Complexity Theory and Conflict Transformation:

An Exploration of Potential and Implications

Diane Hendrick

June 2009

UNIVERSITY OF
BRADFORD

DEPARTMENT OF PEACE STUDIES

Other titles in this Series

"To study history means submitting to chaos and nevertheless retaining faith in order and meaning."

"'The game as I conceive it,' Knecht once wrote,
'leaves (the player) with the feeling that he has
extracted from the universe of accident and confusion
a totally symmetrical and harmonious cosmos,
and absorbed it into himself.'"

Hermann Hesse,
The Glass Bead Game

Abstract

This working paper is intended as an exploration of the usefulness of complexity theory to the field of peace research and conflict intervention. I have used the term conflict transformation to indicate a comprehensive and long term approach to social change in situations of violent, often intractable conflict and reference will also be made to development and aid, security and ecology as being relevant to conflict transformation processes.

The paper begins by outlining key features of complex systems before going on to illustrate attempts made to apply complexity theory (originating in the natural sciences) in various social science fields with a consideration of some of the difficulties this translation poses.

Conflict analysis is the basis of research and strategy formation and indispensable to intervention in conflict situations, therefore, the potential for deepening and sharpening analysis that complexity theory may offer are discussed and conclusions about the advantages of a complexity-influenced conflict analysis are drawn. Some of the tools available to augment analysis are briefly presented, whereby the main emphasis is given to computer simulation.

The understanding of the nature of change processes in complex systems is considered and the implications of a complexity approach for intervention in conflict and development environments in terms of strategy development are discussed. The view is taken that the gains to be made (at least so far) are largely in terms of an altered and, it will be argued, more sophisticated and realistic orientation that affects the way that things are perceived in analysis and done in the field rather than in the introduction of specific new methods.

On the basis of the foregoing exploration it will be argued that a change is required in the education and training of peace researchers and conflict and development workers such that the above-mentioned orientation to complex conflict situations may be developed and here transdisciplinarity is seen as playing an integral role. The varying conceptions of transdisciplinarity are discussed and specific examples of transdisciplinary research and education enterprises are presented.

The importance of the intra-personal complex processes not only of conflict parties but also of conflict interveners (and even conflict transformation researchers) is highlighted. The view is taken that the peace worker becomes part of the complex system in which he or she seeks to intervene and, therefore, requires self-reflective abilities and the development of awareness and mindfulness in analysis, through strategy development and into actual intervention. The development of these abilities thus becomes part of an appropriate education and training for those working in the field of peace and conflict. This aspect of the topic is to be elaborated in further research papers.

The conclusion briefly reviews the valid concerns and doubts with regard to the application of complexity theory within the social sciences before attempting a tentative balance of the benefits to be gained from continued engagement in the process of adaptation and integration of complexity concepts and approaches in the field of conflict transformation.

Contents

Introduction

Complexity theory in the natural sciences has brought fresh insight into the nature and working of complex systems and some have hoped that applying this theory to social systems, albeit necessarily in an adapted form, could be equally revealing and useful. I confess to being among their number although the degree and extent of the usefulness and applicability of complexity in these areas is not yet clear to me. I am, however, convinced of the *potential* to, at the very least, facilitate a more realistic (i.e. closer to the reality of how the social world works) and open approach to analysis and action for change. This working paper is an exploration of ideas, opinions and attempts related to the application of complexity theory to the field of conflict transformation and some early reflections on these.

The term conflict transformation has been used here to indicate a comprehensive and long term approach to social change in situations of violent, often intractable conflict. I find the term sufficiently broad to reflect the agenda of peace research and peace studies in their concern for justice as well as peace and, therefore, reference will be made to development and aid, security and ecology as being relevant to conflict transformation processes. I have also drawn on studies from the field of management and organisational change and military studies. The former as there has already been a relatively longstanding engagement with complexity theory in this field and also due to the historical influence between management and conflict resolution, the latter in order to remain open to insights in processes even where values and methods may be radically opposed.

Peace research and peace studies have identified themselves as interdisciplinary, however, have often, in my view, failed to achieve the potential that this term implies. Complexity theory begs integration at theoretical and practical levels and it is possible that transdisciplinarity could spur this development within the peace and conflict field and for this reason it receives attention here. Allied with this must be the integration of an awareness of the intra-personal aspect of conflict transformation that is not limited to taking the psychological processes of conflict parties into account but recognises that the analyst and intervener enter the conflict system and their own inner processes are relevant to achieving the aims they pursue. The importance of the intra-personal level for conflict transformation processes is referred to, but not explored in depth, in this paper and will be the subject of further research and reflection papers.

1) What is Complexity Theory?

There is no one theory of complexity but rather several theories, or elements of theories, that have emerged from natural sciences, particularly biology, computer simulation, mathematics, physics and chemistry.[1] These theories (for ease of reference henceforward referred to here as

---

[1] Stuart Kauffman (Kauffman 1993, 1995, 2000) John Holland (Holland 1995, 1998), Chris Langton (Waldrop 1992), and Murray Gell-Mann (1994) on *complex adaptive systems* (CAS), Ilya Prigogine (Prigogine & Stengers 1985, Nicolis & Prigogine 1989, Prigogine 1990), Isabelle

"complexity theory") represented a recognition of the limitations of the Newtonian, linear scientific paradigm when applied to complex systems. The dominance of this paradigm had already been shaken by the discoveries within quantum physics but these had been confined to a particular scale and the implication has been the Newtonian paradigm holds for most practical purposes. Jay Lemke describes how our analytic approach developed within the human community, sharing knowledge across distance and time, until we became seduced by its successes into a belief in its universal applicability:

> "In all this, we have adopted the habit of constructing the properties of wholes from samplings of their parts. Confined to the human scale in our specific interactions with the here-and-now, but benefitting from overlaying these with models of the there-and-then, we have had to learn to make sense of higher levels by piecing them together 'from below'. When this same adaptive strategy was turned to the analysis of levels below us (anatomical studies, mechanical and chemical theories) we found first that we were well-served by our technologies (our machines, built by assembling pieces into wholes), and then that we had to sample still lower levels, where changes happened too quickly for our eyes and where units were many. But we still thought in terms of aggregation and piecing together, we sampled and constructed always 'as if from below', our ancient phylogenetic trick, for which our symbolic systems of communication and representation were themselves long adapted. We were, not very surprisingly, most successful as reductionists.
>
> But in order to make the reductionist program work it was essential that we leave *ourselves* out of the picture. For once we see our representations of the levels below as actually models of our human-scale relationships *to* phenomena at those levels, then the neat homogeneity of scale that defines the separability of levels is broken."
> (Lemke, 2000 p. 190)

Unlike complicated systems, where there may be many interacting elements such as, for example, wiring in an aircraft, no amount of studying of the parts will allow us to predict what will happen in the system as a whole. Complicated systems are determined and, with sufficient effort, knowable. Complex systems by contrast have many interacting agents where the interaction is unpredictable resulting in surprising outcomes. Clearly this sounds applicable to social systems and the insights gained through complexity theory in the natural sciences have been applied to various fields in social science on the basis of this analogy, where theory is understood as "an *explanatory framework that helps us understand the behaviour of a complex social (human) system"* (Mitleton-Kelly, 2003 p. 2) Complexity provides an explanatory framework for:

> "how individuals and organisations interact, relate and evolve within a larger social ecosystem. Complexity also explains *why* interventions may have un-anticipated consequences. The intricate inter-relationships of elements within a complex system give rise to multiple chains of dependencies. Change happens in the context of this intricate intertwining at all scales. We become aware of change only when a different pattern becomes discernible." (Mitleton-Kelly, 2007)

Stengers (Prigogine & Stengers 1985), Gregoire Nicolis (Nicolis & Prigogine 1989, Nicolis 1994) Humberto Maturana, Francisco Varala (Varela & Maturana 1992) work on *chaos theory* (Gleick 1987)

Before looking at the validity of this translation from natural to social science, and its relevance for peace and conflict studies, a brief presentation of the characteristics of complex systems is needed to illustrate their character more clearly.

Characteristics of Complex Systems

Self-organisation is considered to be one of the hallmarks of a complex system. Agents interact within a system without any external governing agency and in the process produce new order. Lemke reminds us that the self-organisation in such systems is the result of interactions with the environment, not a purely internal and autonomous process (Lemke, 1993 p. 247). Early work on self-organisation was influenced by Maturana and Varela's research on biological systems (Maturana, 1980). They coined the term autopoiesis for internal processes in which each component is involved in the production or transformation of other components and hence the system as a whole − the system reproduces itself (Walby, April 2003 p. 6)

The outcomes of such self-organising processes are both uncertain and irreversible. The second defining characteristic of a complex system is ***emergence,*** a concept familiar from systems theory. Checkland describes emergent properties as the result of the "whole" of the system, deriving from its component activities and their structure but, crucially, unable to be reduced to these (Checkland, 1981 p. 314).

> "Emergent properties, qualities, patterns, or structures, arise from the interaction of individual elements; they are greater than the sum of the parts and may be difficult to predict by studying the individual elements. Emergence is the process that creates new order together with self-organisation." (Mitleton Kelly p.19)

In these processes accidental factors may play a role with new "couplings" (to use Maturana's term) of reactions occurring in one particular system but not in another. Random fluctuations, whether internal or external, may also influence the development of the system through jumps to new states (Lemke, 1993)

The causal connections in these systems are ***nonlinear*** i.e. not proportional. The conventional scientific paradigm leads us to expect that a small input will lead to a small output and, correspondingly, a large input will produce a large output. This proportionality is broken in complex, non-linear systems where feedback plays a key role in the emergence of new order. Negative feedback plays a regulating role (as with the thermostat in a heating system) tending to maintain stability in the system. It is ***positive feedback*** that has a reinforcing or amplifying effect. In complex systems that are operating far from equilibrium there is great sensitivity to perturbations. These may be very small scale and yet through the process of positive feedback produce "huge, startling effects" (Prigogine, 1985 p. xvi). A related concept, derived from chaos theory, is that such developments are extremely ***sensitive to initial conditions*** i.e. a slight difference in any aspect of the situation from which such a process begins can result in

widely different trajectories as the difference becomes amplified through positive feedback – Lorenz's renowned "butterfly effect"[2]

Complex systems are open systems, exchanging energy and information with their environment. The agents in these systems interact in such a way that they adapt to the behaviour of other agents, who in turn adapt. This adaptation is cause for further adaptation and so on. Such *complex adaptive systems* (CAS) are dynamic and interact also with their environment causing it to change and then responding to these changes themselves. They are thus in a process that may be described as *co-evolution*.

The development of a complex system within the environment, and in relation to other complex systems, can be tracked in what are termed "*fitness landscapes*". This term was first coined by Wright in the field of evolutionary biology and it has been adopted, and further elaborated, by complexity researchers. A fitness landscape is a "mountainous terrain showing the locations of the global maximum (highest peak) and global minimum (lowest valley) [and] the height of a feature is a measure of its fitness." (Coveney, 1995 p. 108) Within this fitness terrain the landscape alters and deforms as the actors within the environment act and change, in turn altering the conditions for the actors. According to Kauffman:

> "Real fitness landscapes in evolution and economies are not fixed, but continually deforming. Such deformations occur because the outside world alters, because existing players and technologies change and impact one another, and because new players, species, technologies, or organizational innovations, enter the playing field. Fitness landscapes change because the environment changes. And the fitness landscape of one species changes because the other species that form its niche themselves adapt on their own fitness landscapes . . . " (Kauffman, 1995 p. 208)

It is possible to construct such a landscape for any complex system and, by tracking interactions over time, observe how the environment is affected and responds to the changes that are occurring.

2) Application in Social Science

There are proponents of the application of complexity theories to the social sciences in practically every field, particularly where the complexity of social interaction appears evident together with an awareness of system level behaviour that is not amenable to prediction (at least not in the medium and long term). Peace research and peace studies have always regarded themselves as necessarily interdisciplinary and I will highlight a few of the arguments for the potential added value of complexity approaches in a few disciplines traditionally associated with peace research: sociology, international relations, social psychology, development studies but also management studies and military studies.

---

[2] Lorenz first published his findings in 1963 and in 1971 used the image of a butterfly flapping its wings in Brazil causing a hurricane in Japan to illustrate the complex nature of weather systems.

Sociology

Sylvia Walby sees in complexity theory the opportunity to re-conceptualise old theories in sociology, making them relevant and useful and transcending dichotomies that have frustrated analysis in the past, while at the same time reflecting a more realistic picture of social interactions[3]. Key is the "anti-reductionist analytic strategy" of complexity theory and the re-conceptualisation of systems so that the dynamic aspects of the inter-relationships are also included. Walby finds this latter to be particularly important in the face of globalisation where the "systemness" of connections needs to be studied. Complexity theory provides a way out of the reductionism in sociological perspectives, whether expressed in terms of the emphasis on the individual in rational choice theory or an exclusive focus on structures. Interestingly, in this regard Walby sees a return to some of the concerns of classical sociology:

> "such as combining an understanding of both individual and social structure, that does not deny the significance of the self-reflexivity of the human subject while yet theorising changes in the social totality." (Walby, April 2003 p. 2)

Here Walby is referring to what she sees as the major strength of most classical sociology where it is engaged analytically with "individuals and social institutions and often several further ontological levels within a single explanatory framework" (Walby, April 2003 p. 2). This strength has been lost at times in sociology but Walby sees complexity theory as providing a means to revive it.

Walby argues that old versions of systems theory, requiring an understanding of systems as nested, fell into disrepute by virtue of the lack of explanatory power in relation to complex intersections of relations. It was criticised that agency was neglected in any forms of structural or system-led explanations (Walby, 2007). Nevertheless, Walby notes, the essential requirement to conceptualise social interconnections led to the use of systems analyses under other names.

Complexity theories allow a solution to this impasse by utilising a distinction between system and environment, where each system takes all other systems as its environment (Bertalanffy, 1968). Here systems are not necessarily nested and the parts do not necessarily constitute one whole:

> "Instead, each social system (whether economy, polity, violence nexus, or civil society) takes all other systems as its environment. Likewise each set of social relations (e.g. gender, ethnicity, class) is a system, taking all others as its environment. Each system, whether domain or set of social relations, can have a different spatial and temporal reach. … A system does not necessarily fully saturate the space or territory that it is in. This enables us to think of a set of social relations as not fully saturating an institution or domain—it can overlap with other sets of social relations." (Walby, 2007 p. 459)

---

[3] The interpretation of complexity theory by social scientists is also very varied. Byrne (1998) argues that complexity theory constitutes a defence of realism, while Cilliers' (1998) considers that complexity theory advances postmodernism. There are several different approaches to the utilization of complexity concepts in Sociology, including Luhmann (1995), Jessop (2002), Urry (2005), and De Landa's (2000). See (Walby, April 2003)

In Walby's conceptualisation of institutionalised domains, they are broadened (and thus even more appropriate to a peace research approach) where the economy includes not only free wage labour but domestic labour, the polity includes supranational entities and organised religions that govern areas of life (such as personal life). Her inclusion of "the violence nexus" as a domain echoes peace research for, as she argues,:

> "interpersonal violence is so important in the constitution of gender and minority ethnic relations and organized military violence is so important in the formation of nations and states." (Walby, 2007 p. 459)

Walby develops a sophisticated and comprehensive approach to understanding complex social systems that deserves attention within the field of peace research:

> "Each set of social relations is a system. Examples of sets of social relations are those of class, gender, and ethnicity; each is a social system. Each of these sets of social relations is not flattened to a culturally reductionist concept of identity, or economically reductionist concept of class. Each set of social relations of social inequality is understood as a social system with full ontological depth, being constituted in the institutional domains of economy, polity, violence, and civil society. Not only are gender relations constituted in the economy, polity, violence, and civil society, but so also are ethnic relations and class relations. These systems of social relations are constituted at different levels of abstraction; one level is emergent from another. An individual will participate with a number of different sets of social relations.
> These are overlapping, non-saturating and non-nested systems of social relations. Gender is not contained within class relations; they are not nested. Gender relations are a separate system; it overlaps with class, but neither gender nor class fully saturate the institutional domains." (Walby, 2007 p. 459)

The concept of emergence, where macro-level outcomes are the result of numerous micro-level interactions (and furthermore constitute something new in kind and not predictable from a study of the agents or components of the system) also provides a way through the difficulties faced in theorising the connections between agency and structure. The concept of co-evolution contributes to an understanding of the relationship between different social systems, previously problematic in sociology, and here downward causation also plays a role. Particularly, where the intersection of inequalities is a concern, where gender, ethnicity and class play a mutually influencing role in the constitution of inequality:

> "Mutual adaptation, conflictual as well as more harmonious, takes place within changing fitness landscapes (Kauffman 1993). Class, gender, and ethnicity are complex adaptive systems that coevolve in a changing fitness landscape. Gender relations coevolve in an environment that includes both class and ethnic relations. This environment, or fitness landscape, may be conducive to the development of one or other form of gender regime." (Walby, 2007 p. 463)

Here also path dependency is useful in understanding the differences in how groups develop in terms of social relations in different countries despite following a common programme of economic modernisation.

Walby's is not the only approach to utilizing complexity theory in sociology, she herself refers to the work of Luhmann (1995), Jessop (2002), Urry (2005), and De Landa (2000). As an illustration of the radically different interpretations of complexity theories it is possible to find Byrne (1998) arguing that complexity theory constitutes a defence of realism, while Cilliers' (1998) considers that complexity theory advances postmodernism. Although this appears contradictory, Walby argue that viewing this as a polarization is misguided and unnecessary. (Walby, April 2003)

International Relations

In international relations Neil E. Harrison makes the case for the value of complexity theory given the unpredictability of events in world politics that has confounded expectations based on existing theories. While there are various explanations proffered for this situation, Harrison sees the tendency of current theories of world politics to work with models of the social world that present it, for analytical purposes, as a simple system as fundamentally misleading. In contrast to realism, that sees political behaviour being driven by essential human characteristics within fixed structures, complexity theory sees world politics as a self-organising complex system in which macroproperties emerge from microinteractions. It is precisely the interactions among interdependent but individual agents within the system that account for the surprising events that defy prediction through the simple models used at the moment.

Harrison thus takes the state as a system that is not closed but open to other natural and social systems: "defined as a political system, it is open to technological, cultural and economic systems that influence political choices and processes." (Harrison, 2006 p. 8) The state is also influenced by other states and by numerous transboundary interactions between major corporations, NGOs, terrorist groups, etc. In such complex systems it is not possible to trace linear causal links:

> "Despite occasional attempts to bring in domestic politics the state is usually modelled as a unit with exogenous identity and objective interests. This greatly reduces the range of possible causal explanations for any perceived social event, simplifying causal analysis and hypothesis generation and testing." (Harrison, 2006 p. 11)

It is a disconcerting fact that outcomes may have multiple causes and that in different contexts, historically or spatially, the same cause may lead to different outcomes. This cannot be captured by the over-simplified models of international systems. Given the multiple, mutually influencing interactions within social systems it is necessary to look to the evolution of the system rather than to individual events when seeking the causes of observed effects. Complexity theory focuses on processes and relations *between* components, or in the case of social systems, agents, rather than the components themselves.

In a similar criticism to that of Walby, Harrison points to the tendency of theories in international relations to focus on one level of analysis and to present competing theories based on these. Where systems are theorised, they are limited by being presented as nested. Harrison notes that the impact of positive feedback in systems has been acknowledged:

> " '(I)ntra-national and inter-national events all impinge on one another in a cyclical and ongoing process within which the self-aggravating propensities frequently exceed the self-correcting ones by an unacceptably large amount' (Singer 1970, 165) thus national elites use rhetoric for domestic political consumption that can incite potential enemies, the public and military desire the psychological comfort of discernible superiority, media amplify inter-nation conflicts, and the benefits of participation in the ideological mainstream preserve the distribution of power and inhibit changes in the historic patterns that transform inevitable conflicts into costly rivalries." (Harrison, 2006 p. 28)

While Walby refers to examples of the importance of the notion of path dependence with reference to differences in development between countries, Harrison sees its relevance at the level of the international state system. Thus development through time is not wholly random and there are limits or constraints created by the prior development of the system that restrict the possible options for change. In this way the international system may change its structure without becoming another system and here Harrison brings the example of the Cold War. While it is true that the Cold War was produced by historical interactions, it is still not possible to claim that it was an inevitable effect of historical causes. The myriad micro-interactions that occurred introduce unpredictability into development, especially given the above-mentioned possibility of positive feedback.

Harrison is optimistic with regard to the gains from the application of complexity theory to world politics in theoretical but also in policy terms:

> "This ontological shift from simple to complex systems opens new paths to knowledge and understanding yet incorporates much current knowledge; it validates novel research methods; and theories founded in this approach will generate radically different solutions to policy problems." (Harrison, 2006 p. 2)

Social Psychology

The complexity of social systems cannot be understood without reference to the inner processes that guide perceptions and behaviour. Psychology and social psychology are here of great importance. In much of peace research and conflict transformation work psychology plays a central role. At least this is the case in conflict analysis and strategy development in as far as there is a focus on conflict parties and stakeholders. However, the importance of these psychological aspects for the conflict intervener or peace researcher his- or herself, in terms of self-awareness, self-reflection and self-development, are seldom considered worthy of investigation or, in the case of peace practitioners, of development. This is a theme to which I will return later in this paper but first I would like to provide an illustration of how complexity theory is being applied in social psychology.

The extent of internal psychological processes becomes evident when one considers the large variety of factors that influence the way people think and behave, covering social stimuli from interactions that vary in duration and significance, also processes of reflection on the past and future as well as aspects of the larger social context, both cultural and institutional (Vallacher, 2002 p. 265). The interaction between these factors increases the complexity potential such that quite diverse patterns of thought and behaviour may be generated across individuals but

also different patterns may be established within an individual. In fact, as Vallacher et al point out:

> "Even if we somehow managed to identify all relevant factors and specified how they interact to influence thought and behaviour, we may still be at a loss to explain or predict a person's beliefs, decisions, desires, or courses of action" …[as] "the complex edifice of interacting causal forces permeating social life can collapse in the face of personal desires, values, and momentary whims." (Vallacher, 2002 p. 265)

In the face of such intricate and multi-faceted interacting processes at intra- and inter-personal or social level, comprehensive description, let alone prediction, is impossible. Vallacher et al also find application for the concept of the emergence of system-level properties by means of self-organisation, for example, in the way group norms may develop through the spontaneous coordination of members' impulses and actions without requiring a higher-level authority that imposes rules and standards (Vallacher, 2002 p. 266). They also point to work on social influence and interdependence that has shown that simple social interactions over time tend to promote the emergence of public opinion, altruistic values and other group level properties (e.g. (Axelrod, 1984) (Nowak, 1990)). They posit an application at an intrapersonal level where spontaneous self-organisation of cognitive and affective elements into higher order structures has been revealed in experimental work on social judgment (Vallacher, 1994) and action identification (Vallacher, 1998).

Path dependency in this discipline can be demonstrated, for example, within group norm formation, where there might be: the initial dispositions and attitudes of each group member, the nature of the relationships among group members, and the exposure of the group members to ideas and information from sources outside of the group. It is in the interaction of these constraints that the norms emerge. Analogously, Vallacher et al argue that:

> "an individual's attitudes and values presumably arise from the attempt to reconcile his or her pre-existing judgements, diverse pieces of old and new information, and conflicting social pressures and expectations." (Vallacher, 2002 p. 267)

The important point here being that external factors do not cause change within a passive system but affect the course of the internally generated dynamics whether within a person, a group or society. The non-linear nature of the potential changes are characteristic for complex systems:

> "Lacking insight into the ongoing processes within a persona or social group, it is difficult to know what effect a given external influence is likely to have. When external influences are present, the system's macro-level properties may change in a manner that is non-proportional to the magnitude of the influences. Sometimes an external factor produces only resistance, with little or no change in the ongoing processes of the person or group. At other times, the person or group may show an exaggerated response to a lesser value of the same external factor. At yet other times, an external influence may initiate a process that unfolds according to its own pattern of changes, the effects of which may not be apparent for days, minutes or years, depending on the phenomenon in question." (Vallacher, 2002 p. 267)

Vallacher et al also see the potential in tools and methods developed in mathematics and other scientific fields for investigating complex dynamics for the study of personality and social

psychology. They argue that beyond the generation of specific insights in the field there lies scope for integration:

> "This suggests the potential for developing general laws of psychology dynamics that apply to all levels of social reality, from the flow of individual thoughts to societal transformations. Beyond providing coherence to an admittedly fragmented discipline (..) the discovery of such laws in social psychology may foster new levels of integration with other areas of psychology that have already embraced the dynamical perspective (e.g. developmental and cognitive psychology) and with other areas of science as well." (Vallacher, 2002 p. 268)

Development

Development theorists and practitioners have been among the first to try to integrate broader considerations into their domain of interest, for example, the relationships between conflict and development or climate change and development. However, explicitly complexity approaches to development are still relatively rare but there is a cautious exploration of the possibilities in Ramalingam et al's paper for the ODI (Ramalingam, 2008). They argue that a complexity paradigm could help improve understanding of the nature of change processes and modify expectations with regard to development policies and projects. Robert Chambers has written of the potential and implications of complexity sciences for understanding and operating in the aid system (Chambers, 1997). Alan Fowler is also convinced of the value of applying a complexity approach to development:

> "In the broad canvas of social change, an approach drawing on complexity is potentially powerful. It would entail incorporating different views about what is and is not effective. Combining these ideas would offer more robust grounds for action, and provide more realistic insights about processes and measures. It would also provide clearer assessments of how long different types of change in societies need in order to be realized, and a refined understanding of the relational power shifts involved in the process." (Fowler, 2008)

Samir Rihani, as with many in the field, has reviewed the achievements of billions of dollars of aid and varying paradigms and found the outcomes to be very disappointing. Some speak of a crisis in development theory and policy and Rihani sees a major problem in the application of linear assumptions to situations where non-linear phenomena within a complex system are operating and he would favour a complexity paradigm in development research and policy (Rihani, 2002). Groves and Hinton are concerned with aid practice and policy and have observed that the complex interrelations that are familiar to many on the ground are not reflected in the structures of aid relations and development projects (Groves, 2004).

Ramalingam et al point out that in many disasters there are rarely single causes but rather many interacting and interdependent dimensions and factors:

> "Famine can be caused by drought, a rise in the price of grain, a drop in the price of livestock, inadequate road infrastructure, a lack of food aid, or by all these factors simultaneously (Pirrotte et al., 1999)." (Ramalingam, 2008 p. 13)

Sen has long argued for a more complex understanding of the emergence of poverty including such factors as: income consumption poverty, deprivation of capabilities linked to health, education, mortality, under-nourishment, illiteracy and participation in the activities of society, which involves freedom, social inclusion, employment, dignity and human rights (Sen, 1999). It is the interaction of these factors that is the reflection of the complexity in the situation. Therefore, any intervention to tackle one dimension will have effects on other dimensions, intended and unintended. Evaluation of impact along a purely separate dimension is then not possible.

Furthermore there are different perspectives on the nature of the system itself and these must be taken into account including the perspectives of those affected by aid initiatives:

> "As there are many perspectives on how to understand the complex social, economic and political contexts of aid work, it is important to bring together as many of these as possible in order to gain a rich picture of constraints and opportunities. This means that the practical, social and institutional dimensions should be of as much concern to aid agencies as the scientific and scholarly concerns." (Ramalingam, 2008 p. 14)

The 1990s saw much attention being paid to the link between environment, population and conflict in the context of human security. There are significant debates about the nature of the processes at work and differing conclusions about how, and where, to intervene to reverse downward spirals. Thomas Homer-Dixon is one of the theorists in this field who stresses the value of a complexity approach. He advises that:

> "At the methodological level, we need to explore how causation works at the interface between the physical/ ecological and social worlds. Environment-conflict research brings us face to face with some of the most intractable issues in philosophy of science, specifically whether causal generalizations describing the social world have the same status as those describing the natural world. Because systems in both these domains are fundamentally complex—characterized by huge numbers of components, causal interactions, feedback loops, and nonlinearity—environment-conflict researchers can gain insights from complexity theory. We urge greater receptivity to the concepts and findings of this rapidly developing field." (Homer-Dixon, 2000 p. 89)

Homer-Dixon is scathing towards those who deny the relevance of complexity approaches rather than taking up the challenge to find new ways to research complex problems:

> "The problem of complexity exists in the real world. It cannot be wished away by assuming that it resides only in the mind of the researcher. …Researchers in a variety of fields increasingly acknowledge the reality of complexity and are developing powerful theories to understand complex systems. These theories raise serious questions about conventional (often mechanistic) explanations of social phenomena and about the conventional methodologies used to study these phenomena (Cowan, Pines, and Meltzer, 1994). Rather than denying complexity's existence, … social scientists should explicitly acknowledge the problems it creates for their research and try to develop methods—such as those focusing on causal mechanisms—for dealing with it." (Homer-Dixon, 2006 p. 87)

Management

Peace research owes a debt to this field, for example, some of the approaches familiar from conflict resolution have emerged from management studies and practices going back as far as the work of Mary Parker Follet in the 1920's (Follett, 1995) on integrative negotiation, identifying interests, breaking down problems into sub-issues, etc. As the field of management studies and organisational consultation has taken up complexity theories with enthusiasm and creativity there is much that can be drawn from here that is of relevance for peace and conflict.

An influential early attempt to bring the insights of complexity from the natural sciences to bear on issues of organisation and business were the writings of Meg Wheatley (Wheatley, 2006).) Also Peter Senge et al and their book entitled the Fifth Discipline, which links systems theory to complex dynamics (Senge, 1990; 2006), is often quoted in the field and beyond.

Since then research interest has grown and the applied nature of the discipline means that there are also valuable action research projects such as those carried out at the LSE Centre for Complexity. Eve Mitleton-Kelly describes the link to practice and evaluative opportunities:

> "If organisations were managed as complex evolving systems, co-evolving within a social ecosystem, emergence would be facilitated rather than inhibited, and self-organisation would be encouraged, as would exploration of the space of possibilities available to an organisation. Managers would understand that an organisation is an entity capable of creating new order, capable of re-creating itself. Management would focus on the creation of conditions that facilitate constant co-evolution within a changing environment, and would encourage the co-creation of new organisational form with those directly affected." (Mitleton-Kelly, 2003 p. 23)

With the journal Emergence: Complexity and Organisation, a collaboration between academic researchers, businesspeople and practitioners, there is a broad platform for exchange on ongoing work in the area. Already in the second issue in 1999 (co-edited by Stuart Kauffman, Steve Maguire, and Bill McKelvey) the journal conducted a review of some thirty "complexity theory and management" books, indicating the level of interest in this field.

