systema

2014 | Volume 2
Issue 1 | 14–22

ISSN 2305-6991
BCSSS

# Complex Thinking for a Complex World – About Reductionism, Disjunction and Systemism

Edgar Morin

*Emeritus Director of Research, Centre Nationale de la Recherche Scientifique (CNRS), France. edgar.morin2009@gmail.com*

**Abstract:** The following theses will be elaborated on: (a) The whole is at the same time more and less than its parts; (b) We must abandon the term "object" for systems because all the objects are systems and parts of systems; (c) System and organization are the two faces of the same reality; (d) Eco-systems illustrate self-organization.

**Keywords**: The whole and the parts; system; organization; self-organization

**Editor Note**: This article is based on the keynote address presented to the *European Meetings on Cybernetics and Systems Research* (EMCSR) in 2012, on the occasion of Edgar Morin receiving the *Bertalanffy Prize in Complexity Thinking*, awarded by the *Bertalanffy Centre for the Study of Systems Science* (BCSSS).

When thinking about systems, the first thing to note is that systems are *complex*. They are complex in several senses. First, systems include many connections between parts that appear as separate entities when viewed from the perspective of the classical scientific disciplines. Second, the system is a unity even though it is comprised of a diversity of parts. Thus we have the primary definition of the complexity of a system, given by Ashby as being a measure of the diversity of parts within the system. This was the first important definition of complexity in the field of science.

However, I maintain that a system is also complex in a logical sense, because when you look at a complex problem you immediately see the limits of classical logic, because we can see that the system is, at the same time, both *more* and *less* than the sum of its parts.

The claim that a system is more than the sum of its parts is very well known, and indeed was already made by Aristotle, and it encapsulates a very interesting point, namely that a system has certain qualities and properties that we cannot find in the parts by themselves. These qualities come from the *organization* of the system.

However, the system is also *less* than the sum of its parts, in the sense that it imposes constraints on the behavior of the parts, so that some qualities or properties of the parts cannot be expressed. This phenomenon is especially evident is social systems: as individuals we have many qualities and potentials that present us with many possibilities for behavior which we cannot exhibit because of constraints, due to socially determined laws or inhibitions due to group norms. Such phenomena take us beyond the limits of classical logic because here the terms “more” or “less” can only be used in a metaphorical sense. In this case the term “more” signifies the existence of new qualities that we designate by the term “emergence”. It is interesting that in this case these emergent qualities cannot be inferred from an examination of the different parts – we cannot deduce them but only observe and characterise them at the level of the system. This confounds the powers of deductive logic.

In my view the systems concept provides us with the essential insight needed for gaining knowledge of complex phenomena, in the sense that when we begin to look at classical science from a critical perspective; we see that the “objects” studied by science, and treated by science simply as *objects* in fact are all systems. For example, molecules are systems of atoms and atoms are systems of particles. The fundamental particles also can only be understood from a systems perspective. They are usually presented to us as logically paradoxical objects, having mutually contradictory properties such as being both corpusclar and wave-like. However, this problem arises because the classical perspective does not take account of the systemic context of the object. Classical science is based on the two principles of disjunction and reduction. “Disjunction” is an investigatory principle whereby objects are divided into more basic things and the specialized disciplines study objects at every level of separation without regard for the connection between them. In this approach it is virtually impossible to see the object in a way that preserves its connection to its environmental context. We cannot understand the significance of the context when we have removed the context! It means something very different to be called “darling” by your wife in your home, and to be called “darling” by a prostitute in the street – the different contexts change the meaning completely. For this reason we have to take as a fundamental principle when dealing with complexity that we have to take account of the connections between things, so we take proper account of the significance of contexts.

In my view present-day classical science is in crisis in many areas, with apparently intractable problems in fields such as fundamental physics, cosmology, biology and so on, but people have a mind-set which makes it very difficult for them to look at things in a new way, and to change to a different paradigm. The crisis of classical science began with the

breakdown of the great principle of universal determination. This breakdown is provoked in the 18th century by the second law of thermodynamics. This law implies the existence of irreversible processes, and this introduces a time-element in physics. Before this it was thought that processes are always reversible, but the second law implies that the passage of time introduces disorder that makes deterministic prediction impossible. The behavior of atoms or molecules can now only be assessed as a group, by using statistical methods, and not traced on the level of individuals. This law also introduces a principle of disintegration or destruction, by implying the accumulation of disorder over time. We see this at work everywhere in the universe. We know that the stars are undergoing disintegration, and that our own sun will die in five billion years, and that dispersion is occurring throughout the universe.

