# Complexity and participation: the path of strategic invention

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The epistemological basis of the participatory action-research (PAR) methodology in the so-called 'paradigm of complexity' is plagued with misconceptions, imprecision and significant omissions. The appropriate and contextualised translation of concepts from the natural sciences for use in the social sciences is particularly necessary in qualitative-structural and participatory-dialectic methodological trends. This paper focuses on the concepts of 'entropy', 'complexity' and 'strategic action'. Based on a general notion of complexity relating to the consideration of uncertainty, innovation and the contextualisation of systems, performance-related aspects indicative of actions implied by this paradigm may be highlighted. Thus, it is argued that the conceptualisation of operations such as 'acting in order to know' and 'act knowing/know by acting', encompassed in the notion of 'strategic invention', complement and exceed the scope of typical planning operations and even self-planning ('knowing in order to act'). In short, these definitions are coherent with an ecosystemic perspective of social and natural reality, in which it is necessary to contextualise what is more or less complex in the world, in our knowledge of the world and in our practical actions when acting in the world. Consequently, participatory action-research methodologies should adopt this complex ecosystemic epistemological perspective, and be designed through a 'strategic invention' approach, in order to clarify the concepts imported from other scientific disciplines.

Neither in Ecotopian universities nor in research institutes can one find professors of several once flourishing disciplines: political science, sociology and psychology. Their practitioners evidently drifted off into programs that take place in research institutes, farms, factories, and other productive institutions of the society. Here students are subjected to the same standards as their 'masters'. The publication of a brilliant short paper counts for more than a number of dull long ones. 'Inventions', whether abstract ideas, proposals for better production processes or creative works, are greatly respected and much discussed. And participation in the community, whether a college, a living group, or an academic association, is thought to be important for all.

The intriguing and singular novel *Ecotopia* described an ecologically organised society characterised by a certain degree of libertarian communism. However, the author, Ernest Callenbach, surprised readers with his prediction of the disappearance of the social sciences. Either the social sciences died from success, transforming into a kind of widespread knowledge or popular craft, similar to the self-construction of homes; or else they failed to evolve sufficiently to help build the new society. These dilemmas loom large over the social sciences today, even if the issue is not addressed publicly. How can we make the social sciences more useful to projects aimed at the ecotopic transformation of society?

Will they become sufficiently popular by virtue of their social validity, or will the ruling classes keep them hidden under lock and key in the box of esoteric knowledge?

Since the 1960s and 70s, various researchers have sought tenaciously to establish closer links between sociological knowledge and the emancipatory actions of local communities and specific collectives.[2] 'Participatory action-research' (PAR) methodologies drove social scientists to collaborate with social groups in their efforts to achieve political emancipation, producing, at the same time, useful knowledge for achieving such goals. This process was essentially driven by the same logical limit proposed in *Ecotopia*: could individuals who need to examine themselves sociologically achieve this objective? However, from the standpoint of institutionalised science, these types of participatory methodologies and practices have also been suspected of lacking a solid epistemological basis. Is it not a question, perhaps, of knowledge corrupted by spurious and partial interests? What professional and scientific rigour can these processes have in a scenario in which everyone claims to know something valid?

When efforts have been made to respond to criticism, the main sources of epistemological justification for participatory methodologies have been relativism, historical-dialectical materialism and other heterodox visions distant from positivism (Feyerabend, Kuhn, Foucault, Habermas, etc.).[3] Less frequently, authors have adopted positions closer to critical realism (Bhaskar *et al.*), applied rationalism (Bourdieu *et al.*) and the 'epistemologies of complexity'. In Spain, researchers such as Jesús Ibáñez and Tomás R. Villasante[4] have begun to explore the epistemologies of complexity, but their work remains, in my opinion, affected by certain problems and misconceptions. This paper aims to unravel some of these problems and misconceptions.

Some recent studies have helped to clarify the links between the social sciences and epistemologies of complexity,[5] but only occasionally have they been associated explicitly with participatory methodologies. Studies geared more to promoting participatory methodologies and some of their intended goals (self-research, co-research, participative community development, participatory municipal budgets, and so forth)[6] also tend not to use reasoned argument to propose concepts of complexity adopted from the 'hard' (i.e. mathematical and experimental) sciences, appropriately translated into the social sciences. So, what bridges need to be built?

First, two preliminary definitions of 'complexity' are proposed: a definition relating to the circulation of concepts between the social and natural sciences; and a definition that questions the indeterminable aspects of social and natural reality. The related discussion, to borrow a phrase from Michel Serres, will indicate the need to open 'north-west passages' to communicate epistemological concepts amongst all fields of knowledge. In the next section, the concept of 'entropy' is used as an example to show the dimensions and contextualisations that must be kept in mind in any transfer of terminology between scientific disciplines. These explanations, coupled with an awareness that the concept of complexity originates from thermodynamic phenomena (the first to be considered formally complex), will then allow examination of the misconceptions which come to the fore when a simplified approach is used in which the notion of 'complexity' is identified with the concept of 'variety'. These arguments will lead towards the definition of a more precise conception of complexity linking knowledge and action through 'proliferation', in other words through increasing complexity. Since the links between knowledge and action are crucial underpinning elements of PAR methodologies (and of any process of planning, policy implementation and social application of scientific knowledge), the final section will

try to clarify the notion of 'strategic action', providing a basic classification of its typology and adding a complex dimension for its interpretation: the 'observer' context. This will permit the definition of the notion of 'strategic invention' as a type of bulwark condensing the actions of 'acting in order to know' and 'act knowing/know by acting' that complement or overrun typical planning and even self-planning ('know to act') operations.

In short, I begin with a modest goal: to show that by reflecting on these fundamental epistemological issues and their methodological consequences we can avoid the unjustified conceptual leaps and errors often committed in the development of participatory research. However, the conceptual determinations proposed here are more ambitious: PAR can only be developed from an ecosystemic perspective, by contextualising what is and what is not complex in the world, in our knowledge of it, and in our practical actions. 'Strategic invention' is in my opinion one such approach, one such path (more striated, less well mapped), but there are many more already open and yet to be opened.

## OF WOLVES AND MEN:
## THE CIRCULATION OF INTERDISCIPLINARY CONCEPTS

Pask's first theorem argues that teachers must be students otherwise the action of teaching cannot take place. Teachers must learn about their students' idiosyncrasies, goals, etc. Similarly, students must learn teachers' idiosyncrasies, which may include their fields of expertise, e.g. organic chemistry. A corollary to this theorem is that the teaching-learning scenario is symmetrical.[7]

First, a complex vision of the world provides us with a starting point to reflect on the history of science: all sciences (for purposes of simplification, the 'social' and 'natural' sciences) have been born from mutual imbrications and conceptual exchanges. Their abstract and analytical separation has resulted from both the unequal, intrinsic development of individual disciplines and the social contexts in which they have become separate.[8]

When analysing the transfer of concepts between philosophy, economics, sociology and biology, Marshall Sahlins offered, in one of the most quoted examples, the image of a vicious – or virtuous, depending on one's viewpoint – circle.[9] This refers to the application to society by Hobbes (1588–1679) of the principle of natural competition between humans ('man is a wolf to man'). The liberal economist Adam Smith (1723–90) used these ideas to develop his theory of the self-controlled operation of markets (the 'invisible hand') resulting from the unintentional consequences of individuals who pursue selfish interests. A similar approach was adopted by one of the first theoretical sociologists, Herbert Spencer (1820–1903), who referred to the broadening of the need for competition between mature individuals to avoid the degeneration of society. Later, the evolutionist biologist Darwin (1809–82) read Smith and Spencer (as well as the demographer and economist Malthus) and used their ideas, combined with his own disquisitions and observations, to formulate his theory of 'natural selection'. Independently of biologists' interpretation of the laws enunciated in that theory, Spencer and Sumner, another social philosopher, found scientific proof of their visions of society in Darwin's theory; hence, they became known as 'social Darwinists'. The circle closes once again almost a century later, in 1975, with the publication by the biologist E. O. Wilson of his book *Sociobiology*,

using social Darwinism and its axiom of 'possessive individualism' to reconceive biological processes ('the wolf is a man to other wolves').[10]

This last example shows how the social sciences have imported concepts from the natural sciences (recall, for example, all those Marxist and functionalist concepts concerning force, value, order, legality, evolution, revolution, etc.) and vice versa.[11] Although it may seem to be an infrequent case of humanism ('nothing human is alien to me'), the chemist Prigogine recognised on numerous occasions the analogical and substantive influence the philosophical ideas of Lucretius, Bergson and Deleuze had on his studies of thermodynamic processes.[12] Consequently, history, society and culture (including scientific, political and artistic culture) provide us with a relevant, initial context of complexity intrinsic to the concepts and axioms used in any knowledge-production process. In order to clarify this context, we shall first define 'complexity' as an interdisciplinary circulation of 'hard' and 'soft' concepts of reality.

The above argument has even been used in an extremely relativist manner, claiming that what is social 'is not unitary but multiple', that it can only be conceived in a 'fragmentary and disordered manner', and that 'its specific, ever-changing particularities' must be taken into account;[13] in other words, the social sciences cannot be guided by the mechanistic paradigms of the hard sciences and these should even distinguish complex social qualities (specifically disorder, change, diversity and singularities) in non-human phenomena (in contexts of both discovery – the conditions in which science is performed and its consequences – and justification – the way in which arguments are used). Although that position already provides a second meaning of the idea of 'complexity' in reference to realities (mainly social) that cannot be determined by classical science, it is only a 'strong' vision of the sociology of science which contrasts with other epistemological trends in the social sciences and with most of the natural sciences (although numerous exceptions exist[14]).

