From Context to System and Back. How Systems Emerge from Actors Cognitive and Social Interactions. A System Dynamics Perspective

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Abstract
In this paper, the system is viewed as a construction based on the actors' cognitive and social interactions. The system is the result of multiple – actor sense making (Weick 1995), but at the same time it orients social sense making. In this process each actor's point of view is a representation of both the system and the context perceived as pertinent by the actor. In other words, the actor defines a strategy which couples him/her with the system and with the context at the same time. We consider that system and context co-evolve through (and orient) the actors' interactions. We approach System Dynamics (SD) as the grammar (Burke 1968) of these interactions. As a grammar, SD frames the actors' social and cognitive interactions, and poses few limitations to the actors' freedom (and creativity) in comprehending system – context relationships. We demonstrate, in particular, that SD provides a simplistic representation of ago – antagonistic relationships.
The paper addresses both the advantages and the limits of SD in building a multiple – actor approach to system – context coupling. The example of the strategic management model of an airport illustrates our position.

"Celui qui se représente un arbre est forcé de se représenter un ciel ou un fond pour l'y voir s'y tenir"
***Paul Valéry**, Introduction à la méthode de Leonard de Vinci, Gallimard, Paris, 1957, p. 12.*

De la contestation à la contextualité. Vers la structuration d'un système de pilotage multi – acteur

We propose the above statement as the starting point of our reflection on the models we use to represent systems perceived as increasely complex. Our representations are aimed at understanding and governing these systems at the right level of complexity, which could mean to complexify our representations and at the same time to simplify the political praxis at different levels: general politics, economic politics, corporate strategy, trade union strategy and so on. The dialogue between a complex representation and a simplified action is also applicable to communication between social and economic actors in multidimensional problematic situations.

Enlargement or construction of a large airport radically impacts on local systems. The effects are comprehensive and involve multiple dimensions thus triggering a series of interdependencies between various stakeholders. This is a typical case where a rupture in the established equilibrium poses a strategic issue forcing the actors involved to redefine their representations and actions through discussion and, at times, conflict. These are situations where often violent opposition can occur resulting in the project being brought to a standstill for months or even years. The most successful opposition – from the protesters' point

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of view – (as those who have some experience of similar cases are well aware of) are those where on the one hand there is strong local interest and, on the other, there are other powerful lobbies whose objectives may be less explicit and motives less clear. It is unfortunate (and perhaps also cynical) to have to recognise or have founded reasons to suspect that movements of this type have a

The case of Malpensa Airport offers an interesting perspective from this point of view. The enlargement project, which began in the early Eighties, had always been supported by the local financial community (both in Varese and North of Milan). There was however, forceful opposition, at times extreme, on the part of local councils and groups of residents as well as from environmental lobbyists. The trade unions never made their position explicit. The cynics knew that Italian state enterprises had typically been governed by political appointees and the business and competitive aspects where influenced by politics. In this specific case ideological resistance and local interests were further complicated by the cold and at times downright bitter relationship between Alitalia and the airport authority (SEA). A simplified analysis points out that the reasons behind this complex power struggle lie in the Milan – Rome conflict. This seemed to be further exacerbated by SEA being dominated by the Socialists whereas Alitalia tended to be governed by Christian Democrats. Without going into the details of the issue, it is important to note:

a) That an issue involving local players in the first instance and with major implications on local affairs but with a strong impacts on national interests also is exploited (covertly) by stakeholders at all levels. These groups which have both business and political interests nationally and locally have the power to influence outcomes at both levels as well as the ability to contact and interact with local movements.

b) Secondly, that local players are able to propose solutions independently when there is a structured network within which to operate (and which can also direct their actions to a certain extent). In the absence of a structure the risk of local players being manipulated by external groups multiplies.

The structuring of a complex multi-actor system of governance to manage complex systems requires a shift from a logic of opposition to a dialogic.

Identifying context and environment. A simplification which respects complexity.

We propose to identify the context through ago – antagonistic relationships between some variables within the system and other variables belonging to the environment.

“ **La science des systèmes ago-antagonistes** … se préoccupe d'identifier dans les systèmes concrets des couples à la fois conflictuels et coopératifs, éventuellement sous la forme de réseaux ago-antagonistes, et surtout de préciser les concepts, souvent originaux, qui autorisent la mise en oeuvre des dites stratégies » (Group de travaille « Stratégies paradoxales de l’AFCET)

This definition requires an analysis on how to represent, model, govern and exploit these relationships. A dialectic simplification can be excluded because it does not lead to the involvement and integration of stakeholders selected on the basis of entitlement (self selection and social verification). Dialogic (Morin 1991) is the mechanism which permits the preservation of stakeholder identity (group and individual) while promoting the creation of solutions which can be shared by all actors in the process (or at least by a wide enough majority necessary to operationalise). Dialogic implies social and individual sense-making (Weick 1975) as well as transdisciplinary consistence. (Letiche 1999). Both these components are promote trust which strengthens with every interaction.

