Organizational Entropy - Case of Study: The Colombian Peace Process

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***Abstract*—Entropy is known as the second law of thermodynamics responsible for measuring chaos. However, we can also use it to measure the adaptability and effective organization of any organizational system. In engineering there has always been a dichotomy between quantitative and qualitative methodologies for problem solving. The proposal we developed in this paper is an heuristic that integrates both qualitative, structural analysis methodologies and quantitative, experimental software in addition to a Viability System analysis, an organizational pathology diagnosis, all this to offer decision makers of organizational complex systems tools to make better decisions based on limited information and limited resources.**

Keywords—Organizational Entropy, Sistemic Thinking, System Dynamics Estructural Analisis , Experimental Software, Viable Sistems, Orgaizational Pathologies, Dynamic Hypoythesis.

Introduction

Entropy is the second law of thermodynamics it states that systems tend to chaos over time. Organizational systems composed of people are not an exception, however within these organizations there are actors in charge of anticipating possible changes that may occur both inside and outside organizations and that may affect their functioning. This decision makers are in charge of avoiding that chaos an keeping the organization working.
Authors as Standfor Beer, Raul Espejo or Alfonso Reyes they talk about the importance of analyzing the viability of systems. to see that in complex systems there are 5 key areas necessary to ensure cohesion. (Appendix 2)

System dynamics seeks to explain system behavior through the interaction of feedback loops. This explanation is called "dynamic hypothesis" [22]

Several methods have been proposed to develop dynamic hypotheses in complex organizational system which can be classified between two main paradigms qualitative and quantitative. This paper presents a method that use elements of both perspectives to promote the ability to build dynamic hypotheses in addition to a viable system approach. Although many engineers prefer a quantitative approach, our heuristic proposal for decision making is to use both. start by using qualitative tools of structural analysis to then use quantitative tools of experimental software and simulation models

System Dynamics seeks that the scientific intervention in organizational complex systems will benefit from a rigorous explanation of how the behavior of a system is explained from its structure.

Studying the most recognized methodologies of induction to critical thinking, systemic thinking or divergent thinking we choose 3 methodologies that combined could guide the construction of these explanations. This Methodologies are The Soft Systems Methodology from Checkland, The critical systems heuristic from Ulrich and the Interactive planning and Idealized design from Ackoff [28],[29] [37] Understanding the connection between behavior and structure is a central objective of systems dynamics [2],[3].This methodologies are The Soft Systems Methodology from Checkland, The Critical Systems Heuristic from Ulrich and The Interactive Planning or Idealize design by Ackoff.

However, and similarly to what happens in many disciplines, has a dichotomy has been developed between two approaches: qualitative and quantitative. In this article I present a method that I have been working for the last couple of years that seeks the development of dynamic hypothesis focused on the proposal of public policies or value propositions for private sector companies building skills from elements both qualitative and quantitative and integrating the ideas of viable systems and organizational Pathologies to diagnose organizations performance.

The article is organized as follows.

From a motivation originated in the dichotomy mentioned and the interest in seeking a middle point between the so-called approaches qualitative and quantitative and complement them with Viable systems diagnose to improve organizations performance. I will explain the methodology to build dynamic hypotheses public policies or value propositions that I am developing and illustrated its application with The Example of The Colombian Peace Process. and at the end we will make a small final reflection

Motivation

Colombia is a country that is recognize for having voted no to peace and no to the anti-corruption consultation. It is not something to be pround of, but it can be explained.
If you would ask any of the almost 50 million Colombians if they wanted peace they will all say yes but if you ask them if they wanted peace as it was imposed by the peace Nobel prize winner Juan Manuel Santos, the majority of voters said no. It is not very easy to explain but some engineering tools can help those decision makers whose decisions will affect us all the validate legitimize and give continuity to their projects.

System dynamics is an engineering tool that can help us explains the behavior of organizational complex systems from its structure, what it means to consider the interaction and dominance of the feedback cycles that compose them [4]. Therefore, the development of methods to build these dynamic hypotheses it is of central interest [2, 3]. The possibilities of how to do so vary across a large spectrum between two extremes: qualitative and quantitative. What we want to do in this case is creating a Methodology that includes both perspectives in addition to the viable system and organizational Pathologies.

I. ENTROPY

Nature, the Universe, our own existence is ruled by laws that are well known, laws that nothing and nobody can escape. This Laws are extremely precise, so precise they are expressed throw the language of mathematics. Laws of nature we are yet to discover cannot be that different from the ones we already know. We are getting close to completing a description of the universe and understand how it actually works.

Nevertheless, the scientific community had overlooked something until now: The strange and deep relationship between those laws and complex organizations behavior. We are about to find out how these laws of physics can be applied to the organizations we are a part of. And including, especially those of a much lesser known discipline: thermodynamics. As the name indicates, thermodynamics is the study of the movement of heat, specifically, the ways in which energy is transformed because as you know energy can take many forms.

In case of organizations, energy is transferred in the form of resources, tasks, communications, responsibilities among many others. Energy is passed on in the organizations from the heads or decision makers to those responsible and executors through a chain of command a communication chain. Authors such as Stanford Beer, Raul Espejo and Alfonso Reyes study the viability and cohesion of these systems and the relation between their parts.

The principles we are talking about not only rule our lives, but they also determine the fate of our organizations.

In order to discuss thermodynamics, we need to refer to a system. We can choose any organizational system formed by people, interrelated decision makers.