These precedents suggest that it is not so much a problem of the *reciprocal* importation of concepts between specific sciences (or specific fields within a given scientific discipline) and others, but rather a problem of the *indiscriminate* importation of these concepts. In this regard, it is a very confused claim of epistemological complexity for various social sciences to seek to import large groups of inherent concepts from the experimental sciences to give the former an appearance of the technical and scientific they otherwise lack, without selecting and defining appropriately those concepts for the specific purposes of each social research project. Consequently, the same epistemological warning must be issued when conceptual options are adopted by social research guided by participatory methodologies. Last, but not for that less important, more or less complex social phenomena or types of complexity (e.g. teaching-learning scenarios, as indicated in the quote at the beginning of this section) must be defined from a social science perspective to ensure that their public communication, social usage and even importation by natural scientists is as rational as possible. In the next two sections I will examine one such concept, 'entropy', and attempt to provide less confused notions of complexity.

## ENTROPY: DISORDER WITHIN ORDER

A demonstration by 10,000 people on the same route, chanting the same slogans and pursuing the same goal, is a type of disturbance that can be easily controlled by the police. So, what would

happen if, instead of having to deal with an intense, homogeneous disturbance which can be controlled using signs or a series of equally homogeneous signs, the System had to deal with 10,000 different, unforeseeable disturbances resulting from the free will of each individual? It would simply be unable to produce 10,000 appropriate responses and would start to fluctuate as a consequence of the disorder caused in its degree of information about the environment. Its degree of entropy would reach high levels.[15]

According to Prigogine, the first 'science of complexity' was born in the nineteenth century with the development of thermodynamics. Ibáñez has proposed Gödel's theorem of incompleteness and Heisenberg's principle of uncertainty as two epistemological landmarks in the study of complexity.[16] Progress in biology and information theory during the twentieth century has also been crucial. First cybernetics (from the Greek word for the art of controlling, navigating and piloting ships), as advocated by Wiener, provided more detailed models of mechanistic systems and their self-control processes. These were rapidly embraced by the early social sciences and attempts were made to integrate them into a kind of General Systems Theory supposedly valid for both natural and social realities. The next chapters in this story were studies of artificial intelligence, computers, the evolution of stock values and meteorological and aeronautical turbulence. These emerging new conceptions differed from the mechanical and deterministic visions of classical science, but it is worth noting that this did not occur in all fields, nor did they completely replace previous dominant conceptions.[17]

At this point I would like to stress that failure to give sufficient consideration to these precedents would prompt the clumsy simplification of basic notions imported by the social sciences, as well as the underlying definition of complexity used. Thus, it would not be an exaggeration to say that the concept of 'entropy', for instance, is often simply translated as 'disorder', and that 'complexity' is claimed to be synonymous with 'variety', 'multiplicity' or 'difficulties for knowledge'. In what follows, by contrast, we will see how details are important and force us to find more precise definitions of such notions.

Until the late nineteenth century, Newtonian mechanics were used to reflect the skeleton of most phenomena in the natural and social worlds. Newton's theories explained reversible cause–effect phenomena, which were timeless and predictable because knowledge of the state of something was considered to provide certain knowledge of the state of something else, both forwards and back in time. Everything from a clock to planetary movement seemed to be explained by these types of deterministic laws. With the spread of steam-powered machinery during the early days of the Industrial Revolution, interest in more in-depth knowledge of the effects of heat propagation grew – thermodynamic phenomena, the conversion of thermal energy into work, and so on. 'If you have one hot container and one cold one, you can put a thermal machine between them to perform work, e.g. drilling, pumping, pulling, etc. But the smaller the difference in temperature between the two recipients, the less likely it is that one thermal machine will remain operative.'[18]

That observation prompted Clausius to determine a dimension or magnitude he called 'entropy' to define the gradual advance of 'no change', i.e. the progressive impossibility of transforming heat into work as processes develop and the temperatures of both containers approach the same level. Von Foerster notes that the concept should in fact have been called 'utropy', because in Greek the prefix 'u' negates the following noun (in this case,

'trope' = change). As may be deduced, the concept of 'entropy' is associated with specific types of phenomena, and at least the following aspects should be borne in mind for its sociological conversion: 1) its context of application in '(relatively) closed systems'; 2) its relationship with 'transformation processes' (in the physical sense, i.e. between different types of energy); 3) the need for an 'observer' to distinguish the states of matter in each part of the process (in the experimental sense: the positions, temperatures and molecular speeds in each container).

As is well known, the first law of thermodynamics derives from a more general law, the law of energy conservation. The latter is popularly articulated as 'energy is neither created nor destroyed, only transformed', as stated by Robert Mayer in 1841. More precise definitions are, for example: 'Although energy assumes many forms, the total quantity of energy is constant, and when energy disappears in one form it appears simultaneously in other forms';[19] 'When a system undergoes a transformation of state, the algebraic sum of the different energy changes, heat exchanged, work done, etc., is independent of the manner of the transformation. It depends only on the initial and final states of the transformation'.[20] System here means a system isolated from its environment: 'an isolated system is defined as being closed to both energy and matter transfers in or out while a closed system is only closed to matter transfers'.[21] Energy is not lost but it is degraded, although it can also be transformed or used more efficiently.

The first law of thermodynamics incorporates 'work', i.e. a 'process of productive transformation'. This work can be performed on a system or by the system itself. The second law of thermodynamics states that any process of energy transformation has a certain natural limit, usually defined as 'entropy', which can also be considered as a measure of heat (thermal energy) that cannot be available to do work in an isolated system. More precisely:

The second [law] captures the fundamental asymmetry of the universe, in which the distribution of energy changes in an irreversible manner. This irreversibility is measured by the production of entropy. There are several ways of expressing the second law. One states that work can be totally converted into heat, but the reverse is impossible. Entropy is defined as the heat supplied to a system divided by its absolute temperature. . . . One other formulation is relevant here: heat cannot flow from a cooler to a hotter reservoir without any other change (i.e., work must be done). The increase of entropy is equivalent to the increased inability of an *isolated* system to do work, resulting from the degradation of low entropy into waste heat.[22]

So, the original meaning of 'entropy' is an amount of heat that cannot be transformed into work (per unit of temperature). This is lost, unrecoverable heat which cannot be reused in a specific closed system (or machine) – although it can be used by other systems on a broader scale, e.g. the heat emitted by a car engine can power a car's heating system. Thus, it is all the energy not used, or the residual energy from any machine or system, which must, by definition, be imperfect: there is friction, leaks, insulation with fissures, etc. 'Matter can only be constrained or controlled to a certain point', and 'transformations imposed by machines imply an orientation or ordering of matter'.[23] (The temptation of social analogies is not easy to avoid: we could substitute 'matter' by individuals or collectives, and 'machines' by political regimes, social organisations, public policies, religions, schools, and so on.)

The important point here is that the context of 'thermodynamic machines' is usually quite absent from habitual associations established in the social sciences between 'entropy'

and 'disorder'. It is true that the definition of entropy alludes to disorder, but not just any type of disorder. The second law of thermodynamics may also be enunciated as the unavoidable evolution of any system isolated from its environment towards 'a state of more molecular disorder', with 'maximum disorder' occurring when 'the system reaches its state of equilibrium' and the 'balance' or 'equilibrium' being characterised by 'a perfect macroscopic homogeneity that prevents any net flow of matter or energy passing from one part of the system to another'.[24] As may be appreciated, in the statistical interpretation of the second law of thermodynamics, entropic 'disorder' is understood as the absence of work (transformation of heat into work), as the amounts of matter and energy that do not undergo an externally-imposed ordering process and, also, as a balanced state of a complete and equiprobable mixture of all the elements.

The example of a drop of ink spreading spontaneously and homogeneously through every point in a container of water shows that even without externally-imposed order or 'shaking', a closed physical system evolves towards a state of maximum entropy in which maximum molecular disorder is, nonetheless, representative of the maximum state of equilibrium, mixing, equality and, at the same time, the lack of evolution, productivity and creativity. Similarly, Shannon's theory of information uses the notion of entropy to measure 'mean uncertainty', i.e. the amount of unusable or lost information (i.e. noise) in the transmission of messages. In that sense, information would be the data that actually reaches its destination, the opposite of entropy or uncertainty (which is why information is sometimes referred to as 'negentropy'). Thus, if we would like to import the notion of thermodynamic entropy into the social sciences, we should refer it, at least, to the absence of – virtual, potential – work and information more than to the vague idea of 'disorder'.

As Atlan points out,[25] statistical definitions of entropy exclude any reference to the meaning of either messages or the order of molecular distributions, although that meaning is always implicitly present for the observer gauging the limits of each observed system. For example, the sun makes no distinctions, spreading its heat in an entirely disordered manner (randomly, in all directions, without any homogeneous distribution of all molecules in the same direction), although the main question for biologists, and also for social scientists, is how new species, organisms, societies and ideas arise (self-organisation) in opposition to the second law of thermodynamics.[26] For this reason, couching the notion of entropy in terms of 'disorder' implies, in principle, limiting the type of system to one isolated from its environment, not incorporating value judgements or interpretations of meaning in the type of 'entropic disorder' observed, and specifically identifying, after reflection, the distinctions drawn by the observer.