However, at the same time, we see in the universe processes that create organization. Right at the beginning we had a great dispersion in the form of the "Big Bang" from which our universe originated, and this process was so violent that neither matter nor antimatter could persist during this time. However, despite this great dispersion, things were still connected at the quantum level, and via processes mediated by these connections there formed firstly atoms and in due course stars, solar systems and so on. So we see in the universe processes that produce complex matter and complex organization, and in the case of our planet the production of the complex organization represented by living systems.

It is impossible to understand this scenario from the perspective of "disjunction", for when things are treated separately we cannot understand why in some parts of nature we see disintegration while in other parts we see progressive organization. But in fact these processes are a single phenomenon – it is the interplay of ordering and disintegration that makes the development of new kinds of organization possible. This is the great principle behind the complexity of the universe, but it is impossible to discover this if we look only at the second law's production of disintegration, or we look only at the production of complexity.

In this light it is interesting to consider the nature of life. Living systems represent a complex type of organization. The organization of a living system is more complex than the organization of the molecules of which it is composed. However, this organization is achieved using only molecules from the physical universe – living systems are not made from something like 'living matter', but from ordinary physical and chemical substances. "Life" is a property created through complex self-organisation. Life is characterized by processes of self-reproduction and self-repair, processes that involve knowledge and memory. The central feature of a living system is the self-organizational capacity to produce and reproduce itself. However, as von Foerster noted, calling this self-organisation is paradoxical, because the organizational processes of life require a continuous input of energy. We need energy even when we sleep – energy to drive our heartbeat, our digestion, our breathing. We use energy in all moments of life. However, we also need to compensate for the dissipation of energy in line with the second law of thermodynamics, and this means we must take in energy from the environment. We do this by ingesting material that contains energy, and to this we need knowledge of the environment, and in particular knowledge of the organization of the environment. So self-organisation requires an interplay between the knowledge of how to organize the self and the knowledge of how the environment is organized.

The significance of this is that while living beings are autonomous systems in the sense that they maintain themselves, they are necessarily also dependent systems because they cannot self-organize without an input of energy and matter from the environment. This is one of the logical paradoxes of complexity, that autonomy is always accompanied by

dependency. Here again we see that complexity takes us beyond classical logic. This is an important insight because it shows that to understand living systems and many other kinds of complex systems we have to consider such interactive loops between the systems and the environment. This presents a deeper understanding than just to regard the autonomy of the system as grounded in the negative feedback loops that constrains deviations in the system within its homeostatic limits. In my view the "separatists" assign fundamental importance to the homeostatic feedback loops in order to eliminate linear causality and hence to establish the scientific possibility of designing autonomous systems.

A good example is a heating system in a house that uses a feedback loop between a thermostat and a furnace to regulate the temperature in the house. However, such interactive loops provide a very limited kind of autonomy. A fuller kind of autonomy is provided by *recursive* loops. A recursive process, in the sense at stake here, is a process where the product produced by the process is necessary for sustaining the productive process. A living system is like this, in that it is both the product of a process and the producer of that process. As living systems we are both the product and the producer of the product. Societies are also like this. A society is the product of interactions between individuals, but the society has emergent properties that are retroactive on the individuals, and hence shape what we become as human beings, so we are both the product and producer of the society. This notion of recursivity is important for all processes of self-production, and significant for understanding complexity at the human level.

There are two issues at stake here. First, we are obliged to define what we mean by "humanity" in a "trinitary" way, in terms of being spatial, an individual, and a member of society. Just like in the example of the Holy Trinity these elements are generated in a specific sequence, and although they are distinct they also constitute a whole in which the elements are not fractional parts. We are not 30% each element but each one wholly. I am located in space, but there is also space inside me, the spatial volume that I occupy. I am a member of society but I also have society 'as a whole' inside me, existing as rules, culture and so on, so although I am in society, society is also in me. I live in an ecosystem but there is also an ecosystem inside me. These elements form a "trinity", each one generating the others and being regenerated by the others. In this way a person is a perpetual recursive loop, and it is only to this that the complexity of humanity can be reduced.

