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Complex Systems – New Conceptual Tools for International Relations

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Abstract: Globalization, as a social process, induces particular constraints on the analysis of peace and war. The increasing complexity of social systems can only be ignored at the cost of inefficient social intervention and a decrease in the understanding of the phenomena. The distinction between the "classical" and the "complex" system becomes an issue at the core of the epistemological debates. Non-linearity is inherent in politics, and therefore linearity assumptions do not help very much in understanding the non-linearity of the real world. In order to analyse peace and war from a complex systems perspective we need to identify the ways in which the states of peace or war can be stable attractors of the systems. The property which makes the attractors valuable for studying conflicts and peace is their emergent nature. In order to make the concept "attractor" more operational, we analyse the "degree of freedom" of the systems and the way it is diminished by the emergence of certain normative regulations. Social attractors express the limitation on the degree of freedom of the systems. The emergence of a powerful conflictual attractor in the system causes the system to return, after any perturbation, into the state of conflict. On the other hand, the emergence of pacific attractors is a condition for any stable peace. Finally, the case of the European Union is analyzed as an example of a pacific attractor that shaped the post-war European states system.

Key words: peace, war, complex systems, attractors, European Union

INTRODUCTION

Why apply a theory that originated in physics in international relations? In an article (Bernstein et al., 2000) that analysed the position of the social sciences, particularly of the science of international relations, in the framework of other scientific disciplines, the extreme difficulty to make consistent and valid predictions on the incidence of wars is considered a paradigmatic example that illustrates the explanatory weakness of theories in the field of the international relations. As the chemical or nuclear processes, wars are caused by the interactions between the *underlying* causes and *catalysts*. Although the arms race and the formation of alliances can be seen as the causes of the First World War, it was the assassination in Sarajevo that eventually triggered the conflict, i.e. the catalyst of the conflict. Even when we can identify the determinant factors, or causes, of a conflict, the effect of the catalysts, which is rather random in most of the cases, makes actual prediction of a conflict extremely difficult. This makes general statements about the causality of war highly problematic, *"since we have no way of knowing what wars would have occurred in the presence of appropriate catalysts"* (Bernstein et al., 2000: 47).

No single factor can be considered a unique cause for the emergence of wars. In such complex systems as the human system, concepts as cause or effect have "a dubious value" (Boulding, 1974: 31). Correlations between factors, non-linear causal relations, simultaneous processes, and critical momentary values of certain variables, usually form an incomplete and oversimplified picture of war.

Some specialists (e.g. Goertzel, 1994; Louth, 2005; Mesjasz 1988, 2006) have suggested that in order to build more applicable explanations in social sciences, it is better to approach the phenomena through the lenses of a complex systems theory, hoping that it would increase the understanding of the phenomena. It was even said that the complex system approach to the social science is a very essence of the "interdisciplinarity" concept (Bar-Yam, 1997).

The first section of the paper outlines some of the concepts of the complex system theory. The next section the paper looks at the reasons that make us consider the complex system approach appropriate to the study of international relations. In the third section, the current systemic approaches in social science and particularly in international relations are reviewed. In this section the paper focuses on the distinction between the classical systemic approach and the complex systems approach.

The fourth section develops the concept of "attractor", trying to operationalise the term so that it is usable in social sciences and more precisely in international relations. The fifth section of the paper analyses the idea of conflicts as attractors, introducing the distinction between conflictual attractors and pacific attractors. The sixth and final section analyses the European Union as a pacific attractor, outlining a new area of research in the international relations, under the complex systems approach.

1. THEORETICAL OUTLINE

Complex system theory is not just another theory, rather it is more a general perspective of analysis (Morel and Ramanujan, 1999), a paradigm that brings new instruments into the conceptual toolkit of science of international relations. In this section, we will define some concepts of the complex systems theory that will later be used to explore the new tools that this approach can bring to the field.

We use the term *complex system* to denote *a set of interconnected and interdependent parts*. The most important features of the complex systems are interconnectedness and the emergence, i.e. the fact that *the whole cannot be reduced to the sum of the components*. Later in the third section the paper makes the distinction between the classical notion of system and the "complex" one. In the social field, many authors prefer to use the term "complex adaptive systems", that refers to the capacity of a complex system to adapt and therefore to react to the challenges from the external milieu.

To approach international relations through the lenses of the complex systems paradigm we must take a look at the older idea of the level of analysis. The first time that this was used in international relations was by Kenneth N. Waltz (1959), who structured his explanatory theories of war, on three separate levels: the individuals, the state, and the states system. The number of levels of analysis that different scholars used as references were in some cas-

es even greater. An analysis (Buzan, 1983) of the concept of security also used intermediary levels that were considered useful for the research aimed at proving that sub-state communities can be considered relevant. One of the scholars that approached the society as a dynamic of complex systems, starts from the cell, then increases the aggregation to its highest level, which for him is the human civilization (Bar-Yam, 1997). The most important thing is not to de-compose a complex system into lower level complexities, or to increase the level on a scale of increasing complexity, instead we should look at the logic of the interaction and the manner in which it reaches the emergence of the phenomena. In complex systems, from the living cell to the global social system, we can essentially identify an infinity of levels of organisation. Of course, not all of them are relevant for the purpose of this paper. Although the human person as an individual can be analytically decomposed into lower level complexities, for the purpose of the present analysis – the approach to peace and war – we will consider the individual as the elementary unit of analysis. From the level of analysis point of view, the emergence is the most important property of the complex systems. From one level of analysis to another, the functioning of the component parts is not sufficient to describe the behaviour of the next level. An organ is not just the sum of a few thousands of cells, as the functioning of every component cell, taken separately, is not enough to explain the behaviour of the whole tissue. As Bar-Yam pointed out, the emergence is the property that forces us to approach complex systems with the prerequisite of *multiscale complexity*, that is, to assume complexity at all levels. In this sense, the complex system theory is a useful tool to bridge the micro-macro gap in social science (Goldspink and Kay, 2004).

To analyse peace and war from a complex systems perspective means to identify the way the states of peace or war can be stable attractors of the systems.