In this sense, it does not seem appropriate to characterise all entropic disorder in social terms as necessarily synonymous with freedom and emancipation from external controls.[27] However, greater conceptual enrichment without axiological a-prioris characterises 'social entropy' (in its maximum state) as 'anomie'.[28] Thus, social entropy could define the natural evolution of any social system or organisation towards its disintegration (disappearance, replacement, etc.) or towards 'the disappearance of distinctions' (equality, homogeneity, etc.) at the core of the system in question. Social norms would thus be the social control mechanisms necessary to avoid such losses of energy and entropic trends towards unproductivity, noise and equilibrium. It has also been claimed that 'anomia is the maximum state of social entropy', according, clearly, to the original meaning proposed by

Durkheim. A state of anomia refers to a severe state of social crisis in which there is an uncontrollable increase in social deviance (crime, immoral behaviour, protests, etc.), and not simply specific and functional deviations by society as a whole. If we identify 'deviations' with 'disorder', we will agree that anomia as entropy occurs only when the former increases towards a new order (equilibrium) of unproductivity and noise. On the other hand, deviance and disorder of any kind are inherent to society (i.e. to social order and cohesion, which are protected through repressive reaction) even without turning it into a state of anomia-entropy or any other new social order.

For the social sciences, the virtues of the concept of entropy can also be found in that essential requirement – in what could be redefined as one of the cornerstone aspects of the basic programme of Marxist research – to study social realities as social processes irreversible in time, in which any production or transformation of energy is restricted by a tendency towards decreasing productivity, certain homogeneity and the generation of unusable energy. As mentioned above, one of the first influences on the social sciences of complexity studies (originating from the field of thermodynamics) was precisely those elements and the reflexivity of observations of those elements, but they were not the only ones. It is clear that the accumulation of anomia-inducing social disorder is only a partial concern, characteristic of functionalist schools. A broader consideration of social complexity must at least take into account any type of social process (productive or unproductive), identify the type of social disorder (according to its origins, development and consequences, e.g. gender-related and political murders and suicides) and 'social machines' (organisations and policies).

Lastly, a truly ecosystemic focus of social complexity must integrate the entropic effects of the human use of all sources of natural energy (renewable and non-renewable) within the relatively closed system – i.e. not isolated from the incoming energy of the sun – of our planet (and not just in every 'isolated' organisation, society, culture, country, etc.): the environmental effects, with the continual degradation of the biosphere; the social effects, with growing inequalities between populations in terms of their access to, and capacity to use, matter and energy. 'The apparent order of the [existing] [productive, economic and social] model [based on the logic of growth and accumulation] must, in order to be maintained and developed, make greater use of coercive and repressive mechanisms to control the progressive disorder which it causes, together with the tendency to create megastructures, growing inefficacy and economic costs that hinder the operation of the model itself.'[29]

## SOCIAL COMPLEXITY: FROM VARIETY TO PROLIFERATION

Knowledge of what is human must, in turn, be much more scientific, much more philosophical and, in short, much more poetic than it actually is. The corresponding field of observation and reflection is a huge laboratory, the planet Earth, in its entirety, with its past, its future and its finitude, with its human records that started six million years ago. . . . Slavery, concentration camps, genocide and, lastly, all inhumanities, reveal a lot about humanity.[30]

The concept of entropy and its simplifying identification with the notion of 'disorder' has developed in a similar way to the identification between 'complexity' and 'variety'. There are advantages and problems with such an identification, and below I suggest alternative

ways of defining 'complexity' in the social sciences, taking account of what has been learnt in the natural sciences.

Above all, the equivalence of 'complexity' and 'variety' originates from the first systems theory, which categorised systems as (a) open or closed, and (b) more or less complex. Open systems are, thus, ones that exchange matter and energy with their environment, whereas closed ones do not. In short, the paradigm of an open system is any living organism that organises itself (grows and reproduces) by virtue of metabolisation processes: it absorbs, processes and expels matter and energy. As we have seen, thermodynamic machines are the classic example of closed systems. Complexity, on the other hand, is determined by the level of organisation of a system. In this sense, organisation would be defined according to the relevant relationships and elements established to preserve the system. Consequently, a system can be defined as more complex, the greater its variety (in quantity and quality) of elements and relationships.

Now, taking 'complexity' to mean 'variety' already implies, on the one hand, a reference to this variety of elements and relationships with a certain organisation and, on the other, a qualification of the relevance of the elements and relationships defining that organisation. Second, open systems are normally considered to be more complex than closed ones because the former have both internal relationships, just like any closed system, and also relationships with their environment. As can be easily deduced, 'variety' is as important as 'organisation', 'punctuation' of organisational relevance, and 'environment'-oriented relationship.

The question of scale or context is relevant here again because self-organisation does not exist in absolute terms: living beings also die (they stop metabolising efficiently), their organisation and structure can disappear or transform (they stop working or working in the same way), and species can become extinct (their members stop reproducing). The complexity of open and self-organised systems is limited in time. It is not just their relationships with the environment that make them more complex (or varied in terms of relationships), but their capacity to generate rules that control their organisation and their own organisational changes (of adaptation and evolution): 'If we consider that the organisation of a system is the set of rules that make the system work, and we think about a change of rules, then organisation is not just that set of rules but also what controls and makes this group of rules work; and the notion of a self-organising system refers to a system that can change its set of rules to, for example, adapt the new organisation to another situation or do something different.'[31] As can be easily deduced, such sets of rules, meta-rules and capacities for change are more important than 'variety' in obtaining a more precise notion of 'complexity'.

The development of these premisses has broadened our conception of complexity substantially. First, a general principle has been formulated for classifying orders of complexity: whilst the disappearance of the most complex order does not imply the disappearance of an immediately less complex order, the disappearance of the latter *does* imply the disappearance of the former.[32] Hence, the notion of 'variety' (or 'diversity') is accompanied by notions of 'constriction' among levels of complexity and 'emergent qualities'. According to the same author, the following four orders of complexity can be considered (from the simplest to the most complex): inorganic nature; organic nature; society (kinship, division of work and linguistic codes); and culture (each society's

representations of itself). The most complex orders are the most diverse and have more emergent qualities – in the restricted sense, properties of the system independent of the properties of each individual part; from a broad perspective, capacities to produce unpredictable innovations, both real as well as imaginary or symbolic. However, the most complex orders are also more dependent hierarchically on (i.e. constrained by) simpler orders of reality. To summarise, the planet and the solar system will still exist if life disappears on Earth; more specifically, humans could live as wolves if culture disappeared.

The foregoing suggests that it is easily deducible that social sciences based on complexity not only have to be based on the study of the most complex environments of reality (cultural creativity). Rather, they should also study the relationships of social systems with other less complex scales of reality (social organisation and nature) which they need for their long-term survival. For this reason, it has been argued that the social sciences should study the actual 'ecosystemic hypercomplexity' of social systems: they are regulated by rules governing exchanges (of messages, objects and subjects), they are affected by events (surplus accumulation processes, formation of the State and institutions controlling exchanges) and upheavals (the outbreak of revolutionary processes, prohibited behaviour, gifts, exploitation, etc.), and they prompt reflection (about themselves and about other orders of reality).[33]

More specifically, one logical and one empirical meaning of complexity have also been identified:[34] 'logical complexity' refers to any explanation of reality that seeks to find simple, specialised, causal, objective and analytical truths and laws, but is rendered useless as soon as it is forced to recognise that there are always errors, insufficient proof, insurmountable contradictions, new phenomena and interferences with other fields of knowledge; whereas 'empirical complexity' refers to the fact that in nature and society everything is interrelated, multiple processes take place simultaneously, and in each process singular, random and uncertain phenomena exist. In this sense, complexity exists in both the limitations on our knowledge of the world and in the world itself. Other authors have embraced either the former meaning, or the latter.[35] However, all authors agree with Luhmann that complexity should be amplified and not eliminated or simplified when it is being studied by the social sciences.[36] This is particularly important for predicting the consequences of that argument in establishing and developing participative methodologies of social research.

Amplifying, increasing or proliferating complexity may mean different things, but the interpretations of Luhmann's proposals may be summarised as follows: there are means of communication (language, money, power, possibly even sociological discourse) that transmit 'reduced complexity', insofar as they reflect a varied, but not limited, reality of possible choices for recipients (of ideas, wages, orders, sociological reports). The world is complex and we do not know everything about it, but the best way to act in the world and to learn about it is by proposing certain possible choices and actions for those who act and learn with us, for those who explore the uncertain. In more conventional terms, as we obtain a better understanding of a social reality (its conditions of possibility and evolution up to a given moment) and recognise that we cannot accurately predict its future development, the only validity of the study would consist in defining the general and most likely possibilities of that evolution based on our knowledge.[37]

Even 'interpretative' Weberian sociologists would accept that rule: 'The only recommendations sociologists can make are ones like "If you want to achieve objective X,

then my discoveries may help you to choose a specific practical course of action." . . . Sociologists cannot be moral guides. . . . I couldn't say "This is what I've discovered, so this is what you have to do.'"[38] However Prigogine, who was a natural scientist, offered a more substantial formulation concomitant with this idea. First and foremost, empirical or ontological complexity could not be absolute: there are important 'islands of order' and simplicity in natural and social realities. In nature and in society, some things are more complex than others. Natural and social scientists deal with processes where the organisation of matter and energy differs in terms of complexity. One of their aims, as a consequence, is to distinguish them.