The first thing we must know is that all thermodynamic systems tend toward equilibrium. In this case equilibrium means dispersion of the particles in the system and the absence of activity, of heat exchange. Unfortunately, that´s what we tend to move towards. But extrapolating this to the organizations this means that if we do not intervene the systems they will tend to the disorder to failure and to disappear eventually. The job of decision makers as heads of this complex organizations is to make decisions that prevent their organizations to be disorganized to fail or to disappear they are in a permanent war against the second law of thermodynamics.

The second law states that the sum of the entropy of a system and its environment must always grow. In other words, disorder always increases. And this seems strange but what it really means is that when there is concentration of energy, naturally the universe is responsible for dissipating it effectively. Seeing it this way the decision makers of complex organizational systems are in a permanent war against the very laws that govern our universe

Now this happens also in organizations, the macro and micro environment of organizations is always changing, and this means that the heads of organizations must be constantly making decisions so that these organizations are able to adapt to these changes in the environment.

The success and failure of organizations depends then on the capacity and flexibility they have to adapt to changes.

At the head of organizations there are decision makers who accumulate energy, and they are responsible for the success or failure of an organization and are responsible for making decisions that affect many actors and key variables based on incomplete information and a provision of limited resources. It is not an easy job.

II. METHODOLOGY

As engineers we have many tools to face problems and among these tools are Systemic Thinking ,System Dynamics and Cybernetics.

In what we can call "dynamics of qualitative systems "we have the structural analysis approach there is no use of simulation and is defended by several authors as a good option enough to develop dynamic hypotheses and inferences of behavior intuitively from the polarities of structures of feedback [5-8]. Under this approach it is usually argued that reinforcement cycles produce divergent behaviors and that balance cycles

produce behaviors convergent [2, 9-12]. The so-called "simulation" mental "illustrates this position with the intention of "Speculate in a focused way" to intervene and redesign systems from said understandings For example, Wolstenholme suggests that the behavior can be estimated in simple cases identifying the polarity of the feedback cycles [9]; for more cases complex recommends following the effect of the changes of the variables in what he calls cycles "Major" feedback. Another example are the so-called "archetypes", i.e. descriptors of common patterns of behavior associated with interactions of specific structures of feedback [13-19]. Reflexibility properties states that has active actors of a complex systems our decisions affect our environment and the perception of changes in our environment is responsible for our decisions. It's a infinite feedback adaptative cycle.

III. Viable Sistems and Cohesion

The first step of the methodology I am proposing is the Viable Systems Model this is one of the main components of Organizational Cybernetics and one of Beer's best-known and most widely used contributions scope of the Theory of Organization [2] [3] [4] [5]. The advantages of its use lie in its systemic character, Comprehensive and multilevel, as well as its capacity for managing the dynamic complexity that surrounds the management of an organization and its interaction with the environment. It establishes the necessary and sufficient conditions that every organization must comply to be a system viable. In particular, the presence and proper functioning of a series of functions or subsystems identified as indispensable in any organization (System One, System Two, System Three, System Four and System Five) and one series of communication relationships between these functions or subsystems or between these and the environment in which operate

IV. Organizational Pathologies Diagnose

The second step in my methodology is the Organizational Pathologies. As we know from medical practice, detecting a pathology is essential when it comes to prescribing the treatment required for the diagnosed deficiency. In the case of organizations, a knowledge of all the most frequent pathologies, the individual characteristics of each one and the indications for dealing with them is in itself very useful for the managers responsible, as it enables them, on the one hand, to identify the problem rapidly and, on the other, to decide on how it might be dealt with. One class of diagnostic examples found in other areas of Systems Thinking employs common structures called "archetypes", which facilitate conversation among the managers involved to speed up the process of identifying the particular problem. In the case of OC, there are also studies with a similar aim

Structural Analysis

The Third step of th methodology is the structural analysis it consists on both the Checkland , Ulrich and Ackoff sistemic thinking methodologies, the Systems arquitipes defined by Braun and the inspection detail of the model, its structures of feedback, variables that compose it, equations, parameters and graphical functions and makes for the purpose of building a first dynamic hypothesis.

From this analysis, identifies the polarity of causal relationships between the variables, the polarity of the cycles of feedback and the possible function that can comply. The next heuristic summarizes the construction of the hypothesis structural dynamics:

a. to identify the initial values of the variables and parameters.
b. Identify the polarities of the links
causal
c. Identify the polarity of the cycles of
feedback and define its possible
functionality
d. Estimate the behavior of the variable in
cases in which it is not given (mode estimated). and.
e. Identify time intervals (stages) according to changes in the exchange rate of the variable (behavior patterns).
f. Study if any generic structure of Feedback can support construction of the hypothesis according to the given situation.
g. Build the dynamic hypothesis based on This element.

The construction of the hypothesis can begin with an explanation of why the pattern of initial behavior, that is to say beginning of the first stage (e); for this it is particularly useful to know the initial conditions of the system (a) and the polarities of the causal links (b) to identify the polarity and possible function that meet the cycles of feedback (c). With these elements and considering the rate of change of the variable (e), can propose what structure (s) of feedback is (are) responsible for encourage (booster cycle) or regular (cycle of balance) the variable of interest in that first interval of time either explanatory or in an estimative way (d).After the analysis of the first stage, it is possible propose the dominant cycles in the following stages (e) taking into account the functionality (c), the parameters, the equations and the functions table that are part of the cycles (a) and the rate of change of the variable of interest (e). From these elements are expected to establish what structures of Feedback can be mainly responsible for the behavior of the variable of interest for certain time intervals. With all the mentioned elements and once you establish the cycles that have action or dominance in each stage is built a first dynamic hypothesis through the elaboration of an explicit text that explains the behavior of the variable of interest. The next step is experimental simulation to confirm, reject and / or modify the dynamic hypothesis.

let's talk a little more in detail about the 3 methodologies that induce critical thinking and their synergies.

