

# Towards a Complex Non-linear Systems Theory of Organisation

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**ABSTRACT:** *In this paper we draw on Maturana & Varela's theory of autopoiesis in order to explore ideas toward the development of a non-linear systems theory of organisations and organisational change. It will be argued that theorists drawing on systems approaches have commonly reified key organisational processes obscuring the dynamical elements of the organisation. Furthermore, recourse to cognitive theory founded on a realist or representationalist epistemology has led to reductionist approaches unsuited to the development of an adequate theory of emergent properties of social systems. As such, it will be argued there is a need to develop a rigorous theory of organisations, which makes possible the application of complex systems theoretic approaches to organisational analysis. A theory of organisations as structurally coupled autonomous unities is proposed.*

*Keywords: non-linear systems, autopoiesis, organisation theory, structural coupling,*

## INTRODUCTION

This paper proposes a tentative framework as the basis for a non-linear systems theory of organisations. The argument is presented in three sections. In the first section we examine some of the inconsistencies in current approaches to organisations and organisational change. We focus in particular upon the epistemological and ontological inconsistencies and what we regard as a problematic reification in many common characterizations of the organisation as an entity. We argue that there remains a fundamental challenge in examining organisations. This is related to the problem of the micro-macro transition that remains problematic in many fields (Coleman 1994). Our particular concern has to do with understanding the interplay between what we will refer to as the biological dimensions of organisation (by which we mean cognition, emotion and behavior, including language) and the phenomenological aspects of an organisation (for example, politics, culture and market forces). We are concerned to identify a theoretical link between the two aspects that does not involve the need for a methodological or conceptual disjunction. The necessary existence of such a disjunction has long been assumed with the social sciences and is the basis of the rejection of naturalism as a philosophical approach.

The second section introduces the basic concepts underpinning Maturana and Varela's autopoietic theory. We argue that autopoietic theory provides great potential to address the problems and inconsistencies discussed in Section 1. Readers already familiar with the central tenets and concepts of autopoiesis may wish to proceed directly to Section 3. It should be kept in mind however that this concept has been variously interpreted and applied (Mingers 1995, Goldspink 1999).

In the Section 3 we discuss how autopoietic theory can address the inconsistencies described in Section one by providing a conceptual bridge linking the biological and phenomenological dimensions of an organisation. We consider the implications of this and propose future research directions necessary to build on this beginning.

## PART 1 - THE INCONSISTENCY OF CURRENT APPROACHES TO STUDYING ORGANISATIONS

Within organisational science there have been and continue to develop a multiplicity of theoretical stances regarding the nature of an organisation. Many of the differences in stance have their origins in the different perspectives,

methods and technologies arising from the different 'fields' of sociology, psychology, economics, the law and the systems sciences. Differences in stance arise partly from attempts to explain:

- different phenomena; the origins of difference compared with the origins of cohesion for example;
- differences in time-frame, history and scale; such as short term phenomena within small local groups or long term evolution of cultures;
- different perspectives; such as the needs of management compared with the interests of workers or governments; or
- different levels of analysis, e.g. the behavior of individuals, of an organisation or the development and operation of nation states.

Differences also arise due to the various assumptions underpinning the different research programs, in particular assumptions about the nature of reality (ontology) and the nature of knowledge (epistemology). These differences are seldom explicitly stated but rather are implied. This 'pluralism' (Reed & Hughes 1992) within organisational science has its advocates and detractors. They give rise to a '*contentious meta-discourse*' (Cooper and Burrell 1988) or '*paradigm war*' (McKelvey 1997). Hughes (1992) has it that this has '*...plunged the field into relative chaos*' while Aldrich (1992) has argued that the variety of theory provides alternative perspectives and useful insights. Those theories drawn on by managerial practitioners fall on a continuum, often drawing eclectically and uncritically on alternative perspectives sometimes simultaneously.

Having adopted a reified view of organisations, the processes that give rise to system wide behavior are overlooked or ignored. Thus systems approaches can focus on the macro behavior—behavior at the level of the system as a whole, and fail to make clear or even obscure the relationship between the macro and the micro. Consequently, the organisation has, as is sometimes argued by critics, been given an undue ontological status.

