The current issue and full text archive of this journal is available at
www.emeraldinsight.com/0368-492X.htm

Models of organizational cybernetics for diagnosis and design

José Pérez Ríos
University of Valladolid, Valladolid, Spain

Abstract

Purpose – The purpose of this paper is to introduce a framework, based on Beer's viable system model (VSM) that enables managers of public and private organizations to cope with the complexities faced by their organizations.

Design/methodology/approach – Based on concepts from organizational cybernetics (OC) concepts, an heuristic is elaborated for the design or diagnosis of any organization, from the point of view of its viability.

Findings – An outline of the process that enables managers to diagnose or design the organization they manage is formalized in a structured sequence which, starting with the clarification of an organization's identity, purpose and boundaries, guides the whole process of structure creation and the detailed diagnosis of all its structural components from the point of view of its viability. A taxonomy of frequent pathologies that affect organizations is also presented.

Practical implications – This kind of framework can guide managers to apply the cybernetic concepts for higher organizational performance, thereby overcoming the oft-bemoaned difficulties in applying these concepts in practice.

Originality/value – The paper tries to fill the gap between the conceptual deep theoretical works in OC by Stafford Beer and other researchers, and the need of managers for a structured process that can guide their application. The framework presented tries to provide that kind of guide. It integrates different components within a single framework, which covers the creation of the general structure, the diagnosis of each particular organization within it, the evaluation of the degree of coherence between organizational levels, and a taxonomy of organizational pathologies to facilitate such a structuring. Another contribution is the introduction of the VSMod software, created precisely to facilitate the implementation of the VSM.

Keywords Organizational analysis, Cybernetics, Modelling, Public sector organizations, Private sector organizations, Corporate identity

Paper type Research paper

1. Introduction

As the Conant and Ashby theorem makes clear Conant and Ashby (1970), the quality of the decisions made by managers is limited by the quality of the models they use. The current turbulent environment in which managers must carry out their activity requires that they use adequate models for the task. Contributing to their need in that sense is the main purpose of this paper. We will lay out a frameworks based on a systemic approach, specifically on Beer's organizational cybernetics (OC) and his viable system model (VSM). This framework is aimed at helping managers of any organization or enterprise, public or private, to diagnose or design an organization in order to ensure its viability.

This work has been supported in part by the Ministerio de Educación y Ciencia (Plan Nacional de investigacion cientifica, desarrollo e innovacion tecnologica) of Spain. Ref.: SEJ2006-06972/SOCI.

Kybernetes
Vol. 39 No. 9/10, 2010
pp. 1529-1550

0368-492X
DOI 10.1108/03684921011081150

The need for a systemic approach has been accentuated due to the changes happening in the world in the last decades of the twentieth century and the beginnings of the twenty-first, some of them, notably the current economic and financial crisis, quite virulent. The qualification of this crisis as "systemic" by analysts (Niño Becerra, 2009) may be linked to the fact that the concepts of *systemic thinking* and *systemic management* have been adopted increasingly, aptly for our purposes. Systems thinking provides an intellectual framework quite useful for coping with some of the numerous problems facing humanity (ecological disasters, unequal distributions of wealth, migratory movements, climate change, etc.) as well as organizations and companies (the impact of globalization, financial and economic crises, delocalization, the impaired functioning of justice or health systems, etc.). These hugely complex problems, that is, problems dense with variety, require "adequate" tools for their treatment. But the "models" that have been used to deal with these problems have not always evolved a complexity commensurate with them.

Among the various theoretical developments available today for dealing with these kinds of problems, those provided by the systemic approach are particularly suitable. Over the last few decades, this field has experienced considerable growth. If we take as just one example, the case of systems approaches to management, we can track the far-reaching evolution that took place in the second half of twentieth century. Midgley (2000), for example, identifies three main waves within systems thinking. The first wave is exemplified by systems engineering, systems analysis and the early version of system dynamics. The first-wave approaches were later criticised for considering the models of problematic situations as representations of reality, and for giving insufficient consideration to the individual's perception of that reality. The second wave of systems thinking emphasised dialogue and the inter-subjective construction of realities. Some representative approaches in this wave are strategic assumption surfacing and testing, soft systems methodology, interactive planning, etc. By the end of the 1980s, a third wave of systems thinking appears, as the outgrowth of critiques brought to second-wave approaches for what was seen as their inadequate treatment of power relations. One example of this approach is critical systems heuristics. Another aspect, in the same wave, concerns a growing interest in using multiple methodologies in the same study.

The relatively recent eruption of new approaches to studying complex problems is exemplified by agent-based modelling, which through a bottoms-up approach tries to understand the emergent behaviour of a system generated by the behaviour of the individuals who compose it, and the interactions among them and with the environment. This approach complements the ones mentioned previously (Pérez Casares *et al.*, 2008).

From this great diversity of approaches available within the systems field, in this work, we will focus particularly on Beer's OC and VSM. We have selected these because OC and VSM are particularly powerful in facilitating the design or diagnosis of organizations from the point of view of their viability. A detailed study of their strengths and limitations is beyond the scope of this paper but has been carried out elsewhere (Schwaninger and Pérez Ríos, 2008b).

