Iriki 2019) in the interaction between the society's information-processing apparatus (including mental and material tools such as ideas, institutions, and artifacts) and the society's environment. Observations in the environment are interpreted insofar as they resonate with existing knowledge. But because the resonance is partial, it also provides novel signals, and processing those further changes the knowledge (information-processing) system. In the action of the society upon its environment, these changes in information processing result in changes in the environment. The society and the environment thus concurrently coevolve to shape both the (individual, collective, institutional, cultural) knowledge of the society (the internal niche) and the environment (the external niche) with which it interacts.

There is an important difference related to the direction of the interactions between the mind and its environment. The categories that the mind derives from observations in the environment are limited in complexity because human information processing can handle only the interaction between 7 ± 2 sources of information (Coolidge and Wynn 2005; Read and van der Leeuw 2008), so that the complexity of the perception of the environment is always partial and biased, compared to the unlimited uncognized complexity of the dynamics of the environment. When people or societies act upon their environment, their partial conceptions are confronted with the much more complex, noisy, and mostly unknown dynamics of that environment. *As a consequence of this difference in complexity, any society's action upon the environment always has unanticipated consequences*. Or to put this in everyday language: solutions always cause problems (van der Leeuw 2012). The interactive cycle of resonance between the external and the internal niches *drives* the trajectory of human-environment interaction. But it only partly *directs* it.

THE PRESENT IS CONSTRUCTED BY INTERACTION BETWEEN PAST AND FUTURE

When Taleb (2007) refers to the "benefit of hindsight," he employs an image that the ancient Romans referred to as the activity of the god Janus, who has two faces, one clean-shaven and youthful looking toward the future, and one bearded and older looking toward the past (see figure 2).

That image emphasizes that human perception iteratively relates existing knowledge to new observations in an interaction between *ex post* and *ex ante* perception. As humans, we live in a momentary present between the past and the future. In interaction with our environment, we distinguish between "exploitation" of things known from the past and "exploration" of novel phenomena that creates new knowledge. As humans, we use existing knowledge, values, and ideas to understand the world around us. But whenever that does not enable us to gain such understanding, in efforts to extend our knowledge we explore phenomena that we are not sure about. Such exploration results in hypotheses and is expressed in terms of possibilities and probabilities. These can subsequently be confirmed or rejected as being part of existing knowledge. Perceptions (registrations of signals by all sensory organs and their extensions) thus dynamically combine an established framework of values and ideas with information about emerging novelties.

Figure 2. The Roman god Janus combines looking backward and looking forward

This interaction between ex post and ex ante perception shapes the cognitive interface between the society and its external environment. As it proceeds, in certain domains information processing is only enriched and refined, while in others the perspective on the outside world and the way in which information is organized are fundamentally changed. In the domains where that happens, we initially see uncertainty and ambiguity between different perceptions because the balance between established ideas and novelties leans toward the latter. But once certainties come to dominate, perceptual revolutions occur such as the abandonment of Newton's conception of physics in favor of those of Einstein and Heisenberg. Kuhn (1968) shows how, in that process, newly discovered unpredictable dynamics at the periphery of those well-known are transformed into known predictable ones when the society has identified interpretative characteristics that have until then been considered as noise. The discovery of electricity involving new ideas, experiments, and measurement techniques has fundamentally changed our conception of part of the natural world, leading to new concepts ("fields," "electrons," "conductivity") as well as new technologies (light bulbs, electric engines, dynamos). In due course, such "cognitive revolutions" mean that initial control after a time devolves into another illusion of control based on the novel interpretative framework.

CATEGORIZATION

The core dynamic between exploitation and exploration occurs when there is resonance between an existing knowledge system and novel observations. Both of these are grounded in *categories*. Creating categories requires pattern recognition, a comparison between similarities and dissimilarities among the phenomena observed. According to

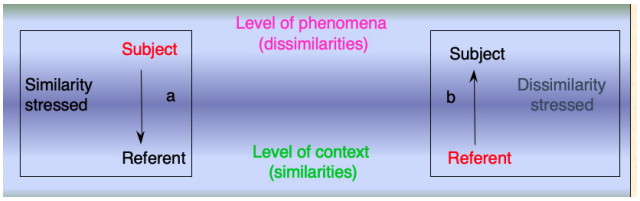

Figure 3. Categorization occurs in two steps: first stressing similarity between signals to create a referent, and then comparing the referent with further signals to decide which do and which do not fit the referent

Tversky and Gati (1978), categorization proceeds in two steps (figure 3).

One first considers an *extrinsically defined* sample of phenomena that is delimited in space and time—for example, a random sample of furniture. Among that sample, one looks initially for similarities among the various objects, which may separate them into different categories, such as tables and chairs. These similarities describe each of these groups of phenomena as *potential* members of a hypothetical category ("tables" or "chairs") but do not yet include any potential members of either category outside the space-time defined sample. Nor do they include characteristics that exclude objects from the categories involved (e.g., "sofas"). At this stage, "tables" and "chairs" are therefore *open* categories, approximately describing *groups* of phenomena. It is known which objects might be included in the categories, but not which will ultimately not be included.