At the opposite extreme are approaches that attempt to reduce the macro to the micro—to seek explanation of all macro phenomena at the level of the individual. Only individuals, as 'real' biological entities are regarded as having ontological status with all higher order phenomena a product of behavior at this (most fundamental) level. The most common theoretical stance (consistent with the functionalist perspective) adopted for understanding the behavior of individual social actors is that of the cognitivist. This is derivative of what von Krogh & Roos (1995) have described as a 'representationalist' epistemology. This way of thinking about how individuals come to 'know' the world and respond to their environment is again one that is not helpful in explaining emergent behavior. It limits development of a theory of organisations that helps us to understand the complex patterns of behavior observed at various levels within organisations. We argue that adopting a representational framework works against the construction of an adequate theory of language, and cognition, and hence of socially coordinated activity or organisation. In particular, the use of a representationalist framework ignores the multiplicity of spaces and modes through which organisations may be perceived and, as we will later argue the basis by which they are brought into being and sustained.

## **PART 2 - AUTOPOIETIC THEORY: A POTENTIAL WAY FORWARD**

From a 'reductionist' perspective, the fundamental 'things' or components of any social system are the living individuals that constitute it. Let us begin then by better understanding their phenomenology. Maturana and Varela developed the concept of autopoiesis to describe the characteristics of living things and in so doing distinguish them from the non-living. Autopoietic systems are defined as those systems where the primary 'product' of the system's operation is itself. Note that all living systems are autopoietic but not all autopoietic systems are living. As discussed, the defining characteristic of autopoietic systems is their capacity to self-produce. Autopoietic systems continually act to maintain this capacity for self-production. In other words they are capable of undergoing change to maintain their capacity to self-produce. Autopoietic systems have a number of key characteristics; they contain:

- relations which determine the topology of the unity (system) and therefore its physical boundaries—that is, they bring forth their own boundary;
- relations which specify the properties of the components of the system; and
- relations of order, i.e. those that determine the dynamics.

Maturana and Varela note that it is the capacity of an autopoietic system to bring forth its own boundary that further distinguishes it from many other systems: "The most striking feature of an autopoietic system is that it pulls itself up by its own bootstraps and becomes distinct from its environment through its own dynamics" (Maturana & Varela, 1988, p. 47).

According to the theory of autopoiesis, the phenomenology of living systems is totally determined by their autopoiesis and all change within a living unity is subordinated to the maintenance of its autopoiesis. Change is due to reactions to perturbations arising from its operation in a medium (environment) or in relation to other unities. It is important to note that all changes occur in an operationally closed way and emerge due to the internal dynamics of the particular unity. As such changes are structure determined, the structure of the autopoietic system determines both the source and nature of any changes. Over time these changes produce a history of structural transformation

(the ontogeny) of the autopoietic unity. Recurrent perturbations may lead to the unity becoming **structurally coupled** to its environment or to other unities

## Structural Coupling

Structural coupling is a key concept of interest for the construction of a social theory consistent with a complex systems perspective and forms an important part of the fundamental architecture for the alternative perspective being proposed here. Operationally closed systems may become 'structurally coupled' through mutually recurrent perturbation. "In the history of interactions of a composite unity in its medium, both unity and medium operate in each interaction as independent systems that, by triggering in each other a structural change, select in each other a structural change" (Maturana and Varela 1980, p. xx).

Maturana goes on to point out that if a systems adaptation is conserved and it remains viable as a system, then the outcome is the selection of a sequence of structural changes in the unity and the medium which are complementary. In other words they are structurally coupled and **co-evolve**. If the unity is autopoietic, then its autopoiesis is the fundamental characteristic that is conserved. The strength of the resulting coupling will depend on the internal structures of each unity, in particular their plasticity and sensitivity to certain types of perturbation. Unities may influence one another in one or many dimensions and the nature of the response, again depending on the structure, may be discrete, or continuous. The degree of structural coupling that arises when two or more unities interact is a fundamental factor in determining the dynamics and emergent behavior of the resulting structurally coupled system – part of what we would propose constitutes the notion of an organisation. The dynamics will be determined by the density of 'connectedness', that is the number of dimensions upon which structural coupling occurs. Kauffman's work with boolean networks (1991) demonstrates how this occurs in a network of elements with discreet states.

## PART 3 – LINKING BIOLOGY AND PHENOMENOLOGY

We turn now to the assembly of these building blocks into a theoretical foundation for the study of organisations. It is important to note that there is considerable debate as to whether social systems (including organisations) are themselves autopoietic or whether they are simply comprised of autopoietic entities. Maturana and Varela appear to differ on this subject, whilst Mingers (1995) has clearly argued against viewing social systems as autopoietic. We take the position that social systems are not, in themselves, autopoietic but rather comprise autopoietic unities in structural coupling (Goldspink 1999, Kay 1999).