Traditional reductionism claims that we are all individuals, in society and in ecosystems. In this perspective we are merely units inside these systems, and we are not the connections. In contrast complexity tries to understand the type of connections that are present. And looking at complex systems in this way reveals something interesting – not only is the part inside the whole but the whole is inside the part. For example, each cell in my hand contains the complete genetic code for my whole body. Some of this code is inhibited, but the whole of it is present in each part of my body. We can call this a "holographic principle" because in a holographic image, each part of the hologram contains a substantial portion of the total image. If one cuts a hologram in half and projects light through the two parts, one does not get two half-images but two complete ones. The holographic principle describes this – the whole is in each part. The implication is that human beings have a very complex ontology, and it is important to keep this in mind.

The definition of *homo sapience* is of man as a reasonable being, but this is a deficient view, because we are also *homo demens*, existing in a tension between the two polarities of rationality and madness. This madness is not something exceptional – we become mad when we are angry, or in a state of furore. There is also the madness of the great conquerors, which the ancient Greeks called *hubris*. It may also be that we are in the grip of a kind of political madness. It is interesting that we have these two polarities, but more

importantly we should recognize that we cannot be rational in a pure way – as Damasio and others have shown, even in our most rational intellectual moments our emotions are engaged. Even mathematicians who are doing completely abstract work are passionate about their mathematics. It is because of emotion and passion that we can become mad, but when we are completely coldly rational that is another type of madness. And so we always try to create a balanced interplay between reason and passion, while recognizing that passion is only passion and not reason.

It is also possible to define humankind as *homo faber*, man the tool maker, who thinks up techniques and technologies. But this is also a deficient view because humans also have other kinds of ideas, such as having a sense of there being a life after death, and the existence of genii and of spirits. All societies have religions, and in my view being *homo mythologicus* is of central importance for being human and for being *homo faber*. The capacity to make myths and to imagine is a fundamental ability for humanity. We are not only *homo economicus* with a passion for modernity and acting only in self-interest, but we also play games and write novels, we are also *homo ludens*.

The point is that humanity has all these possibilities. We cannot make a policy decision that only says that humans are rational, because they can be mad as well. We cannot only say that people are good, because they can be bad also. We need to look at both sides. Just as it is deficient to look only on the positive aspects, we should also guard against focusing on the negatives and just setting constraints in society, this is also a false approach. Human complexity requires a versatile politics.

In thinking about this it is important to remember that life is more than just living. People strive to survive but life is more than just survival – people have fundamental needs beyond survival – needs to express themselves, to expand their capacities, to commune with each other, and so on.

Another aspect of life that is also very interesting is that man is also a member of a species, the human species, which is part of the primates, who are part of the mammals, who are part of the vertebra, who are a part of all animals, animals being part of life. Western civilization has totally forgotten the deep, vital relation between humanity and the living environment, the biosphere, ecosystems. Perhaps this started with the Bible, because in the biblical narrative God separates creation: he makes man in his image and the animals are totally separate. But it is mainly the development of Western civilization in the 17$^{th}$ century and afterwards that makes the great separation. Descartes says that science must make man the master of nature. For Buffon and Marx man becomes the dominator, who can manipulate all of nature, all living beings: but he forgets that this manipulation conducts us, finally, not only to the degradation of the biosphere, but ultimately to our own degradation – this is the problem of our scientific civilization.

We can say that if we look at complexity, complexity's presence suggests logical paradoxes. Heraclitus, a philosopher of the 5th century before our era, said: "living by death, dying by life". Dying by life is self-evident, but living by death does not only mean killing in order to eat. Now we know that our bodies are self-destructive to make room for new cells. The regeneration of cells, the creation of new cells means that we are living through the death of cells. The regeneration of cells ensures the continuation of life. Life, in order to fight against death, utilizes death from within in order to be stronger in in the confrontation with death. In the end death wins this battle, but this type of relation is very interesting.

The paradox in the physical world is also the paradox of the "separability", which goes with inseparability. It is the same as with the wave-particle paradox. The wave-particle duality is a paradox of microphysics, but in a similar way: we are separate as individuals, but we also emerge from continuity: the continuity of life, of the species, of society. It is not only a paradox for microphysics it is a general paradox. We are product and producer, we are the cause and the effect, the effects becoming the cause, life and death. This gives a sense of the logical problem which the reflection on complexity must confront, and it must do so in a way that I call "dialogical". "Dialogical" means the union of two antagonistic terms in order to understand a complex problem.