In a second phase, one tries to generalize the categories by replacing the space-time constraints as criteria for membership with definitions based on inherent characteristics of the objects, thus changing the description of the categories from extrinsic to intrinsic. In that process, one also defines—by omission—the characteristics *that exclude phenomena from the categories involved because they are too dissimilar*. The result is a closed (class) definition of each category.

In the first phase (on the left side of the diagram above), the category to be created is the subject, and the phenomena studied to do so are the referent; the reasoning is inductive (from particular phenomena to more general ideas), and the emphasis is on similarities. In the second part (on the right side of the diagram), the reasoning is deductive (from ideas to the particular phenomena to which they apply); the categories become the referents and the phenomena the subjects (van der Leeuw 2019), biasing the comparisons toward dissimilarity and determining—by omission—which phenomena do not belong in the categories established.

As a result of the process summarized in figures 1a, 1b, and 4, one can distinguish three different "cognitive spheres" in the process of coming to understand phenomena (van der Leeuw 1993) in the virtual cognitive space of a society:

- A "problem sphere," consisting of domains for which there are no categories (yet), and which therefore in-

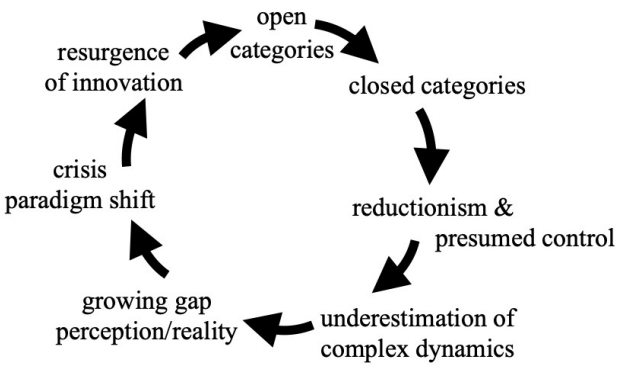

Figure 4. The interaction between open and closed categories

cludes unknown or dimly perceived, unsolved challenges

- A "possibility sphere," which consists mainly of "open" categories, about which there is a degree of indecision, and which is therefore flexible and potentially open to new phenomena
- A "certainty sphere" rooted in the past, which is made up of the "closed" categories, ensuring that a person, group, or society knows exactly what is what, and has fixed ideas on how to proceed

Thus, in the interaction between the (individual or collective) mind and its environment, the "mind" distinguishes three kinds of phenomena: known unknown ones, tentatively known (hypothetical) ones, and definitely known ones. The interaction between these, we argue, will determine the way in which the society interacts with its environment, shaping both the society's knowledge and its environment in a process of interactive niche construction (Odling-Smee 1988; Laland et al. 2013; Laubichler and Renn 2015; Iriki 2019).

NARRATIVES

In two recently published papers, van der Leeuw (2020; van der Leeuw and Folke 2021) has linked these dynamics between the three spheres in the cognitive domain to the existence of narratives. Narratives are probably as old as modern humans. One of the oldest narratives known, the Gilgamesh Epic (dating to the mid-third millennium BCE), already has the typical structure of many narratives through the ages: in his travels, a hero encounters many dangers and obstacles that he has to overcome. It has essentially the same structure as the narratives of Jason and the Golden Fleece, or the travels of Odysseus/Ulysses that date back to the first millennium BCE in Greece. Similar narratives occur in most cultures, where they collectively form the backbone of each society's worldview. In such narratives, gods and heroes reflect different aspects of human nature and behavior, and in certain cases behave like human beings. The society's worldview is closely related to its fundamental narratives. This is nicely illustrated by the difference between the ancient Greek mythology and those of the monothetic Judeo-Christian and Islamic religions. In ancient Greek mythology, *gods behave like humans*—they fall in love, kill, play games, et cetera. In the Judeo-Christian and Islamic worlds, *human beings are supposed to behave like gods*. The narratives that sustain these cultures reflect this difference and thereby shape the behavior of the people involved (Yutang 1998, 15–23).

In superficially linear (told or written) stories, such narratives summarize events in a highly multidimensional world by referring to *Gestalts* in the encounters described. These *Gestalts* are categories that are deeply anchored in a culture. They can concern mountains, rivers, myths, heroes, places, battles, or any other phenomena that connect the people among whom the narratives are told with their culture and their values. The link between the linear stories and the multidimensional world is constructed through resonance with the *Gestalts*: the linear narrative refers to the role multidimensional categories such as characters and phenomena play in the imaginary of the cultures involved. The narratives thus anchor the people concerned and (re-) assert their identity.

Narratives are grounded in categories and are essential in shaping people's decision-making, and therefore their individual and collective behavior. Decisions reflect the values of the people concerned as represented in their narratives; they are shaped in the interaction networks of people. The UN's Sustainable Development Goals (SDGs) (https://www.un.org/sustainabledevelopment/), for example, are in essence based on a Western imagined future of continued "progress" that, as part of globalization, has been projected onto other cultures. In other parts of the world, one finds underneath that global projection very different imagined futures.