Irrespective of the stance taken, there is general agreement that social systems may be considered as operationally closed in the sense that they comprise a '*network of dynamic processes whose effects do not leave the network*' (Maturana and Varela 1988, p. 89). Furthermore, in human societies, domains of interaction are primarily brought forth and maintained in language. We propose therefore a view of social systems as networks and heterarchies, of intersecting systems of operationally closed and structurally coupled unities.

The congruencies in structure between the people involved in the organisation are the result of experiencing similar environmental perturbations over an extended period of time. Although these perturbations effect each individual differently, due to the plasticity of the nervous system, over time the natures of their ontogenic drifts develop congruities. Consequently it is difficult to distinguish those elements of an individual's behaviour that could be said to be a function of their environment and those that are a function of their individual structure. As Varela observes, "...organism and environment enfold into each other and unfold from one another in the fundamental circularity that is life itself. (Varela et al 1992, p.p.217)

Accepting the above, the environment clearly is important as a causal agent of behaviour. However, the environment may be construed as being both physical and non-physical. The physical environment refers to physical objects. This position does not assume, however, that the individual has direct access to those objects, as "...our cognition emerges from the background of a world that extends beyond us but that cannot be found apart from our embodiment."(Varela et al 1992, p.p.217). The non-physical environment refers to objects that are distinguished in everyday life but do not exist in the physical sense, for example systems. Such phenomena exist within a consensual domain of discourse—in language. Although it can be argued that conceptualizations relating to the physical environment are triggered by environmental perturbations from those objects such as reflected light and sound etc, it is the process of distinction itself that triggers change to elements of the non-physical environment. This process takes place against the background of all the other distinctions the individual makes in order to orient him/herself in the environment.

In an organisational setting, the range of environmental perturbations an individual may receive relative to the physical environment will be fairly similar to the next person. For example if everyone has their own office, with the blinds pulled down and the doors closed, the pattern of human interaction that people experience will be dramatically

different to the pattern of human interaction people will experience in an open plan office. Emerging from the physical environment, people will generate a non-physical conceptualization of what the organisation is and the behaviour that is appropriate to it. This conceptualization will be either reinforced through continued environmental perturbations of the kind described by the 'closed office' example, or gradually changed if the ongoing sets of perturbations do not reinforce it.

As a consequence of this process, it is possible to conceptualize new environments that will offer new ranges of perturbation. Open plan offices increase the level of communication between people, by opening up the spaces between them. The reduction of dividing walls and visual barriers has the effect of increasing the number, and changing the nature of, environmental perturbations that usually occur from human interaction. Although it is not known prior to the installation of such offices what new interactions may arise, it is possible to say with some confidence that increased communication between people is highly likely. This change is not, however, caused purely by the physical environmental change and cannot be guaranteed. It is rather a complex result of the interaction of the physical and non-physical dimensions of the environment.

The implication of this discussion for the way in which we view and think about organisations relates to the distinction between the phenomenological aspects of organisation and the physical, or this case biological dimensions. By viewing organisations as structurally coupled autonomous unities, we would argue it is possible to account for both the physical (i.e. biological, cognitive) dimensions of organisation and the phenomenological (i.e. social, cultural, political). This is similar to a shift from viewing the organisation as something that is 'out there' and reified (Figure 1) to something that is internal and specific to each of us (Figure 2).