In particular, Prigogine included 'irreversibility' as one of the features of complexity. In short, irreversibility refers to processes where the same causes produce different effects, to those where there is a great sensitivity of effects to initial conditions (to slight variation of causes), to those where dissipation of energy produces new structures, and to those where there is communication and correlation between distant particles. According to Prigogine, the phenomena of irreversibility are not universal in all of nature (there are systems that are very stable and resistant to external fluctuations, such as glass), but they are intrinsic to both numerous chemical systems and to living organisms. Owing to this irreversibility, they can organise themselves, evolve, adapt to different environments, learn and change their own environments. Causal explanations and probabilistic approaches are often insufficient for understanding these 'systems far from equilibrium'. Moreover, since we have accepted that we are part of the nature we observe, and that our observations change nature because our means of observation are developed from the matter of nature, neither the description nor the explanation can be fully objective. For this reason, Prigogine proposes a science based on 'exploration combined with nature' or 'participatory exploration'.

Prigogine and other natural scientists are very cautious about the mechanical translation of such notions into social research.[39] Natural processes are not identical to social processes – the latter are more complex. However, some basic aspects of the complexity of some natural processes can be observed in many social processes. The idea of 'stability', for instance, is crucial, and has to do with linear order in the sense that the evolution of a process follows causal and reversible patterns. Problems occur when some events within the process do not follow causal patterns and, then, instabilities and disorder appear. These may be caused by fluctuations from the environment or by disturbances from the internal relations of the system. Finally, when complex processes are reconstructed through research, all linear and non-linear (i.e. bifurcational) evolutions of the system as a whole and of some of its elements should be considered.

Therefore, what Prigogine calls 'participatory exploration' would specifically distinguish the following: (1) the appearance of unique instabilities and stabilities; (2) the coexistence of areas of stability and areas of bifurcation; (3) their mutual relationships and forms of coexistence; (4) sets of fluctuations (which could be measured probabilistically, although this would not be applicable to every fluctuation); (5) increases in fluctuations until they form polarisations and correlations (so-called 'disturbances').[40] Thus, Prigogine considers an epistemology of complexity as the study of 'complex determinisms' ('The determinist description is only applied to simple, idealised situations not representative of the physical reality around us. . . . The message of the second principle of thermodynamics is that we

can never predict the future of a complex system. The future is open.'[41]), whereas Ibáñez preferred to study 'indeterminisms of the second kind' (phenomena with so much noise that they cannot be observed, seen or handled and in which various causes produce various effects) together with 'indeterminisms of the first kind' (phenomena with much noise but which can be managed and single cause–various effects relationships) and classic determinisms (phenomena with little noise and single cause–single effect relationships).[42]

In short, for some authors these premisses, rather than a science of complexity, open up paths towards a 'complex thought' that transcends classical scientific tradition:

The knowledge we propose is complex:
- because it recognises that the human individual studying it is part of its object;
- because it conceives human unity and diversity inseparably;
- because it conceives all existing disjointed and compartmentalised dimensions or aspects of human reality that are physical, biological, psychological, social, mythological, economic, sociological, historical;
- because it conceives *homo* not just as *sapiens*, *faber* and *oeconomicus*, but also as *demens*, *ludens* and *consumans*;
- because it preserves the unity of disjointed truths that exclude one another;
- because it combines the scientific dimension (i.e. the confirmation of data, the mentality of hypothesis and the acceptance of refutability) with epistemological and reflexive (philosophical) dimensions;
- because it rediscovers a purpose to lost words rejected by science, including cognitive words, such as soul, mind, thought.[43]

To summarise: first, 'complexity' is more than just 'variety'; second, social research into complex realities is itself complex and requires attention to processes of proliferation of complexity and 'participatory exploration' which affect the social sciences themselves. Since we are concerned with complexity not only in the social sciences but also, specifically, in PAR methodologies, the next section goes on to deal with the notion of 'strategic invention' and tries to develop some of the further implications of the complexity paradigm as established above.

## DO NOT TEACH KAMIKAZE TACTICS: LEARN COOPERATIVE STRATEGIES, INVENT STRATEGICALLY

Our liberation logically / requires joint action. /
But for security reasons / I am alone in this box.[44]

After clarifying some of the relevant content of the notion of complexity and the translation problems this may entail, I now propose to focus on some particular concepts that, in my opinion, provide PAR methodologies with a 'complex' epistemological basis. It is, in short, a question of using a new perspective to define the relationships between theory and practice which have proved to be so troublesome for social scientists since Marx formulated his famous theses on Feuerbach: 'Man must prove the truth, i.e. the reality and power, the "this-sidedness" of his thinking in practice. . . . All social life is essentially practical. All mysteries which lead theory to mysticism find their rational solution in human practice and in the comprehension of this practice. . . . The philosophers have only interpreted the world, in various ways; the point is to change it.'[45]

Perhaps the relationships between theory and practice, between knowledge and action, between strategies and tactics at the core of any process of PAR, self-research, self-organisation and self-planning, are best represented in M. C. Escher's engravings of whirlpools and Möbius strips. Each of the 'two' faces of the Möbius strip could refer to theory and practice, respectively. But when we slide across the surface of one face, we reach the opposite side. Is it as if each end is playing with the other, taunting it by saying something like, 'I bet you can't catch me! But I can catch you!' Something similar seems to tell the white fish to leave the centre of the whirlpool when the black fish arrive and vice versa, as if theory were saying to practice, 'When you leave, I return', and vice versa. In any case, the social reality in which sociological knowledge is produced, exchanged and used contains even more dimensions of complexity than the circular relationships suggested in Escher's work: the knowledge of experts and apparent non-experts is combined; the velocity, rhythm and duration of links between theory and practice vary; each process has one or several relevant contexts that confer meaning or significance. Thus I believe that notions of 'strategic invention' such as the one proposed here, understood from the perspective of the epistemologies of complexity, can shed more light on this question.

Just as it was mentioned above that knowledge of the complexity of the world constantly raises questions about the actions and practical proposals of the observer, I will now briefly show how action in a complex world is immersed in a dense web of strategies, calculations, purposes, rationalities and other actions. From an ecosystemic perspective, strategic action has been enunciated according to the following principle: actions are not controlled by the will of the actors but by all reciprocal retroactions in society.[46] In fact, knowing an action according to the intentions of the person performing the action is clearly insufficient, because those intentions are not always revealed, the same action may respond to different intentions and, more importantly, it may have unintended consequences, even of a macro-social nature, as argued vehemently by Weber.[47] Retroactions are, from the standpoint of systems theory, the constrictions and potentiations exerted by the emerging qualities of a whole on its constituent parts. According to this 'ecological principle of action', we must also take into account the following: first, the moment of maximum efficacy of an action occurs at the beginning of the process or discourse of the action, and this is when social change could materialise ('when you want to carry out reforms, you have to carry them out quickly'[48]); and second, the ultimate consequences of an action are unpredictable because it is impossible to control all possible retroactions and interactions; hence, actions should be promoted according to probable short-term changes.

As can be appreciated, this notion of strategic action differs substantially from that promoted in the 'strategic planning' of companies, cities and all types of organisations. Some of the most important constituent elements in long-term planning are the prediction of probable scenarios and the flexibility of rules.[49] However, in terms of the epistemological complexity of strategic action, this is something less than planning (or maximum order) and something more than a 'free market' (or maximum disorder): 'Strategy is an action scenario that can change according to the information, circumstances or random events that occur in the course of the action. Strategy is the art of working with uncertainty.'[50] Just as Bateson considered that strategic learning consists, from a theoretical and practical

standpoint, in comparing contexts and integrating new aspects,[51] Morin considers that strategic action in general consists in preventing the possible actions of others, reacting to them when they occur and knowing how to make use of the mistakes of both adversaries and allies (as well as one's own). Hence, all such action presupposes an exercise of invention.

Another complementary conception considers that all living beings establish hierarchies of strategies and tactics.[52] Strategies would correspond to everything we want to do, the establishment of long-term survival objectives, the art of the general ('to win the war') and the designation of the frontier between system and environment, whereas tactics allude to the way we do the things we want to do, means of short-term survival, the art of making do with particular means ('to fight the battle') and the practical expression of theoretical strategy. Again, survival and learning would depend on an ecosystemic strategic action: the accurate and in-depth evaluation of the context in which every system is inserted. That context contains other social and natural systems, as well as the strategies and tactics of other actors. From this perspective, no individual or community is simply a passive object of social research or action, because he/she/it will reveal its strategic nature at all times – 'we are all strategists' claims Wilden. For this reason, he argues that the priority of all complex research is 'to teach strategies', particularly strategies of cooperation and persuasion (such as the 'tit for tat' system studied by Axelrod, or 'communication guerrilla' tactics[53]) rather than zero-sum games (everything one side wins is lost by the other side) and annihilation.