The important thing to note in the present context is the dimensionality of the description of the narrative's phenomena and characters. If that description is rich, it refers to many of the dimensions of the value system of the culture, but if it is poor, it will exclude many such dimensions and thereby reduce the society's representation of reality. *We argue that, as part of a general process of proliferation of closed categories, the dimensionality of the phenomena referred to by narratives has been declining in Western society. Gestalts* are increasingly simplified, in some cases to the point of caricature. But at the same time, they have become

more ingrained and more difficult to open up to exploration (van der Leeuw 2020).[2]

The fundamental question for our times is therefore, Can we open up the narratives underpinning our current worldviews? And if so, How can we do so in order to distance ourselves from our reductionist worldview and face the highly imponderable multidimensional world in which we actually live, viewing the risks of the present in the light of the future?

THE EMERGENCE OF AN ILLUSION OF CONTROL

What generates, in this light, the illusion of control? The anthropologist of business Tett (2015) argues that any organization is subject to a "silo effect"—a narrowing of its perspective that progressively excludes exploration of novelty and change (open categories) and increases reliance on what the community considers known (closed categories). In business, one sees this most clearly in efforts to increase productivity by increasing efficiency, discarding all redundancy, and thus reducing resilience and the overall information load. That process gives the people involved a sense that they are in control. But as Taleb ([2007] 2010) argues, that sense is an illusion, which has been achieved by banishing from their thinking the imponderables of the context in which the company operates, and no longer considering the unknown risks and their effects for their company or community. For example, the idea of having parts or products in storage is replaced by "just-in-time" delivery. That creates the illusion that one has achieved the leanest, best controlled manufacturing or sales approach, but excludes the possibility that because of supply problems, manufacture may have to be halted. Our perception is always more limited than the complexity of the phenomena perceived, and is thus always suboptimal.

Western societies and their constituent communities generally have defined more and more closed categories, focusing on existing knowledge (perspectives, values, and norms based on past experience), and thus moving their overall perception from exploration of the unknown, novelty, and change to exploitation of existing knowledge and stability. That increasing emphasis on the exploitation of existing knowledge reduces the overall information load by reducing its cognitive dimensionality by removing all dimensions referring to possible, but not certain, aspects of the phenomena, thus reducing our expectation of the unexpected. Some of this simplification is mental (knowledge, routines) or institutional in the form of set "tools for thought and action," while another part is material in the form of technology. This fixes the society's values and norms, as well as its interpretations of the world it is facing, and excludes the exploration of the unknown. *Such exclusion of potential novelty is what we call the "illusion of control."* The rapidly expanding techno-sphere of our societies (Haff 2014) is an important corollary of this shift toward closed categories because solutions based on technical equipment require interaction in very specific, narrowly defined ways. In the contemporary world, the "modernity" perspective has developed technology (based in part on science) with, within the capitalist system, control as its primary goal (minimizing costs, maximizing comfort, acceleration, etc.).

The illusion of control deliberately ignores for each solution, whether technological, institutional, or social, the fact that it superlinearly generates unexpected problems, some of which remain unobserved ("unknown unknowns") or are cognized but do not lead to attempts to forge new knowledge ("known unknowns"). A less rapidly growing proportion of problems is solved in terms of existing knowledge, whereas a yet smaller proportion is explored and leads to new open categories. As the volume of unexpected problems grows, an increasing proportion of them will remain unsolved or will be dealt with through known, but unsuitable, solutions. This is what Goudsblom (2002) calls the control-dependency loop. Over time, as a result, we would thus expect that we will observe a rapid decline in efficiency of the society's interaction with its environment.

It follows that for the survival of the society, the balance between (1) closed and (2) open categories and (3) problems left unsolved is fundamental. Any society will at times rely heavily on closed categories so that it has difficulty adapting to changes in its environment, while at other times it will rely too heavily on open categories, which leaves it directionless. The biologist Monod has captured this balance in the title of his book *Between Chance and Necessity* (1972), pointing out that there are in the trajectory of any dynamic system episodes in which a combination of feedback- and feed-forward loops makes the behavior of the system predictable, while at other times—bifurcation points in complex adaptive systems language (see Mitchell 2009; van der Leeuw and Folke 2021)—the system is not predictable. But this balance should also be seen against the background of unsolved problems, the "known unknowns."

Societies usually cannot deal imminently with such "tipping points" (van der Leeuw 2006), as this requires a fundamental, time-consuming restructuring of its worldview, its values, its institutions, and the definition of its identity. When a community first becomes aware of the need for such a restructuring, it generally spends much energy on focusing on its established knowledge and the narratives

2 The following example was suggested to us by Henrik Österblom of the Stockholm Resilience Center: When "the hero's journey" narrative was introduced in the late 1970s to a mainstream film audience through the *Star Wars* movies, it was somewhat new. Now, it is almost impossible to watch a movie that is not using this narrative as a detailed cookbook—very exhausting and resulting in movies of zero creativity and with no surprises. It is almost as if the narrative myth has become so ingrained in mainstream culture that one may suspect it reflects a reality we think we should live with. See, e.g., https://medium.com/swlh/the-heros-journey-is-outdated-as-a-creative-tool-for-writers-d88461f3ed5f.

that are based on it, in an attempt to hold onto its illusion of control in a changing world and forgoing the further exploration of *unprocessed information* relating to those changes. But subsequently, the hold of the society onto its illusion of control is overwhelmed by the sheer volume of unprocessed information, and fundamental change follows.