V. SOFT SYSTEMS METHODOLOGY

The first one is the Soft systems methodology (SSM) is an approach to organizational process modeling and it can be used both for general problem solving and in the management of change.

It was developed in England by academics at the University of Lancaster Systems Department through a ten-year action research program.

The methodology was developed from earlier systems engineering approaches primarily by Peter Checkland. The primary use of SSM is in the analysis of complex situations where there are divergent views about the definition of the problem. These situations are "soft problems" In such situations even the actual problem to be addressed may not be easy to agree upon.
To intervene in such situations the soft systems approach uses the notion of a "system" as an interrogative device that will enable debate amongst concerned parties. In its classic form the methodology consists of seven steps, with initial appreciation of the problem situation leading to the modelling of several human activity systems that might be thought relevant to the problem situation.
By discussions and exploration of these, the decision makers will arrive at accommodations over what kind of changes may be systemically desirable and feasible in the situation.
Later explanations of the ideas give a more sophisticated view of this systemic method and give more attention to locating the methodology in respect to its philosophical underpinnings. It is the earlier classical view which is most widely used in practice. [27]

7-stage representation of SSM:

1. Enter situation considered problematical
2. Express the problem situation
3. Formulate root definitions of relevant systems of purposeful activity
4. Build conceptual models of the systems named in the root definitions
5. Compare models with real world situations
6. Define possible changes which are both possible and feasible
7. Take action to improve the problem situation

VI. CRITICAL SISTEMS HEURISTIC

The second methodology is the Critical systems heuristics [28-35] is a framework for reflective practice based on practical philosophy and systems thinking. The name stands for three major concerns.

First, the aim is to enhance the critical competence not only of well-trained professionals and decision-makers but also of ordinary people.

Second, reflective practice cannot be secured by theoretical means only but requires 'heuristic' support in the form of questions and argumentation tools that make a difference in practice.

And third, systems thinking can provide us with a useful starting point for understanding the methodological requirements of such an approach to reflective practice.

It actually make us question how rigorus our mental models are by asking 12 questions divided in 4 boundaries

SOURCES OF MOTIVATION
(1) Who is (ought to be) the client or beneficiary? That is, whose interests are (should be) served?
(2) What is (ought to be) the purpose? That is, what are (should be) the consequences?
(3) What is (ought to be) the measure of improvement or measure of success? That is, how can (should) we determine that the consequences, taken together, constitute an improvement?

SOURCES OF POWER
(4) Who is (ought to be) the decision-maker? That is, who is (should be) in a position to change the measure of improvement?
(5) What resources and other conditions of success are (ought to be) controlled by the decision-maker? That is, what conditions of success can (should) those involved control?
(6) What conditions of success are (ought to be) part of the decision environment? That is, what conditions can (should) the decision-maker not control (e.g. from the viewpoint of those not involved)?

SOURCES OF KNOWLEDGE
(7) Who is (ought to be) considered a professional or further expert? That is, who is (should be) involved as competent provider of experience and expertise?
(8) What kind expertise is (ought to be) consulted? That is, what counts (should count) as relevant knowledge?
(9) What or who is (ought to be) assumed to be the guarantor of success? That is, where do (should) those involved seek some guarantee that improvement will be achieved – for example, consensus among experts, the involvement of stakeholders, the experience and intuition of those involved, political support?

SOURCES OF LEGITIMATION
(10) Who is (ought to be) witness to the interests of those affected but not involved? That is, who is (should be) treated as a legitimate stakeholder, and who argues (should argue) the case of those stakeholders who cannot speak for themselves, including future generations and non-human nature?
(11) What secures (ought to secure) the emancipation of those affected from the premises and promises of those involved? That is, where does (should) legitimacy lie?
(12) What worldview is (ought to be) determining? That is, what different visions of 'improvement' are (should be) considered, and how are they (should they be) reconciled?

VII. IDEALIZE DESIGN

The Third methodology is the Interactive planning, as defined and disseminated on by Russell L. Ackoff, focuses on creating the future by designing a desirable present. Interactive planning is unlike other types of planning, such as reactive planning, inactive planning, and preactive planning.

This is because interactive planning is focused in systems thinking and is "based on the belief that an organization's future depends at least as much on what it does between now and then, as on what is done to it.[36]
The organization will then create its future by continuously closing the gap between its current state and its desirable current state. Interactive planning has three unique characteristics:[37]
Interactive planning works backwards from where an organization wants to be now to where it is now.
Interactive planning is continuous; it does not start and stop.
Interactive planning lets the organization's stakeholders to be involved in the planning process.
Interactive Planning has six phases, divided into two parts: Idealization and Realization.

With these methodologies we build mental models of the problems that affect us in complex organizational systems and we can try to identify predictable behaviors in those models.