In the field of economics, Brian Arthur has argued that conventional theory is based on the implicit assumption of negative feedback loops in the economy, which lead to *diminishing returns*, which in turn lead to (predictable) equilibrium outcomes. Thus negative feedback has a stabilising effect, and implies a single equilibrium point, as "any major changes are offset by the very reactions they generate". (Arthur, 1990 p. 92) However, Arthur posits that such stabilising forces are not always at play in the economic system:

> "Instead positive feedback magnifies the effects of small economic shifts", and increasing returns from positive feedback makes for many possible equilibrium points, depending on the negative feedback loops that may also operate in a system (Arthur 1990)". (Mitleton-Kelly, 2003 p. 17)

The oft-quoted example is of the establishment of VHS video tape dominance over the rival Beta system due to an early gain in market share but other examples of technical standards or conventions that became established due to positive feedback, increasing returns and path dependence, are the gauge of railway tracks, the English language becoming established as the standard language of air navigation and a particular screw thread, and these often "cannot be changed even if alternative techniques or conventions may be better" (Mainzer, 1996 p. 271). The number of publications in organisational theory, business studies and economics related to complexity theory is evidence of the extent of the influence in these fields if not yet an indication of the impact of the application of a complexity approach in practice.

Military Theory

Complexity theory has influenced military thinking implicitly since the work of John Boyd through training and briefings in the 1970s and 1980s and has increasingly come to be explicitly discussed by academics and students in the military field. The application of complexity theory in analysis and strategy development is, as elsewhere, shaped by the beliefs and mental models emerging from intra-personal complex systems, or in other words viewing the world through a complexity lens can lead to many differing conclusions depending on the personal and cultural context. This point is reflected in the "OODA loop" originally developed by Boyd for training fighter pilots but later expanded and developed to apply to war fighting and also competition in the world of business.

Boyd posited that all intelligent organisms and organizations undergo a continuous cycle of interaction with their environment. He created a model that describes four interrelated and overlapping processes that are continuously repeated:

- *Observation*: the collection of data through sensory perception
- *Orientation*: the analysis and synthesis of data to form one's current mental perspective
- *Decision*: the determination of a course of action based on one's current mental perspective
- *Action*: the physical playing-out of decisions
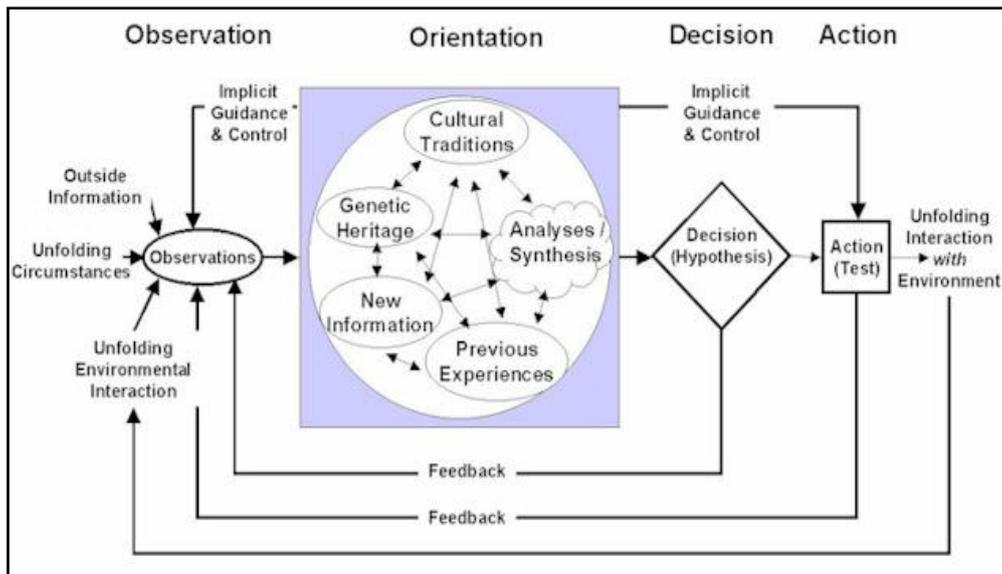
Figure 1 John Boyd's OODA Loop

Orientation is of key importance, shaping not only decisions and actions but further observation (similarly to the selective perception described by Argyris in the construction of mental models (Argyris, 1978)). Feedback is analysed in the context of cultural traditions, genetic heritage, previous experiences, and new information in the orientation process. Often the OODA Loop was understood as a simple linear process and the complexity of the processes involved not recognised.

> "… the entire "loop" (not just orientation) is an ongoing, many-sided implicit cross-referencing process of projection, empathy, correlation, and rejection. Boyd emphasized that this decision cycle is the central mechanism enabling adaptation (apart from natural selection) and is therefore critical to survival." (Hammond, 1997)

Boyd understood the world as containing three elements − matter, energy and information − which exist in space, time, and the mind of those sensing the environment. In fact, the environment is to be understood as a composite of *mind-time-space.* We are in a constant process of adapting to the environment, assessing changes consciously and unconsciously and interpreting within the constraints of our personal and cultural make-up. Here co-adaptation is being described with other words.

Boyd's observations on the nature of strategy in a complex world are as relevant to peace and conflict work, though the response to conflict may be quite another, where strategy may be understood as:

> "A mental tapestry of changing intentions for harmonizing and focusing our efforts as a basis for realizing some aim or purpose in an unfolding and often unforeseen world of many bewildering events and many contending interests." (Boyd, 2005 p. 58)

Lost in Translation

As already indicated above, in its application to social sciences there is no complexity theory as such but a number of concepts and approaches that are utilised by different researchers and

practitioners to aid in understanding complex systems and to shape responses or interventions in various fields. As complexity concepts were developed within the natural sciences there have been some concerns about importing them wholesale into quite distinct disciplinary environments. I present here some of these concerns, which I group around three themes: a) the use of some but not all concepts; b) the definition of terms ; and c) the extent to which complexity concepts are to be considered metaphor or analogy.

a) The particular concepts that are identified as relevant, and the relative importance given to them in the application, varies from researcher to researcher. For example, in the field of peace education, Lynne Davies (Davies, 2003) refers to the six *features* of complexity theory[4]. In management and research at the LSE Eve Mitleton-Kelly (Mitleton-Kelly, 2003) refers to 10 *generic characteristics*[5], Walter C. Clemens Jr. (Clemens Jr., 2001) refers to nine *basic concepts*[6]. Recently, Ramalingam et al (Ramalingam, 2008) have referred to ten *basic concepts*, which they have divided into three sets[7]. These lists all have overlaps and share key features but definitions of some terms also vary. A further significant difference is the extent to which these concepts are seen as bound together in a theory or relatively autonomous to be applied as when required. Ramalingam et al :

> "the concepts can be used in a highly flexible manner – for example, in combination or individually, to augment existing models or frameworks or as a framework in their own right." (Ramalingam, 2008 p. 60)

Contrast with Mitleton-Kelly:

> "It is not enough to isolate one principle or characteristic such as self-organisation or emergence and concentrate on it in exclusion of the others. The approach … argues for a deeper understanding of complex systems by looking at several characteristics and by building a rich inter-related picture of a complex social system. It is this deeper insight that will allow strategists to develop better strategies and organisational

---

[4] Davies, Lynn, Conflict and Chaos: War and Education,
Non-linearity, Sensitive dependence on initial conditions', self-organisation, attractors information. edge of chaos'
[5] Self-organisation, emergence, connectivity, interdependence, feedback, far from equilibrium, space of possibilities, co-evolution, historicity & time, path-dependence
[6] Fitness, co-evolution, emergence, agent-based systems, self-organization, self-organized criticality, punctuated equilibrium, and fitness landscapes. Walter C. Clemens, Jr., Complexity Theory As A Tool For Understanding And Coping With Ethnic Conflict And Development Issues In Post-Soviet Eurasia
[7] Ramalingam et al, 2007.
Complexity and systems: These first three concepts relate to the features of systems which can be described as complex:
    1. interconnected and interdependent elements and dimensions
    2. Feedback processes
    3. Emergence
Complexity and change: The next four concepts relate to phenomena through which complexity manifests itself:
    4. nonlinear
    5. Sensitivity to initial conditions
    6. Phase space
    7. Chaos and edge of chaos
Complexity and agency: The final three concepts relate to the notion of adaptive agents, and how their behaviours are manifested in complex systems:
    8. Adaptive agents
    9. Self-organisation
    10. Co-evolution

designers to facilitate the creation of organisational forms that will be sustainable in a constantly changing environment." (Mitleton-Kelly, 2003 p. 3)

Walby sees complexity as offering a set of theoretical and conceptual tools rather than a single theory to be adopted in its entirety. She describes her own approach thus:

> "My utilization of complexity theory is not a simple adoption of concepts from other disciplines, but an active process of selecting insights that can be synthesized with social theory, rather than imported or transplanted in their entirety. I offer my own hybridization of complexity theory with social theory here to address the challenge of intersectionality." (Walby, 2007 p. 458)

b) Diaz argues that there are discrepancies in the understanding of complexity theory and offers his interpretation of the situation with reference to three, as he terms them, "approximations to complexity": (Díaz, 2004)

> "First, complexity as science: the study of self-regulated dynamical systems - of their dynamics – from the most diverse disciplinary and interdisciplinary perspectives. Second, complexity as method: the attempt to extract ideas that favor the construction of a method of thought and education inspired by the advances of what has become known to us through the particular research on nonlinear dynamics, self-organization and emergence. Third, complexity as worldview: the attempt for a new look at the world and at its relations, at man and at its place in society, in life and in the world. Although all three approximations are, to my judgement, absolutely legitimate, necessary and complementary, I believe that to make no distinction in their different degree of generality produces more than one misunderstanding. So much for my thesis." (Díaz, 2004 p. 50)

There may also be varied definitions for particular terms such as, for example, "emergence". Sawyer presents some of the differing interpretations: within social systems properties are said to be emergent when they are unpredictable even given a complete knowledge of the lower-level description of the system – a complete knowledge of the state of each component and of the interactions of all the components; or properties could be seen as emergent when they are irreducible, in any lawful and regular fashion, to properties of the system components; or again when they are novel i.e. when they are not held by any components of the system (Sawyer, 2004 p. 4).

c) Complexity theory in the social sciences has been called a useful metaphor, a misleading metaphor and more than a metaphor. James Rosenau speaks of the attractiveness of complexity theory for those seeking to better understand the unpredictable, multipolar political world and the uncertainty that seems characteristic of our times, where our existing theories do not seem capable of adequately explaining processes or predicting events. However, he sees theoretical weaknesses and high expectations for something that possesses merely metaphorical utility in the description of social reality. Saperstein echoes this scepticism when he asks:

> "Do we gain any useful policy making and/or strategic tools as a result of the concordance of the new metaphors, derived from the physical sciences, with the long recognized chaotic-complex aspects of war and national security in a competitive anarchic world?[2] Has anything been gained by the transfer of the growing popularity of these paradigms from "hard" to "soft" scientists or the recognition of the growing prevalence of these "fads" by the military and political elites? A new set of metaphors

to describe a world does not imply new or different behaviors of that world—we must be very careful not to confuse changes in an intellectual outlook with changes in world events or patterns which we hope to understand and master." (Saperstein, 2003)

However, he does qualify this assessment when he argues that such metaphors could be useful in "educating that majority of citizens, soldiers, and statesmen" as:

"It is clear that the set of metaphors which underline our thoughts and discussions about the political world determine our responses to matters of war and peace. Action often follows theory. … Moreover, we also recognize that our metaphors may also shape that political world. The "field of endeavor," within which we are trying to find appropriate responses, is not itself fixed a priori; its contours may be molded by our metaphors; the topographic maps relied upon by the competing forces may be altered by the plans and actions of these forces. Hence policy and response are easier and more effective, the more appropriate the available metaphors." (Saperstein, 2003)

Eve Mittleton-Kelly is careful to stress that a direct mapping of the characteristics of complex natural systems on to complex social systems is neither desirable nor possible where the unit of analysis may differ or the domains may have fundamental differences, e.g. human capacity to reflect and choose. She believes social systems need to be studied in their own right. She finds metaphors to be "both limiting and limited" and unhelpful for understanding the fundamental nature of a system under study. Where they are useful is as "transitional objects" in the sense that they help the transition in our thinking when faced with new or difficult ideas or concepts (Mitleton-Kelly, 2003).

For others complexity theory can be used metaphorically but metaphors themselves are understood as being more than merely bridges of understanding or "transitional objects". Alan D. Beyerchen, influenced by cognitive science research, sees metaphors as: "indicators of networks of meanings and entailments that dilate or constrain both our perceptions and our conceptions" (Beyerchen, 2003). Thus metaphors shape the world that we see and the way in which we act. Wendell Jones reflecting on complexity, conflict resolution and how the mind works, is influenced by Lakoff and Johnson's (Lakoff, 1980) arguments about the fundamental influence of metaphor on human perception and cognition:

"Metaphors are very powerful tools in constructing reality. We can limit possibilities by being unaware of the metaphors we're using, or we can create new possibilities by choosing new metaphors. Individual experience also has a powerful effect on this aspect of perception. … each new experience is in intimate co-formation with the complex whole of the person's life. What each person "learns" from an experience is only to a small extent defined by the experience; the formative context plays the dominant role." (Jones, 2003 pp. 10-11)

However, that different mental models of complexity exist for different theorists and practitioners presents us with a set of problems not previously unknown in social science. Differences in definitions and applications of terms, and the attendant assumptions that inform them, are common. Confusion arises from the fact that they are often implicit and unconscious. The circumstance that complexity theories are relatively new allows at least for some alertness to this potential difference and the difficulties it brings, whereas many of the terms in the field of peace and conflict research are so familiar that it is often assumed automatically that we are all talking about the same things. The answer lies partly in the making explicit, in any particular context or collaboration, what is understood by these terms

and what is expected from their application. This is necessary within the working process but also for the prescriptive recommendations for action (as well as in reports and evaluations relating to these) in conflict situations. Awareness of the inner complexity of our individual perceptual and psychological worlds, and the connections with the outer complexity of the field of work, should be part of any programme to utilise this approach in the social sciences. The indeterminacy and changing nature of understanding, also in the emergence of collective new understandings, is a reflection of the complexity of human interaction and a denial of this for the purposes of simplification would constitute a return to business as usual. Paralysis should not be the result but rather, ideally, a more flowing, adaptive, conscious process of communication and work.

Transdisciplinarity

If a complexity approach to social science is seen as an antidote to reductionism it follows that disciplinary boundaries that artificially carve up social phenomena must break down in the face of the need for integration of knowledge and experience in order to adequately reflect the complexity of the real world. In as far as peace research and peace studies have always understood themselves as interdisciplinary, theoretically this should provide a good foundation for the switch into transdisciplinarity, a more thoroughgoing project with aims ranging from a richer integrated knowledge production with a comprehensible common language to the creation of a new kind of knowledge synthesis. In the light of complexity theory there is also a need to break away from a mechanistic understanding about the ways in which things are related and systems operate. Even where the value of interdisciplinary approaches and the complexity of problems has been acknowledged the analysis, strategy and policy-making has occurred within mechanistic paradigms. Julie Thompson Klein sees the paramount necessity for professionals operating in environments characterized by "turbulence and uncertainty" where complex problems are "typically value-laden, open-ended, multidimensional, ambiguous, and unstable" (Klein, 2004 p. 4), as being an ability to manage complexity. While new tools such as computer modelling and what she calls "deeper scientific knowledge and technical expertise" (Klein, 2004 p. 4) from within disciplines continue to emerge, these by themselves are insufficient to deal with these complex problems:

> "Complex problems are not in the book but in the "indeterminate zones of practice"
> and the "swamp of important problems and non-rigorous inquiry." (Klein, 2004 p. 4)

Furthermore, they are not solved once and forever. They must be continuously managed:

> "in a complex problem research domain the research field is open and ill-defined and
> the reality being investigated consists of a nexus of phenomena that are not reducible
> to a single dimension. Their meaning is context dependent, and the relationship
> between elements under study constitutes a core concept for complexity (Caetano, *et
> al.*, 2000)." (Klein, 2004 p. 6)

While transdisciplinarity is also a term that means different things to different people, it can be said that for everyone it means something more, or different, than previous interdisciplinary approaches, especially as they operated within linear frameworks:

> "…common ground and a more comprehensive, holistic understanding … emerge in the cross-fertilization of multiple methods and perspectives that are adapted to the task at hand. … research is multilevel. On the micro-level, research teams must learn to work in inter- and transdisciplinary settings that are inclusive of multiple stakeholders. On a meso-level, the science system is beginning to transform and to create appropriate curricula and institutional surroundings. On the macro level, political transformations have effects on the science system (Loibl, 2000). An added lesson is that new forms of knowledge, institutional structure, and problem solving require a new dialogue of science and humanities." (Klein, 2004 p. 6)

The complexity of the challenges facing humanity and the planet require expertise from many fields. The non-linear connections in our physical and human relations make it inevitable that the consequences of actions will occur in many different areas and any response to a problem cannot be limited by disciplinary boundaries. This necessity throws up philosophical as well as practical considerations for the future of research and practice. The field of conflict is not immune to these and this topic is explored in more detail later in this paper.

3) The Complexity of Conflict

So, attempts have been made to introduce complexity theory into thinking about social systems such as organisations, the world political system and the aid and development system. Within peace research and practice there is also a move to address the system-like properties of conflicts within a complexity framework. Dennis Sandole seeks to establish that there was early recognition of this in the field, quoting Kenneth Boulding who implied that conflicts operate at the edge of chaos – not completely random but not in equilibrium (Sandole, 1999). Boulding's insight could be phrased in complexity terms thus: slight perturbations could lead to bifurcation with unpredictable results given the sensitivity to initial conditions and non-liner relations within complex systems:

> "Human beings are moved not only by immediate pressures but by distant goals that are contemplated in the imagination. These goals are susceptible of change, often of dramatic change, as a result of apparently slight changes in current information. On the other hand, they also have a good deal of stability, and this gives a stability to the system in the large that it may not have in the small." (Boulding, 1962 p. 24)

In particular, intractable conflict qualifies for the epithet "complex". The dual nature of instability and persistence noted by Boulding seems characteristic of such deep-rooted, long-lasting conflict:

> "…a basic paradox of intractable conflicts: they are essentially stable despite tremendous volatility and change. If we consider the conflict in the Middle East for example, it appears by most accounts intransigent; with a past, present, and future cloaked in hate, violence, and despair. Yet, over the years we have also seen major changes in important aspects of the conflict such as in leadership, policy, regional circumstances, intensification and de-escalation of violence, intragroup divisions, popular sentiment, and international intervention strategies. In other words, we have seen extraordinary changes occur within a context of a pattern of stable destructive relations. This paradox of stability amidst change is evident in intractable conflicts at all levels, from estranged siblings and neighbors to warring ethnopolitical factions. They are at once frozen, unyielding, often persisting in hostile states for generations,

yet they are also some of the most volatile and dynamic social processes on earth".
(Coleman, 2007 p. 3)

The levels of conflict are mutually influencing from intra-personal through inter-personal to inter-group and international. Where conflicts are intractable (longstanding and deeply rooted) then there will be different conflict episodes within conflict phases reflecting different aspects of the conflict and engaging some of the same issues and parties but also drawing in new elements. The broader political, economic and social context plays into these and the key factors shaping the conflict change over time as leaders, policies, attitudes among the masses become more or less determining of the conflict dynamics (Sandole, 1999); (Mitchell, 2005).

The complexity of conflict, in particular intransigent conflict, has then not only to do with the myriad mutually influencing factors but the non-linear relationships between these. In the light of this fact there are those in the field of peace and conflict research and application that have sought to use complexity theory to aid in the analysis of conflict and in the development of strategies for conflict transformation.

Conflict Analysis - Understanding Complex Conflict Dynamics

Here the case would be made that using complexity concepts will better allow us to understand what is happening in a conflict process thus providing a more realistic and effective set of options for conflict prevention, mitigation and transformation. Theorists and practitioners in this field vary in the extent to which they make their complexity theory assumptions explicit and, as indicted above, there are differences in the choice and combination of complexity concepts.

Wils et al for the Berghof Foundation (Wils, 2006) draw heavily on systems theory but while they do not take a thoroughgoing complexity approach they do also include elements of complexity and for this reason I include their work in the present discussion. They derive their approach from practical application in such fields as organisational development, consulting and family mediation and therapy. For Wils et al there is a recognition of the complex and systemic nature within highly escalated intergroup conflict − elsewhere referred to as intractable − and they define their mission as the "reduction of complexity" and the organising of complexity into a "coherent story that illuminates the causes of problems and how they can be remedied" referencing Peter Senge from the management field (Wils, 2006 p. 13). They draw from the micro and meso levels (family therapy and organisational development consulting respectively) and shy away from what they term the meta-systems level à la Luhmann [8] as being too abstract and tending towards a "systems conservatism" (Wils, 2006 p. 13) . So for Wils et al there is a commitment to systems thinking and a recognition of complexity within intractable conflict but a skirting around complexity theory,

---

[8] Luhmann is widely cited for his use of complexity concepts in social theory, especially with regard to the concept of system (1985, 1990, 1995, 2000). "Luhmann synthesizes functionalism and phenomenology with the early insights of complexity theory (Knodt 1995) and thereby challenges the simpler versions of the critique of functionalism. However, the range of complexity notions that Luhmann introduces is quite small." (Walby, 2007 p. 457)

so to speak, in order, as they appear to understand it, to maintain flexibility and creativity and to focus on practical applications as far as possible.

They recognize that any intervention is only able to draw on limited knowledge, however, given that the conflict system is complex, the analysis needs to be appropriately complex, too and, crucially, undertaken with local actors. A recognition of the "self-reinforcing" nature of many inter-group conflicts (positive feedback) is also present. Key here is the precise definition of the systems boundaries and an awareness of the interactions and interdependencies in supra- and sub-systems.

In order to develop intervention strategies an "analytical reduction of complexity to a series of working hypotheses" is necessary in order to intervene with an intended "leverage effect" (Wils, 2006 p. iv). This also facilitates the identification of agents of peaceful change and the critical mass required to bring political and social change about. What is missing here is an acknowledgement of the non-linear nature of relations/events in complex systems thus sometimes giving their prescriptions a deterministic flavour. The approach makes use of the methodologies of applied systems theory ("especially in the areas of organisational development consulting, psychotherapy and cybernetics") into which they inject normative values derived from peace research e.g. gender equality, human rights, empowerment, conflict transformation.

The definition of systems boundaries is of paramount importance:

> "A clearly established and defined reference system is a key element of a good strategic focus of peacebuilding projects and programmes. Which conflict system or sub-systems are the interventions intended to address? Which elements are part of the system and which are not? Which function does the reference framework play in the overarching (conflict) system? How are actions on the micro and meso levels of society connected to changes on the macro level?" (Wils, 2006 p. 35)

In the service of complexity reduction a sense of scale with regard to the particular conflict or problem in hand is recommended:

> "Nevertheless, it is important to demarcate the conflict system clearly and not fall into the trap of saying that everything is ultimately connected to everything else, and the global economy and climate change should also be considered as part of the conflict system." (Wils, 2006 p. 35)

They recommend Senge's pragmatic solution

> "The key is the 'principle of the system boundary', which says the "interactions that must be examined are those most important to the issue at hand." (Wils, 2006 p. 36)

This translates in the conflict situation as:

> • interactions between actors who are capable of contributing to the resolution of the specific conflict configuration.

> • interactions communicated by structures that contribute directly to the perpetuation and reproduction of patterns of conflict and violence. (Wils, 2006 p. 36)

The pragmatic line is taken and presented as solution orientated: external actors who (consciously or unconsciously) contribute to reproducing conflicts are thus considered to be

part of the conflict system. However, political processes where local actors are judged to have no, or very little, influence, (here examples of the globalisation process and environmental disasters are cited) are to be considered as the system environment. These factors may be part of the problem (relevant for analysis?) but not part of the solution (not relevant for strategy). Thus there is a difference between rules applying within the system and between the system and its environment (Wils, 2006 p. 36). The strong collaborative aspect to this approach is again apparent in the stress put on the clarification of system boundaries with, and by, local actors.

Ramalingam et al in applying recommendations for organisational change at various levels within aid and development systems, find that analysis must take into account socio-psychological processes in interactions across these levels:

> "This involves 'mobilising the power and the resources to change things' by looking 'to unlock resources claimed by the status quo' (Westley et al., 2006). *To do this, it is important to understand the tensions, feedback processes and simple rules stemming from actors' incentives, beliefs and actions, which hold the current pattern together.* '… different individuals and organisations within a problem domain will have significantly different perspectives, based on different histories, cultures and goals. These different perspectives have to be integrated and accommodated if effective action is to be taken by all the relevant agents' (Chapman, 2004)." (Ramalingam, 2008 p. 50) (emphasis added)

Here again we find reference to the need to appreciate different perspectives, especially of stakeholders, in order to understand how patterns and structures are emerging from the system characteristics and the adaptation undertaken by actors within the system (Ramalingam, 2008 p. 50).
It is clear that conflict analysis needs to be undertaken regularly to take account of political developments, however, this is an activity that is often under-resourced in a context where there is moral, and sometimes financial, pressure for action to bring about change − a counterproductive approach sometimes leading to misguided and inappropriate interventions. Wils et al stress that in order to make interventions relevant it is important that conflict analysis be carried out with the participation of local actors:

> "This is essential as, firstly, local actors possess the detailed knowledge required (insider knowledge on informal political rules and power networks), and secondly, it is they who have to accept and understand the "systemic model" being drafted (strengthening of ownership and acceptance). Local actors can be included either as colleagues in a project or programme team, via partner organisations or via representatives of the conflict parties. It should also be ensured that sufficient account is taken of the perceptions of the conflict, the political scope and the interests of all major actors (not just the state and non-state armed groups)." (Wils, 2006 p. 34)

In addition, conflict analysis carried out with external facilitators can also prove a consciousness raising exercise for conflict parties, allowing them to view underlying patterns of relationships more clearly, to reassess the relative importance of goals or to understand their own reactions in context with a new insight.

The approach being developed at the International Centre for Conflict and Complexity at the University of Warsaw brings complexity theory to conflict research with a strong emphasis on the social psychological aspects of conflict. This approach is interesting in that it links the intra-personal complexity with the inter-personal and inter-group complexity found in intractable conflict. Criticising conventional approaches as too linear in analysis, they comment:

> "viewing conflict at a single point in time, or focusing on a single aspect (e.g. obstacles), was ultimately problematic because it failed to capture the fact that conflict, particularly intractable conflict, is multifaceted; involving multiple experiences and encounters between many different parties over a variety of issues under diverse conditions at different points in time." (ICCCR, 2008)

In seeking to rectify this situation they recognised the value of interdisciplinarity (multi-disciplinarity) but saw the need for a "metaframework", which would be comprehensive and flexible enough to allow for switches of disciplinary frame and this they found in "dynamical systems theory". We can recognise complexity theory here from the characterisation of intractable conflicts as complex, non-linear systems "sustained in a state of destructiveness by a variety of emergent, embedded and automatic processes" (ICCCR, 2008). Here the dynamical systems frame is the starting point but it is necessary to make use of multiple paradigms and methods of analysis "to comprehend the various sources and complex dynamics of intractability in a particular context" (ICCCR, 2008). Within the metaframework of dynamical systems Coleman et al focus on a preliminary set of frames from realism, human relations, postmodernism, and the health sciences.

Influenced by Morgan's work on metaphors and framing within organisations, Coleman hopes that the application of multiple perspectives may provide "frame-breaking insight" into key opportunities for constructive and sustainable change (Morgan, 1997). The concern to generate a multifaceted analysis of the conflict through the application of different frames under the umbrella of the metaframework of complexity echoes calls for transdisciplinary approaches but also of work carried out on the, often unconscious, "mental models" that shape our perception and interpretation of the world (Argyris, 1978). This latter approach is experiencing a revitalisation through the work of Senge and other organisational change theorists. Coleman gives the example of a focus on power and authority (choosing a political frame) as a superordinate frame, while cultural or psychological frames could be utilised to throw light from other perspectives on the power struggles taking place and in the process generate new insights (Coleman, 2004 p. 326).   Coleman suggests that in a specific conflict certain frames will offer themselves, however, this presumes a degree of previously acquired mental flexibility in order to be able to recognise our own mental models and lay them aside − at least for a time. What does seem undeniable is that changing frame is a way to make visible some of our assumptions and could open us up to considering possible alternatives. It is an activity then that promotes self-reflection and can lead to understanding. However, Coleman stresses that the variety of perspectives in itself is not sufficient but the cultivation of an ability to make connections between the problem aspects made visible by the differing approaches. This integration is a vital aspect of this approach, and of transdisciplinary approaches in general. Referencing Morgan, Coleman emphasises the applied nature of such

studies, as the purpose of reframing and multi-framing is ultimately to "develop creative insights that open new action opportunities or give new leverage on difficult problems" (Morgan, 1997 p. 372).

Within intractable conflict variables such as oppression, injustice, trauma, etc. give rise to, and maintain, malignant patterns of interaction. For the purposes of conflict analysis they are to be seen as components of a system that is characterised by underlying processes and structures considered as common to all living systems. A great deal has been written about the nature and causes of escalation and de-escalation in conflict. The operation of negative feedback can be seen in conflict dynamics e.g. the signs of physical damage at a certain level or intensity of conflict (or nature of relationship) or the mutually hurting stalemate that is usually seen as the most propitious phase in conflict willingness of conflict parties to go to mediation. Complexity theory brings a focus on the key role of positive feedbackin complex systems.

At the ICCC one item on the research agenda is the conditions under which catastrophic change occurs within a conflict, a concern with thresholds or tipping points. Incremental escalation is the result of the growth of forces promoting conflict at the psychological and social level but a point is reached at which change occurs in one or more of these factors affecting the others in an interlinked process and producing a qualitatively different escalation. The diminution of negative feedback processes regulating interactions and the increase in positive feedback results in catastrophic change. What is key here is that decreasing the forces that triggered the high intensity is unlikely to reduce it to its original level until a threshold is reached at a much lower point (Coleman, 2006 p. 327). The negative feedback processes that had functioned as a control and mitigating factor are weakened as lines are crossed (legal, moral) leading to a loss of proportion and the breaking of taboos as social sanctions are put out of operation. In the same way, the other parties undermine our restraint through their use of "morally reprehensible acts" – we feel justified to take the same road. The lack of negative feedback means no control or restraint and runaway spirals of violence. However, there are virtuous as well as vicious spirals as we know from the study of escalation and de-escalation quite independent of complexity theory. It follows then that positive feedback is advantageous with regard to peaceful initiatives (e.g. unilateral disarmament, Sadat's visit to Jerusalem).