This delicate three-way balance is also time dependent, and to an important extent that temporal dimension is beyond the society's control. If we assume that a society tries most urgently to deal with the risks that it encounters most frequently, its risk spectrum is initially dominated by frequently occurring, known risks. But temporally, the unintended consequences of the solutions adopted range from very short-term to very long-term (see van der Leeuw and de Vries 2002 for an illustration based on the history of the Roman Empire). Over time the accumulation of unknown, delayed risks may lead to "risk barriers" that will unexpectedly confront the society somewhere in the future, not unlike sound barriers that are caused by a cumulation of sounds on many frequencies. The effect of a risk barrier hitting an illusion of control can be explosive.

FACING THE REALITY OF THE FUTURE

Large components of our societies are deeply involved in digging a hole for themselves by hanging onto their illusion of control and ignoring many of the changes their environments are undergoing. When digging does not improve the situation, the first thing to do is to stop digging. Stopping digging and shedding the illusion of control first of all require that the society fully faces the future and that its members individually concern themselves with it. That is a major change in perspective for our Western societies. Since the foundation of the Royal Society of London (1660) and the explosion of academies that followed in the next century and a half in most European countries, recognition as a scientist has increasingly been based on the ability to demonstrate or prove one's ideas. As neither can be done for the future, in practice, careers of (particularly natural and life) scientists became focused on the relationship between past and present to the detriment of that between present and future. They focused on explaining the origins of the present, developing an "ex post" perspective on history. This is changing, but only relatively recently, in large part because of the development of modeling.

To those who argue that the future is impenetrable and cannot be understood, we respond that first, if we'd had 250 years of thinking about the future (emergence), rather than about the past (origins), there is a good chance that we would currently be better armed with tools to anticipate and to deal with the future in terms of risks and uncertainties; and second, that we have no choice but to stop digging the hole we're in! Currently, our societies change so rapidly that we can no longer adapt post facto to such changes. We must therefore attempt to the best of our ability to consider and anticipate multiple scenarios of future dynamics.

That is the importance of the complex adaptive systems (CAS) approach. The natural sciences have had to exchange the Newtonian mechanistic perspective on "reality" for this new worldview due to discoveries in the twentieth century. The CAS approach uses an "ex ante" perspective that looks at the *emergence of novelty* in the past as well as in the present, thus allowing us to learn *from* the past *about* the present, *for the future*. Because the focus is then on *change*, that also shifts the perspective on the relationship between stability and change. In the Western scientific tradition, following Aristotle, stability is assumed to be the norm, and change the thing to be investigated and explained. Instead, CAS adopts Heraclitus's approach, in which change is permanent, and *stability needs to be explained*. Hence, all perceived phenomena are interpreted in terms of (re-)construction dynamics. The Newtonian, mechanistic conception of "reality" needs to be replaced because of new insights in the natural and social sciences. The changes must include a better way to account for multiple attractors, which includes a way to deal with "tipping points."

The *flow* (of information, matter, and energy) is generated by a potential and dissipates the unstructured (chaos) by creating structure. Structures are always dynamic. Change is therefore irreversible. Prigogine (1980) and his colleagues speak in chemistry of "dissipative flow structures." We appropriated that term for the dynamic flows of information, matter, and energy that dissipate the unknown (chaos) by converging people's thinking around ideas structuring a society. Identifying those dynamic structures often involves extending the temporal perspective, so that human behaviors that are initially effective in controlling a system in its context are maintained after the system and its context have changed due to the unintended consequences of the interaction between them. In those cases, the control becomes an illusion.

CAS dynamic structures are considered to be self-organizing as a result of the interactions of the entities in the system, which create patterns at a more general level, and these patterns in turn have an impact on the behavior of the entities involved. In social science terms, as formulated by Bourdieu (1977), interactions between individuals or entities create societies' (dynamic) structures, and the routines (habitus) of these structures reflexively have an impact on the behavior of the people. The result of that process is not fully predictable—multiple potential futures are involved at any time, among which the system opts for some and ignores others. The approach thus emphasizes both history and unpredictability, leading to descriptions of phenomena in terms of possibilities and probabilities,

rather than in terms of historical causation as is common in linear approaches.[3]

In 1985 the biologist Robert Rosen signaled the capacity of certain animals to anticipate. Beckert (2016) makes an attempt at applying anticipation to economics. He argues that our societies' evolution is determined by individual and collective imagined futures. Since 1750, according to him, a (uniquely "Western") cognitive feed-forward loop has developed that creates in our minds "imagined futures" and then develops "fictional expectations" that motivate people toward realizing them. In his words: "… expectations of the unforeseeable future inhabit the mind not as foreknowledge but as contingent imaginaries […] they create a world of their own into which actors can (and do) project themselves" (2016, 9–10). These fictional expectations are anchored in narratives that are continually adapted. Beckert's perspective thus opens the door to implicating the future in shaping the present,[4] rather than the reverse.