The concept of attractor emerged in the mathematical analysis of complex systems (Prigogine and Stengers, 1984) that showed that some behaviour was more likely in the system then other behaviours. Even seemingly chaotic behaviour could reveal, after a large enough number of iterations, some behavioural pattern which appears to be stable. Non-determination is not complete, and the chaos disguises a certain order, even if it is difficult to visualise or to intuitively represent it. The graphic representations of states of a complex system – iterative maps, in mathematical language – illustrate in many cases the existence of a certain order behind the apparent chaos (Bar-Yam, 1997). After a sufficiently high number of iterations, some points or regions of the iterative map seem to be repeating, in essence they are fixed. In terms of systems behaviour analysis, the fixed points are states that tend to attract the parameters of the systems, no matter what the intermediary states are. The system behaves in such a way that the fixed points *attract* its states. The system has, in essence, certain *preferred states*. There is a *basin of attraction that* consists of all the states of the system that will naturally move towards the attractor points.

An analysis (Skyrms, 1992) of systems' behaviour, founded on game theory analysis, concluded that in the dynamics of social systems, the attractors are better explanatory concepts than the equilibrium. The property that makes

the attractors valuable for studying conflicts and peace is their emergent nature. The conflict is not an event, but a process. In the systems, the attractors emerge as self-generative and self-maintained processes. The attractors are useful in explaining the way in which the conflict occurs but also to explain the manner in which the complex systems remain in the state of conflict. Under this conceptual framework, the issue of conflict solving refers to changing the dynamics of the system from the conflictual state to a non-conflictual stable state, that is, from containing conflictual attractors to containing non-conflictual (pacific) ones. The long term approach is important: ***if these attractors can be identified and properly described, then it is possible that more pragmatic and effective theories for maintaining peace in social systems can be formulated and tested.***

The complex systems approach is situated at the border between the nomothetic and idiographic science. In international relations, this approach is placed at the boundary between constructivism and structural realism, contributing to the agent-structure debate in international relations (see Buzan, Little and Jones, 1993). Although many analyses of the complex systems are quantitative, our approach is qualitative in nature. This does no exclude more quantitatively oriented approaches in the future, as the mathematical apparatus of complex systems theory will be doubled by properly operationable concepts.

2. WHY COMPLEX SYSTEMS IN INTERNATIONAL RELATIONS?

At the beginning of the new millennium, the theory of international relations finds itself in the situation of having remained tributary to an obsolete conceptual system. The nation-state, the main reference point of the dominant paradigm in the international relations, is now seen as an insufficient concept for describing a world which is experiencing an accelerated process of globalisation. The borders of states are becoming more and more permeable, almost to their dissolution, and military power cannot by itself secure a state's survival. Globalisation, reflexivity of object studied, and the social indeterminism principle are the main arguments in favour of a complex system approach of the international reality.

The need to refresh the conceptual means of international relations is illustrated by the globalism phenomena, the increasing interdependency between still partial understandable phenomena and other less predictable ones. The metaphor of the butterfly that, at the flapping of its wings, unleashes a hurricane in another part of the globe becomes less a simple metaphor and instead it illustrates the non-linearity of the social domain. As Urry (2002) stressed, September 11 shows *the limitation of the linear approach* to the global reality.

Globalization, as a social process, induces particular constraints in the analysis of peace and war. The increasing complexity of social systems can only be ignored at the cost of inefficient social intervention and a decrease in the understanding of the phenomena. At the same time, the conceptual toolkit of contemporary international relations proves itself inefficient both on the level of the explanatory and the action dimension, confirming the inadequacy of the theoretical framework as a premise for action in the increasing complexity of the social reality.

In social research we are ready to calculate correlations between dependent and independent variables. We can even calculate the proportion in which the variation of one influences the variation of the others. By this logic, we ignore the intercorrelations between elements and variables, and the reality that they co-evolve leading to the emergence of new phenomena. The project "Correlates of war", probably the biggest effort to systemise empirical data about a large number of wars in history did not really have impressive results at the level of theoretical development (Singer and Small, 1972; Small and Singer, 1985). When referring to humans a complex adaptive system also has the capacity of *self-reference*. This is the consequence of the self-reproduction of the systems. *"As part of the structure of the human nervous system, it is possible for humans to generate a domain of 'self' or to become self-conscious. This is referred to as reflexivity"* (Goldspink and Kay, 2003: 462).

The collapse of the Soviet empire, an event that was not predicted by any analyst of the time, also raises questions on the non-linearity phenomena in the social sciences. Forty years ago, Stanley Hoffman (1965: 134) compared international relations with a huge casino roulette game, where some families get more or less rich, depending of the stakes and into which pocket the ball lands. At certain moments, some families are eliminated, new ones enter the game, but at no time does the game itself stop.

The situation was properly synthesised by Steven Bernstein et al. (2000: 51): *"The more people think that they understand the environment in which they operate, the more they attempt to manipulate it to their advantage. Such behaviour can relatively quickly change the environment and the rules that appear to govern it, possibly to the detriment of all those involved."*

"Few political scientists would deny the fact that the political systems are complex" – wrote Bruner and Brewer (1971: 84). At the same time, few of them would deny that we, as humans, have only a limited capacity to understand the political systems as wholes. The relevance of both assertions makes it necessary to display caution when approaching any of the social and political systems.

In physics, the principle of indeterminism formulated by Heisenberg (1930) referred to the difficulties in precisely measuring certain phenomena, as any operation of measure is conditioned by an exchange of energy between the object and the instrument of measure. This interaction, subject-object, made it impossible to ever get a totally accurate measurement, with the errors being very significant in the field of quantum physics. In fact, the analogy between physics and the social sciences, a desire of the founding fathers of sociology, can be functional if we refer to the field of quantum physics, but much less applicable if we expect an analogy with classical mechanics, with more rigid laws and very high probabilities.

The same law concerning the two-way relationship between subject and object can also be used when dealing with society. The *social indeterminism principle* is founded on the rationality and the conscience of the individuals. A physics theory, be it right or wrong, concerning the way a particle behaves, has no effect whatsoever on the actual behaviour of the particle, as it has not been proved so far that the particles have any consciousness. In some ways things are similar in social sciences, but there are a few marked differences.

The knowledge of social science has, if disseminated, consequences at the social level, influencing the social reality. The consciousness of people is a factor that decreases the possibility of making accurate predictions, as the self-altering prophecies affect the system in the same way the presence of the observer and the measuring device influence the position of the particle. The rationalness and consciousness of human behaviour along with social aggregation decrease the possibility of predictions. The analogy between social processes and chemical ones is a simplifying one. Unlike people, molecules or particles have no memory, consciousness or capacity to learn.