An aspect of the complexity in such conflicts is the multiple levels involved and it is of importance to consider where links are operating across levels of the system from intra-personal through inter-personal to inter-group. There are feedback loops between these levels such that even when the conflict appears fully comprehensible and resolvable in principle, the links to other levels can maintain or compensate in the face of constructive change allowing the conflict to continue (Coleman, 2007).

Coleman refers to the reduction in multidimensionality as conflict escalates. These dynamics have been studied in work on the creation of enemy images (Northrup, 1989), the increase in stereotyping that accompanies polarisation within a conflict (Fisher, 1990), the rich and diverse images we have of own group members in contrast to the paucity of characteristics attributed to members of another group or that group as a whole (Hewstone, 1986); (Kelman, 2001). There is no way to balance the negative experience or interaction through

consideration of other positive attributes or experiences as would be available in the nuanced pictures we have of those with whom we have close relationships. If there are positive occurrences they will be ignored, negatively construed as a trick or insincere in order to maintain coherence. As Coleman rightly notes this can progress to the point where the own identity includes a rejection or hatred of the other identity as one of its defining characteristics. Any disconfirming evidence in such a case is felt as a threat to one's own identity (Coleman, 2006 p. 330).
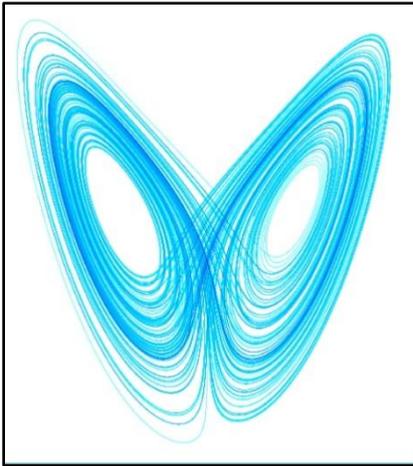

Figure 2 The Lorenz Strange Attractor

At the ICCC they have adopted the term "attractor" from chaos theory. This usage differs, as it must, from its application in the scientific context from which it was taken. In the natural sciences "chaotic" systems in this sense are not completely random in their behaviour although they do trace an unpredictable path through phase space (the space of possible states of the system). Edward Lorenz (1972) while studying weather systems tracked the path of systems and found that the chaotic system would eventually trace an ordered pattern, moving around one loop of the "attractor" before swinging out to the other loop. Although the "strange attractor" pattern that emerges possesses order and an overall pattern of system behaviour, it is not possible to predict where the system will be at any given time. Systems with such a chaotic dynamic develop through an abrupt change in the behaviour of the system once it has reached a critical value. Such a point of change is referred to as bifurcation, although this term is misleading as it suggests the possibility of two options only whereas, in fact, many more options may be available.

Gareth Morgan (Morgan, 1997) uses the image of strange attractors in the context of organisational change. He argues that the creation of new contexts is required in order to break the hold of dominant attractors and bring about transformational change. However, there is no possibility of determining the outcomes through control here as these are unpredictable but the *conditions* for a change can be created. If the existing attractor is too strong than the change will not be significant as co-optation and reform within existing ways of organising occurs. So the heart of the metaphor is:

> "discontinuities, perpetual novelty and ever-changing elements but recurring patterns and discernible structures" (Ramalingam, 2008 p. 52)

Coleman et al describe the unfolding escalation and the entrenchment of patterns of thinking and behaviour as attractors. Coleman refers to the establishment of "stable conflict attractors" (Coleman, 2006 p. 330), which can be conceptualised in terms of fixed point attractor dynamics. It is the convergence of a conflict party's thoughts, feelings and actions, with respect to the other party, on to a narrow range of states, despite the wider range of possible states, that is conceptualised as an attractor. It could be that the attractors of conflicting parties differ in details of patterns but given the dynamics of intractable conflict theory they will likely be negative. Drawing strongly on psychological and social-psychological theory related

to conflict they point to the volatility in mental, affective and behavioural phenomena that underlies apparent stability in opinions, emotions and readiness for action. [9]

Once a conflict has crossed a certain threshold of destructiveness, has low levels of dimensionality i.e. simplified images and concepts of the other party, and is sustained by positive feedback loops across levels, these attractor states emerge. Here a conflict attractor is understood as patterns of thinking, feeling and acting:

> "These attractors attract; pulling thoughts, feelings, actions, norms, even institutions toward a negative, destructive state that becomes self-organizing and self-perpetuating. In extreme cases, the system loses its capacities for positive, constructive actions and patterns." (Coleman, 2006 p. 330)

The basin of attraction refers to the extent of the influence of the attractor, e.g. a wide basin can indicate that even disconfirming evidence or positive overtures by the other party will be perceived in such a way as to maintain consistency within the negative image. The depth of the attractor is an indication of the inertia of the system at the point of the attractor and is an indication of the difficulty in changing the state of the system:

> "Strong attractors may be particularly influenced by key elements (e.g., identities—strongly identifying with being anti-Israeli or anti-Palestinian). However, because of the tightly coupled nature of multiple elements in the system, constructive changes in any element are hard to bring about, and even if they occur, can be inconsequential to the general patterns of the conflict. This results in malignant social processes that the disputants see as irreversible and within which they feel entrapped. In this state, many of the constructive forces and bonds that are inherent in any social system become obstructed or destroyed, constraining their capacities to ameliorate the conflict. This results in a pattern of intractability." (Coleman, 2006 p. 330)

Interestingly, in this theorisation, each party is likely to have more than one attractor for these mental, affective and behavioural dynamics. This will often be the case for conflict with long histories in which many phases have been (perhaps repeatedly) experienced. These alternative patterns of thought, emotion and engagement may remain hidden from the parties themselves and to external observers (latent attractors). Where there are such latent attractors a conflict system can make a qualitative shift (more dramatic than any incremental change) even where the stimulus appears relatively inconsequential (given the non-linear nature of complex systems). However, this re-orientation to another attractor may be a temporary state if the original attractor continues to exist. The chances of some further change tipping the conflict back into the basin of attraction of the old pattern is high (Coleman, 2007 p. 28).

Following the logic of attractors, the solution to intractable conflict will require "disassembling the malignant attractor or moving the system into the basin of a different, more benign attractor (provided one exists or can be established)" (Coleman, 2007 p. 14). A prerequisite for this is the understanding of how attractors are formed. Positive feedback links, where aspects that are independent or normally work in opposition to each other in a balancing or compensatory way become aligned and work in a mutually reinforcing manner,

---

[9] Principles of mental dynamics (e.g. discounting, selective perception, confirmatory bias) and social dynamics (e.g. social comparison, influence, and coordination)

serve to create attractors (Coleman, 2007 p. 15). Coleman posits that within such systems the state of each element depends on, and is influenced by, the state of other elements. As the links between elements become stronger the state of a single element cannot be adjusted independently of other elements:

> "Even if an external force changes the state of a given element, so that it is no longer coherent with the state of other elements, the joint influence of the other elements will reinstate the original value of the changed element." (Coleman, 2007 p. 14)

This observation recalls the difficulties of "transfer" in contact situations (or transformative mediation), where members of conflict groups may undergo a transformational experience during an encounter but it is difficult to transfer these changed attitudes and behaviours to the respective constituency, who do not share the actual experience. The pressure of the conflict context may reassert the status quo or suppresses the change impulse.

Thus the reduction of multidimensionality (polarisation) leads to escalation but also to stabilisation of the conflict (Coleman, 2007 p. 15). As has been noted in various models of escalation (Fisher, 1990) (Glasl, 1999) the conflict moves from a focus on the issues to, eventually, the point where the aim is protection of self and harm of the other. This can lead to the dehumanisation of the other making all actions against them legitimate and acceptable. Negative feedback is increasingly ineffective as empathy and guilt are reduced and humiliation, anger, hate and fear operate as positive or reinforcing factors (Coleman, 2007).

As in-group and out-group boundaries solidify in the face of conflict and polarisation, and segregation reduces the amount of disconfirming experiences available, a simplified reality is created in which the actions of individuals will likely lead to escalation in group level conflict. Proportionality is lost so that even an action that may previously have been perceived as a slight provocation may then result in full retaliation. This is described by Coleman using the metaphors of attractors as follows:

> "If a state of destructive conflict represents a strong attractor for an interpersonal or social system, then, any deviation from this state will result in the system activating its mechanisms to return to the attractor. This is particularly likely if the systems lacks or has lost an attractor for positive interaction. So while the severity of conflict may be related to the amount of violence between groups, the intractability of conflict may be defined in terms of the elimination of sustainable states of positive interaction. In dynamical terms, an intractable conflict lacks attractors for positive states."
> (Coleman, 2007 p. 22)

However, the extent to which the use of the attractor metaphor aids understanding of conflict dynamics is yet to be proved, witness the following proposition, which appears rather tautological and is merely an alternative labelling of a phenomenon rather than an explanation or an increase in our understanding of it.

> "The maintenance of a narrow range of thoughts, feelings, and actions despite the introduction of new ideas and action possibilities suggests that intractable conflict can

be described as an attractor for these mental and behavioral phenomena." (Coleman, 2007 p. 7)

John Paul Lederach, drawing on Wheatley, has found the notion of "process-structures" to be of value in understanding this notion of change and stability. Wheatley uses other terms than Maturana and Varela : "things that maintain *form* over time yet have no rigidity of *structure*." (Wheatley, 2006 p. 16) (emphasis added). Lederach is concerned to show a combination of linearity and circularity in the dynamics of conflicts. His representation of complexity concepts is filtered but has, therefore, the advantage that it is not a direct translation of terms from one realm to another with the inherent dangers mentioned above. He stresses connection but it is important for him to understand this in social systems as "relationship". In the circular change process he describes there are non-linear relationships in terms of unpredictability and disproportionality (no linear progress in this sense) at the same time, however, the system is moving in a certain direction (time irreversibility). He understands system properties as the context of relationships out of which conflict episodes emerge. He recognises the importance of discovering the underlying patterns in the system that are producing the conflicts.

As Lederach notes a systemic approach requires a reorientation from a focus on events and specific outcomes to the recognition of patterns that emerge over time, and here he echoes the advice of Peter Senge when he refers to the human tendency to a "fixation on events":

> "We are conditioned to see life as a series of events, and for every event, we think there is one obvious cause...such explanations may be true as far as they go, but they distract us from seeing the longer-term patterns of change that lie behind the events and from understanding the causes of those patterns". (Senge, 1990; 2006 p. 2)

Coleman follows the same logic when he advises:

> "[analysis] should be attuned to both dramatic shifts in patterns (whether temporary perturbations in intensity or more permanent shifts in attractor structures), as well as more subtle, incremental changes that may be accumulating to create alternative attractor structures (both positive and negative)." (Coleman, 2006 p. 345)

The CDE Model

One approach that seeks specifically to work with the self-organising capacities of complex systems, also in processes of conflict de-escalation and conflict transformation, is that of Glenda Eoyang and Lois Yellowthunder. Their CDE Model (relating to three "conditions" of Containers, Differences and Exchanges) is used for data collection, analysis, intervention, and evaluation. They describe the model as focusing on conditions that influence the speed, path, and outcome of self-organizing processes in human systems that interact with each other in non-linear ways (Eoyang, 2005).

Containers are described as holding a group of interacting agents together and can be based on geographical boundaries or features, political institutions or affinity or ideology.

Differences among interacting agents may be of various types e.g. physical, ideological, experiential or emotional within which significant differences are understood to be those to which specific behaviour is attached. Such differences are seen as potential sources of "energy" released by the selection of particular attributes as the basis for differential.

> "Difference also articulates the systemic pattern. Race, gender, ethnicity, affluence, political loyalties are all examples of differences that delimit the patterns of relationship in human systems. Such patterns can either encompass coherent diversity or unstable conflict." (Eoyang, 2005)

Exchanges represent transactions involving resources such as money, goods and information where "transforming exchanges" are those actions which can amplify or dampen responses. It is posited that by influencing one or more of these "conditions" it is possible to influence the self-organizing patterns of the system. The model has been used within organisational settings and is now being investigated for its utility in larger scale inter-group conflict situations, even in those of an intractable nature, e.g. Kosovo. This is possible, according to Eoyang and Yellowthunder, due to the transferable nature of the "conditions" analysed within the model i.e. containers, differences and exchanges:

> "The CDE model is generalizable, scaled, and pattern-based. It is generalizable in that there may be multiple interacting CDEs in a given situation. Many different locally-determined factors may function as containing, differentiating, and exchanging system features, so the CDE description can transcend the details of a specific situation. A street gang may function within a neighborhood (C), with age and size being significant in role assignment (D), and violent language and action establishing and maintaining relationships (E). In another context, a charismatic leader (C) may bring a group of people together across economic boundaries (D) to engage in religious ritual (E). The conditions for self-organizing provide a coherent, consistent, and context-free way to observe, describe, and influence the human systems dynamics in these dissimilar situations." (Eoyang, September 2008 p. 5)

The range of applicability is a strength of this approach, offering possibilities to work with it also at the intra-personal level and the need to explore the links and processes across levels is also recognised here:

> "Interactions among the various levels are also accounted for in the CDE Model. A difference at one level of organization functions as a container at a lower level, and container at one level functions as difference in the level above. For example, a neighborhood (C) includes different families (D), but within a family (C) individuals play specific roles (D), and within a city (C) differences among neighborhoods (D) can be significant. These cross-level relationships allow the CDE Model to represent relationships between the part, the whole, and the greater whole that are critical in understanding conflict and the emergence of violence." (Eoyang, September 2008 p. 5)

Eoyang and Yellowthunder stress the importance of the time factor in recognising the operation of complex adaptive systems but also in responding to them. Thus they argue that while under conditions of "high constraint" or a short period of time, social systems my appear to be stagnant or predictable in their processes, when one pulls back to analyse the longer term developments and view them across levels of scale then the patterns of self-organisation in response to demands from a changing environmental and internal

developments become clear (Eoyang, 2005). Crucially, they note that not all self-organising processes are healthy or productive:

> "Sometimes systems organize in alignment with one set of concerns and parameters, while survival of the system will ultimately be determined by another set or at another level of scale. In such a situation, survival is the measure of success, and fit determines survival. A system's ability to respond and adapt to changes in its numerous and massively entangled contexts will determine whether a particular self-organizing process was good (productive or successful) in a given place and time." (Eoyang, 2005)

A key value of a complexity approach for them is the understanding that it provides of relationships and their implication within a system. It is in the nature of complex adaptive systems that change can emerge from an intervention at a particular level and point and time within the system (although the extent and nature of that change may not be predictable in any deterministic way) and this releases the intervener from the need to have control over the system as a whole or over a long period of time. The working out of the dynamics and emerging changes happens over time and a long term view is therefore desirable:

> "Both history and future can serve as context for the present as individuals and groups seek understanding and action." (Eoyang, 2005 p. 4)

One of the difficulties is the fact that complex systems often operate across various temporal and organisational scales and so it is important to begin by attempting to identify these.

> "Surprises that will manifest themselves over a long period of time require different strategies than Black Swans that can pop up at any time." (Longstaff, 2005 p. 35)

Each level of the system may be operating separately and it is possible that each level will have its own emergent properties as well as operating over different time scales and respond to different cycles (Longstaff, 2005 S. 35):

> "The majority of interactions will usually be within a scale, but there are often interactions between scales. To understand how the whole system works it is necessary to look at all of the scales at which it operates, and it is unlikely that there will be only one appropriate perspective from which to view the entire system. Two types of cross-scale interactions have been identified. Revolt is where events at a smaller scale trigger change at a larger scale. Remember is where events or conditions at a larger (or longer) scale limit the options at smaller (or shorter) scales. There are forces that have an impact on all scales, but the impact will be different at each level. In the early 21st century, some of these meso-scale drivers of instability (change) include population demographic changes (e.g., age distribution, migration to urban areas and wealthier countries) and globalization (greater connectedness through advanced communication and transportation networks). … greater connectedness often makes a system more complex and less resilient." (Longstaff, 2005 p. 35)

Complexity and Ethnicity

Complexity concepts can be used to explore and better understand specific aspects within conflict constellations. Ruane and Todd's work on ethnicity is a case in point. Ethnicity as a category does not necessarily lead to conflict but where there is conflict with an ethnic

component, the dynamics and nature of ethnic identity in relation to other identities provide important elements for unravelling the conflict causes and developing responses as part of a conflict transformation approach. Posing the question about community rather than ethnicity Ruane & Todd seek to discover how the many elements that constitute a community become ordered, sometimes to the extent that the solidarity experienced, and the resistance to change engendered, play an important role in conflicts at group level. After rejecting and adapting alternative interpretations of the nature and source of ethnic identity they find:

> "the answer in a particular interrelation of categories, communities and power relations which form systemic feedback patterns, or a 'path dependent' system. This theoretical strategy, … sees community is an emergent property of a system[10] constituted inter alia by the intersection of cultural (including ethnic) categories and power relations. It promises both explanatory power and ability to grasp the multiplicity of meanings, the range of determinants, and the variation in intensity of bonding and opposition." (Ruane, 2003 p. 15)

The analysis is explicitly complexity based with systems adapting to a changing environment and producing emergent properties. The category of ethnicity is one among several, or many, and is itself organised in systems of concepts which are embedded in "interlocking and intersecting power structures" including nested systems in geographical and political terms. The effect of these links may be to provide cross-cutting categories but may in extreme cases also reinforce and strengthen each other:

> "Communities, the product of such complex determinants, are multi-faceted, plural in their cultural substance, manifesting – in collective and individual expressions - a fluidity in shifting from ethnic to national to political to religious identities and reference points, a convergence of interest and feeling, and a capacity to strengthen their ethnic linkages and feeling by moving back and forth in focus from macro to micro contexts." (Ruane, 2003 p. 16)

Ruane and Todd describe how social and psychological processes, intersecting with power, work to maintain ethnic community identifications. These form feedback mechanisms that, the closer and tighter they are, lead to the community becoming even more entrenched and resistant to change. The complex set of feedback mechanisms reproduce intra-communal solidarity and inter-communal opposition despite changes in institutions and laws:

> "'learning patterns' (Crouch and Farrell, 2002) allow dominant actors and ethnic entrepreneurs to adapt new institutions to older communal patterns, to invest them with older cultural distinctions and to assimilate new concepts to old binaries." (Ruane, 2003 p. 17)

Countertendencies do exist, however, where local categorisation is at odds with that at a broader social level or there is discontinuity between cognitive categories and power relations:

> "Under such systemic conditions, solidary, bonded, easily-mobilised communities with intense communal identification are emergent properties of the system. This, not any basic or essential human emotion, is at the root of the strong psychological sense of belonging …" (Ruane, 2003 p. 18)

---

[10] The concept of 'system' is here used in a qualitative sense, as a set of interrelated and mutually dependent processes which, as the unintended by-product of their intersection, reproduce themselves.

The explanation for the persistence of such patterns of solidarity and opposition despite any socio-economic developments (such as modernisation or industrialisation) lies in the system's ability to adapt to environmental change. However, should these systems of feedback breakdown then there may be openings through which conflict transformation might occur. These "critical junctures" allow movement in new directions:

> "This strategy of system analysis does not predict change, or provide general laws about ethnic conflict and its resolution, but rather directs us 'where to look for critical phenomena, points of control' (Holland, 1998, 24)." (Ruane, 2003 p. 18)

Ruane and Todd's complexity approach is a welcome change from the overly deterministic and simplistic analyses of ethnic conflict that emerged in the wake of the explosion of intra-national conflicts following the fall of communism and, specifically, for the light it sheds on the intractable nature of conflicts such as that in Northern Ireland.

Networks and Connectivity

Connectivity is an attribute of complex systems and the operation of networks in conflicts is embedded within a complexity context. The study of networks has developed to explore connections between agents in terms of their number and strength. Increased connectivity within complex systems is seen as increasing the opportunities for exchange of information and the options for change and development. Put in another way, as interconnections between autonomous agents are a control parameter in determining the number of available states, increasing the number of interconnections can increase the number of states available. However, extensive connectivity per se is not always an advantage. Although the assumption may be made that the greater the number of connections any agent has the greater the possibilities, it should be remembered that a connection is a perturbation source, so the more connections there are, the more unstable the system will be. Too many interconnections can be deleterious when this leads to the loss of the ability to act independently (Beckerman, 1999).

Marion characterised the relationship between agents in a network as loose, moderate or tight with regard to their degree of interdependence (Marion, 1999). According to Marion complex networks are recursive so that through the process of aggregation[11] and correlation the network develops redundant multi-way chains of causality to accomplish its collective interests and contribute to the network's resilience.

Complexity theory is being applied in military strategic theory as, for example, a critique of existing command and control models and also in the analysis of new types of "enemies". The network theory in Beckerman's war fighting strategy can also be used to describe structure and process in the organisation of terrorist organisations. One example of many is the analysis of Lieutenant Colonel Michael F. Beech in which Al Qaeda is seen as a highly complex adaptive network (Beech, 2004). The network is seen as self-organising, non-hierarchical,

---

[11] Complexity Theory proposes that organizations arise, and leaders (acting as Complex Adaptive Agents) emerge, through a process of aggregation (Holland, 1995; Kauffman, 1993). Aggregation is the structuring of actors and activities into forms and ideas; it is the result of recursive interaction, autocatalysis, and correlation. (Marion)

within which individual agents are "constantly reassessing their need preferences and the degree to which they will compromise to bond with other agents" (Beech, 2004 p. 4).

As Beckerman noted weak coupling allows for local autonomy allowing units/agents to innovate and adapt to the local environment. Loose structures are also more resilient. The disadvantage is that the structure is not well-developed for dissemination of innovation or the consolidation of fitness. By contrast tightly couples systems provide sufficient structure for dissemination of information but, due to conflicting constraints, inhibit innovation. If the system is tightly coupled then any change can spread quickly through the system and if this change is negative the system can collapse. Thus a middle way is sought in order to optimise fitness, i.e. moderately coupled systems with a diversity of weak and tightly coupled systems within it (Kauffmann, 1993); (Marion, 1999).

While network theory may lend itself to the study of such groups as Al Qaeda, it is not an exact science and, in application, can be less than useful in identifying terrorists and their networks as the CIA has found as they have become swamped with information on thousands of connected individuals (Keefe, 2006) resulting in many false leads (not to mention trampled civil liberties). Here, too, competing theories exist on the basis of differing analyses using the same theory. For example, Marc Sageman, formerly of the CIA, argues using network theory, that Al Qaeda is now leaderless and not an organisation to be destroyed but a social network to be disrupted (Sageman, 2008). Beckerman, however, speaks of two types of leadership, direct and indirect, within complex systems and that there is here also an adaptability resulting in resilience for the organisation. Network theory, as complexity theory, is a tool using which many different conclusions may be drawn depending on many other inner and outer contextual factors (see e.g. (Hoffman, 2008).

Nevertheless, network theory has relevance for analysis and also strategy generation in the field of development and peacebuilding. Beckerman describes healthy complex adaptive systems as tending to behave asynchronously – "multiple agents acting independently of one another in response to local conditions." :

> "Complexity suggests the superiority of loosely coupled, modular plans which do not rely on synchronized control for their unity of effort. Such plans allow greater latitude in execution and, importantly, are more easily modified and repaired than synchronized ones. Where synchronization occurs, it should be the result of local cooperation between agents rather than of centralized direction." (Beckerman, 1999)

Wils et al for the Berghof Foundation put a great stress on networks in their systemic approach to peacebuilding. Lederach has pointed to the need to create peace constituencies within conflict areas in which the building of networks within the local, national and international context would play a key role (and in which the middle-level actors would be of vital importance) (Lederach, 2003). Wils et al would seek to use the system's own resources to manage conflict by attempting a comprehensive approach to managing networks:

> "Systemic network management is therefore based on identifying the trends of change and areas where pressure can be applied on the micro level of the political system, as well as locating the underlying networked engagement of small groups. These can then be developed and strengthened by means of effective network management – strategically supporting and connecting actors and issues – to produce synergy effects." (Wils, 2006 p. 57)

By systemic network management they seek to promote a "culture of co-operation" based on strategic partnerships and alliances at the local as well as the international level. By this is meant a:

> "trust-based, medium to long-term cooperation of varying intensity, particularly between local actors interested in a sustainable peace solution, including agents of peaceful change"[12] (Wils, 2006 p. 57)

The identification of networks and their operations within complex systems is important within a complex analytical approach and also has relevance for strategy, as will be discussed later in this paper.

Advantages of a Complexity Analysis

What is the added value of using a complexity lens for analysis? What advantages does it bring over other analytical approaches? In general terms:

> "Application of complexity ideas and principles is possible across a range of scales and time lines that would anticipate the unexpected as the norm. In addition, complexity theory offers categories for a more nuanced, deeper and conceptually connected context analysis." (Fowler, 2008)

At a basic level it contributes to a reduction in the prevalent tendency to over-simplify in conflicts by drawing the boundaries too tightly around the conflict parties or excluding factors at another level that may be relevant but are left out for ease of analysis. A complexity analysis is not about including all possible parties to a conflict, stakeholders as well as those who may indirectly influence the outcomes, but a comprehensive analysis of factors in complex systems that may account for processes observed and may influence outcomes.

The focus on interaction and process, rather than on components or agents, alerts us to perturbations which, through the operation of positive feedback loops, could have significant effects on conflict developments. However specific the focus of the intervention in the conflict system, at the level of analysis everything speaks for the complexity of the analysis being reflective of the complexity of the conflict system and its environment. The expansion and deepening of analysis adds to the soundness of the basis for strategy development. Taking a complex systems approach makes conscious the often unconscious decision of boundary drawing within conflict analysis. The drawing of the artificial boundary that will define the

---

[12] Three kinds of network have been identified that are particularly important for systemic interventions:
1. Networks of effective action (NEA): these comprise networks in the above-mentioned sense, however their members also pursue a common goal and have certain common principles for action. It is not a priority for NEAs to coordinate the activities of the organisations involved.
2. Strategic partnerships or alliances that aim to increase efficiency by cooperating on a specific project. (p.57)
3. Strategic alliances in an international/regional context, which both assist with the joint lobbying work in the political arena with national or international institutions, and also organise the exchange of information within the region. (Wils, 2006)

system illuminates relationships, our own priorities, and increases awareness of the other systems that form the environment of the system upon which we choose to focus.

A complexity approach also sensitises the analyst to the potential impact of his or her actions and thus serves as an aid to consciousness-raising. Seeing the intervention – whether mediation, reconciliation project, supporting or catalysing input to networks – as perturbation within the complex system, characterised by non-linear relationships and processes and therefore productive of surprising emergent outcomes, makes evident that the analyst (let alone the intervener) cannot be seen as external to the conflict system under consideration. Making explicit some of the factors shaping our analysis − some relating to our mandate or the interests of the group or institute that we represent (e.g. prestige, funding, etc.), some relating to our capacities and skills making us favour one perspective rather than another (link to disciplinary background), and some relating to cultural, ideological factors which could inject bias or prejudice into the particular analysis being carried out − would then become integral to the analysis process. The mental models that we possess about what conflict is, or what constitutes conflict transformation and how that should be implemented, differ from person to person despite common language, and the underlying assumptions need to be explored wherever we undertake collaborative work (Shouldice, 2003). These "mental models" are already shaping the analysis that we do. The intra-personal complexity and the inter-personal complexity within the analysis setting is not unrelated to the complex conflict that is the focus of the task but rather integral to it. As Wendell Jones argues, anyone observing the system is already affecting the system and there can be no "neutral" observers as there is no single "objective reality" that describes the system in conflict (Jones, 2003). Coleman also remarks on the necessity of recognising one's own impact on the patterns of the system:

> "Analyzing conflicts is a dynamic process that brings the analyst together with the situation being analyzed in an unfolding process through which the analyst begins to perceive, shape, and interpret the pattern of events in question (Morgan, 1997)"
> (Coleman, 2006 p. 334)

Who we include in the analysis, which sets of relations we focus on, and who is invited to participate in the analysis process, all have unintended consequences just as implementation decisions bring unforeseen and unintended consequences, sometimes positive, sometimes negative, regardless of the successful attainment of goals and aims within a project. The choices made by interveners e.g. in mediation processes (who to invite to the table), or in humanitarian aid (where to direct the funding), have an influence on the dynamics of the conflict. Those denied participation are the potential spoilers that scupper negotiated peace agreements. The unintended consequence of actions generate the next set of problems to be addressed, e.g. empowerment of women through the Grameen Bank leading in some contexts to increased domestic violence and increased incidence of divorce. This awareness of the normal nature of unintended consequences caused by interventions would be an improvement on the unrealistic expectations associated with projects and interventions. The concept of "do no harm" in development work already represents an advance but where this results in ever more detailed planning to avoid the possible negative consequences of intervention this can constitute even greater efforts to control the uncontrollable.

Similarly, the decision as to which issues are of relevance in the analysis is influential −
which will be highlighted and emphasised and which not. For example, an over-emphasis in
the 1990s on ethnic identities in the analysis of inter-group conflict led to an ethnicity lens
being used for almost every conflict almost automatically. This had the effect, in some cases,
of limiting perceptions and obscuring complexity thus excluding or missing particular factors
that may have been as relevant to the conflict in question as identity markers.

A further advantage of a complexity analysis, as noted by Sylvia Walby, is the potential to
overcome polarities in theoretical approaches, e.g. the tension between a focus on structure or
on agency. Neil Harrison also points out that systems theories attempting to explain processes
and events at the level of world systems do not take account of the impact of decisions and
behaviour at the individual level. Although constructivism uses an alternative approach in
which the goal is to understand behaviour and where the means are often hermeneutical,
examining "human action from within, seeing I as intentional and meaningful behaviour" (S.
Smith 1994, 400), it has proved impossible to create an overarching theory that could explain
how state behaviour derives from the interaction of system-level and unit-level factors
(Harrison, 2006 p. 38). In complex systems theories it is possible to overcome the split
between inside and outside views as micro-interactions within a complex self-organising
system lead to emergent properties at the macro level. Through the use of computational
modelling it is possible to simulate behaviours of whole systems:

> "from the inside without consciously interpreting behaviour and with no presumption
> of motives of meaning at any level by using randomised internal models and rules of
> interaction." (Harrison, 2006 p. 38)

However, this case is not yet proved and will require, as Harrison notes, further theoretical
development and empirical and experimental application to demonstrate if, and to what
extent, world politics enriched by complexity theory can overcome the incompatibility of
these views.