The exchange between imagined futures and present conditions shapes the narratives involved, which in turn drive our imagined futures and our decision-making. Hence, "Fictionality, far from being a lamentable but inconsequential moment of the future's fundamental uncertainty, is a constitutive element of capitalist dynamics, including economic crises" (Beckert 2016, 12).

But imagined futures are maintained only as long as there is confidence in that future, as long as the balance between open and closed categories is in favor of the latter. In the absence of such confidence, when open categories dominate, a degradation in the clarity of a society's perceptions and certainties, or even a crisis, is experienced. The anticipatory loop can then, very rapidly, be turned in a negative direction characterized by self-fulfilling negative dynamics driving toward uncertainty, as in the case of recent financial crises. But this is not confined to such sharp crises—it can also slowly undermine the totality of our confidence in the future and result in hesitations, contradictory actions, and general loss of self-confidence.

The interaction between imagined futures and the "real world out there" is a complicated one. It is clearly open-ended and not fully controllable, subject as it is to unintended consequences and "ontological uncertainty" (Lane and Maxfield 2005). As the imagined futures are confronted with the material and social "real" world, it is difficult to predict the outcome, especially over the longer term, due to changes in the second-order dynamics of the context in which shorter-term decisions are made. This can theoretically very rapidly transform peace into war, progress into the opposite, trust into distrust. We tend to take the current reality as a normality, that peace and democracy in Europe are eternal, while it is only a few generations since Nazi Germany exterminated Jews and two atomic bombs were detonated over millions in Japan. What may seem unimaginable can rapidly become reality, as illustrated by the Russian invasion of Ukraine in February 2022 along with Russian threats of using nuclear weapons in Europe. These developments are most likely to change European-Russian relations for decades and change the global geopolitical order established since the end of World War II (H. Österblom, pers. comm. email 4/4/22).

This perspective, in which anticipation of the future is accorded a role in shaping the evolution of societies, will demand much further research but in our opinion provides an opening for an interesting reorganization of our thinking based on a balanced dynamic between the present's perspectives on the past and on the future.

BREAKING THROUGH, AVOIDING, OR TINKERING WITH THE ILLUSION OF CONTROL?

A crucial question for the future of our societies is, of course: *Can we, in one way or another, shatter, circumvent, or modify the illusion of control?* In many instances in the past, the illusion of control was shattered when a particular perspective on a set of phenomena was confronted with much new information that could not be integrated by the community in its existing worldview or paradigm. This is the process described by Kuhn (1968), experienced in many scientific domains but also in societal ones, where social tensions may trigger revolutionary activity, as in the French Revolution, for example. In such instances, phenomena that were considered noise are transformed into signals by applying a different paradigm. Many intellectual changes are generalized during such a transition.

The triggers for such paradigm changes can be endogenous, exogenous, or both. Evernden (1992) describes how, following the fourteenth-century epidemics of the bubonic plague, for example, so many dead were observed in many urban centers that the exogenous epidemic changed people's perspective on time from cyclical (the natural cycle of recurring birth and death) to linear (the trajectory between a birth and a death). The fifteenth century also changed the nature of commercial interactions from relational to topical, and initiated the transformation from the rural feudal social system to an urban world in which industry, trade, and commerce ultimately became dominant, fostering the emergence of revolutionary ideas about the position of the Earth in the universe.

And at the end of the eighteenth century, an endogenous trigger combining demographic and social pressures with

3 There are too many other implications of this fundamental change in perspective to be mentioned here. One important one is that in this perspective, one no longer holds onto "Occam's razor," the idea that among potential explanations, one must always choose the simplest. Indeed, complexity and context often provide more realistic explanations. Some other implications are discussed in van der Leeuw (2020, chap. 7). A more extensive introduction to CAS is found in Mitchell (2009).

4 NB: This does not imply a fully constructivist perspective on the future, as there is no implication that the future is controlled or controllable.

innovative political and scientific ideas born in the Enlightenment was responsible for the French and American Revolutions. These initiated a shift in the balance between top-down and bottom-up political power, laying the groundwork for our current democracies. A similar instance is that of the Russian Revolution of 1917, where an exogenous societal trigger (World War I) combined with endogenous demographic, economic, and social pressures shattered the political structure of Russia and led to a major global field of tension between liberalism and Marxism.