VIII. SYSTEMS ARQUETYPES

The System archetypes are patterns of behavior of a system. Systems expressed by circles of causality have therefore similar structure. Identifying a system archetype and finding the leverage enables efficient changes in a system. The Systems Archetypes describe common patterns of behavior in organizations. As diagnostic tools they provide insight into the underlying structures from which behavior over time and discreet events emerge. As prospective tools, they alert managers to future unintended consequences. Collectively they challenge managers to consider the merits of fundamental solutions by making time an explicit variable in decision making.

The System Archetypes are highly effective tools for gaining insight into patterns of behavior, themselves reflective of the underlying structure of the system being studied. The archetypes can be applied in two ways - diagnostically and prospectively. [38]

1,Limits to Growth (Limits to Success)
2. Shifting the Burden
3. Drifting or Eroding Goals
4. Success to the Successful
5. Escalation
6. Fixes that Fail
7. Growth and Underinvestment
8. Tragedy of the Commons
9. Accidental Adversaries
10. Attractiveness Principle

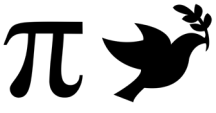
Quantitative Experimental Simulation Methodologies

IX. SYSTEM DYNAMICS SIMULATIONS

Once the dynamic hypothesis is constructed, it is used a simulation model to review the explanation of the behavior of the variable of interest. In the case where the structural dynamic hypothesis has been carried out in estimative mode, proceeds to simulate the behavior of the variable of interest with the help of a computational tool from a model provided. Based on this behavior it is possible to contrast what is estimated by analysis structural with what the simulator shows. In this case the experimental simulation is used to understand the functioning of feedback structures in the production of behavior of the variable of interest. At case in which the dynamic structural hypothesis is has carried out in an explanatory way the exercise of simulation is carried out to corroborate, contrast and complement the initial hypothesis about the explanation of the behavior of the variable of interest through functionality and the dominance of the cycles. The experimental simulation consists of performing a series of experiments in which they are made changes either in the structure or in the parameters of the model in order to modify and test the action and function of the cycles. Starting of these experiments is to identify changes in the behavior pattern of the (s) variable (s) of interest to evaluate if you are feedback structures are dominant or not in a certain stage. The results of the experiments allow to obtain information that supports, contradicts or complements the proposal initial dynamic hypothesis. The experiments are based on two types of tests, deactivation of cycles [4] and variation of parameters.

X. DEACTIVATION OF CYCLES

This test consists of deactivation systematic of individual cycles and subgroups of cycles, based on the guidelines of the method of evaluation of feedback cycles proposed by Ford [4]. To deactivate a cycle is temporarily canceled one of the causal relationships that make it up with the aim of temporarily disabling the feedback action of the same and examine its effect on the behavior of the variable of interest. It must be ensured that this link does not make part of another feedback



structure to be able to evaluate only the dominance of cycle to deactivate. To illustrate this procedure, consider a cycle Y and a couple of variables variable1 and variable2 that are part of of it (Figure 2). Between variable1 and variable2 there is a causal relationship that is characterized by an equation in which the variable1 depends on variable2. To undo temporarily the incidence of variable1 on variable2 is replaced in the equation of the variable1 the variable2 by a constant parameter at the modeler's discretion1.

Disabling a cycle can be done both at the beginning of the simulation, and starting of a time defined by the modeler, in the If you only want to deactivate the cycle from a certain stage. In this case we suggest replace the causal relationship by the value of the variable in the simulation time of the deactivation. Case of unique and shared links: A special case occurs when all the links of a cycle are shared with other cycles of feedback or when you can not cancel the incidence among the variables as occurs with the implicit causal relationships between flows and levels. When analyzing the results in this case, it must be kept in mind that when you undo a relationship causal of a cycle, the 1 This parameter can be the initial value of variable2, a average value, the value at which it stabilizes (if this occurs), or a value at some point in the simulation. cycle with which the link is shared. Huang et to propose alternatives to address this situation [25]. b. Variation of parameters: This test consists of the modification systematics of parameters and auxiliary variables that have a direct impact on a cycle, for evaluate its dominance in certain stages of behavior of the variable of interest. Sayings changes can modify the action of a cycle making it more or less dominant. The variation of parameters can be implemented at the beginning of the simulation, or from a time T defined by the modeler.

XI. Results and Analysis

The results of the application of the two tests allow observing the effects of cycles on the behavior of the variable (s) of interest. These effects can be

(i) null: the behavior remains the same as the original;
(ii) Of magnitudes: the pattern of behavior maintains but the magnitude (numerical values) is different,
(iii) The behavior: the pattern of behavior changes.

Yes when deactivating a cycle Changes in the pattern of behavior occur of the variable (s) of interest, it can be assume that this cycle is determinant in the original behavior of the variable. The conclusion about the dominance of a cycle in a determined stage will depend on the joint analysis of the results of the tests. it's possible perform multiple experiments and combinations of the two types of tests mentioned previously, and to do so there is no pre-determined heuristics. Finally with the results of the experiments is confirmed, rejects and / or modifies the action and dominance of the cycles defined with the structural analysis and it builds the new dynamic hypothesis. qualitative and contrasting this intuition with the Quantitative information provided by the simulation experimental.