The most intelligent and efficient classifications of strategic action I have found are those proposed by Ibáñez, Ortí and Villasante:[54] 'conversion' – collaboration with the dominant and/or established social order; 'perversion' – reactive rebellion against that order; 'subversion' – active insubordination building other social orders or self-organisations; 'reversion' – deactivation of the efficacy of the dominant order with ambiguities, contradictions and paradoxes. The relationships between ends (strategy, theory) and means (tactics, practice) elucidate the distinctions more clearly: an ideal correspondence would exist between both poles (in conversive behaviour, the existing ends–means relationships would be reaffirmed; in subversive behaviour other alternative ends–means alternatives would be invented), or a lack of correspondence (in perversive behaviour 'the end justifies the means'; in reversive behaviour 'the means justifies the end'). Lastly, an order–disorder dimension may be included in this general classification. On the one hand, without temporary dysfunctions combined in the short and medium term, the paradigm of 'centralism', 'conservation of the status quo' and the 'hierarchy' of conversive behaviour would tend to produce maximum order (authoritarian planning and control); the paradigm of the 'counter-centre', 'destruction of the status quo' and 'heterarchy' of perversive behaviour would tend to result in maximum disorder (free market and generation of inequalities). However, with temporary dysfunctions, the paradigm of 'decentring-acentring', 'construction of a new status quo' and the 'anarchy' of subversive behaviour would tend towards maximum disorder in the short term and maximum order in the long term; whereas the paradigm of 'polycentrism', 'radical reforms of the status quo' and the 'polyarchy' of reversive behaviour would tend towards maximum order in the short term and maximum disorder in the long-term.
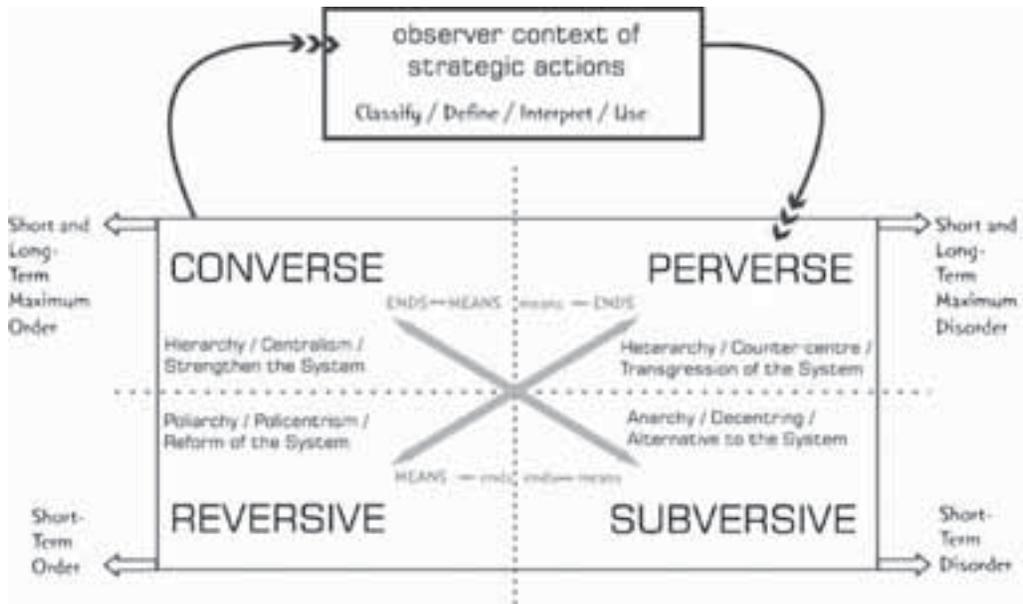
**1** Strategic actions (adapted from J. Ibáñez: *Del algoritmo al sujeto*; 1985, Madrid, Siglo XXI; J. Ibáñez: *El regreso del sujeto*; 1991, Santiago de Chile, Amerindia; A. Ortí: 'Para regenerar la democracia ¡Vivan los 30 años de CEISA! Cuchará y Paso Atrá', *Revista Cultural de Ciencias Sociales*, 1996; and T. R. Villasante: 'De los movimientos sociales a las metodologías participativas'; in *Métodos y técnicas cualitativas de investigación en ciencias sociales*; 1994, Madrid, Síntesis)

There are of course limitations and theoretical debate provoked by each attribute identified for these ideal categories (note that I have avoided associating them with the value-laden labels of conservatism, insurrection, revolution, reform, etc.). To start with, we can say that none of the abovementioned strategic actions is good or bad in itself: that will depend on the context in which it is judged, the position of the person judging the actions, and the distinction between elements that are deemed to be valuable or not valuable in each action by the person judging the actions. In fact, the position of these authors varies, from a certain ideological and political characterisation of these types of behaviour (the system, in abstract form, seems to allude to the capitalist society) and a more general characterisation of behaviour which takes place at any level of reality (in other systems, such as 'communist' or 'state-capitalist' regimes; in any subsystem and even for any type of individual). This also allows prompted social research (theory) to be perceived as just another type of strategic action (practice): we take decisions affecting the clients or consumers of our research and about the contents we feel may be useful to them, we forget about how our research is used and interpreted once it is disseminated socially (or concealed), etc. For this reason, Ibáñez, Ortí and Villasante propose understanding the different actions as follows: conversive actions as contributions of 'information to improve the system' and 'association with its rules'; perversive actions as 'transgressions of the system that eventually confirm and strengthen it', because this is still the only benchmark available to build and 'explore new roads without abandoning their networks';

subversive actions as actions 'critical to the logic of the system', proposing, at the same time, the 'construction of new networks or alternative systems'; and reversive actions as actions that 'reject system injustices', take advantage of system cracks or gaps and informal networks to propose and negotiate partial (albeit radical) changes.

However, the complexity of this outline may be increased by incorporating the 'observer context' of the four typical strategic actions. If strategic actions are relationships between means and ends, and these relationships are developed within certain contexts, we can say that contexts are sets of relationships, or relationships of relationships. In these contexts, the 'observer context' would be the one that allows operations of a syntactic, semantic and pragmatic nature with respect to strategic actions: their classification, definition and provocation. From the paradigm of complexity, the pragmatic dimension is particularly interesting. It alludes to what has traditionally been referred to as 'planning': building the future by observing past behaviour, knowing in order to act.[55] More conventional or 'regulatory' planning relies on the possibility of predicting the future based on deterministic observations (one cause–one effect) and 'strategic' planning does so by exploring the future and evolutionary probabilities based on indeterministic observations (various causes–various effects). Therefore, these two types of planning would result from the relationships between conversive and perversive behaviour with the observer's 'participatory exploration'. However, we know that any planner involved in planning must also deal with unlikely interactions (which are insufficiently predicted or explored, indirect relationships between ends and means) and retroactions between relationship contexts (e.g. the factors conditioning researchers, planners and participants). Therefore, two new relationships may be identified between the observer context and the subversive and reversive behaviour I will refer to as 'strategic invention'.

Inventing means participating in something that is being planned, in the planning process and in implementation/management/intervention processes. When inventing, we
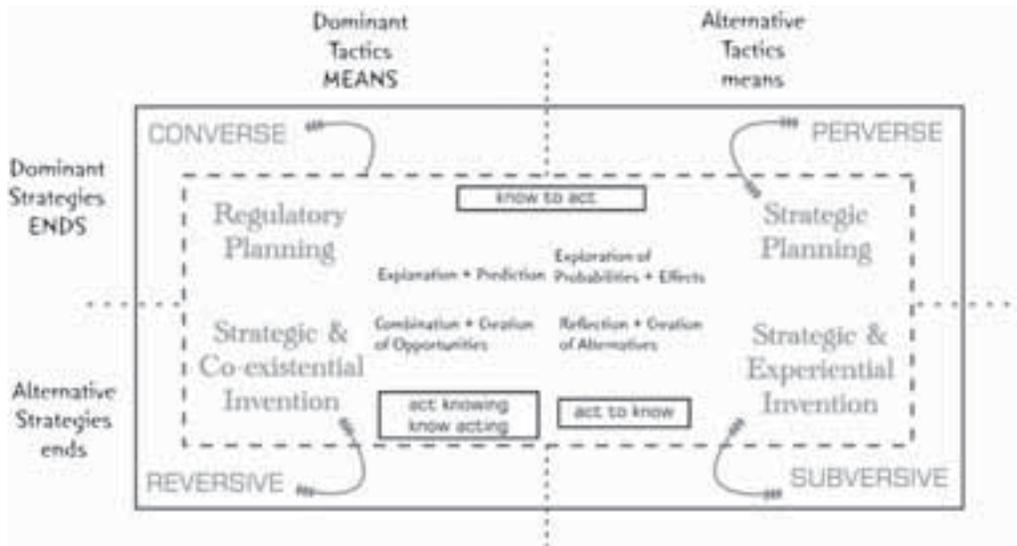


**2**   Relationships between strategic action and the observer context

emphasise the constructive and creative activity of possibilities of future evolution of a system, group, social network, etc., including all the individuals who observe, plan and act. Therefore, evolution possibilities and probabilities should not just be explored, they could also be induced, generated or provoked. An invention would be strategic because it relates (compares, contrasts, opposes, confronts or combines) the contexts of probable evolution that have been explored in strategic planning with the unlikely and/or desirable contexts of evolution whenever they are not impossible. Therefore, it would include the basic operations of 'acting in order to know' and 'know by acting and act knowing' which question the planning operations without neutralising them.