In all these cases, and most other ones we know of, ultimately tensions that have built up in a society's worldview combine with unanticipated events to shatter illusions of control at what are nowadays called "tipping points." Climate change, for example, brings tensions to the fore that were already prevalent in capitalist societies while those societies thought everything was under control. We argue that it is very likely that such ruptures will also occur, sooner rather than later, in our current Western societies' approach to their own colonial past and their environment. But the issue is so urgent that we cannot wait for that to happen. We have to look for ways to trigger disruptions in societal perspectives that sustain current illusions of control over global health, biodiversity, migration, climate change, and a wide range of related phenomena.

The inverse question—is the illusion of control built on perception of phenomena, or is the perception of phenomena built on the illusion of control?—is of importance in this context. Here, Kahneman suggests (2022; see above) that "*The power of reason* [in making someone change their mind] *is an illusion. The belief will not change when the reasons* [for the belief] *are defeated. The causality is reversed. People believe the reasons because they believe in the conclusions.*" And that belief is solidly anchored in the values they have adopted, whether consciously or unconsciously, at very early stages of life. Belief comes first; reasons for it are secondary as they are elaborated as instantiation of those beliefs later in life. This might suggest that narrative(s) that are responsible for the illusion of control are more important in maintaining that control than whatever arguments can be mustered to confirm or undermine them. That, of course, leaves us with the question, Where do beliefs come from? We would argue that they are shaped individually in the first years of an individual's life, and collectively by small groups in society that negotiate them over time, and are then accepted by wider communities and institutionalized. The persistence of concepts like capitalism or the idea of progress against numerous arguments to subvert them may be an example of this. The capacity of a society (or some of its members) to control the flow of information is essential to its survival.

It seems to us that there are three ways in which one can go about changing the narratives that underpin illusions of control. One can try to (1) crush them by brute force, (2) provide a different narrative that lays the groundwork for a replacement illusion of control, or (3) change an existing illusion of control by tinkering with the narratives that sustain it. In evaluating these approaches, one needs to acknowledge that maybe because of the dominance of the belief in narratives just mentioned, unlearning an approach one has already acquired is more difficult than learning a new one (Bonchek 2016).

Of these approaches, it seems to us that the first, crushing by force, demands the most stringent conditions to be successful. In the corporate world, it is generally confined to old, established organizations that have existential momentum. Because of that, they can choose their own approach independent of the society in which they operate. A successful example is IBM, which made major transitions in its operations to remain successful over time. There is, however, an important risk involved. In such a confrontation, a positive feedback loop often emerges in which two or more illusions of control initiate a competition that reinforces both of them, as no reasons or arguments will ultimately topple a belief (such as an illusion of control)—the belief comes first, and the reasons for the belief are instantiations of the belief. That argument converges with the one stated long ago by Hume (1738), that it is impossible to move from statements about observations to statements that include reference to norms—but it is possible to move in the opposite direction, from normative statements to statements about observations. This directly converges with Kahneman's statement above. Therefore, in the case of a conflict between two belief systems, an escalation often follows as convincing either party of a position contrary to their belief is not possible. As we write, the invasion of Ukraine by Russia is an excellent example of this, as two different perspectives on societal organization (democratic vs. authoritarian) clash in a very destructive attempt to destroy each other. We see how in some countries, the resurgence of the extreme Right is boosted by choosing the environmental movement as a focus of electoral conflict.

Numerous attempts at merging the cultures of two companies have failed for the same reasons. In both, the silo effect (e.g., Tett 2015) has promoted a (different) company culture, in which the companies' identities are anchored. To avoid merger failures, one of the two cultures needs to be destroyed. Generally, what happens in the case of a merger is that around one-third of the people in the company that is taken over will accept the changes, either by conviction or because they simply accept the new authority. One-third will sit on the fence, and one-third will be against the new system. The officers of the company taking over will have to fire, retire, or otherwise get rid of those against, and then try and nudge those sitting on the fence. The "merger" is, in effect, a replacement of one culture by another. Core to achieving it is making changes to reward structures in order to nudge participants. If that does not work, the merger will not be effective.

The difficulties encountered by our societies in their attempts to move substantively ahead in implementing the sustainability measures necessary to avoid major environmental collapse—the fundamental question underpinning this paper—are a salient example of the absence of a novel, adapted reward structure. Although in the last few years, major communities have joined long-standing NGOs such as Greenpeace in creating massive movements in favor of change (e.g., Fridays for Future, Extinction Rebellion),

these focused on raising the alarm and pushing politicians to take action but did not develop proposals for alternative reward structures. That seems to us the reason they felt "as if they had reached a glass ceiling" (Lisa Neubauer at meeting of Earth League, Hamburg, July 2019).

Buckminster Fuller proposed another way to go about fundamental change: "You never change things by fighting the existing reality. To change something, build a new model that makes the existing model obsolete" (Wikipedia, https://www.goodreads.com/quotes/13119-you-never-change-things-by-fighting-the-existing-reality-to, consulted 03/16/2022). In our opinion, this is relatively feasible in the world of ideas, but much more difficult to implement in society. Lane and Maxfield (2009) have described the many pressures that are encountered by such a novel approach in the domain of industrial marketing by Echelon of a novel, distributed approach to control. The major difficulties are not in designing the novel approach, but in convincing the holders of older illusions of control that adopting the novel approach will actually be helpful. In Echelon's case, this required a novel way to propagate its approach, including a major effort building and maintaining what it calls "social scaffolding structures"—social organizations that sustain the novel approach by reinforcing communities willing to adopt it. Growing such communities requires proposing adherence to the new narrative, its dynamics, and its social structures.