Walby has also argued the necessity of theorising against levels and pointed to the potential in
this regard displayed by complexity theory. Harrison believes that complexity supplies a
conceptual framework that allows both for causes working from below and from above the
system under study. So, if emergence is the process by which individual micro-interactions
produce macro-level effects in complex systems what about the other side of the coin: how
does environment affect system behaviours?:

> "In complexity, environment affects system behaviour in two ways. First, it constrains
> what is possible and "selects" behaviours that are most appropriate within current
> institutional arrangements. Second, perceptions of environment influence agents'
> internal models. And there may be interaction among both processes." (Harrison, 2006
> p. 35)

Within conflict research the generalisability of conflict dynamics across levels has been
posited and the mutual influence between these levels recognised. Coleman sees the
dynamical properties of complex systems as couched in formal terms and manifest in "much
the same way in different phenomena and at different levels of personal and social reality"
(Coleman, 2007 p. 4). So, as with conflict theory in general, intractability displays the same
basic mechanisms from intra-personal through inter-personal to inter-group levels and
complexity theory actually strengthens the explanation of the dynamic links between levels,

which Coleman conceives as "a larger dynamical system with nested components" (Coleman, 2007 p. 5)

However, by virtue of the non-linear nature of connections within complex social systems, prediction in other than the very short term is problematic. Thus some would echo Walter Clemens' caution when, while recognising analytic advantages such as the potential to enhance our ability to describe and explain the past and the present, he is less sanguine about the potential contribution to policy prescription given the unpredictability of emergent properties within complex systems (Walter C. Clemens, 2001).

Tools

In order to capture or reflect, at least to some extent, the complexity of the conflict situation theorists switch between approaches and make use of sets of tools intended to illuminate different aspects of the conflict and, through integration, to provide a richer picture. Jones also reminds us of the need to accept the fact that we have become part of the conflict system and it is already the view from within that is operating. Wils et al refer to axis diagrams[13], intervention architecture[14] and scenario analysis as some of the tools that they find useful in exploring the difficulties and potentialities in a conflict situation. However, while these tools reflect the systemic nature of the conflict there can be something rather deterministic about the way they are used. For example, in scenario analysis there are different projections of potential future developments, which, once identified, can be discussed with local and international stakeholders.

> "The development corridors identified can be assessed in terms of whether it is likely and desirable (in the eyes of the analysts involved) for them to occur. The strategic steps necessary to increase the chances of the "desired" scenarios being realised can be then be identified." (Wils, 2006 p. 45)

A series of narrative scenarios are developed with reference to factors perceived as relevant to the development of the peace process in a particular conflict. These are then compared and discussed to assess their usefulness in "monitoring process in the peace process" (Wils, 2006 p. 45).

Eve Mitleton-Kelly and the LSE group working with complexity theory at the organisational level also recommend using various tools in conjunction for purposes of triangulation, to provide fresh perspectives and in order to reflect complexity. One of the tools they use is Landscape of the Mind [15]developed by Kate Hopkinson for cognitive mapping and identifying of habitual perspectives. Also Netmap on communication patterns within an organisation reflecting network theory and the concept of hubs and nodes and patterns of relationships

---

[13] Frederic Vester use something called an axis diagram for analysis and planning with the aim of identifying the "passive, idle and active factors within a group of factors. Here the active factors are particularly important for interventions as they indicate possible leverage points for processes of change

[14] the aim of systemic intervention is seen as creating framework conditions that bring about a constructive process for restructuring and changing the way people live together.

[15] Mitelton Kelly explains that individuals and teams use different **'conceptual architectures'** when taking decisions, generating knowledge, etc. and these can "act as potential constraints or enablers in effective knowledge generation and sharing, innovation, decision taking, strategic thinking, etc." (Mitleton-Kelly, 2004 p. 4)

being reflected in patterns of communication. However, this latter tool has some drawbacks as it shows only quantitative and not qualitative data and is thus open to misinterpretation if not used with data derived from alternative methods.

Mitleton-Kelly also uses traditional qualitative data-gathering through in-depth interviews, working with teams of interviewers, but it is at the point of data review and analysis that the complexity aspects come to the fore. Apart from self- and group-reflection on the part of the interviewers themselves with reference to the data and to the process of gathering, there is also the "Reflect Back Workshop" with the interviewees who are able to respond to the analysis of the interviews that is presented, to qualify and to make links. Crucially, this can be a consciousness-raising process for organisation employees as well and can be the first step in the change strategy itself.

The LSE group is also aware of the value of tapping into subconscious processes in this work and use an artist to make a visual impression of the situation within an organisation. Through this means intuition is also playing a role and visual metaphors can also help to reveal some of the underlying problems that might not be reflected in the logical discourse habitual in the organisational setting.

Simulation

Simulation using computer models of complex social situations is the tool that has been seen as, at one and the same time, the characteristic method and the proof for the operation of emergence in social systems. There are different types of models available and various claims for their usefulness, as well as variations in the guidelines for the construction of such models and their realm of application.

Robert Axelrod would like to see simulation accepted as a research methodology and argues that simulation is a third way of "doing science". It uses aspects of both deduction and induction: as with deduction, a set of initial explicit assumptions, and at the same time, generating data that can be analysed inductively. The difference to the usual uses of induction is that the data comes from a "rigorously specified set of rules rather than direct measurement of the real world" (Axelrod, 2006):

> "While induction can be used to find patterns in data, and deduction can be used to find consequences of assumption, simulation modelling can be used as an aid to intuition." (Axelrod, 2006 p. 139)

What simulation allows is a series of thought experiments, particularly useful for complex systems where the myriad agent interactions at micro-level will produce unpredictable effects − "emergent properties of the system". And this is true even for simple interactions within a complex system. Agent Based Models (ABMs) generate effects through interaction between agents where there is no central direction, the emergent properties are the result of "bottom-up" processes. Axelrod is adamant that the rules developed for the agents in the model must be simple :

> "…agent-based modelling … does not necessarily aim to provide an accurate representation of a particular empirical application. Instead, the goal of agent-based

modelling is to enrich our understanding of fundamental processes that may appear in a variety of applications." (Axelrod, 2006 p. 140)

The models reveal complexity in their results rather than reflect it in their assumptions. Although this is not always the case. Axelrod admits exceptions, e.g. in training applications or in simulations of the economy aimed at predicting interest rates where a faithful reproduction of the setting is important. However, in social science applications where the goal is to deepen our understanding of some fundamental process then what matters is the simplicity of the assumptions and not the realistic representation of all the details of a particular setting (Axelrod, 2006).

One of the most often quoted examples to illustrate the principles of agent based models, or at least the emergence of complexity from the observance of simple rules by agents in a complex system, is the flocking of birds. There is no director of the flock and yet the adaptation of the birds' movements seems co-ordinated and appears sophisticated. However, it can be demonstrated that by each bird following only a limited number of simple rules, this complex flocking behaviour will be produced.[16]

At the ICCC Andrzej Nowak and his colleagues are making use of simulations (in this case cellular automata[17]) to explore conflict intractability and constructive transformation. From previous exploratory and experimental research on ripeness, collective identity and moral emotions they derive the main parameters for the dynamical models of conflict intractability. The aim is "to assess the long-term consequences of changes in the levels of the variables (like more adaptive identities), in the context of a network of other key relations" (ICCCR, 2008). The value of such tools is that some of the unanticipated consequences of interventions can be revealed and thus aid the exploration of proposed intervention strategies

Epstein and Axtell (Epstein, 1996) have termed complexity simulation a "generative social science" :

> "Artificial society modelling allows us to "grow" social structures *in silico* demonstrating that certain sets of micorspecifications are *sufficient to generate* the macrophenomena of interest." (20, emphasis in original) (Saunders-Newton, 2007 p. 166)

Saunders-Newton underlines the transdisciplinary nature of complexity theory application in the social sciences by characterising ABMs as an important part of this development:

> "[simulation] affords an opportunity to explore theories of complex international and global social phenomenon. I would like to deepen this definition by asserting that agent-based modelling – or, more broadly considered, computational methods that emphasize agency-level phenomena – reflect a maturing transdiscipline that allows analysts and inquirers not only to consider increasingly complex phenomenology in a rigorous fashion, but also to pursue such inquiry in a more interdisciplinary fashion." (Saunders-Newton, 2007 p. 166)

---

[16] The rules are: 1) **Separation**: steer to avoid crowding local flockmates; 2) **Alignment**: steer towards the average heading of local flockmates; 3) **Cohesion**: steer to move toward the average position of local flockmates. Craig Reynolds, Boids website http://www.red3d.com/cwr/boids/

[17] Cellular automata are models based on a regular grid f cells, each one in a finite number of states.

Bankes, Lempert and Popper also find ABMs an appropriate method for representing much of the data about social actors and systems.[18]

However, James Rosenau is a critic of the attempt to apply complexity theory to the social world in general and of ABMs in particular. He admits the attractiveness of the complexity paradigm but sees this as a seductive illusion, making promises that it cannot keep. As metaphor complexity terms have a role to play in helping to understand the complex, fast changing, unpredictable world but no more than that. ABMs, too, have their sphere of relevance, e.g. the study of markets and exchange, some specific politico-social situations e.g. riots and protest movements (Kurn 1991; Opp and Gern 1993; Lohmann 1994) (Rosenau, 2007) . That is, the areas where authority is dispersed. In Rosenau's view ABMs are not sufficiently scientific or rigorous. Simulations are neither inductive nor deductive. Using inductive methods to inform simulations is open to the criticism that the assumptions used are "empirically groundless and theoretically undetermined" (Rosenau, 2007 p. 148). They are not deductive as they cannot prove theorems of test hypotheses (in this case about global politics). Rosenau's damning comment on simulation:

> "[it] lacks both the empirical appeal of induction and the disconfirmative value of deduction." (Rosenau, 2007 p. 149)

For Rosenau the central problem is that the models do not account for authority within social systems:

> "A social system may have authority present and be complex; it may be complex and adaptive; but it cannot have both (p.149) authority and adaptation through complex iterations of autonomous agent, since centralized authority and individual autonomy, by definition, are mutually exclusive." (Rosenau, 2007 p. 149)

This problem is not overcome by the suggestion to complement simulations with empirical investigations, although a number of complexity theorists would favour this approach (Elliot, 1997); (Coleman, 2004). Rosenau also points out that assumptions about interests are not theoretically neutral. The assumptions made in a model are the assumptions of the model-maker and not necessarily of the agents modelled. How useful and reliable can the model then be if the emergent properties are actually constrained by the model-makers interpretations? However, as argued above, an awareness of the framework and the influencing factors operating in analytical processes is important for any type of analysis not just for ABM's. Assumptions are made in all types of analysis and interpretations will always be influenced by the bias and prejudice of the analyst.

---

[18] The following paraphrases suggest how Bankes, Lempert and Popper (2002), 377) characterize the efficacy of ABMs in the social sciences:

♦ The agents in an ABM can be based upon the wide breadth of actors that arise in natural and artificial systems – for example, individuals, groups or institutions.
♦ The decision algorithms that these agents use can be based on knowledge and data available regarding the decision behaviour, perceived or actual, of the associated individuals, groups, or institutions. (p.168)
♦ What we know about the relationships between such agents can easily fit into the agent-based mechanism
♦ Environmental processes and effects that are "not inherently agent based in character" can readily be reflected in hybrid computational models with significant agent-based components.

> "It is important, however, to remember that while models are devices to help us understand the real world more clearly, they are also part of that world both through their physical - or cognitive presence and more significantly through the impacts which arise from their development and use. (Jeffrey et al 1999 76)" (Byrne, 2001)

Rosenau rightly points out that models of human agency always face the problem that humans are complex and unpredictable in their behaviour. Bias, prejudice and selective perception (becoming more acute as a conflict escalates) are operating and this means that they are not accurately perceiving environmental feedback as the model makers would perhaps suppose. Or perhaps they are and this uncertainty is what limits the value of the results of genetic algorithms. In short:

> "Human psychology and decision making are so idiosyncratic as to make the ascription of simple behaviour rules highly problematic." (Rosenau, 2007 p. 122)

Saunders-Newton counters that the complexity and unpredictability of problems in international and global social systems are faced by other models and other methods. The failure to produce point predictions should not be the measure of the value of the system. Rosenau questions even the exploratory value of the outcomes due to bias and lack of accurate information. Every analysis and every experiment construction is subject to the same biases: the chosen focus, what is included, the weight assigned, the meaning interpreted. There are no objective data in this sense. Saunders-Newton takes the view that simulations can be used to provide credible arguments on the basis of experimental computations. They are more flexible and provide more information than a single model could hope to do. He refers to ABMs as "laboratory equipment". Of course, the reproducibility and the relevance of results outside the lab has always been a problem for social science and it is precisely why the usefulness needs to be tested in practice in the field.

Byrne believes that insisting on mathematics (or game theory) as the basis for modelling is overly restrictive even misconceived (Byrne, 2001). He argues that in engineering physical models are used to explore turbulence, i.e. an emergent, non-linear phenomenon that it is not possible to represent in mathematical formalisms. Measurement is important but as part of an integrative methodology which includes qualitative approaches and which is "organised in an interpretative mode" (Byrne, 2001). By this is meant textual description and interpretation as part of the modelling process. The purpose is to explore and to project (not to predict!).

Bhavnani provides an example of using complexity concepts in a complementary (or supplementary) way to other social science approaches. In his study of the Rwanda genocide he defined the problem under consideration in a specific and narrow way: why did the genocide proceed at such a fast pace and reach such a magnitude? (Bhavnani, 2006). These questions are related to, but do not equate to, the political and social psychological considerations of the causes of the conflict. Such an application of simulation can provide insights in situations where the events seem surprising and counter-intuitive or illogical.

Harrison sees ABMs as a tool to test ideas about the relations of agents, systems and environment. The generation of novel insights such as aspects of social behaviour or the range of possible action options available and the reduction of uncertainty provided through the experiments can improve policy. The very complexity of human subjects in their social

relations and psychological states make the "cross-mapping and redundancy" available through simulation of great value in knowledge accumulation (Harrison, 2006 p. 187).

Nevertheless, Michael Warner expresses some unease about the "the mapping of an understanding of complexity theory grounded in experimentation with non-linear mathematical dynamics with computers onto human social systems" (Warner, 2001 p. 16). He is referring to the inductionist approach adopted by DFID[19] funded projects that reviews practice and derives generalisable rules for success (in terms of achieving sustainability and adaptability to development pressures) in development projects. And he joins Mitleton-Kelly in expressing caution over the relatively static nature of the "rules of interaction" generated by computers for the behaviour of humans within social organisations as the "rules of interaction" will most probably alter and evolve over time (Warner, 2001 p. 16). Robert Chambers has also warned that what is being sought is not "the uniform behaviour of flocks but the diverse behaviour of individuals" (Chambers, 1997).

Warner sees that a few rules may lead organisations to "the edge of chaos", which he accepts in complexity terms as being the state most supportive of creativity and adaptation, however, they cannot be general but must rather be specific to the context from which they were derived. Here we are moving from analysis to applicability in strategy and we will see that one of the strongest lessons of a complex approach is that there is no best practice. There should, therefore, be inbuilt caution about a transferral of a computational approach for exploration to development practice. However, in general this is not the intention of simulation.

Axelrod believes that the credibility or acceptance of ABMs could be strengthened if the "agent-based modelling community" could agree on standards for testing the robustness of an agent-based model. Also if it were possible to "converge" on tools, including programming tools, this would strengthen the field but this has not yet proved possible. According to Axelrod, linked to this is the need to agree on a fundamental set of concepts and results that could guide training in the field through textbooks and set readings. Axelrod and Tesfatsion have already made moves in this direction by producing a guide for newcomers to agent based modelling (Axelrod, 2005). Furthermore, agent based modelling may also provide an opportunity to help realise the potential for links across disciplines.

Advice on Complex Conflict Analysis

Drawing together some of the general advice from those advocating a complexity approach to the analysis of conflict, we can identify a strong emphasis on flexibility and variety in methods in order to do justice to the complexity and to avoid rigidity but also to break patterns that are ingrained due to culture and practice in our society and in academia, shaped by Newtonian views of the world. We have the use of multiple tools, we have time intensive analysis but crucially we have "shifting". With Wils et al this takes the form of balancing perspectives. Within a systemic conflict analysis two things need to be borne in mind:

> • the location (and function) of the reference system within the overarching system

---

[19] The Department for International Development in the United Kingdom

• a balance between the different perspectives of the conflict actors

Characterising the view of the system as a whole as the "bird's eye view" and the detailed examination of the sub-systems as the "frog's eye view", they encourage an awareness of the functions and interrelations between the elements of the system by repeatedly switching between these perspectives with an increasingly sharper focus (Wils, 2006). Having defined the system boundaries carefully, an exploration of the role of the sub-systems within the overarching system is in order.

Lederach uses a slightly different image to encourage flexibility in response to the complexity of conflict. What is required is a change of focus. This relates to Lederach's perception that often conflicts are episodes within a larger pattern of relationships that tend to reproduce these over time. It is necessary to address the conflict that presents itself but it is also necessary to pull back and become aware of the context out of which it has grown and the potential for the underlying relationships to lead to conflict episodes in the future. So, multiple lenses to see different aspects of a complex reality (Lederach, 2003). It will not be possible to see these multiple layers of complexity by relying on one lens only. These lenses then are changing our focus. The first lens allows us to focus on the immediate situation, the "presenting problem" as it were, which could be a symptom of an underlying or intractable conflict. The second lens will allow us to "see past" the immediate problems and view "what is happening in human relationships at a deeper level" (Lederach, 2003). Thirdly, we need a lens that "helps us to envision a framework that holds these together and creates a platform to address the content, the context, and the structure of the relationship. From this platform, parties can begin to find creative responses and solutions" (Lederach, 2003). Perhaps the term "platform" is a little unfortunate here conjuring up, as it does, a rather static construction.

A piece of advice from Peter Coleman is to "differentiate elements of the case before integrating the analysis. This points to a reframing of the conflict using multiple frames with the objective of specifying the particular dynamics of the system.

> "Reframing is both schematic and evaluative, as analysts move back and forth through various perspectives to garner the most comprehensive and useful reading of the current situation." (Coleman, 2006 pp. 335-336)

Using alternative frames, different aspects of the conflict become salient. Coleman has also been influenced by Lakoff & Johnson's work on the role of metaphor in the cognitive process, and thus sees the specifics of any given conflict, i.e. the data, as playing a large role in our analysis of conflict but that we are also strongly influenced by the cognitive structures through which we view it, i.e. the frame. This tendency is even more marked what the situation is complex (Coleman, 2004).

Coleman refers to the roles of both explicit and implicit framing. Cognitive science has found that much of human thought operates at an unconscious level and this includes "our automatic cognitive operations, our tacit knowledge, and our beliefs" (Lakoff, 1980). The inference here is that our cognitive unconscious shapes and structures all conscious thought, crucially influencing our view of the external world. This contested view, that most human thought is metaphorical, if accepted, means that we perceive, understand and respond to conflicts on the

basis of "implicit images"[20] (Coleman, 2004). These metaphors contain assumptions about fundamental aspects of ourselves and our environment, e.g. the possibility of knowing "reality", the nature of human beings, the way the world works, etc.

Julie Shouldice and Cheyenne Church discovered that such "mental models" are at work at an unconscious level and can lead to friction, misunderstanding and ineffective co-operation in the field of conflict resolution (Shouldice, 2003). Conflict workers possess implicit theories about the nature and origin of conflict, how change happens, what constitutes conflict resolution and how to go about it, down to the specific working methods in a particular situation. These implicit "theories" shape how we see our role in the conflict, the roles of conflict parties and stakeholders. Such frames or mental models are presumed to be largely socially constructed and work powerfully to organise our knowledge and how we take in new information and process experiences. A certain inertia in these frames can be construed from the findings of neural science that patterns of thoughts create physical connections in our brains (links between synapses) (Lakoff, 2003). This can also contribute to the selective perception that tends to reinforce presently held views. The fact that these frames or mental models are largely unconscious poses a challenge for those working in the conflict field and there are implications for training and education that will be taken up later in this paper.

Coleman is advocating a frame switch in looking at intractable conflict and here one can work with the explicit frames that we construct – the theories and models that we present (which are, of course, derived from our implicit frames). Coleman finds even more differentiation in these explicit models with theories varying according to timescale, level, degree of complexity, particular causal explanations, etc.:

> "Accordingly, conflict paradigms present views of enduring conflict that are distinct and compelling enough to motivate scientists and practitioners to develop theories, models and practices largely consistent with their paradigmatic worldviews. These worldviews are based on core images and assumptions (implicit frames) and have a logical consistency that influences the subsequent development of explicit theories and practices." (Coleman, 2004)

Clearly there are many possible approaches to be found within the field of conflict theory and practice but Coleman finds sufficient similarity in specific approaches to be able to group them around five "major paradigms". These paradigms he titles: realism, human relations, pathology, postmodernism, systems. Realism is concerned with politics and power; human relations with the nature and quality of communication and interaction; the medical frame would consider the health aspects, psychiatric, psychosomatic; and postmodernism is concerned with the multiple constructions of meaning around experiences and events. However, the integration aspect of this multi-frame approach is challenging and this issue will be looked at below under the section on transdisciplinarity.

Complexity theory can contribute to conflict analysis at the very least by making it more sophisticated, richer and, ideally, self-reflective. However, analysis is only the beginning of the story, the necessary basis, for the transformation of conflict, i.e. the comprehensive, long term change process that seeks to address, in Lederach's terms, not just conflict episodes but

---

[20]Coleman gives the following examples: viewing protracted conflicts alternatively as zero-sum games of domination, distressed human relationships, pathological diseases, incommensurate meaning systems or as deep structural patterns within complex systems. (Coleman, 2004)

the relationships out of which they grow as these are expressed in political, social and economic structures and processes. Before proceeding to look at some of the recommendations for applying complexity theory to the actual work of change it will be useful to pause to explore some mental models within complexity theory relating to the way that change comes about.

4) Conflict Transformation

How does change happen?

Conflict transformation is about change, if not change limited to a certain form or determined direction then change with certain values – justice, non-violence, participation. As has been shown, complex systems are unpredictable due to their non-linear dynamics but how then does change take place in complex systems and is it possible to learn to work with these change processes? Sylvia Walby points out that assumptions about how change occurs within complex systems have led to a certain divergence in the interpretation of the consequences of complexity theory for a traditional scientific research programme. The Santa Fe school[21] see applications within the existing paradigm whereas an alternative view, following Prigogine, sees the unknowability generated by non-linearity as calling for a new epistemological framing of how science is done:

> "However, while the differences between the various interpretations of complexity theory may be significant (Medd 2001), the apparent divergence between the Santa Fé and Prigogine schools of complexity and chaos theory should not be overstated. If the former is seen as more concerned with mathematically modelling the inner structuration of systems, while the latter focuses on their external relations then their efforts may be considered more complementary than opposed (Harvey 2001)". (Walby, 2007 p. 457)

It is true that there are two main ways in which change processes within complex systems are portrayed but there appears ample evidence to support the case that both of these occur. One of these is co-adaptation, where rather than it being the unidirectional impact of, say, a social force on another social entity that brings about change, the process of change is generated by interaction between agents, components (or for that matter systems) in on-going mutual adaptation. In responding to its environment a system changes internally and, as the environment is other systems, these, too, change internally in response. The environment as a whole is thus changed, triggering further adaptation in the system. The system and its environment thus change together in mutual adaptation but a term considered by some theorists as better reflecting such closely intertwined development "co-evolution".

Kaufmann (1993) uses the concept of fitness landscapes, originally drawn from analyses of the evolution of species, to explore how co-evolution occurs. The landscape is the environment of the system, which is made up of other systems. The fitness, i.e. the

---

[21] The Santa Fe Institute, founded in 1984, has led research in the field of complex systems and played an influential role in the development of the theories of complexity.

appropriate state/form necessary in order to thrive within the environment, is represented by peaks in the image of the landscape. Unfitness, or inappropriate adaptation to the environment, is shown as valleys within the landscape. As systems change, their ability to thrive in the environment also changes, and they rise or fall relative to other parts of the landscape. In this way they change the landscape for other systems, who must then adapt, bringing consequences for their fitness and for the shape of the landscape and therefore other systems. So all are evolving in mutual response to changes internally and externally. The landscape is adapted, or deformed, thus altering the opportunities available to other systems. Naturally, the adaptations of systems and environment do not occur instantaneously but require time. Tracking fitness landscape changes is a way to make visible the interconnected change processes between systems and their environment.

Co-evolution suggests a series of gradual, mutually influencing changes over time. However, within complex systems there may be sudden and radical change. As discussed in the section on modelling, the interactions of agents or components at a particular level can result in outcomes that cannot be predicted from knowledge of the agents or components alone. These outcomes, or properties, are termed emergent and are characterized by being more, or indeed different, than the sum of their system parts. When a system is subject to perturbations that push it away from its usual way of working, or established norms, it may reach a critical point from which it could degrade into disorder or create some new order and organization – create a new coherence (Mitleton-Kelly, 2003). Positive feedback processes provoke such transformations.

> "In human systems, the degree of connectivity (dependency or epistatic interaction) often determines the strength of feedback. Feedback when applied to human interactions means influence that changes potential action and behaviour. Furthermore, in human interactions feedback is rarely a straightforward input–process–output procedure with perfectly predictable and determined outputs. Actions and behaviours may vary according to the degree of connectivity between different individuals, as well as with time and context." (Mitleton-Kelly, 2003 pp. 16-17)

Within non-linear systems a small perturbation amplified by positive feedback could result in a relatively sudden, disproportionate change. At the point of change there are several, perhaps many, possible paths for the system to follow and no way to predict which path will be taken. This is the so-called bifurcation point.

A further term from chaos theory that is sometimes referenced e.g. (Sandole, 1999) is "phase transition" indicating the process whereby a system changes state at a critical point. The usual illustration for this is the transition from ice into water and water into steam, where a particular combination of environmental factors, significantly temperature, are the trigger for state change. Within conflict development an analogous process is posited when, for example, latent conflicts become manifest or manifest conflicts become violent. The period just before phase transition has been referred to as "the edge of chaos", a state in which a system is perturbed out of its balance but not propelled into random activity. It is out of this state, in which many lines of possible development exist, that the new self-organisation occurs and new order emerges. Analogously, it may be claimed that in conflicts where old social processes and/or political and economic structures have been shaken and dislodged, but not completely destroyed, the situation exhibits that mixture of stability and flexibility (the edge

of chaos) that allows creativity and change to come about. And by extension, this is the most fruitful time for third party intervention. However, given the non-linear nature of complex systems there is no way to know if interventions will bring about insignificant or catastrophic (i.e. radical) change.

It is also true that self-organising systems may possess "self-organising criticality", allowing them to provide their own catalyst for emergent change rather than relying on outside intervention. However, there is some debate as to whether social systems may be considered as having this capability. In biological systems Maturana and Varela characterised living systems as self-producing, i.e. autopoietic. Autopoiesis is the production/reproduction of components for the maintenance of processes.[22] Maturana and Varela define structure as the combination of the system components and how they fit together, i.e. the static elements of the system and the dynamic processes that govern it. Organisation in this understanding signifies the fundamental aspects of the entity that identify it as belonging to a particular type or class. Thus different structures can realise the same organisation. Many accept that social systems are not strictly speaking autopoietic but are capable of changing their internal structure while preserving organisational identity (internally and externally). Warner argues that in social systems re-structuring should be possible without losing the essential organisation that is fundamental to the system (Warner, 2001) and makes this the basis for his recommendations for restructuring in the face of change, specifically in challenging development environments (see later section).

Change in complex systems is non-proportional or non-linear such that surprising large-scale change may result from a relatively small perturbation (the butterfly effect - Lorenz) but, by the same token, large perturbation may also only result in small-scale change thus making the prediction of what might happen in specific situations extremely difficult. However, as indicated above, there are different interpretations as to the extent to which these outcomes are determined or unknowable.

Self-organisation on one level results in emergent properties on a higher level but in addition to this "upward causation" there is a "downward causation" too:

> "…, however neatly the 'upward causation' model fits with the general political and ideological program of modern Euro-cultural societies (i.e. individuals as more fundamental than communities), we all know that our individual behavior is still profoundly shaped, controlled, or limited in various ways by our interactions with other organisms on our own scale, and since each of these others is also similarly affected, we sum up our net mutual constraints by reference to larger-scale entities like the family, the community, the environment, society, culture, etc. In our scientific models of ecosystems we see again and again that the behavior of organisms and populations, however apparently free and independent when viewed at its own scale, nevertheless collectively repeats the same larger-scale ecological patterns and cycles." (Lemke, 2000 p. 183)

---

[22] An autopoietic machine is a machine organized (defined as a unity) as a network of processes of production (transformation and destruction) of components which: (i) through their interactions and transformations continuously regenerate and realize the network of processes (relations) that produced them; and (ii) constitute it (the machine) as a concrete unity in space in which they (the components) exist by specifying the topological domain of its realization as such a network. (Maturana, Varela, 1980, p. 78)

Any entity's constituents allow it a certain range of possible behaviour but this is not exercised in a vacuum. We adapt to other entities that:

> "impinge upon us, and they to still others, in ramifying chains of reaction that bind us together as communities, ecosystems, societies, cultures. As we all strive to adapt to one another, only some self-consistent collective patterns are possible for the whole swarm." (Lemke, 2000 p. 182)

Referring to the emergence of new order from self-organising systems subject to perturbations Lemke relativises its surprise value:

> "Order forms because there are only relatively few solutions to the problem of correlated motions, and when contrasted with an ideal of randomness in which all possible states of motion are equally likely, those few solutions stand out as 'orderly'." (Lemke, 2000 p. 182)

Lemke gives the example of movement in a crowd where, theoretically, movement in any direction is possible but in practice if others are tending to move in one direction then spaces will open up in this direction and a person will be pushed from behind in this emerging direction.

Change within a system can be conceived as taking place within what is termed "phase space". This represents all the phases or states that it is possible for the system to occupy. Mapping this phase space is carried out by taking all the relevant dimensions of the system and their possible interactions. Clearly such a task requires considerable computational power (and this has now become available) allowing this putative space to be shown in graph or table form. By tracking the interactions of the dimensions over time the "trajectory" of the system through phase space can be mapped. Sometimes this reveals chaotic movement, where the system could be at an random point within phase space at any given time but it can also reveal patterns in the change processes. These patterns have been termed "attractors" and represent tendency within the system behaviour (Capra, 1997). As mentioned above constraints apply such that developments in social systems are bounded and these patterns can be revealed over time when mapped. Mitleton-Kelly quotes Nicolis' (1994) summary:

> "non-linear dynamics and the presence of constraints maintaining the system far from equilibrium" are "the basic mechanisms involved in the emergence of ... (self-organising) phenomena". (Mitleton-Kelly, 2003 p. 20)

Systems also have histories, the histories of interactions, of choices made, and although at the edge of chaos perturbations may open up a number of possible future paths, they are nevertheless influenced by what went before. Where attractors are operating, systems may be locked into a particular pattern which limits the number of likely options. This is path dependence. Walby sees path dependence as crucial to understanding, for example, different modernities and different forms of social relations in different countries. Certain paths of development become locked in through their shaping of rewards, power, opportunity and knowledge (Arthur 1994). [23]

---

[23] Arthur has explored this phenomenon within economics and developed the theory of increasing rather than decreasing returns to scale. Entrepreneurs with an initial advantage, are able to set the path of development around a new technology in an economic system which is not in equilibrium e.g. QWERTY keyboard, VHS videotapes, etc. (Arthur 1989).