Invention is also strategic because it does not originate from nothing or from divine inspiration before going nowhere or finding divine perfection (in both senses of the term 'utopia'). It is a question of creating contexts and conditions to understand uncertainty and act in the face of uncertainty, and to learn cooperative and survival strategies. In this way, bridges could be built between local and global contexts, and based on the certainties and uncertainties of these local and global worlds and on the regularities and irregularities of these two contexts. On a similar level of philosophical abstraction, Serres argued that a creation of this nature is complex and is removed from the classical notion of dialectics as a 'union of contraries'.[56] Dialectics, understood as controversy and exclusive confrontation between two elements, would use the same procedures and digital classifications as formalism, hence it would not accept the new, the analogical and the global. Dialectics would make way for invention if antagonism took an unexplored path, rather than simply synthesising routes that are well-known and opposed. It would not only creatively integrate these new external elements. Instead, such integration could only materialise if a new internal element were created: you cannot love someone if you have not learnt to love yourself first, and we are not born knowing either of these two things automatically; we have to learn them. A strategist is someone who knows how to use innovation, but an inventor is someone who knows how to create innovation without waiting for innovation to appear. Nevertheless, not everything new is valuable for learning and growth and for resolving problems and conflicts; what is new would also have to be distinguished using digital and analogical, causal and exploratory observations.

Along similar lines, Serres suggests that invention is an answer to fear, hate, war (the maximum expression of chaotic disorder, firmly ingrained in time) and death (the maximum expression of order, or thermodynamic equilibrium), but as a marginal, local and paradoxical response, coexisting with them and distancing itself at the same time:

We normally simplify through forced choice: the continuous or discontinuous, analysis or synthesis, excluding the third. God or the Devil, yes or no, with me or against me, only one of two things. Now, complexity sides with what is real insofar as dualism provokes a struggle in which new thought perishes, where the object disappears. Dualism is used to define the actual battlements where scared combatants take up positions, in equilibrium for long periods of time. A fight not to work. If you don't fight, work. . . . Simplification originates from fighting. Peace should be injected to obtain a clearer view, to abandon the battleground where dust clouds rise, and become visible. Inventors always seem to come from outside because inside the chaos of the battle covers the relevant messages, the backdrop of continuous noise, because the inside is structured by that noise. . . . True conservatives are people who fight because we always fight in the same way. Inventors are not inventors because they come from outside: this notion is still one of hate, it belongs to those who believe that an inside, and therefore an outside, exist; no, they are inventors because the whole space is always already taken, battlement by battlement, or millimetre by millimetre as we tend to

say. So, they have to invent if they want to survive, and they also have to invent a completely new space, unrelated to the old space which has already been shared out. They must create to live because they live in the vicinity of Death. No, they are not the heroes of the negative, dragons with lances and armour, picks and fingernails. They are the heralds of a space in another place. The positive and negative are one and the same, like twins. Inventors are somewhere else, they build other places, near the noise, chaos and mortal disorder, where they will rise again.[57]

In regulatory planning, theory (the observation of strategic action) determines what is done in practice: first we know, then we act, always seeking maximum coherence of action through knowledge. In strategic planning, the illusion of being able to control chance is a little more limited: theory provides some pointers on the range of limited possibilities for action; we explore the relationships between knowledge and action.
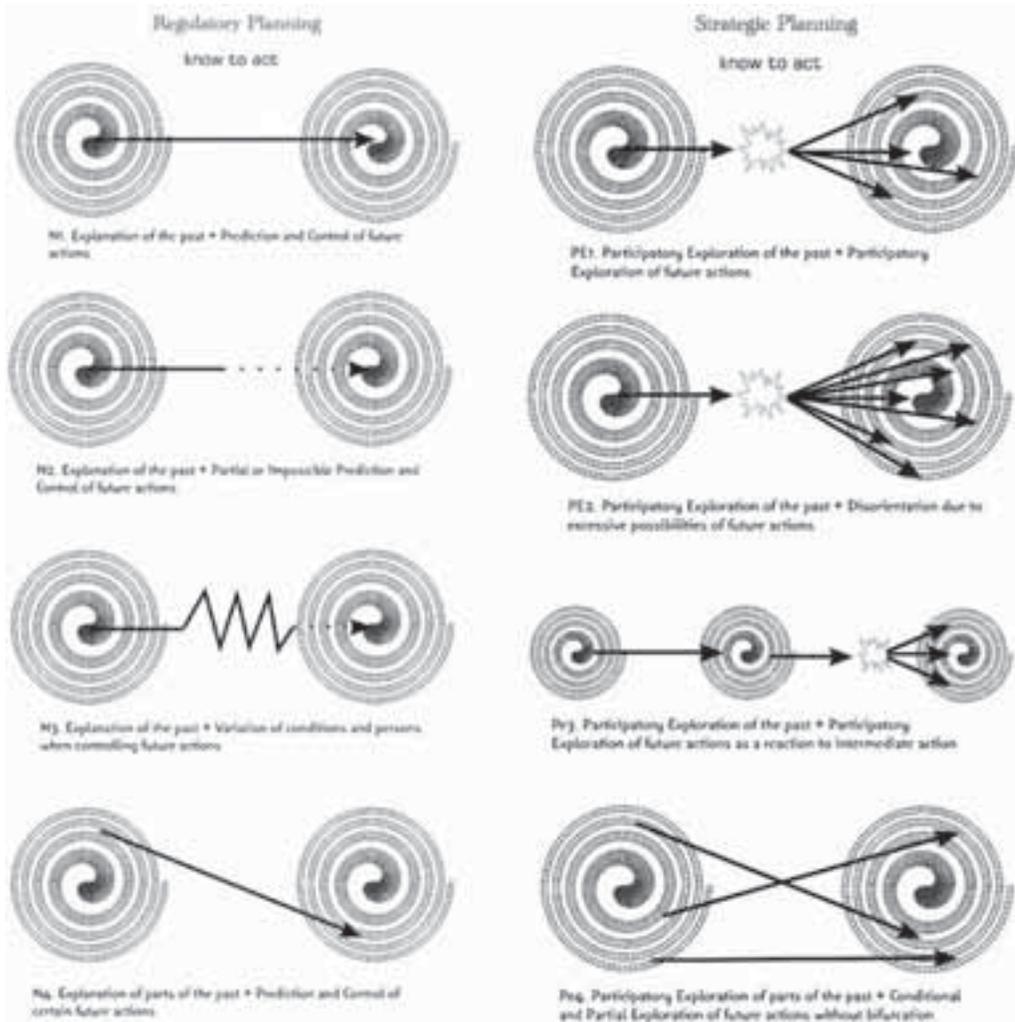


**3**    Processes of regulatory and strategic planning: the left-hand spiral represents 'knowledge' and the right-hand spiral 'action'; Fermat's spirals are used to represent the contiguity between knowledge/theory and action/practice, as in Möbius strips

Strategic invention, on the other hand, is revealed in the reflexivity we apply to subversive and reversive actions. What may be defined as 'experiential invention' consists in producing theory based on the development of 'good' and 'bad' practices: actions would be systematised reflexively before they are continued; hence, we act in order to know.
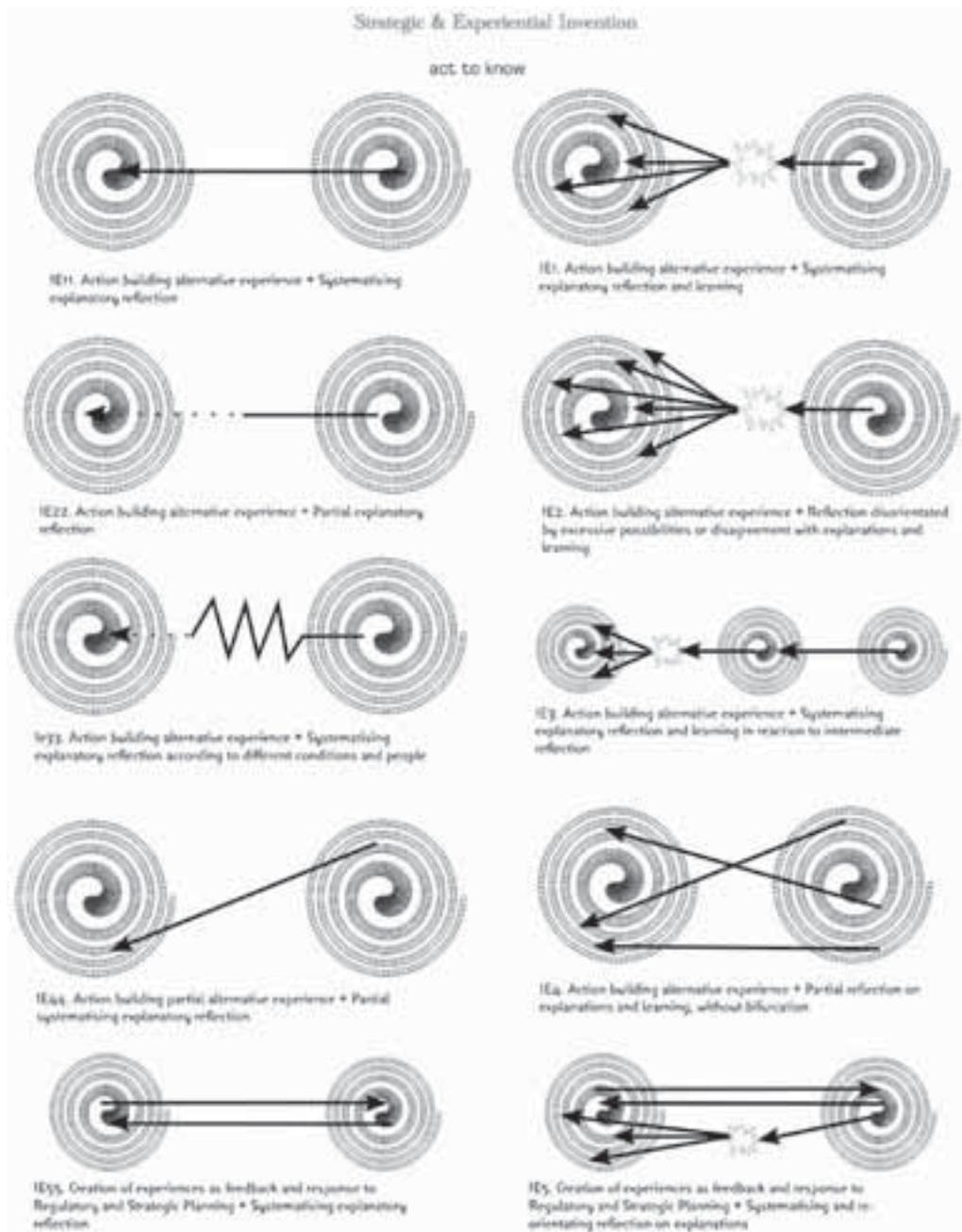