Designing a successful approach of this kind, which avoids such pitfalls, requires first of all strong intellectual and practical leadership to achieve and maintain a coherent focus. That enables the intellectual fusion of a wide range of disciplines and perspectives, which is made difficult by the advanced fragmentation of our societies' worldview due to the shift from comprehension to competency and the identity issues that it provokes. In our societies, in which isolation of, and competition between, communities has been elevated to a fundamental tenet of societal organization, we have for centuries accentuated boundaries and closed categories of all kinds. In essence, issues such as those presented in seven different domains in Vasbinder and Lim's (2021) book *Buying Time for Climate Action* are the result of the proliferation of closed categories and boundaries that has resulted from the shift from relational to topical interactions, combined with the growing importance of the techno-sphere and the growth of competency without comprehension that it has engendered.

At some point, there is a danger in such an effort at confronting the old and the new approaches that a structural or institutional break occurs between the existing approach and the novel one. In the current debate on the future of the global energy structure, for example, most discussions have been on the merits of the existing (fossil) versus those of the proposed (renewables) structure. But the fact that the major barrier to the transition is that one cannot simply replace the one by the other without major economic and societal disruptions has not been discussed as widely. That is part of the current trend to transform complex issues into linear, single-bit ones. It is only very recently that that issue has surfaced and has led to proposals to rely more heavily on nuclear energy—for example, in the European Union's 2022 perspective on the energy transition (https://www.iea.org/reports/nuclear-power-in-a-clean-energy-system).

The third approach we propose for making space for new ideas that undermine the illusion of control is by tinkering with narratives. Its advantage, if successful, is that it avoids the kind of radical break that the second approach may engender. In such an attempt, a first step could be to identify the major barriers and roadblocks that a current illusion of control encounters in dealing with the societal and environmental dynamics of the socio-environmental world. Sheng (2021), for example, has looked at the ways in which the current structure of the international finance system has created barriers to addressing climate change, and comes to the conclusion that these barriers are inherent in the closed mindsets of those whose illusion of control dominates the current financial politics: the concept of "moral hazard," viewing debt as a means to consume more than is necessary, and the idea of valuing capital over labor, which create societal inequalities. In that respect, the actual language in which discussions are held is extremely important. Any modified narrative should then be designed to avoid such pitfalls.

Similarly, for energy our societies depended for a long time on a closed category about electricity generation: use of fossil fuels. Beginning in the 1970s, different alternatives emerged, opening up the closed category by suggesting renewable ways to generate electricity. This led to a range of interesting alternatives. But currently, many environmentalists want to close the category again, preaching belief in absolute reliance on renewables and rapid elimination of fossil fuels. In that battle between two illusions of control—fossils versus renewables—a realistic, reliable, mixed and staged approach risks being lost in the debate.

The relationship between the top of a hierarchy in a society and the remainder of the population is important in this respect. The top can make the decisions, but these have to take the information into account that filters upward in the society, from the base to the top. A coherent and well-organized society-wide information-processing system can do more sophisticated things than one that does not meet those conditions, but *human societies will always bump into a complexity limit*. Ultimately, unintended consequences of actions will overwhelm a society's whole information-processing system and undermine its goals and sense of purpose, so that the illusion of control is lost. That is why

Elinor Ostrom (2010) argues in favor of polycentric governance, establishing that when a society comes to include too many people for its information-processing apparatus, it becomes ungovernable.[5]

Not all narratives are open to change. In a 2021 paper, Folke and van der Leeuw point to a way in which changeable (parts of) narratives could be identified. They propose to identify the expected and observed entropy throughout a discourse or narrative. Where these two kinds of entropy converge, the story is largely based on closed categories, generally a more or less canonical perspective that is heavily reliant on past experience, whereas when they diverge, the story is more exploratory and directed toward the future, for an important part based on open categories and therefore in principle open to being changed. By these means, it might therefore be possible to redirect the outcome of certain stories to coincide more closely with desired outcomes.

How to do this in detail could involve another complicated operation: backtracking how the shift from open to closed categories has transformed the dimensions by means of which the categories are characterized. Frequently, in the process of simplification that characterizes the transition from open categories to closed ones, to reduce the amount of information to be processed, dimensions are merged or otherwise compressed (Dennett 1991; Millhouse 2021). Were one able to retroactively reopen the closed categories by identifying the original dimensions of the open categories that were reduced in the process of closure, one could potentially identify alternative closed categories. In cases where there is a detailed history available of a category, this might be possible. In technology, for example, Simondon (1958) and Arthur (2009) describe how in the development of certain kinds of mechanical equipment such as the car, technology moves from using a combination of existing tools to an integration of these tools that is irreversible.