XII. Aplication Case The Colombian Peace Process

Two years ago, the peace process between the government and the FARC guerrillas was signed in Colombia. This process hopes to end more than 60 years of armed conflict in the country. However, this peace process presents a challenge without precedents for the rulers in terms of the organization of a complex system responsible for maintaining this peace in the long term and ensure that the process is effective. To help in this challenge without precedents, the decision-making actors of this complex system are proposed to use the heuristic developed in the organizational Entropy model starting by making an analysis of the viability and cohesion of the current system a diagnosis of possible organizational pathologies, then the application of 3 methodologies to induce critical thinking of structural analysis to give possible qualitative solutions to the organization of the system to finally complement these with the use of experimental software and computational tools that allow us to generate valuable scenarios to help the heads of the organization to take better decisions. Entropy measures the disorder that reigns within a system and the role of the decision-making actors within these complex organizational systems is to maintain this low entropy to ensure the good performance of the companies to achieve this must be able to adapt effectively and be flexible. So we start by building a rich picture from the Colombian peace process as it is understand by different recognized authors. This is the input necessary to start using our methodology.

XIII. Reflections

The method, presented in this paper, seeks use systemic thinking methodologies , systems arquetipes and qualitative and quantitative elements to develop an endogenous explanation of behavior of a system. From the point of qualitative view, the structural analysis considers the structure of the model and the cycles of feedback as central elements. Also consider the possibility of examining generic feedback structures. From the quantitative point of view, the use of the simulation, the development of experiments and the use of deactivation techniques cycles and variation of parameters are elements that allow to complement the development of dynamic hypotheses. In the literature reviewed, we found that tends to advocate the use of approaches qualitative and quantitative in an exclusionary way and enough to tackle complex systems. Without However, this dichotomy can make development of skills in the construction of dynamic hypotheses and therefore thinking systemically On the one hand, the approaches Quantitative studies focus on formal methods analytics that may limit the scope of models to examine, likewise, the concern for the rigor in the data and the calculations, can result in very detailed models but that hinder the understanding of concepts and important dynamics for the

situation of interest. In addition, focus only on the simulation to understand the system, does not promote development of intuition and learning itself about the system. On the other hand, qualitative approaches with a greater concern to conceptualize and understand the complexity of the system can have greater difficulties to associate structure with behavior and to test what it is intuited or the so-called mental simulation. A) Yes same, the use of generic structures can tend towards the generalization and mechanization of development of dynamic hypotheses, which also can limit the learning and refinement of the intuition.

It is observed that each of the approaches makes important contributions to the development of skills in building hypotheses, proposing public policies or values proposals but also this dichotomy can mean obstacles to this development. What this work proposes for overcoming these limitations is to look for a balance between conceptualization and simulation. He proposed method seeks to take advantage of the analysis qualitative and the use of the computer for development of dynamic hypotheses and thus propitiate learning processes and systemic thinking. The development of an initial hypothesis and the exercise to use a simulator to reject that hypothesis propitiates learning processes on how the feedback cycles interact This process of confronting initial ideas with the simulator allows you to iterate over the cycle of learning proposed by Sterman [2].In this process, learning and understanding of the system, the function, action and interaction of the cycles in the production of behavior of the variable of interest, leading to more complete explanations that allow the construction of the new hypothesis dynamic. The method also emphasizes the use of experimentation that was one of the four pillars of Forrester [22] when he proposed the first frameworks of systems dynamics. The understanding provided by the dynamics of systems materializes in what we call dynamic hypothesis, i.e. the endogenous explanation of the behavior of a system from its structure. We consider that this association between structure and behavior promotes the development of systemic thinking and for construction of these explanations have been developed different methods that can serve as possible answers to the concerns raised by Maloney that we mentioned to the beginning of this article. The dynamics of systems requires tools and methods systematic to develop dynamic hypotheses that support the design of policies and value proposals to private enterprises;

REFERENCES

[1] Maloney, "Notes and insights on essential tension," System Dynamics Review, vol. 9, pp. 301-305, 1993.

[2] J. Sterman, Business Dynamics. Systems Thinking and Modeling for a Complex World. Boston, MA, USA., 2000.

[3] G. Richardson, "Problems with causalloop diagrams," System Dynamics Review, vol. 2, pp. 158-170, 1986.

[4] D. Ford, "A behavioral approach to feedback loop dominance analysis," System Dynamics Review, vol. 15, pp. 3- 36, 1999.

[5] E. Wolstenholme, "System dynamics in perspective," Journal of the Operational Research Society, vol. 33, pp. 547-556, 1982.

[6] E. Wolstenholme and R. Coyle, "The development of system dynamics as a methodology for system description and qualitative analysis. ," Journal of the Operational Research Society, vol. 34, pp. 569-581, 1983.

[7] E. Wolstenholme, "Qualitative vs quantitative modelling: the evolving balance," Journal of the Operational Research Society, vol. 50, pp. 422-428 1999

[8] A. Mejía, et al., "Ser directo puede traerte problemas, pero ser indirecto también: las realimentaciones en dinámica de sistemas cualitativa y cuantitativa.," in V Congreso Latinoamericano Dinámica de Sistemas, Buenos Aires, Argentina, 2007.

[9] E. Wolstenholme, System Enquiry: A System Dynamics Approach. New York, NY, USA: John Wiley & Sons 1990.

[10] G. Coyle, System Dynamics Modelling: A Practical Approach. London: Chapman & Hall, 1996.

[11] G. Coyle, "Qualitative and quantitative modelling in system dynamics: some research questions," System Dynamics Review, vol. 16, pp. 225-244, 2000.

[12] Venix, Group Model Building: Facilitating Team Learning Using System Dynamics. . New York, NY: John Wiley & Sons., 1996.