**4**    Processes of strategic invention

Before comparing practices and contexts, each subject, individual and collective must reflect on their own experience; therefore, this theory is not built from separate pieces or in the form of a collage of distant experiences isolated from their respective contexts. Reflection, in turn, is linked to past and future actions, it is not a point of arrival, just a practical need, a springboard. In fact, total experiences (combining theory and practice, desires and laboratories) would be created, and not just routinely produced experiences would be used. Similarly, theoretical reflection would overcome the mere formal recording of events and the calculation of probabilities to incorporate conflicting subjectivities and any means of expression and communication.

The model of 'co-existential invention' is less well defined, and combines theory and practice: theory is produced at the same time as practices are being developed by the same or different individuals, who are strongly linked to one another; at the same time, they know when they are acting and they act at the same time as they know. They take advantage of their participation in one process in order to gradually identify valid consequences in another process. Co-existential invention combines and does not exclude other forms of invention and planning. It takes advantage of the opportunities afforded by coincidences and affinities and also creates the opportunities and conditions for such complicities to occur (e.g. organising events, building networks, opening free forums, etc.). When gathering and adding combinations of actions and knowledge, these must be distributed according to the circumstances, possibilities and preferences of the subjects involved.
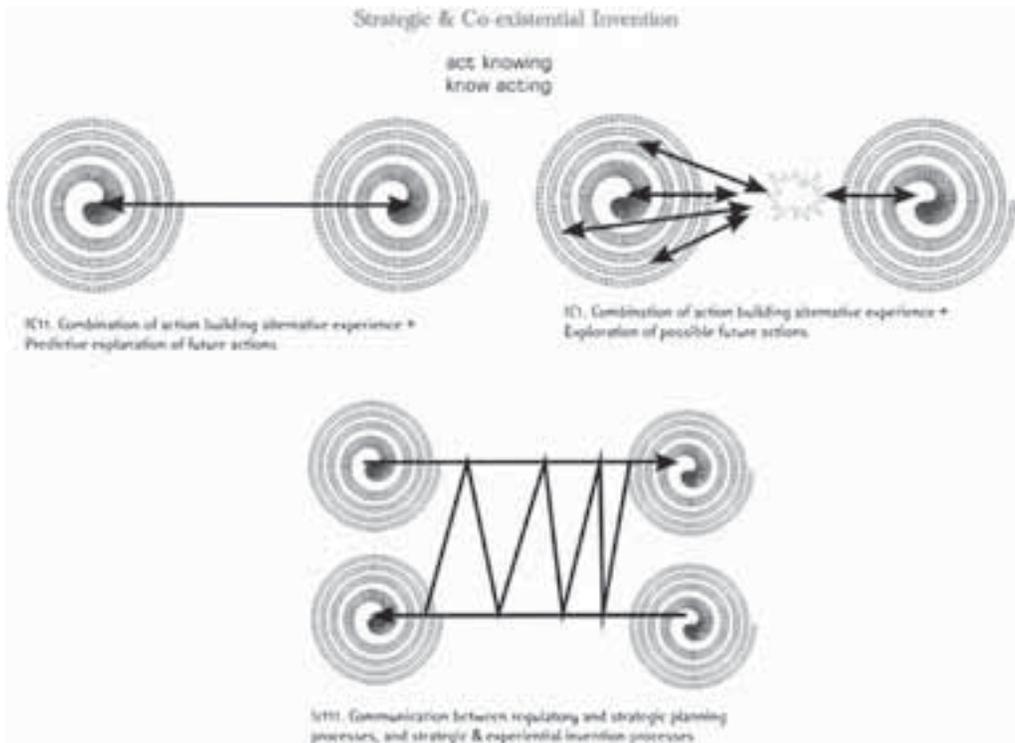


**5**   Basic processes of co-existential strategic invention: the arrows would be duplicated in all processes shown in Figs. 3 and 4

## CONCLUSIONS

A good theory should never leave us with the notion that the world has been made once and for all. Theory should act as a bridge between the empirical and the potential. . . . Why can a good theory not be indicative of action, like in architecture or engineering?[58]

In this paper, I have postulated, first, that an epistemology of complexity in the social sciences requires accurate conceptualisations to clarify the real processes involved. It is a question of avoiding ambiguous, misleading and decontextualised transfers of ideas between different fields of knowledge. Transdisciplinary notions that are complex to use should therefore acknowledge phenomena that escape the formal logic and empiricist and positivist approaches of classical science. In other words, they should avoid creating more confusion than that which they try to perceive with respect to the complex realities they study. The capacity to synthesise, as suggested by Morin, and 'to indicate potential actions', as postulated by Galtung, are just some of the epistemological warning mechanisms we can use to value the social utility of such concepts. In fact, these questions are not just crucial to qualitative sociology or to those undertaking PAR processes; they are also continually relevant in other social processes and 'tales', like the studies and proposals put forward by the Elkarri social movement to strengthen peace processes in the Basque country,[59] critical film-making by certain film directors (e.g. Michael Moore with *Bowling for Columbine* and *Fahrenheit 9/11*, and Michael Winterbottom with *Road to Guantánamo*), or different participative urban-planning procedures.[60]

When referring to 'the real processes involved', we are referring to both complex ontological-empirical processes and epistemological-reflexive processes simultaneously. Although the epistemologies of complexity do not necessarily exclude the use of hypothetical-causal explanations of traditional science, they do situate its starting point in forms of 'participatory exploration' with the reality studied. As proposed by Prigogine, von Foerster, Ibáñez and other authors, the phenomena that are most difficult to determine objectively (indefinite phenomena), and which involve more uncertainty, fluctuations, unpredictable evolution, disorder, etc., should not be studied with complete abstraction of the actions of the observer when studying them; and, conversely, social participation in a process of knowledge (in the study, public discussion and use of knowledge) and the reflexivity exercises of the individuals involved must not ignore their integration within the scope of more complex phenomena (the dynamics of the generation of inequalities and exclusion, illness, contamination, war, social change, etc.).

So, I have argued that we can use notions such as 'strategic invention' to guide us on that path of conceptual clarification. In fact, the definition of this concept includes the components of the epistemologies of complexity (strategy as an attribute of systems open to their environment) and PAR methodologies in social sciences (the construction and verification of knowledge through collective action). Other key concepts in this regard, as argued in connection with the concept of 'entropy', are often laden with simplifications (e.g. the equivalence between 'entropy' and 'disorder') that, when applied in social theory, would even rattle the basic pillars of the explanations and theories proposed by Marx, Durkheim and Weber. In contrast, I consider that they may be useful for obtaining a better understanding of the social and knowledge processes that caused so much concern

to the 'founding fathers', in addition to contributing new elements on which to base methodologies such as the PAR methodologies. The notions of 'strategy' and 'retroaction', as understood by authors mentioned elsewhere in this paper, would prompt us to re-examine more recent social theories, such as those put forward by Bourdieu and Giddens, for example, just as Luhmann did when developing his 'complex' reformulation of functionalism, although that task is beyond the modest scope of this paper.

From a more substantive perspective, I have argued that: (1) 'complexity' is much more than 'variety'; (2) an 'ecosystemic' analysis approach can be adopted as complex processes are contextualised; (3) 'strategic invention' is one way of developing that complex ecosystemic perspective. I believe that all these aspects are relevant for establishing participative action research methodologies.

To summarise, I would like to highlight the following: in accordance with the definition of 'complexity' presented here (essentially working with uncertainty), the complex nature of reality forces us to consider the contexts, scales and systems in which this occurs (or does not occur, because not all phenomena have the same degree or level of complexity) and also incorporate the 'observer context' (i.e. the theoretical and practical reflexivity of the observer) and, in particular, indicate the practical actions relating to that complexity. That indication of practical actions is equivalent to the performance and illocutory capacity of language and to the different possibilities of increasing complexity (a 'reduced complexity' according to authors like Luhmann) commonly found in different types of PAR (e.g. the 'analysers' of psychoanalytical and Marxist socioanalysis) just as in the collective action characteristic of many social movements.[61]

Consequently, 'strategic invention' provides a conception of human action as strategic, enveloped in other actors' actions and definitions of action, but also exceeds the limitations of traditional forms of linking knowledge and action, such as regulatory and strategic planning. While the two latter are based on causal explanations and on the study of evolutionary possibilities, strategic invention refers to constructions of experiences and opportunities for building social relationships that generate knowledge based on, or at the same time as, practice. If the objective of PAR processes is social self-organisation, and not just the resolution of problems or the improvement of public policies, it would be highly unsatisfactory to limit their notions of the analysis of complex social realities (with their actions, relationships and strategic systems) and their social use to the two forms of planning described previously, without methodically developing means or channels such as the strategic invention proposed here.