A public statement about the imminent insolvency of a bank, be it real or not, can bring about a real crash, if the depositors withdraw their money. A self-fulfilling prophecy, as sociologists describe it, is a paradigmatic example of the distinction between the science of nature (e.g. classical physics) and the field of social sciences. In the case of social science, some analysts even exclude the possibility of making accurate predictions.

When he wrote that the consumer does not expect his dinner from the bakers' or grocers' benevolence, but from their tendency to follow their own interest, Adam Smith was referring to what sociologists would later name "aggregation effects". In the same way, two queues in front of two ticket booths will tend to be equal not because of anybody's intentional action or any imposed rule, but because of the wish of people to wait the shortest amount of time.

Smith needed the concept of an "invisible hand" to explain the regulatory role of market forces. Later, sociologists brought into discussion the "aggregation systems" to express the way in which individual actions are composed at the level of collectivities. The term *effets pervers* explains in the logic of actions that undesired or unforeseen results are the results of aggregation logic. A more neutral term "aggregation effects" covers essentially two categories of unintended consequences, classified as "weak" or "strong" forms, that are or are not predictable by the actors involved (Linares, 2003). The partially (at best) predictability of behaviour of human aggregates cause the analysts to find more effective theories in order to better explain society. In this the systems theory, and later, the updated complex systems theory are particularly useful.

To summarise, there are two main arguments for using a complex systems approach in international relations. Firstly, it can help to better frame a reality that is highly complex by its own nature. The intrinsic complexity of the field of human interaction allows us to hope that a paradigm that accepts complexity at all levels will be useful in explaining the phenomena. Secondly, as we already showed, the contemporary world's complexity is increasing, and the assumed complexity at all levels is able to bring new insights in to the field.

3. SYSTEMATIC APPROACHES IN SOCIAL SCIENCE AND TO INTERNATIONAL RELATIONS

The systemic approaches in social analysis precede the explicit formulation of systemic theory as such. For instance, the discussion about the social equilibrium is a much older idea. Malthus performed a systemic theory *avant la*

lettre when he analysed (1963) the intrinsic disequilibrium between the geometrical progression of population and the arithmetical progression of the means of subsistence. The excessive increase of the populations related to the possibilities of the environment to support them is prevented, as he believed, by self-regulation mechanisms: the emergence of vices, wars and epidemics. War, in Malthusian vision, was part of a great plan of Nature, the unstoppable effect of natural laws, very similar to gravity.

Launched by Bertalanffy (1968), the systemic approach quickly became a preferred paradigm for many specialists, particularly because of its high adaptiveness to different situations, whether in technical matters or social life. The isomorphism between the technical and social systems, previously suggested by the systemists, brought the hope of surpassing the excessive disciplinary fragmentation of the sciences. Beside the analysis of social and natural entities, systemic thought allowed the design of highly predictable technical devices.

As von Bertalanffy pointed out (1968: 38), general system theory had as purpose to highlight the tendency of integration between the natural and social sciences and to help the formulation of exact (i.e., mathematical) theories in non-physical fields of science. Moreover, it was expected that the theory would bring about the unification of the scientific disciplines. This idea was not entirely new; Comte hoped that industrial society will be lead by scholars, while "social physics" (see Bagehot, 2001) that emerged at the end of the 19th century, expressed the profound faith that humankind was following a road towards rationality. At its beginnings, the systems theory seemed to be the most appropriate theoretical instrument of this progress (Laszlo, 1972b).

a) Realists' "international system"

For the representatives of the Realist paradigm of International Relations, the notion of system denotes a power configuration, more or less stable, that are the result and structural expression of a balance of forces. When talking about the international system, the Realists were mainly referring to the relations between different powers, the system being equivalent to the power configuration, as the interactions of individual agents influence in a certain manner the actions of each individual agent. An article belonging to Kaplan (1957), for instance, was focused on the structure of the world system itself, analysing the stability of the "balance of power" system in comparison to "bipolarity". This macro-level approach set out to prove that the Realists' "international system" is nothing but a fashionable concept that was adapted to a paradigm that considered that things were clear theoretically. Paradoxically, for the Realist, the concept is emptied of its systemic content. Morgenthau, for instance, considered that equilibrium is an essential dimension of the social system (1967: 163). However, if we are prepared to admit, even theoretically, that not all the elements of a system are necessary for its survival, then the discussion of concepts as "equilibrium" or "balance" in terms of stability is but an intellectual exercise. If we look at European history from the perspective of some actors (e.g. Poland), the notion of equilibrium did not prevent them from disappearing from the map or at least from losing parts of their territory.

b) Reconciliation: Structural Realism

The representatives of Structural Realism (Waltz, 1979; Buzan, Little and Jones, 1993) try to reconcile classical realism with the notion of the system. In this approach, the system is composed of units, but also includes the interactions between the units as well as its structure, all these must be taken into consideration when designing the actions of any actor. Gilpin, for example, developed (1981) a systemic model that associates the equilibrium to peace and the disequilibrium with war. In his model, peace and war are part of the processes that govern stability and change in the international system. In his approach, the structure of the international system, a certain power configuration – not exactly a conceptual innovation – is stable to the extent to which unequal development produces an increase in the power of certain marginal actors that can endanger the position of the dominant actors. The disequilibrium emerges when an economical, political, or technological development increases the benefits or decreases the costs of the revisionist actors' attempts to change the structure of the system. The discrepancy between the structural configuration and the real power distribution is the factor that produces a system crisis that generates the systemic change and the restoration of the equilibrium through its restructuring. This process is similar to the homeostasis of the human organism; the overheating of the system generates a feed-back reaction that lowers the temperature. War shapes the system's structure at a particular moment. The hierarchy of power, prestige, and the distribution of territory are dependent on the successful use of potential power, ultimately of war. It is impossible to accurately evaluate this power without the test of military confrontation, though this has the precise function of shaping the power and prestige hierarchies in the international system. As Gilpin concluded, the hegemonic war is the main mechanism of systemic change in international relations that mark the start of a new cycle of development and expansion.

c) Peace and war as equilibria

Another model that analyses peace and war in terms of social equilibrium belongs to Boulding (1978). For the American economist, the interaction of two human systems can be placed on a scale with two extremes states: peace and war. To explain the phase transition from peace to war, Boulding needs two variables: strain and strength. The ratio between these two variables determines the transition of the systems from peace to war. If the strain of the peace system is bigger than the peace strength then the transition from peace to war occurs. Likewise, if the strain of the system is bigger than its war strength, the system transits from war to peace.