[13] Kim, Systems Archetypes Cambridge, MA: Pegasus Communications, 1993.

[14] W. Braun, "The System Archetypes," in The Systems Modeling Workbook, W. Braun, Ed., ed, 2002.

[15] Kim, "Predicting behavior using systems archetypes," The Systems Thinker, vol. 5, pp. 5-6, 1994.

[16] Kim, "Systems archetypes as dynamic theories," The Systems Thinker, vol. 6, pp. 6-9, 1995.

[17] P. Senge, The Fifth Discipline: The Art and Practice of the Learning Organization. Nueva York: Doubleday, 1990.

[18] Wolstenholme, "Towards the definition and use of a core set of archetypal structures in system dynamics," System Dynamics Review, vol. 19, pp. 7-26, 2003.

[19] A. Mejía and G. Díaz, "Tipos de arcos y hacia dónde disparan: Sobre la naturaleza y las posibilidades de los arquetipos " in IV Congreso Latinoamericano de Dinámica de Sistemas, México, 2006.

[20] G. Richardson, "Problems for the future of system dynamics," System Dynamics Review 12(2): 141–157, vol. 12, pp. 141- 157, 1996.

[21] Homer and R. Oliva, "Maps and models in system dynamics: a response to Coyle," System Dynamics Review, vol. 17, pp. 347-355, 2001.

[22] Aceros et al., 9º. IX Congreso Latinoamericano de Dinámica de Sistemas y II Congreso Brasileño de Dinámica de Sistemas, 2011 13

[23] J. Forrester, "Preview of Feedback Dynamics," in Principle of Systems, ed Walthman, MA: Pegasus Communications, Inc, 1971, pp. 2.1 - 2.39.

[24] N. Forrester, "Eigenvalue Analysis of Dominant Feedback Loops," in 1st International Conference of the System Dynamics Society, Chestnut Hill, United States, 1983.

[25] H. Geert, "Generalised Loop Deactivation Method," in 26th International Conference of the System Dynamics Society, Athens, Greece, 2008.

[26] J. Huang, et al., "An Extension of Loop Deactivation in the Behavioural Method," in 28th International Conference of the System Dynamics Society, Seoul, Korea., 2010.

[27] M. Mojtahedzadeh, et al., "Using Digest to implement the pathway participation method for detecting influential system structure. ," System Dynamics Review, vol. 20, pp. 1-20, 2004.

[28] Checkland, P.B. (2001) Soft Systems Methodology, in J. Rosenhead and J. Mingers (eds), Rational Analysis for a Problematic World Revisited. Chichester: Wiley

[29] Ulrich, W (1983). Critical Heuristics of Social Planning: A New Approach to Practical Philosophy. Bern: Haupt. Paperback reprint edition, Chichester: Wiley 1994. (Note: the 1994 edition is still in print).

[30] Ulrich, W (1987). Critical heuristics of social systems design. European Journal of Operational Research, 31, No. 3, 276-283.

[31] Ulrich, W. (1993). Some difficulties of ecological thinking, considered from a critical systems perspective: a plea for critical holism. Systems Practice, 6, No. 6, 583-611.

[32] Ulrich, W (2000). Reflective practice in the civil society: the contribution of critically systemic thinking. Reflective Practice, 1, No. 2, 247-268.

[33] Ulrich, W (2002a). Critical systems heuristics. In H.G. Daellenbach and R.L. Flood (eds), The Informed Student Guide to Management Science, London: Thomson, 72f.

[34] Ulrich, W (2002b). Boundary critique. In H.G. Daellenbach and R.L. Flood (eds), The Informed Student Guide to Management Science, London: Thomson, 41f.

[35] Ulrich, W (2003). Beyond methodology choice: critical systems thinking as critically systemic discourse. Journal of the Operational Research Society, 54, No. 4 (April), 2003, 325-342.

[36] Ulrich, W (2006). Critical pragmatism: a new approach to professional and business ethics. In L. Zsolnai (ed.), Interdisciplinary Yearbook of Business Ethics, Vol. I, Oxford, UK, and Bern, Switzerland: Peter Lang Academic Publishers, 53-85.

[37] Ackoff, Russell L. "A brief guide to interactive planning and idealized design." 31 May 2001. Linkoping University. 26 October 2008. Ackoff Guide to Idealised Redesign.

[38] Ackoff, Russell L. Re-creating the corporation: A design of organizations for the 21st century. New York:Oxford University Press, 1999.