# NOTES

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2. See for example O. Fals Borda: *Conocimiento y poder popular: Lecciones con campesinos de Nicaragua, México, Colombia*; 1985, Bogotá, Siglo XXI-Punta de Lanza; M. J. Oppenheimer *et al.*: *Radical Sociologists and the Movement: Experiences, Lessons and Legacies*; 1991, Philadelphia, PA, Temple University Press; P. Reason (ed.): *Human Inquiry in Action*; 1988, London, Sage; W. Foote Whyte (ed.): *Participatory Action Research*; 1991, Newbury Park, CA, Sage.

3. See for example P. Demo: *Investigación Participante. Mito y realidad*; 1985, Buenos Aires, Kapelusz; G. Goyette and M. Lessard-Hébert: *La recherche-action, ses fonctions, ses fondements et ses instrumentations*; 1987, Quebec City, Presses de l'Université du Québec; L. R. Gabarrón and L. Hernández: *Investigación Participativa*; 1994, Madrid, CIS.

4. J. Ibáñez: *Del algoritmo al sujeto: Perspectivas de la investigación social*; 1985, Madrid, Siglo XXI; J. Ibáñez (ed.): *Nuevos avances en la investigación social*; 1990, Barcelona, Anthropos; T. R. Villasante: *Aportaciones básicas de la IAP a la epistemología y metodología*; 1993, Documentación Social 92; T. R. Villasante: 'De los movimientos sociales a las metodologías participativas'; in *Métodos y técnicas cualitativas de investigación en ciencias sociales*, (ed. J. M. Delgado and J. Gutiérrez); 1994, Madrid, Síntesis.

5. P. Navarro: 'El fenómeno de la complejidad social humana', February 1997, www.netcom.es/pnavarro/Publicaciones/ComplejidadSocial.html; A. Escohotado: *Caos y orden*; 2000, Madrid, Espasa-Calpe.

6. M. Montañés, T. R. Villasante and J. Martí (ed.): *La investigación social participativa*; 2000, Barcelona, El Viejo Topo; T. R. Villasante and F. J. Garrido (ed.): *Metodologías y presupuestos participativos*; 2002, Madrid, IEPALA-CIMAS; M. Malo (ed.): *Nociones comunes: Experiencias y ensayos entre investigación y militancia*; 2004, Madrid, Traficantes de sueños (www.nodo50.org/ts/editorial/librospdf/nociones_comunes.pdf); Col.lectiu Investigació: *Recerca activista i moviments socials*; 2005, Barcelona, El Viejo Topo.

7. H. von Foerster: *Las semillas de la cibernética*, p. 129; 1982, Barcelona, Gedisa.

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30. E. Morin: *La identidad humana. El método: V. La humanidad de la humanidad*, p. 14; 2004, Barcelona, Círculo de Lectores.

31. H. Atlan: 'Finalidades poco comunes', in *Gaia. Implicaciones de la nueva biología*, (ed. W. I. Thompson), p. 113; 1987, Barcelona, Kairós (first published as *Gaia. A Way of Knowing: Political Implications of the New Biology*; 1987, Hudson, NY, Lindisfarne Press).

32. A. Wilden: *Man and Woman. War and Peace. The Strategist's Companion*, p. 32; 1987, London, Routledge.

33. J. Ibáñez: *Más allá de la sociología. El grupo de discusión: técnica y crítica*; 1986, Madrid, Siglo XXI; J. Ibáñez: *Del algoritmo al sujeto. Perspectivas de la investigación social*; 1985, Madrid, Siglo XXI.

34. E. Morin: 'Epistemología de la complejidad', in *Nuevos paradigmas, cultura y subjetividad*, (ed. D. Fried and J. Schnitman); 1994, Buenos Aires, Paidós.

35. Something is complex when it is between maximum order and maximum disorder, i.e. only apparent disorder or uncertainty due to insufficient information (R. Ramos: 'Jano y el ornitorrinco: aspectos de la complejidad social', in *Complejidad y teoría social*, (ed. A. Pérez-Agote and I. Sánchez de la Yncera); 1996, Madrid, CIS). Some social phenomena are more complex than others, societies combine both types and the explanations are causal or multi-causal according to the phenomena studied (J. Noya: 'Ambivalencia, consenso e igualdad', in *Complejidad y teoría social*, (ed. A. Pérez-Agote and I. Sánchez de la Yncera); 1996, Madrid, CIS).

36. N. Luhmann: *Poder*; 1995, Barcelona, Anthropos (first published in German as *Macht*; 1975, Stuttgart, Enke; published in English as *Trust and Power*; 1980, New York, NY, Wiley); N. Luhmann: *Sociedad y sistema: la ambición de la teoría*; 1990, Barcelona, Paidós-ICE-UAB.

37. Other methods for understanding the idea of 'increasing complexity' include: (1) using new questions to reformulate the objectives of the research and action of the collective that took the initiative (in the Zapatista style of 'walking we ask questions'); (2) identifying the 'analyser' problems and situations that may induce new actions and the discovery of transverse relationships between the dimensions and scales of complexity of the realities that affect a given collective, or those affecting the same collective (G. Lapassade: *Socianalyse et potentiel humain*; 1975, Paris, Gauthiers-Villars; R. Lourau: *L'Etat inconscient*; 1978, Paris, Editions de Minuit); (3) organising 'triangular' and plural discussions, bringing together other collectives and individuals with strong and weak ties with the promoting collective in specific events, the results of the research and the strategic proposals arising from them (in other words, adding up, including, multiplying the networks of affinity, debate and mutual support); (4) supporting the 'proliferation' of other collectives with similar research–action dynamics, but independently from the promoting collective, complementing these and other work areas, which may contribute new perspectives of analysis and intervention in the former; (5) finally, for some, it would simply be a question of a strategy to 'teach strategies' (A. Wilden: *Man and Woman* (see Note 32)) and 'learn to learn' (G. Bateson: *A Sacred Unit: Further Steps to an Ecology of Mind*; 1991, New York, NY, HarperCollins).

38. P. L. Berger and H. Kellner: *La reinterpretación de la sociología*, pp. 91–92; 1985, Madrid, Espasa-Calpe (first published as *Sociology Reinterpreted: An Essay on Method and Vocation*; 1981, Garden City, NY, Anchor Books.

39. I. Prigogine and I. Stengers: *La nouvelle alliance: Métamorphose de la science*; 1979, Paris, Gallimard (published in English as *Order Out of Chaos: Man's New Dialogue with Nature*; 1984, London, Fontana).

40. J. de D. Ruano: *Auto-organización. Entre el orden y el caos*; 1996, Coruña, Universidade da Coruña.

41. I. Prigogine: *El nacimiento del tiempo*, pp. 62, 27–28 (see Note 12).

42. J. Ibáñez (ed.): *Nuevos avances en la investigación social*, p. 9; 1990, Barcelona, Anthropos.

43.  E. Morin: *La identidad humana*, pp. 14–15 (see Note 30).

44.  H. M. Enzensberger: *The Sinking of the Titanic*; 1978, Manchester, Carcanet.

45.  K. Marx: 'Theses on Feuerbach', in *The German Ideology*, pp. 13–15; 1972, Moscow, Progress Publishers (first published 1845).

46.  'From the moment an action enters the context of political and social inter-retroactions, it may change direction and even, just like a boomerang, come back to bother the person launching the action. How often have we seen reactionary actions spark off revolutionary processes and vice-versa?' (E. Morin: *Ciencia con consciencia*, p. 285; 1984, Barcelona, Anthropos).

47.  E. Lamo: *La sociedad reflexiva*; 1990, Madrid, CIS.

48.  E. Morin: 'Epistemología de la complejidad', p. 439 (see Note 34).

49.  E. Ander-Egg: *Introducción a la planificación*; 1991, Madrid, Siglo XXI; J. Borja and M. Castells: *Local and Global: The Management of Cities in the Information Age*; 1997, London, Earthscan.

50.  E. Morin: 'Epistemología de la complejidad', p. 439 (see Note 34).

51.  G. Bateson: *A Sacred Unit* (see Note 37).

52.  A. Wilden: *Man and Woman* (see Note 32).

53.  *Manual de guerrilla de la comunicación*; 2000, Barcelona, Virus.

54.  J. Ibáñez: *Del algoritmo al sujeto* (see Note 4); J. Ibáñez: *El regreso del sujeto*; 1991, Santiago de Chile, Amerindia; A. Ortí: 'Para regenerar la democracia ¡Vivan los 30 años de CEISA! Cuchará y Paso Atrá', *Revista Cultural de Ciencias Sociales*, 1996.

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57.  M. Serres: *Le Passage du Nord-Ouest*, pp. 21–22 (see Note 56).

58.  J. Galtung: 'Theory formation in social research: a plea for pluralism', in *Comparative Methodology: Theory and Practice in International Social Research*, (ed. E. Oyen); 1990, London, Sage.

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61.  For example, see two manuals of the anti-/alter-globalisation movement: Notes from Nowhere: *We Are Everywhere: The Irresistible Rise of Global Anticapitalism*; 2003, London, Verso; Crimethinc: *Recipes for Disaster: An Anarchist Cookbook*; 2005, Olympia, Crimethinc Ex-Workers Collective.

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