A stable peace or a stable war are, in Boulding's model, equally stable and equally probable. Unstable peace or war are the intermediate states, the dialectic of the ratio strain / strength makes the system prone to rapid and frequent transition cycles, dominated by one of the states.

Boulding's composite variables are rather abstract. The static variables that express the strain refer to the image of the past, professionalisation of the conflict, political structure and the prevalent social ethos. The arms race, the repression race, economic, and demographic processes, differences in growth, but also the way the conflict itself is perceived, are the descriptive variables

of the strain. The strength is described by variables, such as, the memories of the past, the professional specialisation of those that are involved in the conflicts, the functionality of diplomacy, the growth of traffic and communication networks, and the economic interdependence. All those are factors strengthen the system, increasing its resistance to strains.

Boulding's composite variables are quite abstract, but more important is the fact that they are rather ambivalent: some factors are mentioned both as increasing strain, and as increasing strength.

The two systemic models share the common focus on the economic dimension. They translate the theories of the economic cycles of growth and decline to the peace-war alternation.

d) From "system" to "complex system"

In 1990 Kaufman announced the birth of a new "science of complexity", expressing his hope that it will transform both the biology and the social sciences. It was recently pointed out (Mesjasz, 1988) that the latest developments in systemic theories – especially those that discuss complexity as a fundamental feature of social systems – reveal numerous interdependences in the social world and also promise new research avenues.

To add to a system the attribute "complex" is not a simple semantic exercise. Bertalanffy himself defined his general system as *"a complex of interacting elements"* (1968: 55). Through this definition, he considered the systems to be *a priori* complex, but the complexity in this case was not a feature of the system; it rather results from the structures and hierarchies, and the sense is that of "complicatedness". A machine composed of a large number of interacting and hierarchically organised parts was considered *complex*, though such a machine was just *complicated*, as the parts are interacting in a strictly deterministic fashion. On the other hand, the complex systems (e.g. the weather) involve not only a large number of components, but also nonlinear interactions and emergence.

This idea was also expressed by Jervis, who wrote that *"we are dealing with a system when a set of units or elements are interconnected so that changes in some elements or their relations produce changes in other parts of the system, and the entirety exhibits properties and behaviours that are different from those of the parts"* (Jervis, 1997–1998: 570). The systemic theory, itself, was considered the answer to the need to order and to optimize a world in which the disciplinary fragmentation was not efficient in helping us to understand it, a world in which the network interaction begin to increase exponentially.

The distinction between the "classical" and the "complex" system is an issue that animates a considerable part of the epistemological debates of our time. The first attempts to use the complex systems approach was to model chemical reactions or to make accurate weather predictions. Terms such as chaos or catastrophes bring into the field of science irregularity or unpredictability, shaping the way to scientific acceptability and respectability of non-linear phenomena and to similar approach in the field of biology or the social sciences. The difference that the complex systems brings to analysis is the adaptive character of biologic or social communities, their capacity to

co-operate in achieving certain objectives, and their capacity (especially of the human communities) to build technical tools to adapt themselves to the external environment. To describe this we use the concept "complex adaptive systems". But, if some chemical reactions seemed complex, the notion "complex system" is really comes to the forefront by its use in the social field. Complexity is an upgrade of the paradigm, as the "classical" systemic approach showed its limits in analysing social entities. The notion of complexity, as Nicolis and Prigogine pointed out, refers to evolving systems, in which history plays an important role in their behaviour (1989: 36).

The simplifying assumption *"ceteris paribus"*, is the basis of the expression of causal relations in social science, which are then dissolved to a reality to continual movement and evolution. The analysts hoped that through the causality, which reminds the mechanics and the "laws of nature", we are able to explain everything (Allen, 1989). The classical causality can explain many things, but it proved incapable of explaining evolution. The social reality refuses often to conform to the schematically and static models of the analysts, and the understanding of this fact is probably one of the most important elements of the complexity theory. In systems "we can never do merely one thing" (Jervis, 1997–1998: 570), and this assertion proves its truth if we refer to social systems.

In the field of international relations, the first acceptance of the term "complex systems" refers to the international system itself. The interconnectedness and the interdependence between the components and the variables that describe the components has for a long time been emphasised. Even the debates between the paradigms, i.e. different frameworks of analysis of the international reality, can be in itself an argument in this sense. The second acceptance refers to the components of the international system that can, in their turn, be analysed as complex systems. The most used example by international relations scholars, the state is a good image for what we call "complexity", if only because the interactions between the components (firms, different social groups, the powers of the state) create unique configurations of a dynamic character. Different sub-state groups, for instance ethnic groups, can also be analysed as complex systems. This makes the paradigm very useful in analysing internal conflicts (ethnic or otherwise). Social aggregations at a lower level can also be analysed as a complex system.

There are important qualitative distinctions between different levels of aggregation, from the chemical systems to human civilization. There are, of course, relevant distinctions between the biological and physical systems. If when we talk about the level of indeterminacy, the physical and biological (or social) systems face certain similarities, one of the distinctions refers to the *degree of equilibrium* of the systems. The physical systems tend to equilibrium, that is states characterised by high levels of probability or to the lowest degrees of organisation (maximum entropy). On the other hand, biological systems behave differently. Concepts as organization, wholeness, directivity, teleology and differentiation are not useful for physicists, situating the biological and social system in the category of that far-from-equilibrium (Bertalanffy, 1968: 34).

Another important element that distinguished the biological and physical or chemical systems is their relation to their environment and the way it alters their behaviour. The physical or chemical systems are analysed as "closed systems", in the sense that their relation to the external milieu is irrelevant, the exchange with the environment being only a matter of exchange of energy. In closed systems, the final state is determined by the initial conditions, and the system evolves, according to the second principle of thermodynamics, towards the state of maximum entropy. Living systems, on the other hand, are in a permanent state of exchange of matter and energy with the environment, but they are able, between certain limits, to function independently of the changes in their environment. In a potentially hostile environment, the organism needs homeostasis in order to keep its vital processes stable. The animals, for instance, keep their body temperature constant even in conditions where the external temperature varies. The anti-entropic mechanisms that function in the case of living organisms are cybernetic processes of negative reactions that are energetically maintained by metabolic processes (Laszlo, 1972a). Even when far from the equilibrium state, living systems are relatively stable in relation to the environment.