Before discussing our present situation, I want to say that complexity is, finally, not only what we encounter when we try to understand the world, to understand life, to understand ourselves. Complexity is also a mode of knowledge when we integrate certain principles: the principle of retroactivity, of connectivity, in a dialogical principle. It is a way of thinking. I am amazed by how researchers go about investigating complex systems. They study complex systems with uncertainty, randomness, chaos theory, but they don't change their mind, they don't change the structure of their worldview, but in fact they need to undergo a paradigmatic change.

I want to make one more point before considering our current situation. One must consider the ecology of action. What does this mean? When we decide upon an action the action often does not fulfill our intent because it enters in a play of interactions, retroactions and so on. The way things turn out can be completely contrary to what was expected. History is replete with examples of this. As you know, the French revolution had its prelude in an aristocratic reaction, based on the intent to recuperate powers lost during the absolute monarchy of Louis XIV. It begins with the provocation of the Estates General of 1789, where the king preserves the majority for himself, the church and aristocracy. In 1789 the third estate imposes a decision to vote by head-count instead, and this totally changed the majority.

Another example shows that even Hitler's decisions led to outcomes that were contrary to his intent. Likewise, the Soviet Revolution eventually led to results that were contrary to its intentions. The challenge is always to do with the ecology of actions. But what can we do? Sometimes we are obliged to take a decision, because not to take a decision is also a type of decision. It is like the abstention of a vote: it is an action. This means that each decision contains a measure of uncertainty about what the consequences will be. In French we say "*un pari*", a wager. It is important to understand the limits of the power of human decision-making and control. Even in the case of the most determinate strategies, we have limitations in our capacity to follow and correct the trajectory of a decision and even perhaps of preventing a negative reaction to a decision.

Finally, today we are in the system *Earth*. This system is a physical system, a biological system, a human system: the spheres are very imbricated. It is evident that in terms of the evolution of life, we are in the "Anthropocene", in the period where humankind's actions are the dominant influence on the evolution of humankind. As a system Earth is both closed and open: it is open to the solar system and galaxy, and life depends on the rays of light coming from the sun. It is also closed due to the restrictions of the atmosphere and the stratosphere. It is always the same logical problem. Some people call this "the theory of open systems", after Bertalanffy. His theory is very astute. We have to be open, in order to receive and to give to the environment, but it is also necessary to be closed in

order to preserve the integrity and the uniqueness of the system. The frontier is at the same time the point of closure and of communication.

If we look at human evolution from this perspective, we see, leading to the Anthropocene and starting in the 15th century, the beginning of what we can call the "planetarian" epoch. It is nowadays called globalization, but it is better called "planetarian", because it connects all the parts of the earth, through colonization, slavery and so on. Today the system is exhibiting a very widespread process of development, a process of development of technology, science, economics, and so on, but it is ungoverned, without control, without limitation. And it is a great positive feedback, because science and technology today engenders the multiplication of nuclear bombs, without constraints. An economy without regulation goes from crisis to crisis, leading to the development of human antagonism and fanaticism. It is very interesting to note that this development is not only material and technical, but is the development of human madness, in the sense of fanaticism, of the human unconsciousness.

I remember when I was young: ten years before the Second World War all politicians were somnambulists, going through the world without the slightest awareness of the war that was about to occur. Madness, unawareness, productivity, and destruction of the biosphere: we are stuck with a series of catastrophes, and we cannot predict them. However, if we do not find a way to regulate ourselves, to change the path we are on, the number of catastrophes will become more frequent. At the point of the system we call 'singularity', the globalized earth system will be unable to deal with its fundamental problems, its mortal or living problems. It will be unable to treat the problem of the degradation of the biosphere, unable to treat the problem of the multiplication of atomic bombs, unable to treat the non-regulation of the economy and the domination of financial speculation. It will be unable to control the phenomenon of madness, of fanaticism in the current world. When a system is unable to treat its fundamental problems, either the system disintegrates or the system regresses and becomes even more barbarian than it already is.