Sometimes change happens too dramatically or too quickly to allow adaptation to take place, whether in conflict situations or developmental and ecological crises. Clearly, as has been argued, these systems are intermeshed but the complexity of the interconnections and non-linear nature of influence makes it difficult to untangle what happened and why. The debates within the field of resource-based conflict research illustrate the difficulty in analysing what has already produced change let alone attempting to predict how and when change will happen in the future (Schwartz, 2000).

Questions of resilience are receiving increased attention due to the rising number, and scale, of natural disasters and climate change but also concern about the vulnerability of systems to terrorist attack. The failure of resilience within a system can be recognized when it:

> "loses its capacity to absorb disturbance or undergo change while still retaining essentially the same functions, structures, identity, and feedbacks. The individual dies or the group reorganizes but looks nothing like it did before. This happens when the danger is "too novel, too fast, or too abundant." That is, the system does not have response capabilities that are diverse enough, it cannot marshal these responses quickly enough, or the danger is so forceful that all responses are overwhelmed. The danger may become too forceful if the system has been weakened by previous dangers and has not had time to recover. The system may also fail if those managing it impose a response that is not consistent with the local system's own trajectory or "path dependence, …" (Longstaff, 2005 p. 42)

Longstaff points out some of the dangers and pitfalls of trying to engender change within a complex system whether from above or below and these comments also have relevance for conflict transformation strategy:

> "Change is more difficult than is sometimes acknowledged … Resisting change is not irrational because many people seem to instinctively know that changing some things in their complex lives (or organizations) will have unpredictable effects on other things. Anyone who has ever tried to manage organizational (or even personal) change will attest that this is invariably true and one spends a lot of time dealing with surprises caused by the change. This cascading surprise is part of the landscape when attempting to adapt something from the top down. If the adaptation occurs from the bottom up, the surprises are dealt with at the scale where they occur but there is a good chance that the end product will not look exactly like what the manager had in mind. It may also take more time to allow an organization to adapt from the bottom up – and for surprises that involve imminent physical harm, time is not an available resource." (Longstaff, 2005 p. 44)

What is complex strategy?

If we accept that conflicts within social systems are complex and that the nature of change in complex systems is as described above, what implications does this have for strategy in conflict situations, in other words what is complex conflict strategy?

In as far as changes in a non-linear system are unpredictable and uncontrollable then constructive interventions may be catalytic or enabling, either of radical change or of the

sustainment of change processes. Coleman et al identify various types of change initiative: a) episodic, having direct and immediate but typically short term or superficial effects; b) developmental, taking longer, perhaps over years, to unfold in a system but with possibly substantial influence on the quality and patterns of interaction; and c) radical effects, which are dramatic – "altering the attractor pattern of the system or moving the system from one established attractor to another." (Coleman, 2007) Drawing on Lederach they refer also to the level of intervention within the system, for example, utilising top-down strategies involving decision-makers, leaders, etc.; or working from the "middle" outwards involving mid-level leaders and community networks, structures and processes; or from the bottom up, the grassroots.

Below I have identified five key elements of conflict strategy that need to be integrated into a complex approach: working with uncertainty; developing and supporting adaptability; creating or reinforcing resilience; co-operating with emergence and self-organisation; and re-conceptualising or re-deploying the tried and trusted.

Working with Uncertainty

Complexity theory makes explicit what has long been experienced in the field, that interventions in conflict situations produce unpredictable outcomes or, at the least, also have unpredictable consequences in addition to those planned and foreseen. Complex strategy then must take uncertainty seriously and include it in any conflict transformation approach.

Wendell Jones believes that postmodernist perspectives can help to generate the necessary flexibility for adaptation to change in complex systems. He refers to Cilliers summary of the image from Jean-Francois Lyotard that describes two basic reactions to postmodernism, where the understanding of, and relationship with, the world is explained through narratives, i.e. stories of what different group/individuals (institutions, disciplines, communities) know and do. These stories are different from each other and allow these groups to achieve their goals and make sense of what they do. The narratives are all local and therefore cannot be linked in a "grand narrative" that unifies all knowledge, thus argues Cilliers:

> "Those who have a nostalgia for a unifying metanarrative – a dream central to the history of Western metaphysics – experience the Postmodern condition as fragmented, full of anarchy and therefore ultimately meaningless. It leaves them with a feeling of vertigo. On the other hand, those who embrace Postmodernism find it challenging, exciting and full of uncharted spaces. It fills them with a sense of adventure. Which of these two evaluations apply is often determined by whether one feels comfortable without fixed points of reference. The choice between the two is determined by psychological just as much as theoretical considerations." (Jones p. 7)

Even where there are some "fixed points of reference" complex strategy still requires a comprehension of the inevitability of unintended consequences, which may be either beneficial or harmful in their effects. Ramaligam et al give examples from the development field:

> "An enforced policy on low-pollution transportation could within a few years result in cleaner air, less respiratory disease, healthier people who walk more – as well as the loss of income

from motor-related activities and a change in the physical structure of the cities and in structure of the national economy. Building a road may increase access of poor villagers to markets (increasing income), but also result in restructuring of the landscape and the local economy in ways that ultimately drive the farmers from the land. The exact outcome cannot be predicted (Waltner-Toews, 1999)". (Ramalingam, 2008 p. 18)

There are numerous other examples that could be cited from policy on the environment (reducing air pollution removes dust particles that reflected sunlight leading to increased global warming), to international politics (democratic processes may lead to increased violence as more hard-line groups are voted into power), to humanitarian aid (refugee camps may provoke the anger of local disadvantaged residents excluded from aid "handouts"), and so on.

Uncertainty, has always been a part of interventions in complex systems it is just that it was very difficult to admit this for personal or professional reasons – an unwillingness to undermine one's own sense of usefulness or control, the pressure of results-dependent funding from donors, fear of it being viewed as an excuse for incompetence or failure – and this has led to unrealistic expectations, less than illuminating evaluations and, in some cases, fantasy strategising. This knowledge may be conscious or subconscious. This does not mean that strategy development and planning are redundant but rather that expectations need to be adjusted, i.e. surprises are normal, resilience is helpful:

> "If you are trying to manage a system that has several subsystems that operate at different scales you will encounter unavoidable surprises. You will fail to manage the system if you try to make the system move faster than you are capable of responding to surprises…. Iterate your way to success. Small steps that allow you to change course often will be more effective than big steps in a time of great uncertainty. Resist the demands for big solutions that impose the same answer on many individuals or many situations, because this reduces diversity. Try many things. Sow many seeds. Encourage experiments. Concentrate on finding things that are working here, today, and reward them with more resources. Pay equally close attention to things that aren't working and reduce resources to them without playing the Blame Game." (Longstaff, 2005 pp. 83-84)

There are disagreements about the extent to which future developments in a complex system can be predicted but, again, it is a question of scope and timescale. For example, Geyer argues that short-term predictions are possible in the realm of basic power resources and political structures, such as forecasting voting and decision outcomes of policy (Geyer, 2006 p. 8). And also there is a certain amount of predictability in as far as there are constraints operating and systems have histories. It is often the case that one option becomes dominant and works as an attractor to lock in the system not allowing it to take advantage of all other options available. However, this path dependence is often only recognisable with hindsight.

Beckerman argues that given two seemingly identical inputs to a system their paths (trajectories) will diverge with time but there is a period during which their trajectories lie close to each other and within this range, "the prediction horizon", there is a relatively good ability to predict. Just where the prediction horizon is located will depend on the system in question:

> "on the order of seconds (a cat), days (weather) or years (planetary paths). This implies that any dependency of planning on our ability to predict outcomes is also dependent on our

knowledge of the sensitivity in initial conditions and how quickly seemingly similar trajectories will diverge." (Beckerman 1999)

Wendell Jones takes a more radical view, advising that one should give up the hope of being able to predict in any case. Strategy then needs to be much more creative and experimental and uncertainty and unpredictability accepted as inevitable and natural. He is referring to the field of dispute resolution but it can be considered a general orientation for dealing with complex conflict systems:

> "we shouldn't worry about what the one intervention is that will make a difference. We should try hundreds of smallish sorts of things that are thought out and we hope have a chance of having a positive impact. We are not looking for the one small intervention that will work, we want to have a lot of interventions that we hope might work and then we will see what happens." (Jones, 2003)

A similar note is struck by Funnell & Parish when they argue that complexity thinking emphasizes the contingent nature of knowledge of both physical and social frameworks:

> "It is making explicit the fact that no one can claim privileged experience in the face of long-term indeterminacy and that 'constantly learning never getting it right' is the way in which most societies proceed. Thus it is necessary to foster what Mill (1956, p.68) would regard as 'experiments in living' allowing for diversity and encouraging a continual reappraisal of the most appropriate strategies." (Funnel, 1999 p. 142)

They quote Allen (1994) on finding the right balance between detailed planning and freewheeling adaptation:

> "Is the wisdom to be found in the anticipation of history, or on the contrary in the knowledge that the future is uncertain. In other words, should we attempt to make plans and shape the world according to our expectations, or, should we simply adapt and change according to changing circumstances? Finding the right balance between these two extremes is very much the core problem'. (Allen, 1994, p.584)." (Funnel, 1999 p. 143)

Geneticist John Holland has counselled that in complex systems there is little sense in:

> "imagining that the agents in the system can ever 'optimize' their fitness ... The most they can ever do is to change and improve themselves relative to what the other agents are doing." (Schmitt, 1997 p. 110)

John F. Schmitt suggests that in such a case it is not worth the effort to find the perfect plan or reach the perfect decision – it is illusory. He uses the term "satisfice" (as opposed to optimise) to denote the attempt to find a solution that will work in the local context (Schmitt, 1997).

Longstaff notes that we are still often surprised that complex human and technical systems do not do what we predict despite ample evidence of the uncertainty that is inherent in such systems. She identifies two sources of such surprises: 1) looking at the wrong scale and 2) the occurrence of a novel event due to several things being put together in a new way. (Longstaff, 2005). With the local/global scale surprises it is sometimes possible to understand a local surprise, or unexpected discrete events, by looking at them in the context of a larger-scale process. Longstaff points out that local political variables can have surprising effects when

they interact with global ones. She gives the example of a terrorist bomb that might come as a surprise at the local level but not if one was aware of international developments. A way to prepare for this is to ensure that local levels are kept informed about developments at the global level, a sensible but rather vague suggestion (Longstaff, 2005 p. 23).

Longstaff also refers to temporal surprises. These are caused by failure to notice or appreciate an interaction between variables that usually operate at different time scales. Unexpected discontinuities in a long term trend can occur when a fast variable interacts with a slow one. Longstaff is looking to develop resilience in systems and a combination of different times scales operating within a system can help build this. Longstaff quotes Brand:

> "Some parts respond quickly to the shock, allowing slower parts to ignore the shock and maintain their steady duties of system continuity. The combination of fast and slow components makes the system resilient, along with the way the differently paced parts affect each other. Fast learns, slow remembers. Fast proposes, slow disposes. Fast is discontinuous, slow is continuous. Fast and small instructs slow and big by accrued innovation and occasional revolution. Big and slow controls small and fast by constraint and constancy. Fast gets all of our attention. Slow has all the power. All durable dynamic systems have this sort of structure; it is what makes them adaptable and robust." (Longstaff, 2005 p. 21)

Also in the realm of development and environmental policy-making it proves difficult to cope with the fact that different processes are likely to be operating at different scales. Although these scales are linked they may require quite different responses (Funnel, 1999). Work on modelling the natural resource/economy relationship in the Mediterranean (Clark, 1995) has attempted to incorporate the question of scale by using a cascade-type dynamic model in which different processes are triggered at varying spatial scales. What has been thus demonstrated is that the processes highlighted at one scale, e.g. local soil erosion, when aggregated and linked to the behaviour of the socio-economic environment, will have a predictable (and therefore straightforwardly manageable) outcome (Funnel, 1999). Policy needs to become more sensitive to scale differentials in effects and the fact of uncertainty. However, as sustainability becomes a key goal in development and resource management it becomes even more problematic to speak in such terms in the face of the indeterminacy in complex systems:

> "In the context of mountain research there are several sources of indeterminacy. In the physical environment, our knowledge of climate is insufficient to provide precise guidelines either for long-term scenarios, or, given the particular importance of microclimates, predictability of short-term patterns valley by valley. The problem of forecasting hazards such as landslides is also well known and the trajectory of social and economic change is equally fraught with uncertainty." (Funnel, 1999 p. 140)

Funnell and Parish provided an example from mountain environments but their reservations about whether sustainability is,, in fact, ever achievable have wider application. Keeping the options open is difficult for many policy makers, not only due to resource implications but also the inference that "expert knowledge" is not all powerful (Funnel, 1999 p. 141). Hence resistance to embracing uncertainty as part of planning and implementation occurs at several conscious and unconscious levels, for various reasons, of which some are valid and some less so.

Hammond sees John Boyd's approach to this uncertainty as being increased awareness for possibilities and opportunities but also, crucially, being:

> "able to recognize choices and make them. *It is all a matter of connections and choices*. The more we know, the more we connect—to the environment, to the past, the future, to people, to ideas, and to things. In doing so, we have to make choices, to prioritize, to do trade-off thinking about options and possibilities." (Hammond, 1997)

Similarly to Lederach, Boyd recommends admission of the inevitable ambiguity inherent in complex systems. Accepting that we will never have complete and perfect information or be sure of the consequences of our actions, we should view our decisions and actions as "hypotheses to be tested against this ambiguous environment":

> "The best way to succeed in it is to revel in ambiguity. Rather than fight against it and attempt to learn or know all, we should accept it and use it to our advantage. We do so by adapting to the circumstances around us and perfecting our ability to deal with incomplete information. Though anchored in moral conviction, we should remain fluid in our actions, being unpredictable and adaptable to unfolding circumstances."
> (Hammond, 1997)

Going even further than learning to cope with uncertainty, actively creating uncertainty □ seeking to stir the system □ may be productive of creative responses and this approach has been incorporated in some problem-solving and mediation approaches in the past. Wils et al argue that it may be necessary to push the system to the edge of chaos in order to create the conditions necessary for change. Part of this may also be attempting to disrupt patterns of interaction and perception at the inter-group level during interventions. They refer to interventions that disturb the system in an attempt to counteract the self-reproductive nature of the conflict and thus, possibly, induce a system transformation:

> "System-disturbing" interventions are not necessarily those that tackle resistances but those that allude more to paradoxes and seek to cause creative confusion.". (Wils, 2006 p. 64)

Lemke echoes the importance of creative disturbance when he suggests that:

> " we also serve, who obstruct stability, who contravene tradition, who say and do the forbidden. We do not know enough yet to identify the critical moments when our small influence might be amplified and guide the course of systems far larger and more complex than ourselves, but we can offer alternatives, even if only in small patches, and we can study the conditions of their survival potential relative to others. We can also de-couple systems of practices and processes that reduce the survival potential of all alternatives." (Lemke, 1993 p. 129)

Developing and Supporting Adaptability

Thus, in the face of the uncertainty intrinsic to complex systems, adaptability is required and hence this is a key aspect of complex strategy. At the bifurcation point, or point of criticality,

there are several (or even many) options in terms of lines of development that the system might follow. Although simulation and modelling helps to expand the range of feasible thought experiments, it will be impossible to explore all possibilities. However, one approach to exploring potential in complex environments is to consider change that is only "one step away from what already exists". This is the "adjacent possible" that Kauffman refers to (Kauffman, 2000 p. 22) and this is the domain of "exaptation". Exaptation is the rearrangement of existing components to create something novel. In order to develop adaptability it is necessary to encourage a new way of seeing things, or perceiving new connections, which can lead to exaptation. Once possibilities have been realised in the current adjacent possible, a new adjacent possible, accessible from the enlarged actual that includes the novel discoveries from the former adjacent possible, becomes available.

In the case of climate change, as in the work on sustainability more generally, there is increasing attention given to the development and support of adaptability. That is to say, rather than advocating the adoption of a particular strategy, designed and determined in all details, the aim is to develop a capacity to anticipate and adapt in the face of change. Smith and Vivekananda recognise, however, that confronted by such serious and compound challenges as climate change and violent conflict, individual governments may be over-tasked in trying to adapt to the situation. One approach would be to focus on financial support for adaptation but this should not be introduced as a top-down programme imposed by outsiders or governments. They argue that a peacebuilding approach which empowers local communities by providing information and resources with which to analyse, reflect and create local knowledge and understanding to find the "best mode of adaptation" would be the most fruitful approach:

> "peacebuilding and adaptation are effectively the same kind of activity, involving the same kinds of methods of dialogue and social engagement, requiring from governments the same values of inclusivity and transparency." (Smith, 2007 p. 2)

Lederach advocates adaptable and creative responses to conflict systems and calls for the setting up of alternative patterns to draw groups out of conflict interactions that have established themselves (with a tendency to escalate) over time, echoing the approach described by Coleman et al at the ICCC using the attractor metaphor. And these are not static prescribed solutions but processes that are dynamic and adaptive. Here self-organisation also plays a role:

> "From the transformational view, developing a process to provide a solution to the presenting problem is important but not the key. Central to transformation is building a base that generates processes that 1) provide adaptive responses to the immediate and future iterations of conflict episodes, and 2) address the deeper and longer-term relational and systemic patterns that produce violent, destructive expressions of conflict." (Lederach, 2003 pp. 46-47)

Lederach uses the term platform, which is unfortunate in its connotations of a static structure. It does not convey the process-structure that he would favour, which would be adaptive and capable of producing creative solutions to a variety of problems. Welsh and Chesters adopt the term "plateau" in their investigation of the anti-globalisation movement as a complex system. It describes the condensation of the loosely connected agents in a certain time and place. They quotes Massumi (1992)

> "…a plateau is reached when circumstances combine to bring an activity to
> a pitch of intensity that is not automatically dissipated in a climax leading
> to a state of rest. The heightening of energies is sustained long enough to
> leave a kind of afterimage of its dynamism that can be reactivated or
> injected in to other activities, creating a fabric of intensive states between
> which any number of connecting routes could exist." (Welsh, 2005 p. 199)

Possibly a re-working of this idea could better express what is needed in order for complex social systems to develop adaptive responses to conflict situations as they arise, while at the same time transforming the underlying social relations that lead to such conflict episodes on a long term basis.

If objectives and processes need to adapt to the needs of the moment, this will require effective monitoring and evaluation, with particular emphasis on leverage points, emerging opportunities and self-organisation already taking place within the situation. Wils et al advocate a:

> "sophisticated monitoring system which not only tracks the impacts of intervention in
> terms of promoting a sustainable peace but also focuses on the *quality of partnership-
> based relations between various actors*." (Wils, 2006 p. 12) (emphasis added)

However, they do point out that such long term engagement, which entails changing form in response to needs perceived, is not only challenging but difficult to fund.

Coleman sees the creation of procedures and indexes for monitoring progress and measuring outcomes of change initiatives as part of the stakeholder-intervener partnership. These could include scoping (identification of 10–15 impact indicators and methods of measurement), data collection (establishing baseline conditions when possible), and assessment (tracking the effects of the initiatives at agreed-on time intervals) (Coleman, 2006).

Success depends partly on receiving sufficient information both from other actors and the environment. Networks and relationships are of importance, as highlighted by Wils et al, and once again key concepts are stakeholders and participation. Adaptation is predicated on receipt of feedback relating to actions:

> "Therefore, local-level and 'rapid-feedback' indicators 'help individuals, agencies and
> businesses make the best choices for their own actions', and they can 'work together
> to improve the system [and their position in it] so long as they get feedback and so
> long as they have the capacity to respond' (Innes and Booher, 2000)." (Ramalingam,
> 2008 p. 51)

Good feedback is essential but a willingness to act on the information is also crucial. Coleman refers to the research of Dietrich Dorner on decision making in complex situations involving "simulated communities". A key finding was the importance of a willingness to adjust decisions in response to critical feedback. Holding on to a course once set (in this example for improving communities) often leads to failure and even harm, while staying open to feedback, reconsidering decisions and altering course, is adaptable behaviour appropriate to complex systems. This is, of course, only possible if there is a degree of detachment from content, no identification with, or investment in, a particular form and a refusal to confuse a mistake with

personal failure, seeing it rather as an indicator of required adaptation. Translated into a conflict context Coleman advises that stakeholder-intervener teams must be prepared to change strategies, tactics, key indicators and even members of the team as the system evolves (Coleman, 2006 p. 346).

So, becoming, and staying, aware of what is happening in the environment (and that includes other systems) requires attention to feedback, in other words recognising what is happening in terms of co-adaptation or co-evolution. Noticing the changes and then responding to them as part of a conscious process. It appears that adaptability based on feedback could be the answer. However, increased sensitivity in registering feedback increases adjustment, which in turn increases readjustment in the system and where this becomes too prevalent it may result in "simultaneous sensations of progress and *déjà vu.*" (Longstaff, 2005 p. 28). This must, therefore, be seen as a field of experimentation, seeking the right balance and choosing, as Schmitt recommends, to "satisfice" rather than "optimise".

Creating or Reinforcing Resilience

Fostering adaptability whether in development contexts, conflict situations or social structures in general, requires the development of resilience. In discussing the difference between engineering and ecological resilience Longstaff highlights the need to be clear about the characteristics of the system one is dealing with and, consequently, what is feasible. Engineering resilience aims to make a system return to one predesigned state or function after it has been disturbed, e.g. in a computer. This type of resilience often emphasizes efficiency and optimal performance. While it can be suitable for systems with low uncertainty, it can be inappropriate, and even counterproductive, when it is used in systems with high uncertainty. This is because:

> "it requires regulatory functions to reduce the uncertainty, and these will often make the system more tightly coupled and brittle. Engineering resilience is often very efficient in its use of resources, but it would not be an appropriate goal if the system is supposed to generate innovation and new opportunities." (Longstaff, 2005 p. 29)

Ecological resilience by contrast focuses on persistence and adaptation. There are several (or many) possible stable states for the system and it might flip into any one of these after it has been disturbed. Once again attention is drawn to phase transition states or "what happens at the boundaries of these states":

> "Human systems (economic and political) have been known to flip from ordered to chaotic and then to a new order when they are disturbed by war or lack of resources. In a system capable of flipping into new states (without perishing), the objective of returning it to any particular state may be impossible if the variables acting on the systems have now changed. It would be crazy to try to rebuild a buggy whip business after the introduction of the automobile flipped the primary mode of transportation. It would be difficult to rebuild old institutions after a society has been changed by new ideas about human rights, democracy, or technology." (Longstaff, 2005 p. 29)

This reminds us that for systems made up of many units with different histories and different local resources, there is unlikely to be a resilience strategy that works everywhere. If a global

strategy is imposed, the resilience of some local groups will fail (Longstaff, 2005 p. 43). A developmental perspective needs to be included as:

> "Economies and societies also develop and their resources, vulnerabilities, responses, and therefore resilience will reflect their development. Developing systems have sensitive periods when their stability and flexibility changes, along with vulnerabilities and opportunities pertinent to surviving a major threat. Consequently, the same strategies to promote resilience to future surprises will not work for systems in different stages of development and planning …" for resilience must include developmental perspectives." (Gundersen, 2008)

Co-operating with Emergence and Self-organisation

While emergence in complex systems accounts for their inherent unpredictability some see this aspect as promising and encouraging as this adaptability may be working to produce appropriate responses to perturbations. Examples of emergent properties in complex social systems, according to work done at the University of Strathclyde, include: structure, processes, functions, memory, measurement, creativity, novelty and meaning (McDonald, 2006) (Ramalingam, 2008 p. 20)

In an attempt to make complexity manageable Wils et al seek to exclude macro-level factors that cannot be affected by the local level actors marking this as the dividing line between system and environment (Wils, 2006). However, it is precisely the self-organisation of these local level systems that produces the macro-level effects within a complex social system (albeit within constraints operating as downward causation) and so this may prove to be, so to say, a false economy.

Lederach sees it as an advantage of complexity that change is not tied exclusively to one thing, action or option.

> "First, we must trust the capacity of systems to generate options and avenues for change and moving forward. Second, we must pursue those options that appear to hold the greatest promise for constructive change. Third, we must not lock rigidly onto to one idea or approach. The potential avenues of change generated in complex systems are numerous. Complexity is especially a friend when cycles and episodes of conflict seem to narrow toward the same outcomes every time. It is here that paying careful attention to the multiplicity of options can create new ways to look at old patterns." (Lederach, 2003 p. 54)

Any strategy must work with the dynamic of the conflict, which Lederach characterises as a dynamic of "ebb (conflict de-escalation to pursue constructive change) and flow (conflict escalation to pursue constructive change)" (Lederach, 2003 p. 33). This latter point is interesting as it sees a potential in conflict escalation rather than focusing exclusively on striving for de-escalation. In the same way, Diana Francis has pointed to the conflict intensifying effect of consciousness-raising in latent conflict situations, whereby what was implicit becomes conscious and leads to confrontation and change, also a part of the conflict transformation process (Forum-ZFD, 2008).

As already introduced in the section on analysis, Glenda Eoyang and Louise Yellowthunder view conflict de-escalation and conflict transformation as complex systems involved in self-organizing processes. They work with the CDE Model within which three conditions (containers, differences and exchange) interact with each other in non-linear ways and they explicitly identify the aim of any peacebuilding activity as a shift in one or more of the conditions for self-organisation. They argue that any intervention that does not take these conditions and their interdependencies into account runs various risks. It may, for example:

> "- Work in contradiction to other related or unrelated peace building efforts, so that no net result is observable.
>
> - Generate unexpected consequences as the system adapts other conditions in response to changes in the condition of focus.
>
> - Consume resources to shift the system when the other conditions are highly constrained or locked in by other forces that are beyond the project scope or influence.
>
> - Set conditions for transformations at other levels (either above or below the level of intervention), so that changes occur (either positive or negative) that are unpredictable" (Eoyang, September 2008 p. 17)

Emergence happens spontaneously in complex systems but it can also be fostered and Mitleton-Kelly argues that learning, and the generation and sharing of knowledge, need to be supported by providing the appropriate socio-cultural and technical conditions, what she refers to as the "enabling environment", to support connectivity and interdependence and thus to facilitate emergence and self-organisation (Mitleton-Kelly, 2003).

The concept of emergence is taken from physical and biological systems but as Eve Mitleton-Kelly points out social human systems are fundamentally different in that they can "deliberately create constraints and perturbations that consciously push a human institution far-from-equilibrium" (Mitleton-Kelly, 2003 p. 14). However, at the same time, humans can "provide help and support for this new order to be established" (Mitleton-Kelly, 2003 p. 14). Mitleton-Kelly draws attention to the necessity of working in an open, adaptable and indirect way to foster self-organisation:

> "If the new order is 'designed' in detail, then the support needed will be greater, because those involved have their self-organising abilities curtailed, and may thus become dependent on the designers to provide a new framework to facilitate and support new relationships and connectivities. Although the intention of change management interventions is to create new ways of working, they may block or constrain emergent patterns of behaviour if they attempt to excessively design and control outcomes. However, if organisation re-design were to concentrate on the provision of *enabling infrastructures* (the socio-cultural and technical conditions that facilitate the emergence of new ways of organising), allowing the new patterns of relationships and ways of working to emerge, new forms of organisation may arise that would be unique …" (Mitleton-Kelly, 2003 p. 14)

Rather than creating an "enabling environment" Lane and Maxfield talk about the need to focus on what they term "generative relationships" within complex social systems, by which they mean:

> "a relationship that can induce changes in the way the participants see their world and act in it and even give rise to new entities, like agents, artifacts, even institutions" (Lane, 1995)

They refer to "complex foresight horizons" where opportunities arise unexpectedly, in the context of generative relationships. In such cases it is necessary to spot and foster these relationships and, when opportunities emerge from them, learn to set aside prior expectations and plans and "follow where the relationships lead" (Lane, 1995).

Lemke poses the question as to whether a subsystem can successfully regulate the supersystem of which it is a part. His answer is, in some cases, yes. As previously pointed out, at critical bifurcation points the system becomes extremely sensitive to small fluctuations and under these conditions:

> "small perturbations from much smaller scales in the hierarchy may become greatly amplified and coherent global effects can result, including the determination of which branch the system's further development takes." (Lemke, 1993 p. 15)

Senge is referring to this implicitly when he emphasises leverage:

> "seeing where actions and changes in structures can lead to significant, enduring improvements. Often leverage follows the principle of economy of means: where the best results come not from large-scale efforts but from small well-focused actions."

> "Our nonsystemic ways of thinking are so damaging specifically because they consistently lead us to focus on low-leverage changes: we focus on symptoms where the stress is greatest. We repair or ameliorate the symptoms. But such efforts only make matters better in the short run, at best, and worse in the long run." (Senge, 1990; 2006 p. 114)

This point is taken up by Wils et al, who argue that the value of the systemic approach is that it can help identify points of intervention and levers of peaceful change, as well as offering a framework for the co-ordination and interaction of activities on various tracks of conflict management and across levels such as state, non-state and international and local actors. However, in a development setting Chambers is wary of hoping for too much from emergence and alludes to the simple rules used in simulations and ABM's to produce emergence:

> '... development projects can be paralysed by overloads at their centres of control. But they differ from [computer simulations]. Projects deal with varied environments and idiosyncratic people as independent agents. The simple rules which then work have to go further, allowing and enabling people to manage in many ways with their local, complex, diverse, dynamic and unpredictable conditions, and facilitating not the uniform behaviour of flocks but the diverse behaviour of individuals' (Chambers, 1997 p. 22)

Ramalingam et al also advise caution as there are processes that hinder, or set limits, to self-organisation. Homeostasis, for example, where adaptive agents seek to maintain certain factors within a desired range "often exerting energy to **maintain** stable levels". (Ramalingam, 2008 p. 51) This includes risk homeostasis (e.g. unconsciously compensating for a safer vehicle with less safe driving habits) and institutional homeostasis (e.g. the scientific hierarchy ignoring radical new discoveries for fear of destabilising existing structures/ways of thinking). A more pertinent example is provided by Ramalingam et al with reference to the mutual construction of events by donors and agencies in development work

such that both agents' ends are met. Co-evolution has occurred here where risk-averse behaviours and the adoption of foreign ways of doing things e.g. using the "logical framework" for projects determine the allocation of resources (Ramalingam, 2008).