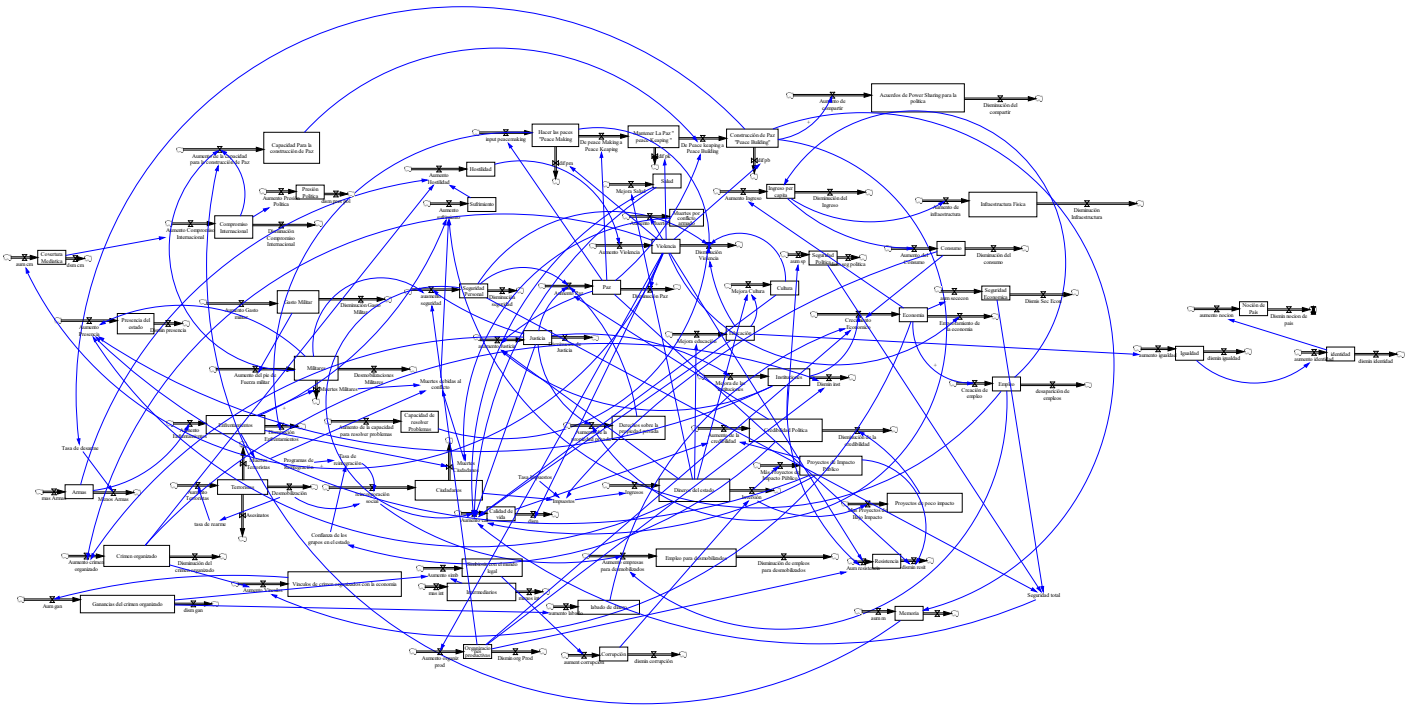
[39] Braun, W. (2002). The System Archetypes. In: Braun, W., The Systems Modeling Workbook

[40] Puche Regaliza, J. C. (2012). Cibernética Organizacional: Modelo de Sistemas Viables. Aula DYNA Julio, Vol. 87 No.4.

[41] Ríos, J. P. (2012). Pathologies of Organisations. En Design and Diagnosis for Sustainable Organizations (pp. 141-170). Springer Berlin Heidelberg.