Non-linearity is inherent in politics, and our linearity-founded assumptions do not help us much in dealing with this non-linearity (Hoffmann and Riley, 2002). This is basically the reason why the complex systems approach can make our research more in touch with reality. Hoffmann and Riley also stressed that the approach will not become popular until it reaches a more important empiric dimension. This is what the paper looks at in the next section.

It is quite logical for analysts to hope to get to the causes of war. If one can identify the cause (or causes) of war, one could at the same time, at least in theory, avoid it by removing the respective cause. In the particular case of the science of international relations, the ultimate purpose of mainstream (positivistic) research programs is to be aware of the mechanisms of the international system, so that the decisions made by statesmen and by bureaucracies that manage the external relations of the states can be the correct ones. Beyond the inherent satisfaction of any intellectual work, the implicit pragmatism of the field imposes certain requirements. At the beginnings of the discipline, the link between theory and policy was explicit, and the purpose of the research, which was also explicit, was to build a better world, by removing the scourge of war (Burchill et al., 2001: 87). These hopes were fuelled by the first positivistic approaches of international relations and of decision-making in international relations. In order to fulfil such a policy – oriented purpose, a minimum of operationalisation is necessary.

4. ATTRACTORS – FROM METAPHORS TO OPERATIONALISATION

Attractors were used more as metaphors than as rigorously defined concepts. We will try to operationalise the concept in order to make it more applicable in social science, specifically in international relations.

From the complexity theory point of view, the attractors are the effects and not the causes, although they may appear similar to gravitational centres (Cramer, 1993). They can be compared to the eye of a tornado: it is not the cause of the movement of the air, but the air is moving towards it.

While attempting to elaborate a general theory of social equilibrium, we can describe three types of attractors (Fararo, 1993): ***the stable attractors*** – the stable states of the system (fixed points) and the ***cyclical attractors*** (representing the situations in which the system repeats periodically different states) are the easiest to analyse. The attractors that were named ***"strange"*** by mathematicians (see Nicolis and Prigogine, 1989) are associated with chaos and are more interesting from the mathematical point of view. In some ways, they can be considered cyclical attractors with a very long cyclical pattern, which does not make them easier to predict. From the point of view of the social theories, the first two types of attractors seem easier to analyse. To build valid nonlinear explanations in international relations, that are useful for policy-oriented works, we cannot analyse a concept like peace as an unpredictable state, or as a momentary one; the stable attractors of the social systems are, from our point of view, the most relevant. An attractor is not necessarily a fixed point, representing an invariable state of the system. In social systems, the attractors can also represent a collection of states, or a cluster of possibilities.

In isolated (e.g. physical) systems, the equilibrium state appears as an attractor for the *far-from-equilibrium* states. The tendency of increase of entropy in thermodynamical systems, revealed by the second principle of thermo-dynamics, expresses the existence of a maximum entropy state as the attractor of the system (as in Figure 1). The intuitive image of the states of a complex system is represented by a landscape with hills and valleys; the lower a point is situated, the more stable is the state it represents.

Any change in the system's state (towards B or C) takes a certain amount of energy from outside the system and therefore such changes can only be temporary. As soon as the energy influence from the outside environment stops, the system will evolve by itself towards the state of maximum entropy (point A in figure 1), i.e. the attractor of the system.

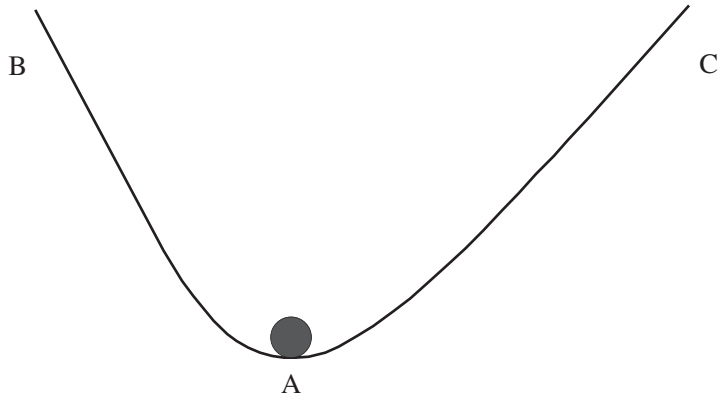
In the case of an open system (including the social system), the attractors are not simply the result of the general laws of the physics. In social systems, the factors that shape the emergence of certain attractors in the systems function along different dimensions. Composite concepts as "energy" were considered useful for operationalising them, but a consensus is still far from being achieved by researchers.

In mathematical systems, the attractors are the result of random factors. In social systems, the randomness is no less important, but the (at least partial) consciousness of human behaviour should help, at least in theory, to make the attractors more easily identifiable.

The attractor functions if there is a *basin of attraction,* i.e. it requires the existence of certain forces inside the system which return its state towards the attractor when perturbed (as long as the perturbation is not as big as to surpass the limits of the basin of attraction). The fundamental distinction between closed and open systems seem to be that as the former have only one attractor, which is the highest probable state, while the later (the living systems being a very good example) are maintained in function by the emergence of *far-from-thermodynamic-equilibrium* attractors. In living systems, the perturbations start the feed-back mechanisms, bringing the system back to the attractor. If the limits of the basin of attraction are surpassed, the system

leaves the limits of the functioning of the living system, and the system evolves towards another attractor: in the thermodynamical equilibrium. Essentially, the attractors are the results of a set of convergent processes, which induce a dynamic self-generative process, the result of a "structural conspiracy" (Goertzel, 1994).

Figure 1: The attractor as the equilibrium state of the closed system



In complex social systems two or more attractors can be identified, each of which have their own basin of attraction. In Figure 2, the points A, B and C represent the attractors of the system. They are not identical; some of them have a larger basin of attraction, or are more stable than others.

The movement of the system from the stable state A to the stable state B actually represents the movement of the system from the basin of attraction of the attractor A towards the basin of attraction of the attractor B, through the point E. Intuitively, an attractor is similar to the flood plain of a river which attracts surplus water in the case of a flood, in essence the water floods toward the points which have the lowest potential energy. The realisation of different attractors is possible by intervention into the system; building a new channel is a way of accessing the basin of attraction of another attractor.