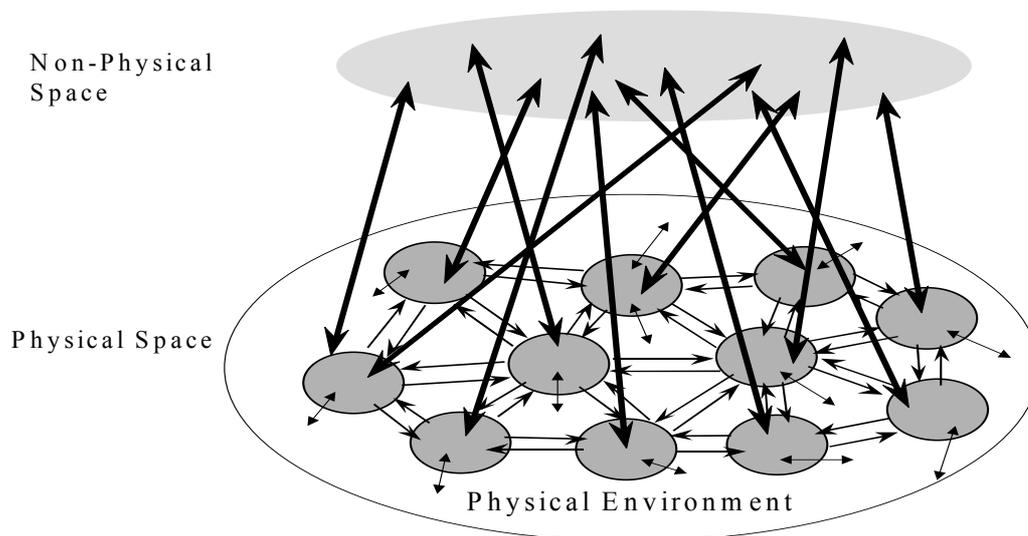


Figure 1: Traditional Conceptualisation of an Organisation (Kay,1999)

Figure 1 depicts what we would consider to be a traditional view of organisation, where the interaction of individuals in the physical space gives rise to a reified entity in the non-physical. This view produces the disjunction spoken of in Section 1, between the emergent entity (the social system or organisation) and the processes of production (the members of the system).

The distinction that must be made clear at this point, is that humans exist in the physical space, whilst organisations are represented in the non-physical space. Although humans may distinguish organisations, organisations, as entities, are unable to distinguish anything, as they are a distinction themselves. The perceived ability of an organisation to distinguish something from its environment is nothing more than a description given by an observer, it does not represent an internal correlation of the system (organisation).

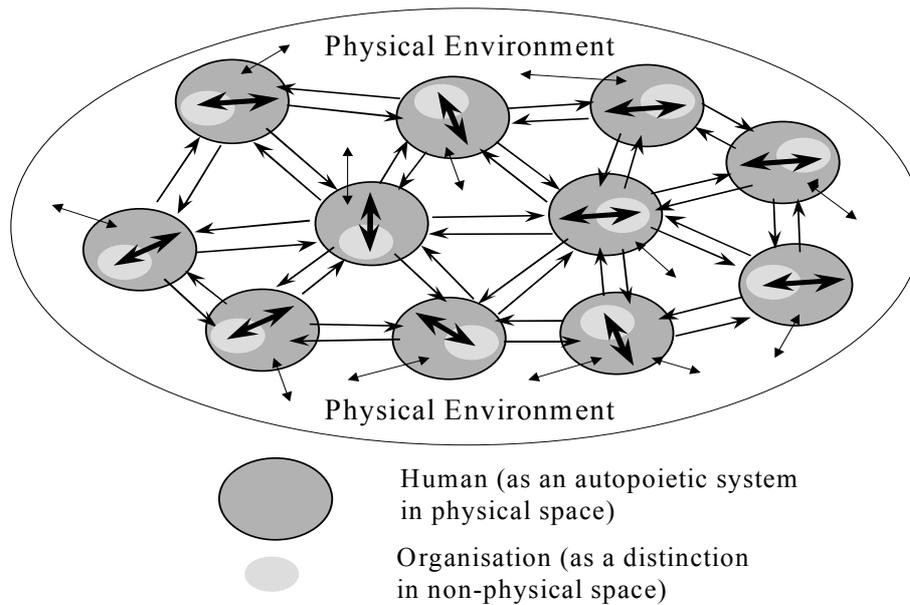


Figure 2: Organisation as structurally coupled autonomous unities (Kay, 1999)

Given the discussion above, the conceptualisation of organisation given in Figure 2, overcomes the inconsistencies of Figure 1. Like Figure 1, the organisation continues to exist in the non-physical space of distinctions, however, the non-physical space is now represented as a function of the internal correlations of the autopoietic unities who could be said to be members of the organisation. As such, the organisation exists in a non-physical environment created by the individual, yet against which the individual orients their behaviour. The non-physical space exists as a function of the internal correlations of the nervous system. For the individual, there is little difference between the way in which the physical environment triggers structure-determined changes and the way in which the non-physical environment triggers structure-determined change. The individual behaves as if the organisation existed in physical space with physical characteristics. In the context of the internal correlations of the nervous system, both are real.