Ramalingam et al also posit that there are some groups of actors that are not able to self-organise or to co-evolve with other actors within systems (in this case the aid system), which locate power, control and legitimacy in the hands of the rich and their representatives. Thus, it is important:

> "to see oneself and one's own organisation and actions as part of a wider system, and pay attention to the way that various actors may adapt and react to various constraints put upon them and opportunities made available, incorporating into the design an understanding of how they may react to a proposed policy and a willingness to engage in an iterative interaction if the reaction is unanticipated (Khan, personal communication, 2007)." (Ramalingam, 2008 p. 55)

They raise the question of whether promoting the use of Western methods in development aid practice is in fact a transferral of ideology rather than provision of a neutral or objective methodology. In as much as such methods are usually passed *down* the hierarchy of power and resources, it is an exertion of power and it can produce the illusion of a common understanding and shared mental models but may in fact be just acquisition of the skills required to play the game. Although this may be an exercise of power, at the same time, what actually happens on the ground may elude this attempted control allowing "parallel realities" to co-exist. The example is given of the log frame required by the donors and an actual practice defined by local needs and circumstances (Ramalingam, 2008).

Chesters points to an example of self-organising systems evading control by virtue of the "complex character of the system of relations", a case in point being social forums. Attempts to control the process by relatively powerful actors have failed and co-optation has been resisted:

> "The variable and contested structures of the forum movement are emergent properties of processes of interaction in real and virtual domains; they are both adaptive to, and contingent upon, the differing contexts of their manifestation. This capacity to change structure in response to external environments is a quality that signifies a high degree of self-organization …" (Welsh, 2005 p. 200)

However, although connectivity is an important pre-requisite for self-organisation it is not valuable ad infinitum as there are natural limits to how much information an individual can deal with and to what degree attention is required to maintain viable connections. Furthermore, it should be realised that not all emergent properties, or all self-organisation, is necessarily "desirable or efficacious" (Mitleton-Kelly, 2003 p. 21). McKelvey also argues that under certain conditions emergence could be "compromised, biased, fragile, sterile or maladaptive." (Mitleton-Kelly, 2003 p. 21). And here we are back to uncertainty, and the need for alertness and adaptability, expecting the unexpected and responding to it accordingly.

Re-conceptualising or Re-deploying the Tried and Trusted

Complexity theory brings a new way of conceptualising what happens in social systems in general and conflict systems in particular. This does not necessarily mean that all the methods and approaches associated with earlier conflict resolution are now redundant. They are part of, not just a repertoire, but hopefully a more integrated approach that sees connections between the ecological and social, between the natural and social sciences. They may be deployed differently but they are still valid.

As has already been emphasised, extreme shifts in attractor patterns (from destructive to constructive) may be initiated by small but important changes. To provide a specific example Coleman et al quote Gersick who argues that influential newcomers (typically young or unsocialised outsiders) may be drawn into a system by a crisis and, as these are "less obligated, constrained, and resistant to change", (Gersick, 1991) they are better able to initiate frame-breaking changes in the mindsets of stakeholders. The ICCC uses the attractor metaphor but drawing on historical examples and interpreting these through a complexity lens. Thus Mahatma Gandhi and Martin Luther King played the role outlined by Gersick in their introduction of nonviolent civil disobedience into conflict situations thus reframing the issues in a manner that reduced destructiveness (Coleman, 2007 p. 342).

The environmental and situational conditions must be conducive for such catalysis to occur. In polarised situations, argues Coleman, the system must be at the edge of chaos. Coleman recasts the classic example of the "mutually hurting stalemate" in complexity terms:

> "In conflict settings, this can involve the presence of an extreme sense of dread and exhaustion from a mutually hurting stalemate between parties (due to a strong negative attractor), coupled with a sense that some type of constructive alternative to escalation and violence is possible (in other words, the beginnings of a positive attractor; see Zartman, 2000)." (Coleman, 2007 p. 342)

Attractors may change slowly but the shift between attractors may be abrupt:

> "From the dynamical perspective, then, important and lasting changes in a social system correspond to changes in the attractor landscape of the system. Although a change within a basin of attraction is likely to be short-lived and resisted by the system, a change in the attractors themselves reconfigures the ensemble of likely states that can be adopted and alters the forces operating within the system. Changes in the attractor landscape can bring about changes in system behavior that are not only lasting but also self-sustaining and self enhancing over time." (Coleman, 2006 p. 71)

However, Coleman et al warn that triggering change in pattern is no guarantee of positive or lasting change in a dynamic system. All outcomes are possible from no change, to slight reorientation to radical change. Key influence on the outcome is the transition process:

> "This includes a sufficient sense of urgency and optimism of the parties involved, adequate external counsel and support, and insight into "key adaptations" that can sustain catalytic change (Morgan, 1997)." (Coleman, 2006 p. 343)

Coleman understands changing the structure of attractors as changing the properties of the system's dynamics and this is possible when there is a change in the relationship between variables in the system. Change in systems may be overt or latent and the unseen change processes may be slower and more gradual:

"Thus, when a specific policy or intervention does not produce a visible effect, this does not mean that it is futile. Rather, such activities may be creating, deepening, or destroying a latent attractor for the system. In other words, it may affect the range of possible states rather than the current state." (Coleman, 2006 p. 344)

Within the attractor metaphor what is happening can be understood as many small incidents, events or interactions creating an attractor, i.e. a set of attitudes and behaviours that will determine perceptions and actions, that may draw the conflict parties in, once a critical (or tipping) point is reached. This is not only the case with destructive interactions but also with positive interactions. The impact of each individual element is not great but together they create a substratum that becomes a structure or systemic element. The building through numerous interactions, events, etc. of a latent positive attractor into which the system can move is an important precondition for conflict transformation. Coleman et al stress that the attractors do not dissolve but remain available should further incidents counter the attractiveness of a positive attractor, resulting in flip back to a previous level of hostility (Coleman, 2006).

Coleman refers to the collapse of multi-dimensionality as conflict situations escalate and polarisation sets in. This indicates a shift between the multiple weak attractors that are typical of multi-dimensionality and a tendency towards strong linkages between variables in the system favoured by positive feedback loops. The attendant evils of such polarisation □ the stereotypical thinking and enemy images, avoidance of cognitive dissonance, etc. □ feed the escalation. Once again existing conflict resolution approaches (e.g. problem-solving, contact work between conflict groups, etc.) are valuable as they are designed to promote de-escalation.

Careful analysis on a case by case basis is required as, even if there are common elements, the linkages and contextual factors affect the non-linear dynamics of the system. So, which elements are relevant and what, in this specific case, is the nature of the linkages? The aim is de-linking or decoupling but the nature of the intervention must be tailored to the cultural context. The decoupling itself does not guarantee the solution to the conflict but contributes to disassembling the conflict structure making it easier to deal with (Coleman, 2006). The tactics for decoupling (restoring multidimensionality) are familiar from conflict resolution work with polarised groups, i.e. reduction of stereotypes (more diverse images of the other) through, for example, providing positive examples of out-group members, introducing high status in-group members that do not share the stereotypes, locating cross cutting categories, identification of common interests, co-operation to achieve superordinate goals, and so on.

The aim should also be to "de-link" positive feedback loops and re-instate negative feedback loops in order to contain escalation. The latter can be introduced at the interpersonal but also at the broader systemic levels (Coleman, 2006 p. 343). Again this recalls a tool familiar from non-violent conflict resolution developed by Jean and Hildegard Goss-Mayr, which is useful for both analysis and strategy development. This graphic tool[24] is based on the premise that

---

[24] ***Method***: Identify the unstable situation (conflict, problem or injustice) and show this as an inverted triangle standing on one point. Next identify the forces or factors seeming to maintain this situation. Show them as the "supporting pillars" on both sides of the triangle. Consider how each of these pillars might be weakened or removed from the situation. Briefly list your strategies for each pillar. Also consider what stable situation could replace this unstable one.

situations of injustice are not really stable but are "held up" by a range of factors or forces: the "pillars". If it is possible to identify these pillars and devise ways to remove them or minimise their effect on the situation, there is the potential to topple a negative situation. Concomitantly, a strategy for the building of a positive alternative is developed.

As well as individuating the members of the outgroups, untangling the issues is an important part of the de-escalation process. For example, breaking down large scale conflict that is perceived as one-dimensional into a multitude of smaller issue-specific conflicts. This could be seen as a form of "patch logic" (to use a complexity term) but the process would be not only solution orientated but attitude and relationship orientated. Again, this recalls conventional wisdom in problem-solving approaches where dividing problems into manageable chunks is seen as a way of breaking deadlock and stimulating new thinking.

"Patches" as conceived by Kauffman, however, are somewhat different. Separate groups work on different aspects of a problem-laden task. The groups work in non-overlapping patches and optimisation occurs within each of these. There will be "coupling" (in Maturana and Varela's sense) between patches by which the "good" solution found in one patch will change the problem to be solved in adjacent patches. Changes in each patch thus alter the problems confronted by neighbouring patches, and the adaptive responses of those patches in turn alter the problems faced by yet other patches becoming a co-evolving, ecosocial system (Kauffman, 1995).

Lemke describes patches as an effective survival and development strategy in ecosystems and argues that the same could be true for ecosocial systems:

> "Mature ecosocial systems ward off terminal senility by the incorporation of a mixed-age mosaic of alternative-succession patches which serve as a reservoir of diversity. Some of these patches may even serve counter-regulatory functions, preventing the system's self-regulation from becoming overly rigid (and so unable to adapt to environmental changes). If not large-scale patches, then subsystems at some scale can be expected to fill this function. In ecosystem dynamics it has been noted (Holling 1986) that some ecosystems never reach a quasi-stable `stationary' state, because there are <u>no</u> stable values of the various population and other parameters which the system's dynamics will continue to regenerate. It remains in a state of continual dynamic disequilibrium, with all its parameters fluctuating (sometimes in erratic cycles, sometimes chaotically), continually seeking a steady-state it can never achieve. In such a system (*and ecosocial systems are surely like this, at least in parts*) no one species or dynamic coupling scheme ever `wins': all co-exist uneasily, in endless competition, with the result that the total diversity of the system remains higher than in any possible stable configuration." (Lemke, 1993 p. 16) (emphasis added)

Complex conflict transformation strategy can make use of the valuable insights developed over years of practice and research on third party intervention. Inclusivity is an important aspect of the peace processes wherever negotiation and mediation are prominent. Sustainable solutions require, at a minimum, a basis of all interests having been heard and acknowledged, if not directly then indirectly, e.g. parallel talks via representatives, or sequential inclusion in the implementation phase. Wils et al advocate increasing problem-solving and dialogue

capacities by empowering the actors and this is not essentially different from traditional approaches to conflict resolution.

Michael Warner looks at the resilience of organisations and communities in a development and aid context using an explicitly complexity framework. In a new context – both actual (overwhelming and threatening change in a development setting) and conceptual (complexity theory) ☐ he advocates an approach long applied in conflict resolution - interest-based negotiation. In this approach decision-making is collective (inclusive), conflicts are resolved by consensus and strategic alliances involving excluded groups can be built up on the basis of mutual benefit (Warner, 2001). Warner sees elements such as prior continuous trust and confidence building, inclusivity, seeking out common ground and joint problem-solving, as being innovative *in this context* and these reflect the standards of conflict resolution. Warner understands this as a process of "facilitated self-restructuring" (rather than self-organisation) driven, in this case, by interest-based negotiation.

One can see here methods and approaches of longstanding in conflict resolution applied as part of a new approach, or at least deployed as consequence of a different mental model, with perhaps, therefore, new impact and outcomes. In the same way that exaptation works in resilience strategies and is crucial to adaptability, so too with regard to the use and combination of existing approaches in handling conflict and social transformation. Lemke is speaking of change in general here but the point is well taken in conflict transformation when he suggests the kinds of interventions that would be useful:

> "… the kind of action most likely to open up new dynamical pathways for the system is a reorganization of the coupling scheme: the linking of processes/practices not previously linked, or the de-coupling of those that formerly were. This is also true of the coupling of whole subsystems. Such actions, semiotically, correspond to re-definitions of equivalence classes and relations of alliance or opposition: to making semantic distinctions not previously made, to combining thematic elements not previously combined, and thus to making conceivable actions that link processes or subsystems not previously linked. In some cases, again, it may be necessary to de-couple before re-coupling in a new pattern, and it may be only in newer, younger, developing subsystems that the new dynamical patterns can first be effected." (Lemke, 1993 p. 16)

Local Approach

What emerges strongly from a consideration of complex systems with their non-linear characteristics, is that it is not possible to transfer practice wholesale from one spatial and temporal context to another. In effect, there can be no "best practice". The particular circumstances of a place and time will allow for certain possible paths of development and any change in any one of those factors will have effect on the dynamics of the whole. This is the "sensitivity to initial conditions" familiar from chaos theory. What becomes evident is that a local view is important and that local strategy development for a particular context has the best chance of working.

In any case, Mittleton-Kelly warns against seeking for a general solution:

> "Complexity also suggests that the search for a single 'optimum' strategy may neither be possible nor desirable. Any strategy can only be optimum under certain conditions, and when those conditions change, the strategy may no longer be optimal." (Mitleton-Kelly, 2003 p. 14)

Searching for a "grand strategy" is not then the most effective approach. As Paul Cilliers advises we must:

> "avoid the trap of trying to find master keys. Because of the mechanisms by which complex systems structure themselves, single principles provide inadequate descriptions. We should rather be sensitive to complex and self-organizing interactions and appreciate the play of patterns that perpetually transforms the system itself as well as the environment in which it operates." (Cilliers, 1998 p. 107)

This begins with knowing the local conditions and clearly the view from outside, while necessary and stimulating, is far from sufficient:

> "... [emergent properties are global, but] context … determines their function. It is important to build a perspective on an issue from the point of view of those who live their lives immersed in it'(Holland, 2000)" (Ramalingam, 2008 p. 22).

However, the precept derived from this insight should not be "all knowledge must be local" but rather "the application of knowledge must be locally appropriate".

One important capacity building aspect, highlighted by Smith and Vivekananda, is to encourage local research capability. For example, in the context of the impact of climate change and its social and political consequences, they argue that university and research networks should be strengthened to develop and spread competence allowing for specific countries and regions to be investigated. They are speaking of climate and conflict but the point is more generally applicable. Agent based models could be useful in this but Ramalignam et al also point to the need to adapt general models when it becomes clear that they are not appropriate to the dynamics of a new local situation as, unless this is done, they cannot deliver the hoped for benefits:

> "Nonlinearity implies that, as well as understanding the limitations of a particular model or perspective, it is important to build and improve new models that can provide the sort of information required for the particular task at hand." (Ramalingam, 2008 p. 25)

In a complex approach to conflict Wils et al see the local stakeholders as playing a vital role not just in analysis but in a dynamic response to the situation in terms of self-organisation. The mobilisation of the system's own resources is seen as a contribution to transformation. Wils et al argue that this should reduce violence but also make changes at a systemic level by establishing or reinforcing support systems that will produce the political and social change required for a just and peaceful society:

> "Due to the centrality of the issue of a fair and equitable distribution of power and resources, another key element of systemic conflict transformation is always to empower local stakeholders and state and non-state institutions to identify and implement forms and processes of power and resource distribution." (Wils, 2006 p. 14)

Warner argues that, in the development field, more is required than the purely participative principle of community participation and recommends a move towards community-based

natural resource management (CBNRM). Earlier participation approaches are seen as possibly having been too insular to facilitate durable change. As Grimble and Wellard note:

> "increasing the participation of beneficiaries or target groups alone cannot guarantee that projects will work…[instead]…the interests of the whole range of stakeholders who can influence or be influenced by the project or policy need to be taken into account" (1997: 184)". (Warner, 2001 p. 21)

However, Funnell and Parish point out that advocating local participation as the best and only solution to development and conflict problems can lead to an over-simplification of complex situations. Just as institutions at the national or international level are operating on the basis of assumptions and mental models so indeed are people at local level. Referring to the situation in the Atlas region of Morocco they point out that local institutions such as the j'maa, or village council, also retain strong elements of conservatism and posses their own vested interests and worldview or, as they term it in cultural studies, their "myth" of how the world should be organised. Funnell and Parish do not deny the value of local detailed knowledge, and the appropriateness of strategies based on this, but argue that the designation "local" is not, per se, a guarantee that this process will work:

> "There has been some tendency to argue in favour of preserving traditional institutions so that in the High Atlas the j'maa is strengthened. However, this is insufficient because such an approach fails to explain exactly how the dynamic of social change would be improved. Put into the language of cultural theory, what happens when the myths compete and what is the actual process of conflict resolution? The focus on existing institutions presumes that they have the capacity to metamorphose into new structures to cope with the changing world. For example, in the High Atlas, two adjacent villages have adopted very different approaches to the availability of external resources (in the form of NGO finance). One has established a development committee to oversee the use of the funds, the other failing to set up any such enabling agency so that the finance remained unused for a considerable period (Johnstone, 1997, personal communication). In the same area, it took nearly eighteen months after the main electricity arrived before agreement could be reached locally about the priorities for connection. The result was that some members of the community felt that important opportunities have been wasted and that failure to resolve these difficulties has held back local enterprise. This case provides an excellent example of the delicate balancing act between different attitudes to resource management and future development." (Funnel, 1999 p. 141)

However, theorists such as Robert Chambers (1997) have argued that it is more than just a question of local knowledge, it is a question of empowerment, such that those who are directly affected feed into the process by directly participating in the collection of information and the design of policy initiatives. Nevertheless, Funnell and Parish are critical of the high expectations for such processes as Participatory Rural Appraisal (PRA), where it is expected that continuous self-learning will occur and all participants will be included in the ongoing process of policy formation:

> "Although a useful step, the approach fails to address the matter of conflict resolution and, by merely pin- pointing the local community as the forum for initiatives, is in danger of assuming away any diversity within the community. As the examples from the High Atlas illustrate, this is an unwarranted assumption." (Funnel, 1999 p. 142)

They also refer to Crawley's view that Participatory Rural Appraisal (PRA) could be seen as providing a framework for more efficient management by external agencies, or the current local power holders, rather than fostering empowerment (Funnel, 1999 p. 142) – "Plus ça change,…"

In terms of resilience the argument goes that the best answers for challenges come from the bottom up as:

> "when the consequences of a surprise are at the individual level, it actually makes more sense for the resilience strategies to come from them since they will have the most incentive to get it right. And there is likely to be wide variability in individual resilience based on things like their experience with similar dangers, their perception of the danger, their perceived control, their sense of community, the resources available to them, and their willingness to see the advantages in any surprise. … In times of surprise it would be foolish to hobble the ingenuity of each citizen with a tightly coupled response. They will look for the right resilience strategy for themselves, their families, and their neighbors. There are many things governments and NGOs can do to help them in this process, but decreeing the right or best thing would not be helpful for most of them." (Longstaff, 2005 p. 45)

Wils et al have a further particular focus in their strong emphasis on participative approaches – they are looking to identify "agents of change" in **all** stakeholder groups. A minimum consensus is necessary (e.g. the need for peaceful change) but the change agents in the various stakeholder groups will have differing ideas and visions of the changes required. What they have in common is that they are willing and able to introduce and support political changes. They may also require different types of support e.g. logistics, concept development, methodological training (Wils, 2006 p. 59). Keeping contact with hardliners within stakeholder groups, and engaging with them to facilitate a shift in perspective, is also important as these can be the most effective advocates for peace initiatives.

5) Education and Training

There is, as yet, no definitive answer to the question as to whether complexity theory applied to social systems constitutes a paradigm shift or rather a new, alternative perspective − less fundamental perhaps but nevertheless generating useful insights. However, even in the latter case it behoves us to find ways to educate and train those working in peace research and conflict intervention to be competent in handling complexity in analysis, strategy development and adaptive implementation. In the following sections some indications of the direction that this approach might take are given.

General Orientation

Fundamental will be the development of an ability to think not *only* in the linear, reductionist style of much western analytical thinking (which has served us well in many areas) but also in

a more holistic, creative and flexible way in response to the complexity presented by the conflict situations we seek to understand and ameliorate. This is not a rejection of all of what went before but an augmentation of that. Even complex systems are relatively robust and much of what has worked well in the past can still be used. A general orientation needs to be created in the peace researcher and intervener that is more realistic, self-reflective, open to insights and perspectives from other approaches, integrative and mindful. Eve Mitleton-Kelly is clear that complexity should not be seen as a methodology or a set of tools (while providing both) but rather complexity theories should be seen as providing a conceptual framework, a way of thinking and a way of seeing the world (Mitleton-Kelly, 2003). In this sense what needs to be created is a re-orientation in the general approach to conflict situations.

Jay Lemke summarises what the complexity approach offers:

> "The conceptual basis of complex systems ideas reflects a change in perspective about our world. This perspective emphasizes both the limits of predictability as well as the possibility of understanding indirect consequences of actions taken, both positive and negative, through the modeling of interdependence. The study of complex systems involves experimental, computational, and theoretical approaches for observation, analysis, modeling, and dynamical simulation." (Lemke, 2008 p. 128)

In research (here Lemke is referring to the education field but this point is more broadly relevant), and again as an orientation in praxis, there needs to be new ways of thinking:

> "a change in the paradigms of our thinking about research on education. Away from input-output 'blackbox' causal models to modeling the specific, local linkages that actually interconnect actors, practices, and events across multiple levels of organization. Away from single interventions and simplistic solutions to recognition of the need for coordinated changes throughout the system and to its 'external' relations to its constraining and enabling contexts and resources. And even perhaps away from the Enlightenment dream of universal laws, perfect predictability and rational control to a new recognition that all genuinely complex systems are individual, surprising, and not a little perverse. Just like us." (Lemke, 2008 p. 128)

A number of authors mention the humility that results from the adoption of a complexity approach in which uncertainty is the order of the day. Senge counsels giving up the "illusion of taking charge" and also shedding what he calls a "fixation on events" as this conditioned way of viewing experience leads to linear cause-effect thinking that has only relative validity and obscures the longer-term patterns of change that lie behind the events and hinders understanding of the causes of those patterns. (Senge, 1990; 2006 p. 20)

Senge also warns against "the delusion of learning from experience". Although rather drastically phrased, the point is well made that the consequences of our actions may occur in the distant future or in a distant part of the larger system within which we operate. Senge refers to the "learning horizon" which he sees as "a breadth of vision in time and space within which we assess our effectiveness." (Senge, 1990; 2006 p. 22) The problem arises when the consequences of our actions occur beyond that learning horizon making it impossible to learn from experience.

The fostering and development of non-rational, or supra-rational, modes of thinking could also be of benefit when educating or training within a complexity paradigm. There is much debate about the reliability and/or value of intuition. However, those who argue that intuition

is derived from conscious elements of processing and subconscious elements (e.g. previous experience, things heard or read but forgotten, clues from the appearance, behaviour, etc of others) believe that there is untapped potential here.

The Harvard paleontologist and evolutionary biologist, Stephen Jay Gould, explains the complementary nature of logic, intuition and insight for the scientist:

> "Historians and philosophers of science often make a distinction between the logic and psychologic of a scientific conclusion - or, in the jargon, 'context of justification' and 'context of discovery.' After conclusions are firmly in place, a logical pathway can be traced from data through principles of reasoning, to results and new theories - context of justification. But scientists who make discoveries rarely follow this optimal pathway of subsequent logical reconstruction. Scientists reach their conclusions for the damnedest of reasons: intuitions, guesses, redirections after wild-goose chases, all combined with a dollop of rigorous observation and logical reasoning to be sure - context of discovery." (Gould, 1996 p. 94)

K. J. Youngman refers to C.S. Peirce, philosopher of science, who coined the term "abduction" ("leading from") to express the imaginative mode of reasoning involved in such intuitive leaps, in contrast to deduction or logical sequencing, and induction, or generalization from accumulated particulars (Youngman, 2007). Youngman argues that to analyse we need deduction and induction but to synthesise we require abduction as well. Nonaka and Takeuchi also consider it important in the conversion of tacit knowledge to explicit knowledge:

> "This process of converting tacit knowledge into explicit knowledge is facilitated by the use of multiple reasoning methods such as deduction, induction, and abduction. Particularly useful for this phase is abduction, which employs figurative language such as metaphors and analogies." (Nonaka, 1995 p. 60)

Insight has been distinguished from intuition due to its initial conscious focus on problems. Whereas intuition may not be explainable or traceable, insight usually follows a period of sustained attention on a question or problem followed by a break in that attention. At some later point an insight – answer or conclusion – emerges in the mind in a "eureka!" experience. There are several theories as to what is happening here. Vance et al refer to Segal's explanation (Segal, 2004) where the break in attention provides a productive diversion:

> "releasing the person from a restrictive mindset and erroneous set of assumptions and allowing fresh new perspectives and organizing assumptions upon returning to the problem" (Vance p. 6)

Gibb posits an unconscious processing of information in non-logical and non-rational ways (this process can often be blocked by the conscious mind) allowing a solution to emerge. There is often a sense of pieces of a puzzle coming together to form a whole picture (Vance p. 6).

Creativity has long been valued in problem-solving settings. Here imagination is desired and the removal of mental barriers that block innovative ideas emerging is sought. Synthesis is also key to the process as in exaptation, as referred to above, where known elements are

combined in a new way or a new function for an existing artefact is found. The value of paradox , fantasy and humour in group, as well as in individual, reflection has been found to be stimulating and useful for breaking habits of thoughts and for generating sparks of creativity in joint problem-solving situations. It would also be valuable to develop a kind of peripheral vision or awareness, to be able to become alert to changes outside the immediate focus of attention, which may be related in non-linear ways to the situation at hand. Unintended consequences fall into this category and an awareness of feedback, indirect as well as direct, is also crucial in order to respond to the changing needs of a situation.

How can one learn to recognise and work with self-organisation? In the section on analysis in this paper there are references to some approaches, various models, that attempt to do this, specifically Glenda Eoyang's CDE model but applying the attractor metaphor within a metaframework of complexity theory as advocated by the ICCC may be relevant here, too. Organisational theorists and business consultants have been applying complexity concepts longer than most and have been faced with the practical implications of the theories within a relatively bounded system, the organisation (although admittedly the broader environment involved in intractable conflict and development contexts scales up the complexity significantly).

In a Bill McKelvy seminar, in a business setting, the question was posed: "how can emergence be measured?" A question with wider applicability would be: "how can emergence be recognised?" This would be important for researchers and interveners alike as it would: a) foster better understanding of the way the system works; b) allow the development of possible scenarios, directions in which the system might go; c) allow a sense of the degree of self-organisation occurring and at what level; and d) develop the ability to work with the complex system as it adapts and consciously co-evolve with it (Peltu, 2000). The questions suggested in a business context (in order to try to gain a picture of whether emergence was taking place, i.e. whether the enabling conditions for self-organisation had successfully been created) were:

- How many new teams or groups have emerged in the last month?

- How many networks have emerged within groups, between groups, between alien and hostile people, between marketing, production and engineering?

- How many novel collective outcomes have there been in addition to new networks?

- How many new products are we running each year?

(Peltu, 2000)

A necessary exercise would to identify what could be analogous questions in the peace and conflict field.

In the Fifth Dsicipline Peter Senge states that the key to seeing reality systematically is to see circles of influence rather than straight lines:

> "This is the first step to breaking out of the reactive mindset that comes inevitably
> from 'linear' thinking. Every circle tells a story. By tracing the flows of influence, you

can see patterns that repeat themselves, time after time, making situations better or worse". (Senge, 1990; 2006 p. 75)

Recognising emergence in complex social systems is one thing. Fostering self-organisation is another, although they are connected closely. Eve Mitleton-Kelly seeks to train managers and others in the skills of change management in complex systems and the creation of enabling conditions for self-organisation is part of this process.

Suitable training methodologies need to be developed for researchers and interveners that are capable of cultivating the skills discussed above – merely stating that this or that would be useful, or even presenting theories of how this might be done, is insufficient. The reorientation in the field of conflict transformation may be most challenging in training and education.

Transdisciplinarity

Transdisciplinarity is intimately connected to complexity. Complex social systems beg multiple disciplinary frameworks but also integration − it is precisely the relationships between agents that create the complexity out of which emergent properties come and it is in the integration, or relationship, between the disciplines that emergent knowledge, appropriate to complex systems, will come. John van Breda posits that transdisciplinary undertakings are complex systems that possess emergent properties that will reveal themselves to be more than the sum of their disciplinary parts (van Breda, 2007).

To begin with, some investigation of the understanding of transdisciplinarity is necessary as, here again, there is no generally accepted definition. There are those who see transdisciplinarity as a deeper, more integrated form of interdisciplinarity but there are also those who see it a project that will change the way we understand the world and hope that it may lead to the emergence of something quite new in our culture, which will have profound effects in many, if not all, areas of our lives.

To explore some distinctions we may follow Klein (Klein, 2004). She describes multidiciplinarity as an approach that juxtaposes disciplinary (or professional) perspectives "adding breadth and available knowledge, information, and methods." (Klein, 2004) Here the approaches speak as "separate voices". The status quo is not investigated and disciplinary elements retain their original identity. Interdisciplinary approaches seek to integrate disciplinary data, methods, tools, concepts and theories with the aim of creating a holistic view or common understanding of a complex issue, question or problem. Klein distinguishes between 'instrumental', 'strategic', 'pragmatic' or 'opportunistic' forms of interdisciplinarity, focused respectively on economic, technological, and scientific problem-solving, as well as 'critical' and 'reflexive' forms that "interrogate the existing structure of knowledge and education" (Klein, 2004). She specifies further with the distinction between "narrow interdisciplinarity", which involves disciplines with similar paradigms and methods, and "broad interdisciplinarity" in which they may be significantly different.

Klein defines transdisciplinary approaches as comprehensive frameworks that transcend disciplinary world views through an overarching synthesis and gives as examples general

systems, policy sciences, feminism, ecology and socio-biology. This understanding of transdisciplinarity, and indeed all three terms, were developed at an OECD conference in 1970 on the problems of teaching and researching in universities. Klein notes that more recently the complexity approach in science and the focus on sustainability (requiring input from not only experts in the fields but also stakeholders in collaborative co-operation) indicates a "new structure of unity" (Klein, 2004).