Appendix 1

Enriched Picture of the Colombian Peace Process



Source: self made

Appendix 2

Viable System organization

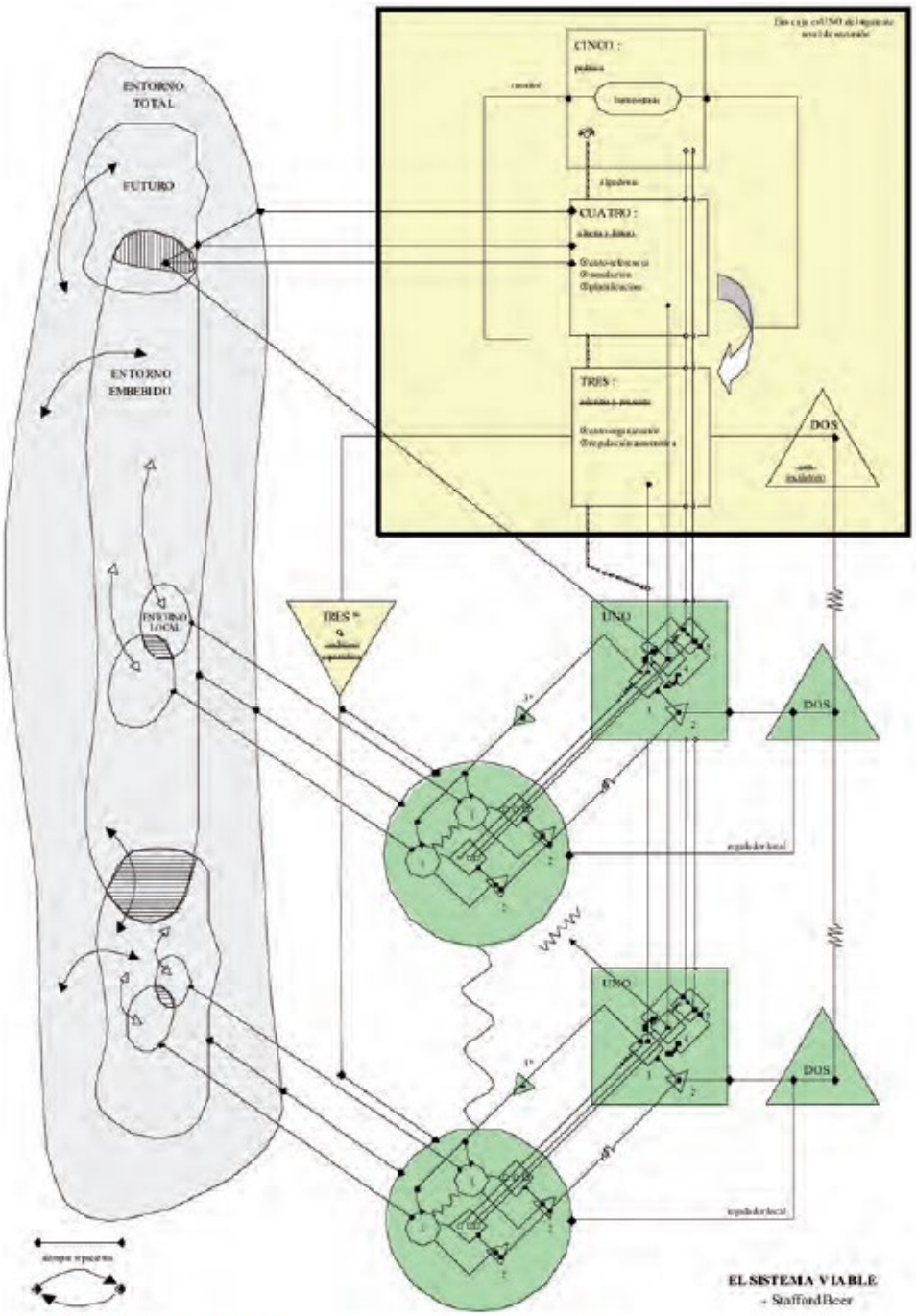
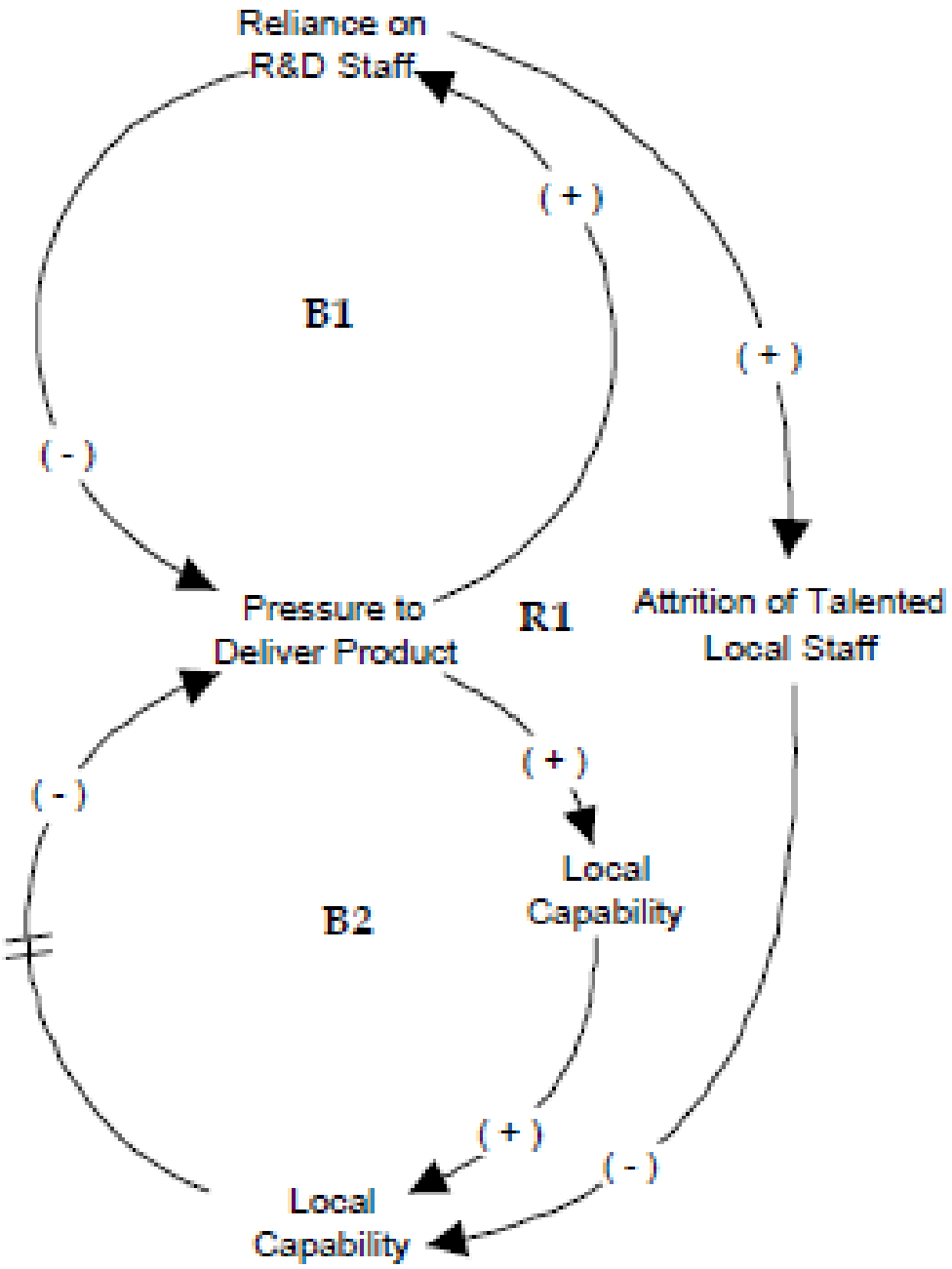


Fig. 1: Modelo de Sistemas Viables [5]

Appendix 3



Source: System Arquetypes Braun 2002