The organisation, as depicted in Figure 2, is no longer an entity external to the individual, it becomes an embodied aspect of the individual's worldview, both influencing and being influenced by the continuous functioning of internal correlations within the individual's nervous system. As such, the emergent (phenomenological) dimensions of organisation have been brought together with the physical (biological) dimensions into a single process for study.

## CONCLUSION

In this paper we have begun to set out a way of thinking about social systems that provides a theoretical foundation for understanding organisations as operationally closed systems capable of adaptation and self-organisation. By presenting a theory which avoids reifying processes such as language and meaning construction, it becomes possible to see alternative approaches to modeling social systems. We would argue that autopoietic theory offers a path for pursuing the application of multidisciplinary complex systems approaches across the currently competing fields within social and organisational theory.

It is evident that the theory of autopoiesis provides a framework capable of bridging the established divide between natural and social sciences. By identifying the mechanisms which allow organisms to bootstrap their own complexity and to enter into co-evolutionary drift and structural coupling, we have the foundations of a naturalistic science which can re-unite current scientific oppositions. Importantly, the approach provides a means of avoiding undue emphasis on cognitive and linguistic interaction in social process. These are approached as emerging from the same processes that give rise to social structure (although they may also serve to extend it) rather than necessary pre-conditions.

Irrespective of whether social systems are or are not autopoietic it is clear that social structures constitute the domain in which (biological) autopoietic unities exhibit structural coupling with other unities of the same order. Such a system can and should be treated as operationally closed. This is because treating them as operationally open requires the re-introduction of concepts of 'purpose' and 'information' to model exchange processes and this is inconsistent with the biological origins of social behavior.

Empirical research that follows this line of thought will require a longitudinal nature in order to accommodate the ontogenies of the people involved. If organisations are to be viewed as a function of the autopoiesis of their

members, it must be recognised that they are a process, not an object. Furthermore, there is a requirement for critique and scholarly debate to ensure that the epistemological and ontological consequences are dealt with appropriately. Debate regarding this point has been heated for many years, not only in relation to the application of autopoietic theory in the social domain but in regard to autopoietic theory in its original form. Although there has not been room to discuss the history of the debate in this paper, it is important to consider previous discussions in any future debate.

In conclusion, the importance of the notion of social systems as comprising autopoietic unities in structural coupling is that social dynamics are seen as being generated by the closed networks of mutual perturbation which maintain the system under observation. This is a major departure from contemporary approaches to the study of organisation.

## REFERENCES

- Aldrich H. E. (1992), 'Incommensurable Paradigms? Vital Signs from Three Perspectives', in Hughes M. & Reed M. (eds.), *Rethinking Organisation*, Sage, London.
- Coleman, J.S.S. (1994), *Foundations of Social Theory*, Belknap Press, USA
- Cooper R & Burrell G. (1988), 'Modernism, Postmodernism and Organisational Analysis: An introduction', *Organisation Studies*, **9**,(1)
- Goldspink C, 1999, *Social Attractors: Examination of the Applicability of Complexity Theory to Social and Organisational Analysis*, Unpublished PhD dissertation, University of Western Sydney–Hawkesbury.
- Hughes M. (1992), 'Decluding Organisations', in Hughes M & Reed M. (eds.) *Rethinking Organisation*, Sage, London.
- Kauffman, S. A. (1991) 'Antichaos and Adaptation', in *Scientific American* August 1991, pp64-70.
- Kay, R. (1999) *Towards an Autopoietic Perspective on Knowledge and Organisation*, Unpublished PhD dissertation, University of Western Sydney–Hawkesbury.
- Maturana, H. & Varela, F. 1980. *Autopoiesis and Cognition: The Realization of the Living*, BSPS, **42**Reidel Dordrecht, Holland.
- Maturana, H. & Varela F. (1988), *The Tree of Knowledge - The Biological Roots of Human Understanding*, Shambhala
- McKelvey (1997), 'Quasi-Natural Organisation Science', *Organisation Science*
- Mingers, J. (1995) *Self-producing Systems: Implications and Applications of Autopoiesis*, Plenum Press, New York.
- Reed M. I. & Hughes M. eds. (1992), *Rethinking Organisation: New Directions in Organisation Theory and Analysis*, Sage, London.
- Varela, F. Thompson, E, & Rosch, E. 1992. *The Embodied Mind: Cognitive Science & Human Experience* MIT Press, Cambridge Massachusetts.
- von Krogh G. & Roos, J. (1995) *Organisational Epistemology*, St Martins Press N.Y.