And not all societies are structured to facilitate or enable narrative change. Our Western democratic societies, for example, are structurally handicapped to implement such changes, as they do not have the authoritarian control necessary to force change, and are biased against the emergence of leadership that could inspire a sufficient proportion of the society to implement change. The illusion of control that governed the energy system since the beginning of the twentieth century has been shattered. It was based on thinking about energy in closed categories and a closed narrative. The narrative of alternative, renewable energy opened up in the 1970s and 1980s, but currently its protagonists are (in vain) trying to close it, too! The interaction between societal "bottom up" and "top down" is such that it is difficult for a leader to emerge who can inspire a sufficiently large proportion of the population to put a novel narrative in place. As a result, our democratic societies are in limbo—not knowing what to do. They cannot mobilize behind an inspiring solution.

CONCLUSION

In conclusion, we will attempt to draw some lessons from these discussions and examples by reformulating them in CAS terms about information processing.

Societal information-processing capacity is at any time on the "edge of criticality" (Kauffman 1993). Its upper limit of processing capacity is closely and dynamically linked to the number of available cognitive dimensions in the society's knowledge system. If there is information overload, the society will initially not be able to handle the situation, but over time will develop new exploratory (open) categories and the narratives to go with it. But if there is for some time not enough information to maintain the knowledge system exploring in all its dimensions, the information-processing capacity will decline, and narratives and categories will be closed around a simplified set of dimensions.

Then, it is necessary for the long-term survival of any society to have a dynamic balance between closed and open categories and narratives. With too many of the former, the illusion of control becomes so strong that adapting to contextual change is hampered. And with too many of the latter, the society will lose coherence and direction.

This points to the essential role of time. Immediate, short-term changes in the system are difficult to handle, whichever the direction of the challenge: increase or decrease of the dimensionality of information processing. But given enough time, generally the knowledge system can adapt to the novel situation. Otherwise, human beings would have disappeared from Earth.

In any society, information-processing capacity is unevenly distributed. Certain individuals, for whatever reasons (innate capacity or cultural learning) process more information per unit of time than others. In most situations, this will result in some form of silo-ing and dominance of those processing more rapidly. They will send signals out to all others in the society through their role in either hierarchical or heterarchical configurations. Often, that ("elite") section of society will be more prone to cognitive reductionism, developing an illusion of control (Gurri 2018). Because of that, it will also push for society to move in a direction that confirms its illusion.

But there are also signals moving in the opposite direction, from outliers to those in the information-processing center. These will have suffered less from cognitive reductionism because they will have been confronted with the unexpected and cognize the world in a higher number

5 A major question is whether AI might enable societies to exceed the human complexity limit. AI does not have the same limitations as societies and might lead to another information-processing system with less of a role for human beings. But AI is subject to another limit, at least for the time being. It does not have intentionality. It approaches independent decision-making, such as in the case of protein folding by machines. But intentionality is the last remaining barrier.

of dimensions. Those signals are compressed and reduced in dimensionality as they are communicated to the center. Whenever these two flows of information are no longer capable of finding shared intermediate dimensionality categories, the society will split and some form of tension will emerge, either within the society or between the society and its environment. Whether that leads to a tipping point or not depends on the balance between open and closed categories and narratives.

Clearly, breaking the illusion of control is difficult, and these few suggestions are but meant as encouragement to begin a major effort to effectively change our current worldview by implementing some of our suggestions. But it is also absolutely necessary if we are as human societies to survive on this planet. In our opinion, the context for such an operation is beginning to be favorable. Here and there in the intellectual world, voices are emerging to "decolonize our minds." Indeed, much of the current mindset (and thus system of narratives and categories) is one that finds its roots in the European intellectual climate of the seventeenth to the twentieth centuries that evolved from the Enlightenment to the Industrial Revolution, the capitalist economy, and, after World War II, the consumerist emphasis on both supply and demand growth that characterizes the present. Colonialism and globalization have spread this approach across the globe to the point that, if we are to ever approach a sustainable state of the human-environmental system, we have to neutralize that paradigm.

COMPETING INTERESTS

There are no competing interests to disclose.

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An archaeologist and historian, Sander van der Leeuw pioneered the application of the complex adaptive systems approach to socio-environmental challenges, technology, and innovation. He coordinated the ARCHAEOMEDES research program (1991–2000) using the CAS perspective on sustainability challenges in southern Europe—the first of its kind worldwide. He held teaching positions in Amsterdam, Leyden, Cambridge, and Paris (Sorbonne), and was founding director of Arizona State University's School of Human Evolution and Social Change and dean of its School of Sustainability. He is Fellow of the AAAS, Honorary Fellow of RIHN (Kyoto, Japan), External Faculty Fellow of the Santa Fe Institute, and Corresponding Member of the Royal Dutch Academy of Arts and Sciences. He held a Chair at the Institut Universitaire de France. In 2012, he was awarded the title "Champion of the Earth for Science and Innovation" by UNEP, and in 2023 the lifetime research award of the Shanghai Archaeological Forum of the PRC.

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