The inclusive approach has been driven by the concern with ecological developments and crises where the interplay of social, cultural, economic, political, as well as climatic and geographical factors requires local knowledge and local input in order to build resilience and adaptability. The innate complexity of the problems facing the planet demands this. Klein has studied the history of disciplines and the rise of transdisciplinary approaches and finds evidence of change reflected in the language used to describe knowledge. Where previously images of boundary formation and maintenance were common, with knowledge fragmented into isolated fields that would develop in a linear way and where expertise, mastery and control were keywords, there is now the emergence of notions of boundary crossing and blurring. Integration is sought, and interdependence is recognised, in an environment characterised by "complexity, nonlinearity and heterogeneity, and a transectorality associated with the term "transdisciplinarity" (Klein, 2004). Klein has produced guidelines for the "doing" of transdisciplinary knowledge creation and she summarises the requirements thus:

> "If disciplinary divides are going to be bridged, and if robust knowledge is going to be created, we must immerse ourselves in the process of negotiating and brokering and leveraging by engaging in joint definition of our tasks, by mutual learning from each other, by bringing to the table state-of-the-art knowledge not only in the disciplines but in interdisciplinary fields as well. We must engage in social learning and communication in order to make dialogue sustainable. We must also take the transdisciplinary step of involving non-academic and public discourse and disseminating results in the public sphere." (Klein, 2004 p. 11)

Reflecting on the origins of the term discipline von Stillfried suggests that there appeared to be the assumption of an undivided whole that needs to be taken apart only for better understanding:

> "With respect to the academic disciplines of today there sometimes seems to be little awareness of this wholeness and instead an almost competitive feeling of wanting to explain everything through one discipline." (von Stillfried, 2007 p. 4)

One of the theorists of transdisciplinarity who takes not only a pragmatic but also a philosophic approach to transdisciplinarity is Basarab Nicolescu. Coming from a background in the natural sciences his approach suggests that transdisciplinarity could have far reaching cultural effects and transform our understanding of what knowledge is and how it is created. Nicolescu conceives of transdisciplinarity as being supported by three "pillars", a view he elaborated in his "Manifesto of Transdisciplinarty":

> There are, in Nature and in our knowledge of Nature, different levels of Reality and, correspondingly, different levels of perception;

> The passage from one level of Reality to another in insured by the logic of the included middle;

> The structure of the totality of levels of Reality and perception is a complex structure: every level is what it is because all the levels exist at the same time. (Nicolescu, 2002 p. 8)

Nicolescu goes on to describe transdisciplinarity as concerning "what is *between* the disciplines, *across* the different disciplines and *beyond* all disciplines" (Nicolescu, 2006 p. 143). Furthermore, new concepts will be required in order to formulate the transdisciplinary findings. As transdisciplinarity involves various "levels of reality", or levels of complexity, it includes not only Boolean logic (the mutual exclusivity of something and its negation) but also the logic of complementarity (the unity of the mutually exclusive on a higher level). Influenced by his background in physics Nicolescu gives the example of a set of laws that appear to operate at one "level" but not at the next, thus quantum theory revealed that Newtonian theory held at the macro level but breaks down at the sub-atomic level. Apparently contradictory occurrences, such as the observation of light as appearing at one time as particles and at another time as waves, are given as evidence of logical paradox being resolved at "another level of reality". The generation of contradictories can theoretically continue being resolved at another level ad infinitum. This is considered as relevant for the object but also for the subject and its perception. It is this issue, action and interaction across levels of reality, that, in this understanding constitutes transdisciplinarity:

> "The 'Three Pillars of Transdisciplinarity' allow for a more comprehensive understanding of complexity. This in turn allows for a radical reformation in our organization of knowledge. The investigation of the dynamics engendered by the action of several levels of Reality at once - the essence of transdisciplinarity- will allow fresh insights into all disciplines, and these insights will in turn feedback into transdisciplinary research allowing further insights to be generated for the disciplines. This dynamic feedback in an open unity of levels of Reality, making use of the logic of the included middle and, where necessary, the logic of the occluded middle, should allow humankind to gain some measure of control on the currently overwhelming deluge of information being generated by the present disciplinary big bang. With greater understanding of the knowledge so generated, this should allow for a more comprehensive ability to tackle the multifarious and inter-related problems facing our planet." (Henagulph, 2000)

Responding to the evident differences in approach and scope of various theorists and practitioners with regard to transdisciplinarity, Nicolescu has presented his own perspective on the field:

> "Much confusion arises by not recognising that there is a theoretical transdisciplinarity, a phenomenological transdisciplinarity and an experimental transdisciplinarity.
>
> The word theory implies a general definition of transdisciplinarity and a well-defined methodology.
>
> The word phenomenology implies building models connecting the theoretical principles with the already observed experimental data, in order to predict further results.
>
> The word experimental implies performing experiments following a well-defined procedure allowing any researcher to obtain the same results when performing the same experiments." (Nicolescu, 2007)

Helga Novotny argues that a new form of knowledge production has already begun and this she terms "Mode-2". She identifies the applied nature of research in a transdisciplinary mode as a characteristic that has led to the inclusion of various stakeholders and an encouragement of dialogue. The formulation of the problem takes place within this dialogue and not before it. This can be a slow process but no research is engaged before this precondition has been met. There is an heterogeneity of skills and expertise linked through loose organisational structures, flat hierarchies (rather the opposite of a usual university setting) (Nowotny, 2003). In transdisciplinary approaches a "forum" or "platform" is generated to provide a "distinctive focus for intellectual endeavour" rather than the problems to be investigated arising from within the disciplines:

> "Rather, it is in the context of application that new lines of intellectual endeavour emerge and develop, so that one set of conversations and instrumentation in the context of application leads to another, and another, again and again." (Nowotny, 2003 p. 2)

Questions of rigour, robustness and quality are often raised in the context of interdisciplinary, and therefore also transdisciplinary, endeavours. The criteria for judging quality within disciplines are readily available and this is not yet defined (some might argue is not definable) for transdisciplinary work. Novotny also speaks of contextualisation, which can be characterised by two questions: "Where is the place of people in our knowledge?" and "What are the implications of what we are doing, of formulating problems in this particular way?" (Nowotny, 2003 p. 6). Furthermore, the inclusion of inputs from outside the discipline, including e.g., pressure groups, leads not only to better solutions for society or "social solutions" but also better "technical solutions" (see Thomas Hughes, on engineering practice and ethos in *Rescuing Prometheus*,) (Nowotny, 2003 p. 5).

Nicolescu classifies the work of Helga Novotny and Michael Gibbons as phenomenological transdisciplinarity and his own, along with that of Piaget and Morin (1999), as theoretical transdisciplinarity. He finds it important for the realisation of the full potential of transdisciplinarity that the three aspects of transdisciplinarity that he discerns be accepted simultaneously and rigorously thus allowing:

> "both a unified and non-dogmatic treatment of transdisciplinary theory and practice, coexisting with a plurality of transdisciplinary models." (Nicolescu, 2003)

Von Stillfried argues that the stronger the interdisciplinary interaction is, the more it will influence and change the disciplines involved. Transdisciplinarity goes even further and blurs boundaries or involves their dissolution. He quotes Piaget (one of the earliest definitions of transdisciplinarity):

> "Finally, we may hope to see a higher stage succeeding the stage of interdisciplinary relationships. This would be 'transdisciplinarity', which would not only cover interactions or reciprocities between specialized research projects, but would place these relationships within a total system without any firm boundaries between the systems."[1] (Piaget, 1972 p. 138)

When boundaries dissolve a new discipline may emerge as in the case of biochemistry. Transdisciplinarity fosters the emergence of frameworks that unify existing disciplines by identifying common principles at work in all of them and development of a common language

comprising these principles and thus facilitating co-operation and exchange between diverse disciplines:

> "To sum up and integrate all the views reported up to here, one could say that the principles of transdisciplinarity (namely the merging of disciplines and the formulation of common axiomatic frameworks) can be applied to academic as well as non-academic undertakings, will usually serve to make individual disciplines more understandable and transparent across their boundaries and may lead to results which are more widely applicable and communicable than research stemming from only one discipline." (von Stillfried, 2007 p. 8)

Von Stillfried also acknowledges the role of intuition and feelings in the process of transdisciplinarity as they become recognised as:

> "an irreducible part of this reality and as such both irreplaceable in any comprehensive transdisciplinary understanding and indispensable for putting this understanding into action." (von Stillfried, 2007 p. 8)

Some frame the transdisciplinary project in an even more inclusive and radical way:

> "Transdisciplinarity entails both a new vision and a lived experience. It is a way of self-transformation oriented towards the knowledge of self, the unity of knowledge, and the creation of a new art of living. The emergence of a new culture capable of contributing to the elimination of the tensions that menace life on our planet will be impossible without a new type of learning that takes into account all the dimensions of the human being. A viable education can only be an integral education of the human being." (Bertea, 2007)

In the process of fusing disciplines and developing overarching frameworks, and with the importance accorded to the subjective as well as the objective, the disciplines will be, according to von Stillfried, integrated and transcended and this situation he refers to as "metadisciplinarity". This would include new aspects such as the self-reflexive and self-referential components :

> "I mean the situation where both the disciplinary (horizontal) as well as the inter- and transdisciplinary (vertical) perspectives advance so far that they recognize the relative nature of epistemology and come to view themselves as both subject and object of both investigation and action." (von Stillfried, 2007)

Von Stillfried illustrates his understanding of the terms relative to each other with the following evocative diagram:
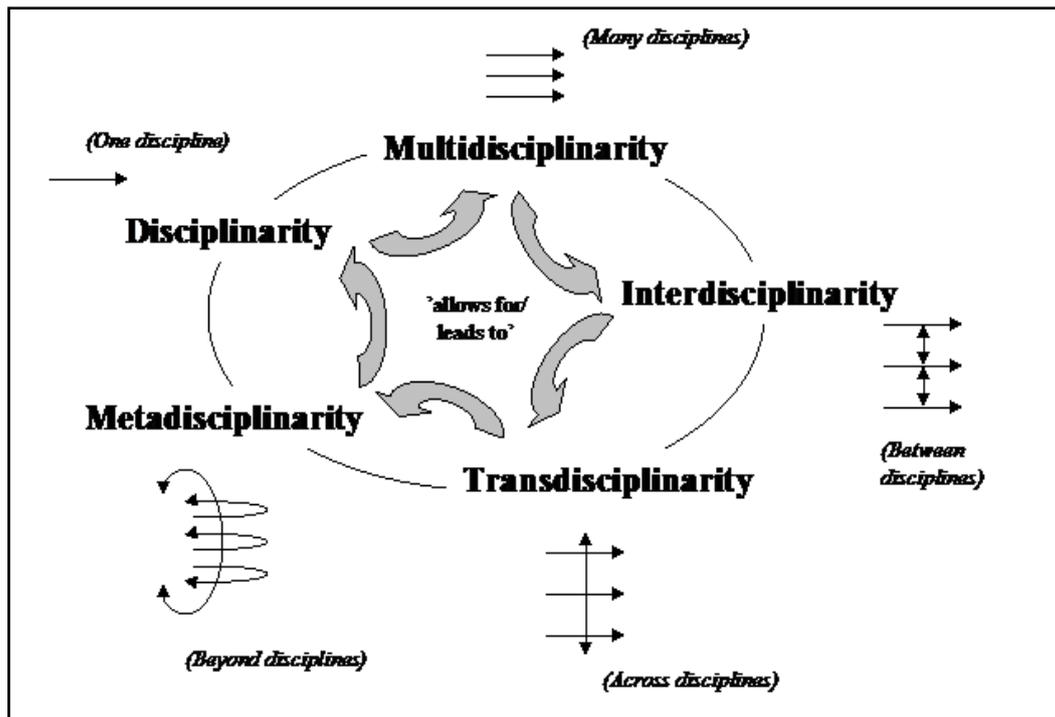
Figure 3 Nikolaus von Stillfried 2007

Lemke strongly argues for a basic element of this new awareness (as referred to by von Stillfried) to be the ecosocial:

> "The great intellectual task of the next century, already begun, is to unmake cultures that deny the unity of ecosocial systems and remake cultures that celebrate it. For this task we will need guiding theories far better developed than what I have sketched here, but I believe that the theories we need will make use of many of these fundamental principles. (Lemke, 1993 p. 16)

Lemke points to the multidimensionality of complex social systems by revealing the link between material processes, social practices and meaning. Any social practice may be viewed as a semiotic, cultural abstraction, however:

> "every particular, actual instance of that social practice is enacted by some material process in a complex physical, chemical, biological, ecological system." (Lemke, 1993 p. 249)

The interrelatedness of these processes is obscured due to the fact that our culture has two different sorts of descriptive discourses to describe two systems of relations:

> "As an instance of a social practice, it enters into relations of meaning with other social practices. These are semiotic relations. As a physical event, it enters into relations of energy, matter, and information exchange with other events. These are material relations. Every instance of a social practice is simultaneously also an instance of some material process. Every system of social practices, linked in semiotic formations according to their meaning relations … is also a system of material processes linked by physical, chemical, and ecological relations." (Lemke, 1993 p. 249)

Lemke gives the example of a building which is built according to notions of design, comfort and practicality that are in accordance with a system of cultural practices. The nature of the building, how it will be perceived (as monumental, public or private), how form and light should relate to use and function, is all created within the architectural semiotics of our culture. At the same time we are engaged in other than semiotic processes:

> "so we also assemble masses with densities, weights, compressional and tensile strengths, electrical and thermal conductivities; we arrange flows of water and air according to principles of hydrodynamics, flows of heat by principles of thermodynamics, and allow for material flows of people and goods. We may provide a system of communications capable of handling certain rates of information transfer, a supply of energy that may flow from solar panels on the roof to heating channels in the walls, or from underground generators through cables to electrical connections in every room. These things we do also according to discourses of our community, those regarding science and engineering, but in all these doings, our actions belong simultaneously to the order of the semiotic and the order of the material (itself articulated, modeled, through the semiotic). The relations we construct are simultaneously semiotic relations in a cultural meaning system and material relations in an eco-physical system." (Lemke, 1993 p. 249)

Thus every meaningful social practice can be enacted only through some material processes. The construction of cities or the clearing of the rainforest are obvious examples, argues Lemke, but he refers to less evident connections such as the publishing of books, the imprisonment of offenders, the selection of mates or the setting of wages and prices, in which "cultural linkages of social practices into semiotic formations produce eco-physical linkages of material processes" (Lemke, 1993 p. 250).

It is generally recognised that interdisciplinary research procedures are difficult and this must also be true for the even more ambitious transdisciplinary approaches. Funnell and Parish refer to a project in the Moroccan Rif (de Maas 1992), which highlighted quite serious divergences in research strategies due to the different epistemological models adopted by physical and social sciences. :

> "In his critique of the project de Mass revealed that individual researchers were reluctant to abandon deeply inbred research strategies in order to dove-tail investigations into a common framework. In his conclusion, de Maas makes perhaps a most telling point when he states, 'Interdisciplinarity, though not easy to attain and not needed in all cases, is important, not because it may in the end provide the participants with better answers to their questions, but because it very soon brings up better questions in the realms to be studied'." (Funnel, 1999 p. 136)

Transdisciplinarity in practice then must be challenging and ground-breaking but it is a project that, according to the several understandings of the term, is already being taken up in various ways.

Examples of Transdisciplinarity

Transdisciplinary approaches are already being attempted in various fields with varying scope. For instance, the difficulties of communication and co-operation across the natural

sciences alone (before attempting to bridge the divide with the social sciences) require explicit structures and processes to realize the potential in this area. One such example is the TRANSIT (TRANSition from Interdisciplinarity to Transdisciplinarity) project at the University of York . Bringing together the disciplines of biology, maths, computer science, electronics and chemistry, their aim is to build on the existing attempts to identify mutual/synergistic research interests across disciplines and take the next step to move towards collaborative cross-disciplinary research. The team at York University have described some of the factors that inhibit transdisciplinary research:

> "Scientists in a given field (like any community) have a tendency to develop their own methods and (often impenetrable) jargon. This specialisation is entrenched within universities, where different disciplines are often located in separate departments As a consequence, scientists are more likely to interact with those within their own discipline than with colleagues in other disciplines, leading to a rather narrow focus to research activities.

> Why don't scientists from different disciplines work together? Individual scientists have their own performance targets and this leads to a tendency to work in their own area, where they are more likely to be competitive. Learning about other fields can be time consuming. This investment can jeopardise output and thus career prospects / if the activity is not fully supported by the institution." (The TRANSIT Programme, 2008)

In order to combat this tendency special efforts have to be made, a task made more urgent by the evident complexity of problems facing humanity:

> "To tackle really difficult problems (e.g. the origin of life, or climate change) we need researchers to break down the barriers of jargon, and their own biases, to really work together, to discover novel approaches, which would not have arisen otherwise (transdisciplinary research). In seeking to create novel ideas we want to make sure that we use the best thinking about thinking to do so." (The TRANSIT Programme, 2008)

With the increasing popularity and cross-disciplinary application of the notion of sustainability has come a commitment to transdisciplinarity. This has emerged strongly in the environmental sciences, an example being the approach at the Swiss Federal Institute of Technology in Zurich which, under the Chair of Environmental Sciences, is the home of the Natural Science and Social Science Interface, which works with case studies having an explicit transdisciplinary approach, both in terms of disciplinary collaboration and stakeholder involvement. NSSI develops methods, models and theories for investigating environmental decision-making with the goal of establishing sustainable human and environmental interactions. Particularly in the transdisciplinary case study there is an attempt not only to cross disciplinary boundaries but to incorporate academic and non-academic participants in the research process:

> "The transdisciplinary case study is a hybrid combining learning, research, and application used to learn competencies and skills necessary for research in problems of sustainable development. In case studies, methods are used that allow to integrate different types and qualities of knowledge, as well as different interests and types of cognitive representations." (NSSI, 2008)

Computer simulations, such as Agent Based Models (ABMs) imply a transdisciplinarity when social situations, or specific problems, are translated into computer programmes with a given set of rules for the agents. This requires close collaboration between computer scientists and social scientists. The recently established Centre for Social Complexity at George Mason University understands its task thus:

> "The mission of the Center for Social Complexity is "to advance the knowledge frontiers of pure and applied social science, by using and developing computational and interdisciplinary approaches that yield new insights into the fundamental nature of social phenomena at all levels of social complexity-from cognitive networks to the world system." ((CSC), 2008)

In the field of peace research interdisciplinarity has been part of its self-concept and there has been a recognition of the necessity for differing perspectives and collaborative interventions in order to respond to complexity in conflict emergence and dynamics. However, here, too, there is a new impetus to cross not only disciplinary boundaries but to integrate non-academic actors in research and projects that build sustainability into their design. One example is the Applied Research Centre in Human Security at Coventry University. Within a systems thinking framework they combine approaches from political, economic, social, ecological and cultural thinking and action. They also seek to work across professional, sectoral and intellectual boundaries in search of integrated solutions to local and global problems. They draw on expertise from specifically sustainable development, peace and reconciliation, corporate social responsibility, human rights, human sciences, conversational learning, tri-sector partnerships (ARCHS, 2008). They incorporate experiential learning and action research with links to the Eden Project in the UK and Stellenbosch in South Africa.

At the Sustainable Peace Action Research Centre – Leuven (SPARC-L) transdisciplinarity exhibits the twin hallmarks of stakeholder participation and integration of disciplinary approaches:

> "SPARC-L developing its own transdisciplinary peace research methodology – in which the human being is central. In order to develop this actionable knowledge, the SPARC-L Research Project transcends the borders of traditional uni-disciplinary research in two crucial directions. First, in an interdisciplinary encounter of the different peace research disciplines such as law, psychology, pedagogy, theology, political science, sociology, criminology, etc. Second, in a transdisciplinary encounter with the different actors in the field such as people suffering from conflict, conflict stakeholders, NGO's, IGO's, grassroots organisations, politicians, military, business, etc." (SPARC-L, 2008)

The degree to which it has been possible to develop truly transdisciplinary approaches to conflict problems and the evaluation of the outcomes of these is beyond the scope of this paper. The difficulties of ensuring rigour, communication and integration, have been mentioned earlier in this section. What can, however, be identified here is the recognition that such an approach is necessary and an intention and commitment to attempt it.

There is an acknowledgement at international level that complex conflicts need to be approached with an integrative analysis, strategy and implementation. The UN Peacebuilding Commission has been one response to this need but, unfortunately, is extremely under-resourced and under-funded for the task with which it has been entrusted. A network of actors

and institutions combining skills and knowledge could be created to support the work of the Commission in a transdisciplinary and transboundary way. An exploration of this theme has been undertaken in Geneva where a mapping exercise sought to identify existing policy, advocacy, research and operational competencies across the range of responsibilities of the Commission. The proposal is that :

> "The respective Geneva-based organizations (both intergovernmental and civil society) could be divided according to the peacebuilding sectors noted in the UN inventory and others, and a mechanism could be established to facilitate communication, knowledge exchange and collaborative planning among organizations. Such a platform could offer beneficial synergies. The various organizations within each sector could group their work in such a way as to provide the PBC with, inter alia, research and coherent policy proposals on specific subjects, experts and personnel or training activities. Such a sector-structured platform could also serve as a direct link between the PBC and civil society practitioners, who could share their field experience, best practices and lessons learned with the Peacebuilding Support Office, the donor community and the war-torn countries under consideration by the PBC." (Atwood, 2007 p. 32)

These are just a few examples of attempts to realize transdisciplinary approaches at both research and practice level and many of these are at an early stage. Evaluation and reflection on processes and outcomes will provide insights and a spur to further experimentation.

6) Connecting Inner and Outer Complexity

In the first sections of this paper attempts to apply complexity theory to psychological and social-psychological processes were briefly discussed. Intra-personal complexity, and the mutual influence of processes across levels in complex systems, lead to the conclusion that what is going on within actors in conflict processes is intimately connected to what is happening between them. This is not a new insight but the tendency to focus on the internal processes of others, albeit with a recognition of the complex non-linear relations with the environment and other systems, still leaves out of account the intervener, the strategist and, for that matter, the analyst for, as noted above, in the words of Stephen Jay Gould:

> "The more important the subject and the closer it cuts to the bone of our hopes and needs, the more we are likely to err in establishing a framework for analysis." (Gould, 1997 p. 30)

An engagement with a conflict system constitutes a perturbation in that system with intended and unintended consequences. The intra-personal processes of the peace researcher or peace worker are part of the complex interaction taking place *within* the system. Therefore, an alertness to the inner world is important and relevant to the engagement in the outer world. Coleman speaks of intervening in a manner that is "mindful, reflective and adaptive" (Coleman, 2006) but this too must be cultivated, few posses this ability naturally.

A utilitarian rationale may be proposed for the development of a basis of self-knowledge, self-reflective abilities and increased sensitivity to processes occurring across levels, within the field of conflict transformation − increased accuracy or comprehensiveness in research and

increased effectiveness in interventions. I would argue further that the project of conflict transformation is an integral one, such that, to borrow Hugh Miall's phrase, "transforming the transformers" must form part of the process (Miall, 2001). This would be, in any case, an ongoing natural development for anyone engaged in this work but it must be explicit in education and training in the field of peacebuilding and conflict transformation, where this ia understood as comprehending a complexity theory approach, a transdisciplinary methodology and an integral process of development of knowledge, skills and self-knowledge. Dennis Sandole has commented on the lack of self-knowledge and self-awareness in the field of peace work :

> "I think that what I am saying is that just like psychotherapists have to go through analysis themselves before they can become an effective intervener in the intra-psychic space of others. I think we, the third party, interveners in inter-group conflicts have to go through something with regard to ourselves to better appreciate that affect cognitive connection and disconnect." (Sandole, 2003)

He is referring here to the emotional component in our thinking and (re-)acting that should not be left out of consideration in work in, and on, conflict. He suggests reflection on motivations, past experiences and one's own psychological make-up because how we react in certain conflict situations, development interventions, etc. will be linked to what we have experienced and patterns of response that we have learned and developed. A related concern is the lack of supervision for many working in this field:

> "The same thing applies to third party interveners, we are not trained to do it. And your labs are meant to get you a little bit close to that but they don't focus on you, they focus on them, the people who are involved in horrible conflicts. We are never addressing the issue of who am I? Why am I in this field?" (Sandole, 2003)

However, it is also about self-transformation, developing the skills and qualities that we are attempting to bring to others: empathy, insight, self- and situation awareness, self-knowledge, e.g. awareness of mental models, bias, prejudice, strengths, weaknesses, etc. It is encouraging to see that new models of education and training are being developed taking account of complexity and seeking to apply transdisciplinarity but also addressing the need for an intra-personal aspect to education in peace and conflict. One example is the proposed "World Peace Academy - Swiss Centre for Peace Studies", where "the development of personal competencies for peace work" are an integral part of the study programme[25].

As conflict transformation workers are well aware, changes in structures are necessary, but not sufficient, conditions for the creation of a sustainable peace. Changes in the attitudes and behaviour of individuals and, through them groups, are the necessary complement. This transformation process also needs to be taking place within those who are attempting to transform the conflict. The link between internal and external conflict, often formally recognized within peace training with regard to conflict actors, is seldom addressed with respect to the peace worker and his or her impact on the conflict.

---

[25] http://www.world-peace-academy.ch/?lang=en&pid=24

7) Conclusion

It is still relatively early days in the application of complexity theory to social sciences and there are doubts and criticisms, either about the applicability of the ideas or about the expectations generated for them. It is true that the translation of terms from natural science to social science is sometimes contested due to the significant differences in these domains, and that there are concerns that the meanings of terms may be distorted, thus making their use arbitrary or even misleading. Developing new, relevant definitions for the new domain applications, where the terms indicate a new idea or a new synthesis that takes our understanding forward, are required. In some cases, particular aspects of complexity theory are seen as of only limited applicability, for example, self-organisation (see Rosenau's argument above that it is only relevant in systems in which authority does not play a role). There are those who argue that much that is being touted as new is actually already known, whether from systems theory or from experience, and so complexity theory cannot be seen as adding value in that way. There are also concerns that the theory has not been worked out in sufficient detail, or with sufficient rigour, to make itself useful yet. Even that it encourages woolly thinking and imprecision.

In terms of application in the field, it could be argued that it may lead to paralysis, in fear of all the unexpected things that could happen, and all the unintended consequences that could result, from a particular intervention. The proposed adaptability and sensitivity to emerging new situations may lead to difficulties in planning or, better expressed, must lead to a different conception of what constitutes planning, which is, in itself, challenging (or even threatening) for many fields. The criteria for funding projects or research may not fit comfortably with a complexity approach, and evaluation, already difficult especially in the field of conflict transformation, would require a re-conceptualisation. Pressure for results could act as a disincentive to change project design in the light of emergent processes. There may be the desire to maintain the illusion of control in order to retain the confidence of funders. On the other hand, there are fears that complexity may be used as an excuse for poor planning, and implementation, which is a valid concern for funders. In addition, there may be scepticism that the co-operation and co-ordination between different researchers or interveners, (let alone transdisciplinary undertakings) appropriate to working on complex problem domains, will not work due to differing mental models, competing interests and aims, competition for funding, prestige, etc. Such attempts appear, therefore, unrealistic or unfeasible.

Despite these concerns and criticisms, this exploration of the potential of complexity theory to contribute to the field of peace research and conflict transformation (although far from comprehensive) is, I believe, indicative of the value that a continued engagement in the development of the application of complexity theory in these fields could bring. Although that may sound tentative, I am convinced of the value of such an enterprise as it is an attempt to reflect the reality of experience in our ecosocial world. In so far it is more honest about the difficulties inherent in any attempt at social change, as well as about the limits of what is achievable, while at the same time offering the opportunity to increase sensitivity within, flexibility towards, and awareness of self, system and environment thus making us more effective, responsive and modest. Expectations in terms of results to be achieved will be restrained and goals will be qualified and, indeed, emergent. The doing of research and practice in the field of peace and conflict could become more conscious and experimental, more self-reflective. It is understandable that we wish for blueprints, new tool kits to reassure

us in the face of uncertainty but it is, in fact, such an approach that reveals itself on reflection to be unrealistic, that is, not reflective of the real world(s) of our experience. Complexity theory does not require the jettisoning of all that went before, although it requires a re-assessment of how methods and approaches may be used, as well as changes in the mental models within which they are theorised.

The required transdisciplinarity has the potential to cross not just disciplinary boundaries but to produce, or necessitate, new ways of working and the production of new kinds knowledge. However, I believe it is not only disciplinary barriers that need to be broken down but the supposed separation between researcher and research topic, between intervener and conflict situation and between inner and outer realities. This will require new ways of educating and training researchers and practitioners and this will be the subject of future research papers.

Although complexity theory has been around for nearly twenty years its impact on peace research and conflict transformation is much more recent and, as yet, tentative. As the theory and methodology is itself a work in progress this is perhaps not surprising. At the moment there appears to be the potential for changes in at least three areas: 1) the production of new analyses leading to new strategies for intervention; 2) new ways of applying existing methods of intervention; and 3) new attitudes and behaviours on the part of the interveners in conflict situations. At the moment new analyses and methods of analysis are being developed, and do provide fresh insights and stimulate thinking about conflict in a new way, however, the strategies being advocated hold little new in terms of methodology. New applications of existing methods and strategies are being advocated and, to some extent, implemented, although recommendations for increased integrative and holistic practice may be unrealistic in the face of poor co-ordination and competing interests on the part of interveners in the field. It is perhaps in the third category, where a changed orientation, a new way of perceiving unfolding developments in the field and responding to them, will produce the richest source of novel strategic thinking once this experience has been the subject of reflection and evaluation.

Bibliography

(CSC), Center for Social Complexity. 2008. Mission Statement & Goals. *Centre for Social Complexity at George Mason University.* [Online] 2008. [Cited: 15 August 2008.] http://socialcomplexity.gmu.edu/index.php.

ARCHS. 2008. About Us. *Applied Research Centre in Human Security at Coventry University.* [Online] 2008. [Cited: 15 August 2008.] http://www.coventry.ac.uk/researchnet/d/592.

Argyris, Chris & Schön, Donald. 1978. *Organizational Learning.* New York : Addison-Wesley, 1978.

Arthur, B. W. 1995. *Increasing Returns and path Depedence in the Economy.* Ann Arbor : University of Michigan Press, 1995.

—. 1990. Positive Feedbacks in the Economy. *Scientific American.* February 1990.

Atwood, David and Fred Tanner. 2007. The UN Peacebuilding Commission and International Geneva. [ed.] UNIDIR. *Disarmament Forum.* 2007, Vol. 2. http://www.unidir.ch/pdf/articles/pdf-art2629.pdf.

Axelrod, Robert. 2005. Agent-Based Modeling as a Bridge between Disciplines. [book auth.] Kenneth L. and Tesfatsion, Leigh Judd. *Handbook of Computational Ecoomics, Vol.2 Agent-Based Computational Economics.* s.l. : North-Holland, 2005.