However, there is also the possibility that the system will be able to produce a meta-system, a system with new properties with the capacity to treat these vital and mortal problems. The problem is to know whether we have the possibility of bringing about that metamorphosis. The concept of metamorphosis is very interesting, because it implies continuity and transformation. A caterpillar can become a chrysalis from which emerges something new, something that has wings. Metamorphosis is not only a phenomenon for insects, like butterflies, but al a historical phenomenon of human societies: in the Middle Ages society was metamorphosed into the Modern society via wars, transformations, destructions and so on. It is not impossible that a metamorphosis to a new type of society will take place again, but it seems very unlikely: we have to change our direction, but we are going at such a great velocity, it seems impossible to change.

And yet, when we consider the great historical changes of the past, all of them seemed impossible. Religious change for example: one began with the idea of a prince, the Buddha, with a new way of thinking about personal existence, about the life of the ruler, and it became a great religion. In contrast Jesus Christ was isolated and crucified but still we have this stupendous deviation within the Jewish world and the Roman Empire that became a great revolution within four centuries. Islam developed in the same way: Mohammed was rejected by Mecca and exiled to be a refugee in Medina, and yet Islam became a great religion. Likewise democracy began in a small city in Greece, Athens, which was destroyed

several times, and yet today democracy is a general ambition in the world. Similarly for ideas like Capitalism and Socialism which became great movements for the best or for the worst in the twentieth century. All the great beginnings seemed so unlikely at the outset.

In the light of this, I think today one cannot think that it is impossible that society can metamorphose again. Maybe the beginning is more diffuse, we don't know. But there is a possibility, even if it is improbable. Very improbable events have occurred quite frequently in human history, and so even if what is probable for humanity is very bad, we still have the possibility of the improbable, and for the possibility of hope in the improbable.

To conclude, I give you an interesting historical example of an improbable outcome coming to pass. It was probable, in September of 1941, the autumn of 1941, that Hitler and the German army would invade the Soviet Union, take millions of prisoners at Leningrad, and finally arrive at the doors of Moscow and take Moscow. But what happened was the deeply unexpected: the German army was immobilized at the doors of Moscow by a premature onset of winter. But, as you probably know, Hitler had planned to attack in *May* 1941, but postponed it. The reason for this was Mussolini, the Italian dictator, was in great difficulty in Greece where the little Greek army had repelled the great Italian army. Mussolini called Hitler for help and Hitler's army had to pass by Yugoslavia to render aid, but the resistance of Serbians cost Hitler a month: that's how long it took him in order to destroy the Serbian resistance. If Hitler had stood by his decision to attack in May he would have taken Moscow, but there was also another confounding element. Stalin's great informer, Sorge, who was in Japan, told Stalin that Japan wouldn't attack Siberia, because Japan was planning to attack the United States in the Pacific. For Stalin this meant he could take the army off the East to put it in front of Moscow. He designated a good general, (because the other generals were only courtesan generals, really very poor generals), Zhukov, to the front of Moscow. On the 4$^{th}$ of December Zhukov attacked and repelled the German army by 200km. It was Hitler's first defeat and the first victory of the Soviet Union. But they could not have done this unless Japan had planned to attack Pearl Harbour. Of course that attack meant that the United States would enter the war.

This means that in the space of two days the probability of the great victory of the century, of the establishment of the Hitlerian empire, becomes improbable and the great improbability of a victory for the other Europeans begins to be probable. You know history is not written. It is not, as the Islamic saying goes "mektum". It is not like that. We are in an epoch of great uncertainty, but, I repeat, with the possibility of hope: hope does not mean certainty; hope maintains confidence, because hope opens up possibilities.

## About the Author

Edgar Morin is a Sociologist and a Philosopher, and Emeritus Director of Research at the *Centre Nationale de la Recherche Scientifique* (CNRS) in France.

He has concentrated on developing a method that can meet the challenge of the complexity of our world and reform thinking, preconditions for confronting all fundamental, global problems. His works - the six volumes of *The Method* (1977-2004), *On Complexity*, *California Journal*, *Vidal and His Family*, *Pour sortir du XXème siècle*, *Concept of Europe*, *New Trends in the Study of Mass Communications*, *Homeland Earth*, *La Voie* - have been translated into many languages, including Chinese, English,

German, Greek, Italian, Japanese, Korean, Polish, Portuguese, Russian, Spanish, Swedish and Turkish.

Morin has received honorary doctorates in subjects ranging from political science to psychology and sociology from universities in 27 countries and holds an itinerant UNESCO Chair in Complex Thought.