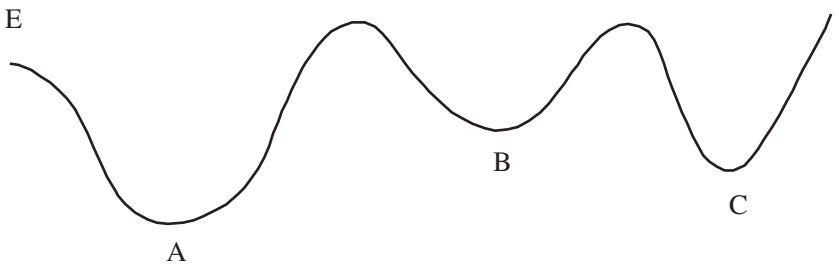
In the social systems, it is the *sociality* factor which shapes new attractors, and which refers to the subordination of individuals to the norms. In the case of social systems, the aspirations of actors are important; they generate certain expectations and influence the actions of the actors towards their fulfilment. Social action is shaped by aspiration, but also by social norms – behavioural prescriptions that the system's conservation impose.

The attractors can have a generative role, as far as they are the source of aggregation processes. The model of Axelrod and Bennett (1993) illustrates this. Shaping a theory of aggregation of the human systems, the Axelrod and Bennett model considered it essential that there is a tendency of two nations to be on the same side in the event of a conflict. This tendency of the two nations is considered symmetrical and is analysed on pairs of states. The shaping of multi-state aggregations can be analysed for all possible variants of

grouping. It is obvious that not all the possibilities are equally beneficial for all the components of the system. One can calculate the *frustration* generated by each combination for each of the countries, and the sum of the frustrations, taken together within the dimension of each country, express the *energy* that can be associated to each of the possible configurations – a measure of the aggregated frustration. An energetic map can then be built from the points that unite the level of energy of each of the configuration, revealing the point with a minimal energy level, towards which any evolving state of the system, respectively the points with minimal aggregated frustration, tend to move.

Applying the model they looked at the international situation prior to WWII. Axelrod and Bennett considered the European states of that period as entry variables of the system and built an energetic map of the interaction between the European states in 1937, two years before the outbreak of the Second World War. The calculations revealed that two of the possible configurations of the alliances, with the lowest aggregated frustrations, had Germany and the Soviet Union in different camps. Moreover, one of them was extremely similar to the actual configuration of the alliances at the outbreak of the war, validating this theory of aggregation.

Figure 2: Graphical representation of a system with three attractors



The conclusion that Axelrod and Bennett reached is that the configuration of the alliances in the international system before the outbreak of the Second World War constitutes an attractor of the system, a minimum energy configuration, with minimal aggregated frustration. The identification of the attractors of the system is thus very important for describing the future behaviour of the system.

For analytical and operational purposes, we must analyse the concept of "degree of freedom" of the system that is linked to the potential states of the system. Each system can be characterised by a certain number of variables that describe its functioning. The degree of freedom of the system is higher when the number of the possible potential states of the system is bigger.

A mental experiment is useful here. We can, for this purpose, imagine a system that is not linked to anything, not even to the environment. Such a system would theoretically have an infinity of degrees of freedom. That means that the variables that describe the state of the system would be able to

take any value, without being linked to each other. This is, of course, an analytical fiction. The discussion on degrees of freedom is senseless if there is no limitation on the evolution or behaviour of the systems.

On the other hand, we can imagine a system that is totally influenced by its environment, in the sense that its environment is entirely controlling its behaviour. Such a system would have no autonomy whatsoever in its behaviour, that is, its degree of freedom would be extremely low, virtually zero.

Of course, it is a truism to say that any system operates within a specific environment that includes all the reality that is not part of the system. It seems that the real systems have a limited degree of freedom, as they are linked to their environment.

Social systems were analysed (Goldspink and Kay, 2003) as self-reproducing systems. This kind of systems, that were earlier named (Maturana and Varela, 1980) "autopoietic", are autonomous in relation to their milieu. What distinguishes them from the "open" systems of the classical systemic theory is their two-way relationship with their environment. When an autopoietic system enters into contact with a certain environment, either one or the other (or both of them) is modified. When the relationship is recurrent, the auto-poietic systems become "structurally coupled" between them and/or with their environment, at a physical or a non-physical level, creating systems of a superior order. A similar behaviour of two or more systems, the emergence of a language, is just one of the possibilities of structural coupling of social systems that lower the *degree of freedom* of the systems. The structural coupling of a larger number of autopoietic systems reveals common behavioural patterns, normative models that constrain their behaviour, and the development of feed-back mechanisms maintains the functionality of norms.

In mathematical systems, the (theoretical) degree of freedom does not have an upper limit, in the sense of the number of possible states. This makes prediction within the complex systems very difficult. Nevertheless, the emergence of relatively stable behavioural patterns in social systems is equivalent to a lower degree of freedom. In this sense, the attractors are expressing the lowering of the degrees of freedom of the systems. However, in any social system, the emergence of certain normative regulations reduces the degree of freedom of a system, in the sense that the component subsystems internalise behavioural regulations, limiting the possible system states (Goldspink, 1999). To summarise, we have a social attractor when there is a complex of factors that reduce the degree of freedom of the sub-systems, that is, when there is a behavioural reference that influence their behaviour as it reduces their alternatives.

5. CONFLICTS AS ATTRACTORS

Why does a system evolve constantly towards a certain state? Because there is an attractor that generates certain types of behaviour, answer the complex system theorists. A group of analysts (Nowak et al.) shaped a theory that explains the emergence of persistent conflicts through the emergence of certain attractors in the social system. The reduction, at a cognitive level, of multiple dimensions of the interaction between two (or more) groups into one di-

mension – the conflictual one – induces the behaviour to refer only to one, no matter what kind of interaction is concerned. Their hypothesis is that when the conflict loses, in the eyes of the actors, its multi-dimensional nature, than it becomes an attractor of the system, that represents a cluster of stable attitudinal patterns, that motivate the individual and the collective action. Furthermore, as the links between the elements strengthen, the degree of freedom of the system decreases, and the state of an element becomes strongly dependent on that of the others'. If the elements which are relevant to the conflict self-organise themselves into an autonomous structure, the intervention in the system by the action on one single variable of the system is no longer effective. The variation of a variable induces the variation of others, and successive feed-back loops activate generative factors. From the standpoint of the complex system theory, the emergence of a powerful conflictual attractor in the system causes the system to return, after any perturbation, to the state of conflict.