In ago – antagonistic relationships trust is not a prerequisite rather the actors are often in conflict (more or less explicitly) because of local problems which are not necessarily related to the current issues. It should be noted that a result of multiple ago – antagonistic relationships is that it becomes more convenient to avoid action.

These situations appear to have few ways out. One possibility is change as a result of trauma. A crisis in the system occurs and the actors understand that the situation is nearing a point beyond which the conflict becomes senseless as there is no longer a stake (Crozier and Friedberg 1977). The conditions are therefore created for restructuring. A second possibility is the presence of a leader able to impose a vision and involve a wide group of actors.

In both cases the actors must understand the structure and logic of systems which are auto – eco – organised and of ago-antagonistic relationships. This is how their interactions (also symbolic ones – Burke 1968) become constructive, generate visions and projects which can progress.

Finally, there is the "direct" solution meaning that the actors themselves learn to reflect on their mental models and approach to modelling. The actors observe their actions and approaches how these change through interactions. The ability to analyse and the observation of system dynamics generates understanding at a meta-conceptual level which promotes a dialogic approach to ago-antagonistic relationships.

System Dynamics as a tool for managing complex multi-actor systems.

System Dynamics (SD) (Forrester, 1961, 1968a, b, 1969, 1971, 1973, 1992), offers a repertoire of tools and concepts to represent and model complex dynamic systems by analysing behavior through computer simulation.

These tools are:

1) A symbolic language which can be used to make sense of and communicate a conceptual image of a system. This language is fairly rich and allows relatively accurate representations.
    - 1.1 – identifies endogenous and exogenous variables
    - 1.2 - distinguishes between variables which represent the status of a system at a particular moment in time (level variables) and variables which describe the laws governing change during a defined period of time (flow variables).
    - 1.3 - highlights how information on the system's status reaches the decision-making units after having being clustered into so-called secondary variables. The construction of secondary variables means that the logic behind decisions must be made explicit.
    - 1.4 - Defines the boundaries of a system as internal-external communication points thus defining it as open from the point of view of thermodynamics (exchange of matter, energy and information with the external environment)
    - 1.5 - highlights cause-effect relationships with relative extremes allowing a graphic representation of ago-antagonistic relations. .
    - 1.6 - identifies the feedback circuits between variables which emerge from the modelling of web of cause-effect relations between the system variables.
2) Principles which help to generate hypotheses about relationships between the structure of feedback circuits and dynamic expressions of a system.
3) Software which allows the simulation of the system's behaviour testing its comprehensiveness, and integrity comparing the implications of differing representations. In this perspective a system dynamics model is not created to forecast the behaviour of a system but to understand the implications of different systemic representations. Therefore SD defines playing fields through the use of symbolic language and shared syntax which in their turn produce different metaphoric representations of reality. Secondly, they are also laboratories where the system under scrutiny can be governed since it is possible to anticipate the consequences of alternative strategies.

The complex management of an airport hub has been approached through SD methodology by simulating the hub itself. The model has two parts a qualitative-descriptive one and a quantitative one. The latter allows computer simulations of the consequences of different growth strategies which can then be used to foster debate among the actors which have mental models and languages which differ greatly and allowing them to use a common symbolic language with a shared syntax.

An airport management company can use the tool to forecast development strategies consistent with the structure of the user base and of competing airports. Moreover, it can help to understand which other actors can guarantee the best development for the airport On the other hand the airline's point of view can be an excellent tool to select an airport which can become a hub and to evaluate investments in production capacity and choices relating to the frequency of connections, number of destinations served or synchronizing connections. From the supplier of handling systems' point of view, the model is a tool which

allows an understanding of the involvement required and the type of structure and organisation required to satisfy the airport's customers. Finally, the model can be used to promote dialogue among the actors within the hub system and between them and external players such as local authorities, residents and public administration organisations. This therefore builds a platform for interaction and negotiation promoting the constant redefinition of the boundaries of the system itself.

Initial conclusions

The ago – antagonist relationships challenge the systemic modelling, but they lead the modeller to conceive, analysed and simulate co – evolving relations. In social sciences, ago – antagonism is not an objective character of phenomena; it is, in fact, the point of view of a representation system (SR). According to his / her aims, SR considers a relation as ago – antagonistic. This attribution might also be related to the represented system's objectives, in the case of action – research.

From a structural point of view, an ago – antagonist relationships shows the presence of a profound structure shared by the analysed variables. When the modelling is deeply enough, it is always possible to identify at least an ago – antagonist relationships between at least to variables.

This conclusion is similar to the metaphor that, at the end each island is a semi – island.

The SD helps the modeller to identify some ago – antagonistic relationships between the system's and the context's variables. It represents a language that the actors can share to reflect on their actions and act on their reflections.

Finally, SD models become leaving artefacts which interferer with both the ideas' world and phenomena sphere (Morin 1991). In other words, these models impact on the actors' representations, as well as on their interactions and meta – concepts.

A new research field is the modelling of the interactions between our models, our ideas and the represented phenomena[3].

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