—. **2006.** Alternative Uses of Simulation. [book auth.] Neil Harrison. *Complexity in World Politics, Concepts and Methods of a New Paradigm.* s.l. : State University of New York, 2006.

—. **1984.** *The Evolution of Co-operation.* New York : Basic Books, 1984.

Beckerman, Linda P. 1999. The Non-Linear Dynamics of War. [Online] 1999. [Cited: 12 December 2006.] www.belarius.com.

Beech, Michael F. Lieutenant Colonel, United States Army. 2004. *Observing Al-Qaeda through the Lens of Complexity theory: Recommendations for the national Strategy to Defeat Terrorism.* Center for Strategic Leadership : s.n., July 2004. Strategy Research paper.

Bertalanffy, Ludwig von. 1968. *General System theory: Foundations, Development, Applications.* New York : George Braziller, 1968.

Bertea, Mircea. 2007. The Recovery of the Transdisciplinary Perspective in Post-Modern Universities. *Transdisiplinarity and the Unity of Knowledge: Going beyond the Science and Religion Dialog, Philadelphia, Pennsylvania.* [Online] 2-6 June 2007. [Cited: 24 April 2008.] http://www.metanexus.net/conference2007/abstract/default.aspx?id=381.

Beyerchen, Alan D. 2003. Clausewitz, Nonlinearity, and the Importance of Imagery. [book auth.] David S. Alberts And Thomas J. Czerwinsk. *Complexity, Global Politics, And National Security i.* http://www.ndu.edu/inss/books/books-1998/Complexity,Global Politics and Nat'l Sec-Sept98/ch05.html#3.#3. : s.n., 2003.

Bhavnani, Ravi. 2006. Agent Based Models in the Study of Ethnic Norms and Interethnic Violence. [book auth.] Neil E. (Ed.) Harrison. *Complexity in World Politics: Concepts and Methods of a NewParadigm. .* s.l. : SUNY Press , 2006.

Bohm, David, Factor, Donald and Garrett, Peter. 1991. Dialogue - A Proposal. [Online] 1991. http://www.infed.org/archives/e-texts/bohm_dialogue.htm.

Boulding, Kenneth. 1962. *Conflict and Defense: A general theory.* New York : Harper & Brothers, 1962.

Boyd, John R. 2005. *Strategic Game of ? and ?* [Presentation] s.l. : Chuck Spinney , Chet Richards, Ginger Richards (Eds), 2005.

Burgess, Guy and Michelle Maiese. 2004. Complexity. *Beyond Intractability.* [Online] July 2004. [Cited: 12 December 2006.] http://www.beyondintractability.org/essay/complexity/.

Byrne, David. 2001. Complexity Science and Transformations in Social Policy. *Social Issues , Special Issue: Complexity Science and Social Policy.* October 2001, Vol. 1, 2. http://www.whb.co.uk/socialissues/db.htm.

—. **1998.** *Complexity Theory and the Social Sciences: An Introduction.* London : Routledge, 1998.

Capra, Fritjof. 2003. *The Hidden Connections.* s.l. : Flamingo, 2003.

Chambers, Robert. 1997. *Whose Reality Counts? Putting the First Last.* s.l. : Stylus Publishers Llc, 1997.

Checkland, Peter. 1981. *Systems Thinking, Systems Practice.* s.l. : Wiley, 1981.

Cilliers, P. 1998. *Complexity and Postmodernism: Understanding Complex Systems.* London : Routledge, 1998.

Clark, N., Perez-Trejo, F., And Allen, P. 1995. *Evolutionary Dynamics and Sustainable Development: a systems approach.* Aldershot : Edward Elgar, 1995.

Clemens Jr., Walter C.,. 2001. Complexity Theory As A Tool For Understanding And Coping With Ethnic Conflict And Development Issues In Post-Soviet Eurasia. *International Journal of Peace Studies.* Autumn/Winter 2001, Vol. 6, 2.

Coleman, P. T., Bui-Wrzosinska, L., Vallacher, R., & Nowak, A. 2006. Protracted Conflicts as Dynamical Systems: Guidelines and Methods for Intervention. [book auth.] A. Schneider & C. Honeyman (Eds.). *The Negotiator's Fieldbook.* Chicago : American Bar Association, 2006, pp. 61-74.

Coleman, P. T., Vallacher, R., Nowak, A., & Bui-Wrzosinska, L. 2007. Intractable conflict as an attractor: Presenting a dynamical model of conflict, escalation, and intractability. *American Behavioral Scientist.* 2007, Vol. 50, 11.

Coleman, Peter T. 2006. Conflict, Complexity, and Change: A Meta-Framework for Addressing Protracted, Intractable Conflict - III. *Journal of Peace Psychology.* 2006, Vol. 12, 4, pp. 325-348.

Coleman, Peter T. 2004. Paradigmatic Framing of Protracted Intractable Conflct: Toward the Development of a Metaframework II. *Peace and Conflict: Journal of Peace Psychology.* 2004, Vol. 10, 3, pp. 197-235.

—. **2006.** The International Center for Cooperation and Conflict Resolution (ICCCR). [Online] 2006. [Cited: 4 April 2007.] http://www.tc.columbia.edu/ICCCR/.

Coveney, P. and Highfield, R. 1995. *Frontiers of Complexity.* s.l. : Fawcett Columbine, 1995.

Davies, Lynn. 2003. *Conflict and Chaos: War and Education.* s.l. : Routledge Falmer, 2003.

Deutsch, Morton. 2000. Justice and Conflict. [book auth.] Morton Deutsch and Peter Coleman. *The Handbook of Conflict Resolution: Theory and Practice.* San Francisco : Jossey-Bass Publishers, Inc., 2000.

—. **1973.** *The Resolution of Conflict: Constructive and Destructive Processes.* New Haven : Yale University Press, 1973.

Díaz, Carlos J. Delgado. 2004. The Political Significance of Small Things. *E:CO Special Double Issue.* 1-2, 2004, Vol. 6, pp. 49-54 .

Elliot, E. and L. D. Kiel. 1997. Nonlinear Dynamics, Complexity and Public Policy: Use, Misuse, and Applicability. [book auth.] R. A. Eve, S. Horsfall and E. L. Lee. *Chaos, Complexity and Sociology: Myths Models and Theories.* London : Sage, 1997.

Eoyang, Glenda and Lois Yellowthunder. 2005. *Beyond Bureaucratic Boundaries: A Case Study in Human Systems Dynamics.* Complexity, Science & Society Conference 2005 The Centre for Complexity Research, University of Liverpool : s.n., 2005.

—. **September 2008.** *Complexity Models and Conflict: A Case Study from Kosovo.* University of Kent, Canterbury : Conflict Research Society and Conflict Analysis Research Centre, Conference on Conflict and Complexity, September 2008.

Epstein, Joshua M. and Robert Axtell. 1996. *Growing Artificial Societies, Social Science From the Bottom Up.* s.l. : Brookings Institution Press and MIT Press, 1996.

Fisher, Ronald. 1990. *The Social Psychology of Intergroup and International Conflict Resolution.* New York : Springer Verlag, 1990.

Fitzduff, Mari. 2004. Meta- Conflict Resolution. *Beyond Intractability.* [Online] September 2004. [Cited: 24 March 2007.] http://www.beyondintractability.org/essay/meta-conflict-resolution/.

Follett, Mary Parker. 1995. *Mary Parker Follett Prophet of Management.* [ed.] Pauline Graham. s.l. : Beard Group Inc., 1995.

Forum-ZFD. 2008. Diana Francis' Conflict Model. [Online] 2008. [Cited: 14 August 2008.] http://www.forumzfd-akademie.de/files/va_media/nid1130.media_filename.pdf.

Fowler, Alan. 2008. Complexity Thinking and Social Development, Connecting the Dots. [ed.] IDP. *The Broker.* April 2008, Vol. 7. http://www.thebrokeronline.eu/en/articles/Connecting-the-dots.

Fritjof, Capra. 1997. *The Web of Life.* s.l. : Anchor Books, 1997.

Funnel, D.C. and R. Parish. 1999. Complexity, Cultural Theory and Strategies for Intervention in the High Atlas of Morocco. *Geografiska. Annaler.* 1999, Vol. 81 (B), pp. 131-144.

Gersick, C. J. G. 1991. Revolutionary Change Theories: A Multilevel Exploration ofthe Punctuated Equilibrium Paradigm. *Academy of Management Review.* 1991, Vol. 16, pp. 10–36.

Geyer, Robert. 2006. *Is there anything to fear from the politics of complexity?* [www.psych.lse.ac.uk/complexity/events/2006/2006/LSE_RGeyer.pdf] Milton Keynes : s.n., 28 February 2006. Joint National Conference, The Application of Complexity Scienceto Human Affairs, The Complexity Society, UK and The Open University Innovation, Knowledge and Development Research Centre.

Glasl, Friedrich. 1999. *Konfliktmanagement. Ein handbuch für Führungskräfte, Beraterinnen und Berater.* s.l. : Bern-Stuttgart, 1999.

Gould, S. J. 1996. *Dinosaur in a Haystack.* s.l. : Penguin Books, 1996.

Gould, Stephen Jay. 1997. *Full House: The Spread of Excellence from Plato to Darwin .* s.l. : Three Rivers Press, 1997.

Gribbin, John. 2004. *Deep Simplicity, Chaos, Complexity and the Emergence of Life.* s.l. : Penguin Books, 2004.

Groves, Leslie and Hinton, Rachel. 2004. *Inclusive Aid: Changing Power Relations in International Development.* s.l. : Earthscan, 2004.

Gundersen, Lance, Panel Chair. 2008. When Resilience Fails – Interdisciplinary Perspectives on Resilience and Natural Disasters. *Resilience 2008, Resilience, Adaptation and Transformation In Turbulent Times, International Science and Policy Conference.* Stockholm, Sweeden : s.n., 2008. http://resilience2008.org/resilience/panels/9.htm.

Hammond, Grant T. 1997. The Essential Boyd. *Robert Paterson's Radio Weblog.* [Online] 1997. [Cited: 24 September 2007.] http://radio.weblogs.com/0107127/stories/2002/12/20/theEssentialBoyd.html.

Harrison, Neil E. and Singer, J. David. 2006. Complexity is more than Systems Theory. [book auth.] Neil E. Harrison (Ed.). *Complexity in World Politics, Concepts and Methods of a New Paradigm.* s.l. : State University of New York, 2006.

Harrison, Neil E. 2006. Complex Systems and the Practice of World Politics. [book auth.] Neil E. Harrison (Ed). *Complexity in World Politics, Concepts and Methods of a New Paradigm.* s.l. : State Univeristiy of New York, 2006.

—. 2006. Thinking about the world we make. [book auth.] Neil E. Harrison (Ed). *Complexity in World Politics, Concepts and Methods of a New Paradigm.* s.l. : State University of new York, 2006.

Henagulph, Seb. 2000. The Three Pillars of Transdisciplinarity. [Online] 22 April 2000. [Cited: 26 April 2008.] Montréal. http://community.livejournal.com/transdiscipline/697.html.

Hewstone, M. and Brown, R. 1986. Contact is not enough: An intergroup perspective on the "contact hypothesis". [book auth.] M. Hewstone and R. brown (Eds). *Contact and Conflict in Intergroup Encounters.* Oxford : Basil Blackwell, 1986.

Hoffman, Bruce. 2008. The Myth of Grass-Roots Terrorism, Why Osama bin Laden Still Matters. *Foreign Affairs.* May/June 2008.

Holland, J. 1998. *Emergence: From Chaos to Order,.* Reading, Mass. : Addison-Wesley, 1998.

—. 1995. *Hidden order: How Adaptation Builds Complexity.* Reading. Mass. : Addison-Wesely, 1995.

Homer-Dixon, Thomas. 2006. Book Review Colin H. Kahl: States, Security and Civil Strife in the Developing World. *Population and Development Review.* 2006, Vol. 32, 3.

—. 2000. *Environmental Change & Security Project Report.* 2000. Issue 6.

ICCCR, The International Center for Cooperation and Conflict Resolution. 2008. *ICCCR Past Research.* http://www.dynamicsofconflict.iccc.edu.pl/index.php?page=complexity-and-conflict : s.n., 2008.

Jones, Wendell. 2003. http://www.beyondintractability.org/audio/wendell_jones/?nid=2448 : Beyond Intractability Version IV, 2003. Interviewed by Julian Portilla.

—. 2003. *"Complex Adaptive Systems.".* [<http://www.beyondintractability.org/essay/complex_adaptive_systems] [ed.] Eds. Guy Burgess and Heidi Burgess. s.l. : Beyond Intractability, Conflict Research Consortium, University of Colorado, Boulder., Posted: October 2003 2003.

—. 2003. Complexity, Conflict Resolution, and How the Mind Works. *Conflict Resolution Quarterly.* 4, 2003, Vol. 20.

—. How We Know What We Know About What We Know. *Metaphor in Dialog and Conversation.* [Online] [Cited: 22 November 2006.] http://metaresolution.com/Theory-to-Practice.pdf.

Kauffman, S. and Macready, W. 1995. Technologcal Evolution and Adaptive Organisation. *Complexity.* 1995, Vol. 1, 2, pp. 26-43.

Kauffman, Stuart A. 2000. *Investigations.* USA : Oxford University Press, 2000.

Kauffman, Stuart. 1995. *At Home in the Universe.* s.l. : Oxford University Press, 1995.

Kauffmann, Stuart. 1993. *The Origins of Order: Self-Organization and Selection in Evolution.* s.l. : Oxford University Press, 1993.

Keefe, Patrick Radden. 2006. Can Network Theory Thwart Terrorists? *New York Times.* 12 March 2006.

Kelman, H. C. 2001. The role of national identity in conflict resolution: Experiences from Israeli-Palestinian problem-solving workshops. [book auth.] L. Jussim, and D. Wilder (Eds.) R. D. Ashmore. *Social Identity, Intergroup Conflict, And Conflict Reduction.* New York : Oxford University Press, 2001, pp. pp. 187-212.

Klein, Julie Thompson. 2004. Disciplinary Origins and Differences, Paper given at 2004 Fenner Conference On The Environment,Understanding the Population–Environment Debate: Bridging Disciplinary Divides, The Shine Dome, Canberra, 24-25 May 2004. *Site: Australian Academy of Science, Conferences and lectures, Conference proceedings.* [Online] May 2004. [Cited: 26 July 2008.] http://www.science.org.au/events/fenner/klein.htm.

—. 2004. Interdisciplinarity and complexity: An evolving relationship. *E:CO.* 2004, Vol. 6 (Special Double Issue), 1-2, pp. 2-10.

Lakoff, George. 2003. 2003.

Lakoff, George and Mark Johnson. 1980. *Metaphors We Live By.* s.l. : University of Chicago Press, 1980.

Lane, D. and Maxfield, R. 1995. *Foresight Complexity and Strategy,.* s.l. : Santa Fe Institute Working Papers, #95-12-106 , 1995.

Lederach, John Paul. 2003. *The Little Book of Conflict Transformation.* s.l. : STL Distribution North America, 2003.

Lemke, Jay L. 2000. Across the Scales of time: Artifacts, Activities, and Meanings in Ecosocial Systems. *Mind, Culture, and Activity.* 2000, Vol. 7, 4, pp. 273-290.

Lemke, Jay L. and Nora H. Sabelli. 2008. Complex Systems and Educational Change: Towards a New Research Agenda. *Educational Philosophy and Theory Volume 40 Issue 1, Pages .* 15 January 2008, Vol. 40, 1, pp. 118 - 129.

Lemke, Jay L. 1993. Discourse, Dynamics, and Social Change. *Cultural Dynamics.* Special Issue, Language as Cultural Dynamic, M.A.K. Halliday, Issue Editor, 1993, Vol. 6, 1, pp. 243-275.

—. 2000. Material Sign Processes And Emergent Ecosocial Organization: Downward Causation and the Levels Paradigm. [book auth.] P.B. Andersen, C. Emmeche, and N.O. Finneman-Nielsen (Eds.). *Downward Causation: Self-organisation in Biology, Psychology and Society.* Denmark : Aarhus University press, 2000, pp. 181-213.

—. 1996. Self-organisation and Psychological Theory. *Theory & Psychologcy.* 1996, Vol. 6, 2, pp. 352-356. Review of L.B. Smith & E. Thelen (Eds), "A Dynamic Systems Approach to Development.

Lewin, R. and Regine, B. 1999. *The Soul at Work: Unleashing the Power of Complexity Science for Business Success.* London : Orion Business Books, 1999.

Longstaff, P. H. 2005. *Security, Resilience, and Communication in Unpredictable Environments Such as Terrorism, Natural Disasters and Complex Technology.* Harvard University Program on Information Resources Policy,. : s.n., 2005. Available at www.pirp.harvard.edu.

Mainzer, K. 1996. *Thinking in Complexity: the Complex Dynamics of Matter, Mind and Mankind.* Second Edition. s.l. : Springer, 1996.

Marion, Russ. 1999. *The Edge of Organization: Chaos and Complexity Theories of Formal Social Organization.* Newbury Park, CA : Sage, 1999.

Maturana, Humberto R. and Francisco J. Varela. 1980. *Autopoiesis and Cognition: The Realization of the Living.* Vol. 42: Boston Studies in the Philosophy of Science : Dordrecht: D. Reidel, 1980.

McDonald, D. M and G. R. S. Wei. 2006. A Methodology for Exploring Emergence in Learning Communities. *International Conference on Complex Systems.* http://www.cis.strath.ac.uk/cis/research/publications/papers/strath_cis_publication_1379.pdf : Information Resources Directorate,Computer and Information Sciences, University of Strathclyde, 2006.

Miall, Hugh. 2001. Conflict Transformation: A Multi-Dimensional Task. *Berghof Online Handbook for Conflict Transformation.* [Online] 30 March 2001. [Cited: 15 March 2006.] www.berghof-handbook.net.

Mitchell, Christopher R. 2005. *Conflict, Social Change and Conflict Resolution. An Enquiry.* [ed.] Berghof Research Center for Constructive Conflict Management. 2005. Berghof Handbook for Conflict Transformation (online). www.berghof-handbook.net/upload.

Mitleton-Kelly, Eve. 2005,. A Complexity Approach to Co-creating an Innovative Environment. *World Futures Journal:.* Special Issue on Complexity and Innovation, 2005,. Eds: Nolas S.M., Garcia-Lorenzo L., Zeeuw de G., Sell-Trujillo L.,.

—. **2004.** Knowledge Generation & Sharing. *Knowledge Anywhere Anytime Workshop 29-30 April 2004.* [Online] 2004. [Cited: 23 November 2008.] ftp://ftp.cordis.europa.eu/pub/ist/docs/dir_f/ws2_eve_mittleton_kelly.pdf.

—. **2007.** LSE ComplexityResearch Group Welcome to Complexity programme. [Online] 2007. [Cited: 25 September 2007.] http://www.psych.lse.ac.uk/complexity/.

—. **2003.** Ten Principles of Complexity and Enabling Infrastructures. *Complex Systems and Evolutionary Perspectives on Organisations: The Application of Complexity theory to Organisations.* s.l. : Elsevier, 2003.

Morgan, Gareth. 1997. *Images of Organization (2nd ed.* Newbury Park, California : Sage, 1997.

Nicolescu, Basarab. 2002 . *Manifesto of Transdisciplinarity (translation from French by Karen-Claire Voss).* New York : State University of New York (SUNY) Press, 2002 .

—. **2003.** Theoretical, Phenomenological and Experimental Transdisciplinarity. *Interdisciplines.* [Online] 20 May 2003. [Cited: 29 April 2008.] http://www.interdisciplines.org/interdisciplinarity/papers/5/12/printable/discussions/view/645.

—. **2006.** Transdisciplinarity - past, present and future. [book auth.] Bertus Haverkort and Coen Reijntjes (eds.). *Moving Worldviews, Reshaping Sciences, Policies And Practices For Endogenous Sustainable Development.* s.l. : ETC/COMPAS, 2006.

—. **2007.** Transdisciplinarity as Methodological Framework for Going Beyond the Science-Religion Debate. *The Global Spiral, an e-publication of Metanexus Institute Published.* [Online] 24 May 2007. [Cited: 26 April 2008.] http://www.metanexus.net/magazine/tabid/68/id/10013/Default.aspx.

Nonaka, I., and Takeuchi. 1995. *The Knowledge-Creating Company: How Japanese Companies Create the Dynamics Of Innovation.* s.l. : Oxford University Press, 1995.

Northrup, Terrell A. 1989. The Dynamic of Identity in Personal and Social Conflict. [book auth.] Terrell A. Northrup and Stuart J. Thorson (Eds) Louis Kriesberg. *Conflicts and Their Transformation.* Syracuse, New York : Syracuse University Press, 1989.

Nowak, A, Szamrej, J. and Latané, B. 1990. From private attitude to public opinion: A dynamic theory of social impact. *Psychological Review.* 1990, Vol. 97, pp. 362-367.

Nowotny, Helga. 2003. The Potential of Transdisicplinarity. *Interdisciplines.* [Online] May 2003. [Cited: 29 April 2008.] http://www.interdisciplines.org/interdisciplinarity/papers/5/9.

NSSI. 2008. Natural Science and Social Science Interface. *Swiss Federal Institute of Technology in Zurich which, under the Chair of Environmental Sciences.* [Online] 2008. [Cited: 15 August 2008.] http://www.uns.ethz.ch/res/index.

Peltu, Malcolm. 2000. Report on a Complexity Study Group and Seminar "Emergent Order and New Science 'Macro' Leadership Dynamics: Strategy, Microcoevolution, Distributed Intelligence and Complexity in Firms" led by Prof. Bill McKelvey on 14 March 2000. *LSE Complexity Events.* [Online] March 2000. [Cited: 24 July 2007.] http://www.psych.lse.ac.uk/complexity/events/2000/2000/report_14march00.html.

Piaget, J. 1972. The Epistemology of Interdisciplinary Relationships. [book auth.] L. et al. Apostel. *Interdisciplinarity. Problems of Teaching and Research in Universities.* Paris : OECD , 1972.

Prigogine, I. & Stengers, I. 1985. *Order Out of Chaos.* s.l. : Flamingo, 1985.

Ramalingam, Ben, and Jones, Harry with Reba, Toussaint and Young, John. 2008. *Exploring the science of complexity ideas and implications for development and humanitarian efforts.* London : ODI, 2008. Working Paper 285.

Rihani, Samir. 2002. *Complex Systems Theory and Development Practice: Understanding Non-linear Realities.* s.l. : Zed Books, 2002.

Rosenau, James N. & Earnest, David C. 2007. Signifying nothing? What complex systems theory can and cannot tell us about global politics. [book auth.] Neil Harrison. *Complexity in World Politics.* 2007.

Ruane, Joseph and Jennifer Todd. 2003. *The Roots Of Intense Ethnic Conflict May Not In Fact Be Ethnic: Categories, Communities And Path Dependence.* s.l. : Issc Discussion Paper Series, 2003. 17.

Sageman, Marc. 2008. *Leaderless Jihad: Terror Networks in the Twenty-first Century.* s.l. : University of Pennsylvania Press, 2008.

Sandole, Dennis. 1999. *Capturing the Complexity of Conflict: Dealing With Violent Ethnic Conflicts in the Post-Cold War Era.* s.l. : Routledge, 1999.

—. 2003. Intractable Conflict Database. *Interview by Julian Portilla.* [Online] 2003. [Cited: 8 October 2007.] http://www.beyondintractability.org/audio/dennis_sandole/?nid=2471.

Saperstein, Alvin M. 2003. Complexity, Chaos, and National Security Policy: Metaphors or Tools? [book auth.] David S. Alberts And Thomas J. Czerwinski. *Complexity, Global Politics, And National Security.* http://www.ndu.edu/inss/books/books-1998/Complexity,Global Politics and Nat'l Sec-Sept98/ch05.html#2.#2. : s.n., 2003.

Saunders-Newton, Desmond. 2007. When worlds collide, Reflections on the credible uses of Agent-based models in International and global Studies. [book auth.] Neil Harrison. *Complexity in World Politics.* 2007.

Sawyer, R. Keith. 2004. The Mechanisms of Emergence. *Philosophy of the Social Sciences.* 2004, Vol. Vol. 34, No. 2, pp. 260-282 .

Schmitt, John F. 1997. Command and (Out of) Control: The Military implications of Complexity Theory. [book auth.] David S. and Czerwinski, Thomas J. (Eds) Alberts. [ed.] http://www.dodccrp.org/files/Alberts_Complexity_Global.pdf. *Complexity, Global Politics and National Security.* Washington DC : National Defense University, 1997, pp. 219-246.

Schwartz, Daniel, Deligiannis, Tom and Homer-Dixon, Thomas. 2000. The Environment and Violent Conflict: A Response to Gleditsch's Critique and Suggestions for Future Research. *Environmental Change & Security Project Report.* Summer 2000, 6, pp. 77-93.

Segal, E. 2004. Incubation in insight problem solving. *Creativity Research Journal.* 2004, Vol. 16, 1, pp. 141-148.

Sen, A. 1999. *Development as Freedom.* New York : Knopf, 1999.

Senge, Peter, Roberts, Charlotte, and Smith, Bryan J. 1990; 2006. *The Fifth Discipline: The Art and Practice of the Learning Organization.* s.l. : Bantam Dell, 1990; 2006.

Shouldice, Julie and Cheyanne Church. 2003. *The Evaluation of Conflict Resolution Interventions: Part II Emerging Practice and Theory.* Derry/Londonderry : INCORE International Conflict Research, University of Ulster & United National University, 2003.

Smith, Dan and Vivekananda, Janani. 2007. A Climate of Conflict: The Links between Climate Change, Peace and War. *International Alert.* [Online] 2007. [Cited: 13 September 2008.] http://harowo.com/2008/06/06/a-climate-of-conflict-the-links-between-climate-change-peace-and-war/.

SPARC-L. 2008. Research Methodology. *Sustainable Peace Action Research Centre – Leuven (SPARC-L).* [Online] 2008. [Cited: 17 August 2008.]

Sword, Deborah. 2007. A Complex Conflict Analysis of Resolution. *Mediate.com.* [Online] May 2007. [Cited: 21 January 2008.] http://www.mediate.com/articles/swordL3.cfm.

—. 2006. Complexity Science Analysis of Conflict. *Mediate.com.* [Online] October 2006. [Cited: 21 January 2008.] http://www.mediate.com/articles/swordL1.cfm .

Tausch, N., Kenworthy, J. B., & Hewstone, M. 2004. Conflict Resolution and Prevention: The Role of Intergroup Contact. [book auth.] M. Fitzduff and C. E. Stout (Eds.). *Psychological Approaches to Conflict and War.* s.l. : Praeger, 2004.

The TRANSIT Programme, University of York. 2008. The TRANSIT Programme - Discipline Bridging at the University of York. *EPSRC Details of Grant.* [Online] 6 January 2008. [Cited: 28 June 2008.] http://gow.epsrc.ac.uk/ViewGrant.aspx?GrantRef=EP/F032749/1.

Urry, John. 2003. *Global Complexity.* s.l. : Polity Press, 2003.

Vallacher, R. R., Nowak, A., Markus, J. and Strauss, J. 1998. Dynamics in the Co-ordinatiion of Mind and Action. [book auth.] M., Weary, G. and Sedlek, G. (Eds) Kofta. *Personal Control in Action: Cognitive and Motivational Mechanisms.* New York : Plenum, 1998.

Vallacher, R., Nowak, A. and Kaufman, J. 1994. Intrincsic Dynamics of Social Judgment. *Journal of Personality and Social Psychology.* 1994, Vol. 67, pp. 20-34.

Vallacher, Robin R., Read, Stephen J., Novak, Andrezej. 2002. The Dynamical Perspective in Personality and Social Psychology. *Personality and Social Psychology Review.* 4, 2002, Vol. 6, pp. 264-273.

van Breda, John. 2007. Towards a Transdisciplinary Hermeneutics. *Transdisciplinarity and the Unity of Knowledge: Beyond the Science and Religion Dialog, Philadelphia, Pennsylvania. 2-6 June 2007.* [Online] June 2007. [Cited: 12 April 2008.] http://www.learndev.org/dl/BtSM2007/JohnVanBreda.pdf.

Vance, Charles M., Groves, Kevin S., Kindler, Herb. Linear/Nonlinear Thinking Style Flexibility for Competing in Today's Complex Global Marketplace. [Online] [Cited: 7 February 2008.] http://isce.edu/ISCE_Group_Site/web-content/ISCE_Events/Christchurch_2005/Papers/Vance_Groves_Kindler.pdf.

von Stillfried, Nikolaus. 2007. What about Transdisciplinarity? Its Past, its Present, its Potential ... and a Proposal. *Transdisciplinarity and the Unity of Knowledge: Beyond the*

Science and Religion Dialog, Philadelphia, Pennsylvania. [Online] 2-6 June 2007. [Cited: 12 April 2008.] http://www.metanexus.net/conference2007/articles/Default.aspx?id=10056.

Walby, Sylvia. April 2003. Complexity Theory, Globalisation And Diversity. *Department of Sociology, Lancaster University.* [Online] April 2003. [Cited: 9 March 2007.] http://www.lancs.ac.uk/fass/sociology/papers/walby-complexityglobalisationdiversity.pdf.

—. 2007. Complexity Theory, Systems Theory and Multiple Intersecting Social Inequalities. [ed.] Sage. *Philosophy of the Social Sciences.* December 2007, Vol. 37, 4, pp. 449-470.

Warner, Michael. 2001. *Complex problems…negotiated solutions: The practical applications of chaos and complexity theory to community-based natural resource management.* s.l. : ODI Working Paper 146, 2001.

Welsh, Ian and Graeme Chesters. 2005. Complexity and Social Movement(s) Process and Emergence in Planetary Action Systems. *Theory, Culture & Society.* 2005, Vol. 22, 5, pp. 187-211 .

Wheatley, Margaret J. 2006. *Leadership and the New Science (3rd Edition).* San Francisco : Berrett-Koehler Publishers, Inc., 2006.

Wils, Oliver, Hopp, Ulrike, Ropers, Norbert, Vimalarajah, Luxshi, Zunzer, Wolfram. 2006. *The Systemic Approach to Conflict Transformation Concept and Fields of Application.* http://reliefweb.int/rw/lib.nsf/db900sid/AMMF-6VZJ92/$file/Berghof-Oct2006.pdf?openelement : Berghof Foundation for Peace Support, 2006.

Youngman, K. J. 2007. A Guide to Implementing the Theory of Constraints (TOC). [Online] 21 May 2007. [Cited: 28 August 2008.] http://www.dbrmfg.co.nz.