The idea of protracted conflicts as attractors of the social systems is extremely important. The key to the understanding of the social conflicts seems to be the emergence of an attractor that stabilizes the malignant dynamics between individuals or between groups. The solution to these conflicts is, in this logic, the disassembling of the malignant attractor and the shifting of the system toward another attractor – that implies the pre-supposition that it exists or that it can be built. Notions as "conflict transformation" (Galtung, 2000) or "building a civilization project" (Maliţa 2001) came to illustrate the idea of dis-assembling the conflictual attractor and of building a new pacific attractor, able to attract the social system. If we are able to identify the degree to which a social conflict acts as an attractor to the systems involved, than we will know when hostilities will end and that peace will only be temporary.

When looking at states of the system we refer to certain configurations of the dynamic variables that characterise it; these configurations generate the emergence of certain conflictual attractors. Coleman et al. illustrate the phases that could lead to the radicalization of a conflictual relation eventually leading to a protracted conflict. As the conflict evolves, we can observe the "emergence of strong, stable attractors (patterns of thinking, feeling, and acting)" that lead the system into a self-sustained conflict. Through such phenomena as cognitive dissonance and selective processing of information, the attractors channel the mental and behavioural experience to a narrow range of behaviours, that form a logically coherent system and that are validated through self-fulfilling prophecies. The attractor is not the result of certain values of the system's variables, but merely of the equations that define the relations between themselves. The conflict-generative factors do not act independently, they activate each other as if they were dominoes through the fact that they become a self-sustained system with positive feed-back loops. A very coherent structure is built, through the inter-conditionalisation and the co-evolution between elements. Coleman et al. identify the stages of this process. Firstly, the positive feed-back loops induce the causal factors to activate one by one, thus making the attractor emerge. In the next phase, the positive feed-back loops are replaced by negative feed-back loops, stabilising the attractor. For example, in the first stage of a conflict, the acts of hostility of the

citizens of two antagonistic nations reinforce each other (positive feed-back loop), up to the point they become critical and the conflict is triggered. In the second phase, the conflict himself can become a regulating factor of the system. The group intervenes to adjust the individual conducts that are contrary to the perpetualisation of the conflict (negative feed-back loop). The conflict becomes part of the group identity that is defined as opposed to the one of the antagonistic group. The intervention of certain individuals to put an end to the conflict becomes, under such circumstances, incredibly risky and dangerous. Assassination committed against leaders that concluded arrangements to end hostilities are an extreme of such risks.

Ben Goertzel (1994) is very convincing in illustrating the way reality is an attractor of the mental equation of humans, by leading the learning processes toward consistency with it and by permanently validating one's own knowledge. In the same way, the faith systems act as attractors of the mental processes, without being the subject of external validation.

By intuitively representing the attractors as a "hill and valley landscape", Coleman et al. have formulated the hypothesis of the difference between the "width" of the basin of attraction of conflict attractors and its "depth". A "wider" basin of attraction will determine the evolution towards a conflict of a much bigger number of initial states, and a "deeper" one will be much stronger, namely it will need a bigger quantity of energy inserted in the system in order to exit the basin of attraction. In *figure 2*, the basin of attraction of attractor A is wider than that of attractor C, and that of attractor C is, on its turn, wider than the basin of attractor B, this meaning that attractor C is much more powerful than attractor B.

6. THE PACIFIC ATTRACTORS: THE EUROPEAN UNION AS A PACIFIC ATTRACTOR

Maliţa (2001) analyses human interactions into two ideal-types, as cultural – types (involving faiths, values and attitudes) and as civilisational-types (involving knowledge). The creation wealth does not necessarily involve a choice on the level of values, but efficiency in economic terms, acquired through the use of science and technology. The identity of the actors is, in this type of interactions, irrelevant. This distinction, though, could be useful in analysing the pacific attractors. Thus, the common projects that involve interactions of economic nature, have an important civilisational character, and can therefore be the basis of peace constructions. On the other hand, the cultural-type interactions, that involve identity and the distinction in-group – out-group, are more likely to activate inter-group differences and thus lead to conflicts. It means, if we translate this approach into complex systems terms, the civilization-type projects are able to stimulate the emergence of *pacific attractors,* i.e. the attractors that keep the system in a non-conflictual state.

The state of peace can be analysed on the international system level or at a lower level of social aggregation. The second variant allows, on the one hand, the analysis of a system with a smaller number of actors, but also a greater link to dealing with real cases. From the viewpoint of a peace theory, history provides us with a unique efficient model: the European Union. The analysis of

the European Union is the paradigm case of a pacific attractor for the European system of states. Initially conceived in order to control the production of raw materials required for waging wars, the three European Communities (of coal and steel, of atomic energy, and the economic community) have contributed to its emergence as an attractor for ever more European states.

This European post-war project does not represent the first attempt to unify the continent. In their desire for a vital space or solely for a worldly glory, many political leaders have designed political projects concerning this unity, which could be accomplished under the ruling of a dominant culture. Many of them left painful traces in the collective memory. As an object for military confrontations and for barter at the negotiation table, Alsace and Lorraine have represented, for many centuries, an excuse for transgressions in a Europe experiencing intensifying nationalism. What led to surpassing these previous attempts is extremely important for a peace theory. Since the end of the Second World War, Europe has experienced peace for more than half a century, and France and Germany have since not been in a situation of confrontation. The European project seems to have constantly attracted towards itself elements of the system, the five enlargements being a proof for this assertion. If we can identify a unifying factor, then this could be used as a foundation of other peace projects. Schumann and Monnet, the initiators of this project, wanted to use it in order to "de-intoxicate the relations between France and Germany, eliminate their secular opposition, and bind West Germany to France through a solidarity of interests" (as quoted in Maliţa 2001: 273). The essence of the European project meant focusing it on the civilisation dimension. It is not the language or faith that counts, but the capacity of the project to provide welfare for the citizens of the member states. The four liberties guaranteed to citizens – the free movement of individuals, goods, capitals and services, as well as the freedom to reside within any member state – no matter the nationality and based on non-discrimination, are all parts of a civilisation project. According to the project of the European Constitution, the European Union has a double dimension: union of citizens and of states.

