The Contribution Of Complexity Theory To The Study Of Socio-Technical Cooperative Systems

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1 Introduction

In this paper we analyze some of the contributions that complexity theory can make to the study of socio-technical cooperative systems. The theory of complex systems has developed along two complementary, but distinct, axes. Chronologically, the first unifying concepts of the complexity paradigm resulted from the study of non-linear systems. Later, the study of distributed self-organising systems made it possible to widen this initial approach to the analysis and modelling of social cognitive systems.

The distributed approach, being interested in local interactions rather than structure and hierarchy, has found many applications fields ranging from the study of animal micro societies (ethology) to the study of human organizations on a social or cognitive level.

2 Intuitive definition of a complex system

A complex system is a system for which it is difficult, if not impossible to reduce the number of parameters or characterising variables without losing its essential global functional properties.

A truly complex system would be completely irreducible. The reduction of a complex is very important for traditional scientific and experimental methodology. After reducing the system to variables that are relevant we can study the systems in a controlled way.

Four specific properties of complex systems will be discussed in relationship to their usefulness to socio-cognitive modelling:

Property 1: non-determinism A complex system is fundamentally non-deterministic, we cannot predict it even if we know the function of its constitutions

Property 2: limited functional decomposability. A complex system is dynamic in nature and hence it is really difficult to divide it into stable parts and study its properties.

Property 3: distributed nature of information and representation A complex system has properties similar to a distributes system and by this we mean that the properties are no localized

Property 4: emergence and self-organisation. A complex system has emergent properties which are not directly accessible
3 Non-Determinism

Non-determinism of socio-cognitive processes is often considered as being due, either to a lack of knowledge of the observer about the analysed system, or to a disturbance of the system as a result of unforeseen causes. An analysis of the properties of complex socio-technical systems suggests that non-determinism can have an important functional role. Broadcasting is an important mechanism for understanding the efficiency of a collective in situations of co-presence (real or virtual). Indeed, it is the only mechanism which allows information sharing at a low cognitive cost. The classical theories of communication (mainly dyadic) have seldom analysed its functional role [Decortis and Pavard 94], although its cognitive components are described with precision [Goffman 87].

4 Limited Functional Decomposability

A system that is functionally decomposable is one whose global functioning can be completely deduced from knowledge of the function of its sub-components. Principal obstacle to the functional decomposability of complex systems is the dynamic and fluctuating character of their constituent functions. The interaction with the environment, as well as the learning and self organisation mechanisms makes it unrealistic to regard such systems as structurally stable.

5 The distributed character of information and representations

A system is said to be distributed when its resources are physically or virtually distributed on various sites. The concept of distribution supports the concept of redundancy, when some distributed resources are redundant.

6 Emergence and self organisation

Intuitively, a property is emergent when it can not be anticipated from knowing how the components of the system function. Emergence is not due to incomplete information regarding the components of the system, but to the non-linear and distributed character of the interactions. If a system is capable of self organisation, its functions evolve over time so that they can
respond better to the requests of its environment. In this sense, a complex self-organised system cannot be described as functionally stable.

7 Conclusion

This paper explored the usefulness of the complexity paradigm in analysing socio-technical cooperative systems. We defined and analysed four characteristics of complex systems. This paper demonstrates that these four characteristics, which are not treated within the framework of classical analytical approaches, are essential to understand certain functional aspect of co-operative work.