The pacific attractor of the European system is the common project, situated in the sphere of civilisation. The reference to the individual as a citizen, and the fact that the European citizenship doesn't replace the national citizenship, but adds to it, are all fundamental elements of the project's functionality. The national identity of the citizens becomes irrelevant under the framework of European citizenship. From the point of view of its functioning, the common project comes into being through norms specific to each field of activity. Being considered as a super-regime, the functioning of the European project is ensured by an impressive number of common regulations, which become compulsory for the member states, engendering expectations and standards for all producers. Although the norms involve in many cases underlying values, some of them now becoming universal norms. The prohibition of killing another human being, for example, is a norm that exists in almost all cultures. We can consider them as belonging to the civilization sphere, as it is the case with all human rights.

A regime that represented an immediate attractor for the population of East-European states is that of human rights, the first European standard adopted by all the states aspiring for the quality of membership. The *aquis communautaire* was a mean of generating a collective process that made the institutional structures of the aspiring countries become more similar and to generate convergent dynamics. Peat (2002) is probably right when he writes, referring to organisations, that the history of the relationships and the repetitive pattern of behaviour is relevant concerning their evolution.

The European Union functions through norms. The prescriptive logic of European norms refers to the ruling of the component subsystems behaviours. Starting with the individuals and continuing to trading companies or states, the obligatory character of subordinating to the norms provisions allows no exception. The term "norms" is used here in a broad sense, also involving cases of common patterns of behaviour which are internalised by individuals, without necessarily being written in a code of law (for instance, the codes of proper behaviour in society, which are ethically defined, or the customary law in international relations). Without being established as legal provisions in all the states, human rights are part of the common ethos and European project.

From the perspective of the functionality of pacific attractors, the relevant normative systems are those which contain practical methods of implementation. The League of Nations was not able to be set up as a pacific attractor of the international system, because it did not dispose of ways of sanctioning non-cooperation. The United Nations is slightly better in that it does dispose some forms of sanctions, but their functionality is still not enough to create a pacific attractor of the international system. On a little lower level of analysis, the international regimes can be considered, in certain conditions, pacific attractors of the system, as long as they don't transform into "talking machines" lacking means of implementations.

To better understand the role learning plays in the functionality of the pacific attractor it is useful to look at a recent book by Robert Wright (2000). He emphasized the fact that as history progresses, people learn to play more non-zero sum games. The increase in complexity is equivalent, for Wright, with the increase of non-zero sum situations in human interactions, and the two processes are simultaneous, coherent and mutually sustaining. The successful performance of non-zero-sum games leads to an increase in complexity, but the increase of the non-zero-sum situations is hindered by two mechanisms. The first is represented by the existence of free-riders, those that have the tendency to benefit from others' generosity without reciprocating. To parasite the systems can be a simple behavioural alternative for some participants, as the cooperation involves at least one cost: the reduction of freedom of action. For small groups, the moral indignation is a sufficiently powerful mechanism of exclusion from the group – or at least exclusion from the benefits of the common good in discussion. This is not sufficient in the case of bigger and more complex social groups that impose the existence of a value allocation mechanism that must maintain cooperation through sanctions for free-riders.

The second important thing is the fact that if the contribution of participants is different, and the distribution is equal, some tend to participate less than others. It also forces people to monitor others' contribution to the common action, in order to compensate for the entropic tendencies of the system.

From this perspective, the problem of the emergence of society is how to make non-zero-sum relations between individuals and groups permanent. Co-operation does not produce sociality if it is occasional, but only when it is permanent, and this action is realised by the social norms in the largest sense, by prescriptions that encourage the desirable behaviours and discourages – through public disgrace or through criminal penalties – the undesirable ones. As social references, the norms make the behaviours of the members of the groups converge.

The functioning of the pacific attractor thus is twofold: on one side it is maintained by the internalisation of the norms, and on the other side, a large array of sanctions, from public disapproval to legal penalties, punishes non-cooperation of some actors that do not internalise them sufficiently.

A prerequisite for the functionality of a pacific attractor is its stable character. The hegemony may not, from this viewpoint, lead to the emergence of a stable pacific attractor. Modelski and Morgan exemplified (1985) the way that the emergence of a hegemonic power in the international system follows a rather cyclic pattern, which may eventually be analyzed as a cyclic attractor. The hegemonic cycles have included, as the two analysts mentioned, wars with systemic amplitude or situations of major conflict, which led to the changing of the hegemonic attractor. Obviously, we cannot speak of a pacific attractor if it leads to war.

CONCLUSION

Peace and war are processes, rather than social states. From the point of view of the complex system theory, *war* or *peace* are even more that that: ensembles of processes which co-exist and co-evolve, so-called *attractors*. In these terms, peace and war can be analysed as attractors of complex social systems. These are states (in the dynamic sense) of social systems towards which their behaviour converges. The attractors of this kind do not only represent an abstraction of these notions; understanding these mechanisms means understanding the manner in which peace and war reproduce themselves. Furthermore, using these concepts in the analysis allows the understanding of peace as an anticipatory learning process (Botkin, Elmadjra and Malitza, 1998). The endemic conflicts, which seem very difficult to solve, are only situations in which the convergence of certain cultural factors produces conflicting attractors. On the other hand, the pacific attractors describe states of stable peace, circumstances in which society creates itself feedback mechanisms capable of bringing back the system to its stable state, mechanisms of co-operation in which there are means of drawing in and possibly sanctioning those who might be tempted by parasitic non-cooperation.

In an analysis of international regimes, Arthur Stein stressed (1982: 301) the idea that not even the most liberal societies allow their citizens to act arbitrarily. Even the market, the essence of human freedom in modern societies,

is not left by itself to regulate human actions. As in social systems individual actions are constrained by society, limiting through a "social contract" the permanent war between the individuals. The rules set by the actors of the international systems act similarly, as the functional equivalents of the social contract that constrain the states' behaviour in certain areas. The constructivist idea of rules as means to control behaviour is not complete without the mechanism to make sure that the rules are observed. A functional regime is an attractor of the social system only as long as it identifies feed-back mechanisms, by sanctioning free-riders, as the perturbations of the social system which determine the activation of correction mechanisms. A recent analysis (Werner and Yuen, 2005) of the stability of peace agreements attach less importance to their provisions, but try to identify factors that explain the maintenance and the enforcement of commitments. This is, of course, a possible issue for future research.

Approaching the evolution of humanity through the angle of the *complexity theory* looks at the idea of a *future seen as a cluster of possibilities*, out of which humanity can choose. Being aware of the existence of multiple possibilities is similar to a learning process, and humanity is only at its beginning.

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