After clarifying the conceptual foundations of this work, I shall underline, as this paper's main purpose, the introduction of a framework based on Beer's VSM that affords the managers of both public and private organizations the ability to cope with the complexities faced by their organizations. This will be done by means of an heuristic which, based on the principles of OC, guides the process of diagnosing and designing an organization.

This work tries to fill the gap between conceptual depth of the theoretical works in OC by Stafford Beer and other researchers, and the need of managers for a structured facilitative process that can guide application. The framework, in providing such a guide, integrates different components within its single view, which covers the creation of an organization's general structure, the diagnosis of each particular organization within it, the evaluation of its coherence between organizational levels, and a taxonomy of pathologies, to facilitate diagnosis.

The paper is structured as follows. After a brief introduction to OC, I shall present the principal components of the proposed framework to facilitate the application of OC to the design or diagnosis of an organization. Once I have clarified the main steps of the OC application process, I shall briefly present some of the more frequent pathologies affecting organizations. The paper ends with a set of conclusions.

Before getting into the description of the framework, let us review some of the key elements of OC.

2. Elements of organizational cybernetics

OC makes reference to one of the systemic approaches, from Wiener's (1948) "cybernetics", which applies the cybernetic principles related to "communication and control" to organizations. Stafford Beer founded the theoretical and methodological development of OC. A thorough review of his gigantic work can be found in the Laudatio of Beer (Pérez Ríos, 2001) pronounced at the occasion of his investment as Dr Honoris Causa by the Universidad de Valladolid.

In this work, I will mention only some of the main aspects of OC which are helpful to understand my methodological framework, namely: the concepts of viability and variety, the Ashby law, the Conant-Ashby theorem and the VSM (Pérez Ríos, 2008b and d):

(1) *Viability*. This term refers to the capacity of an organism to maintain a separate existence, that is, to survive regardless of the changes in its environment. For that, it must have the capacities of self-regulation, learning, adaptation and evolution.

(2) *Variety*. This concept has been used by Ashby to indicate the level of complexity of a system (organization, company, etc.). It refers to the number of possible states and actual or potential behaviours that a situation or problem may contain.

(3) *Ashby's law of requisite variety*. Ashby (1956) establishes that "only variety can destroy (absorb [as reformulated by Stafford Beer]) variety".

(4) *Conant-Ashby theorem*. Affirms: "Every good regulator of a system must be a model of a system" (Conant and Ashby, 1970). In the context of evaluating the managers' decisions, this means that the quality of those decisions will be limited by the kind and quality of the models they use. Those models must have requisite variety to deal with the pertinent situation.

(5) *Viable system model*. In this model, Beer (1979, 1981, 1985, 1989) establishes the necessary and sufficient conditions for the viability of an organization. These are related to the existence in an organization of a set of systems or functions named by Beer as System 1, System 2, System 3, System 3*, System 4 and System 5, as well as a set of relationships among these functional systems and the environment. In Figure 1, we have a representation of the VSM.

System 1 is responsible for producing and delivering the goods or services produced by the organization. In the example shown in Figure 1, System 1 is made

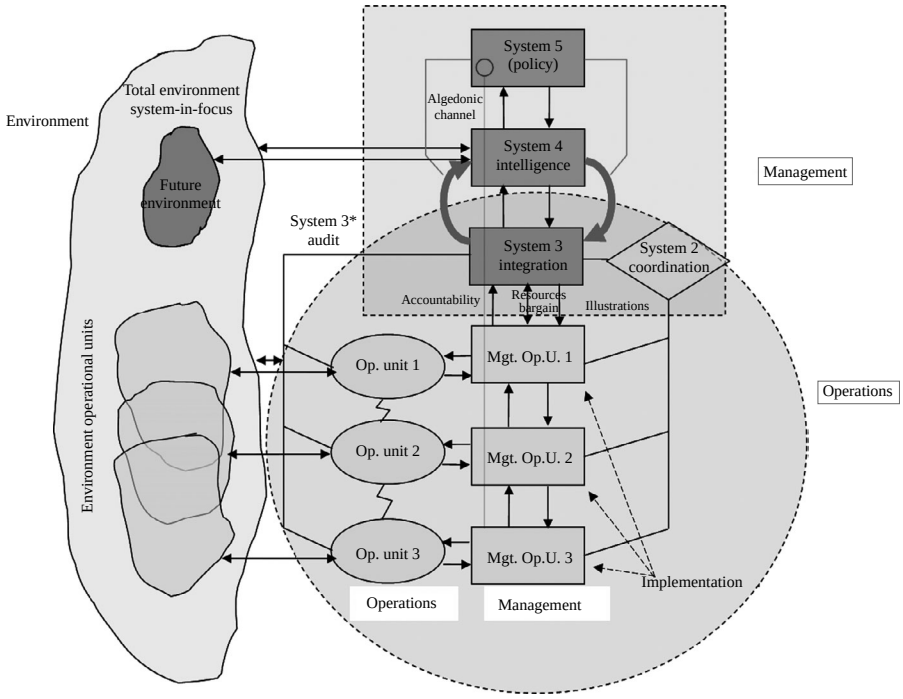
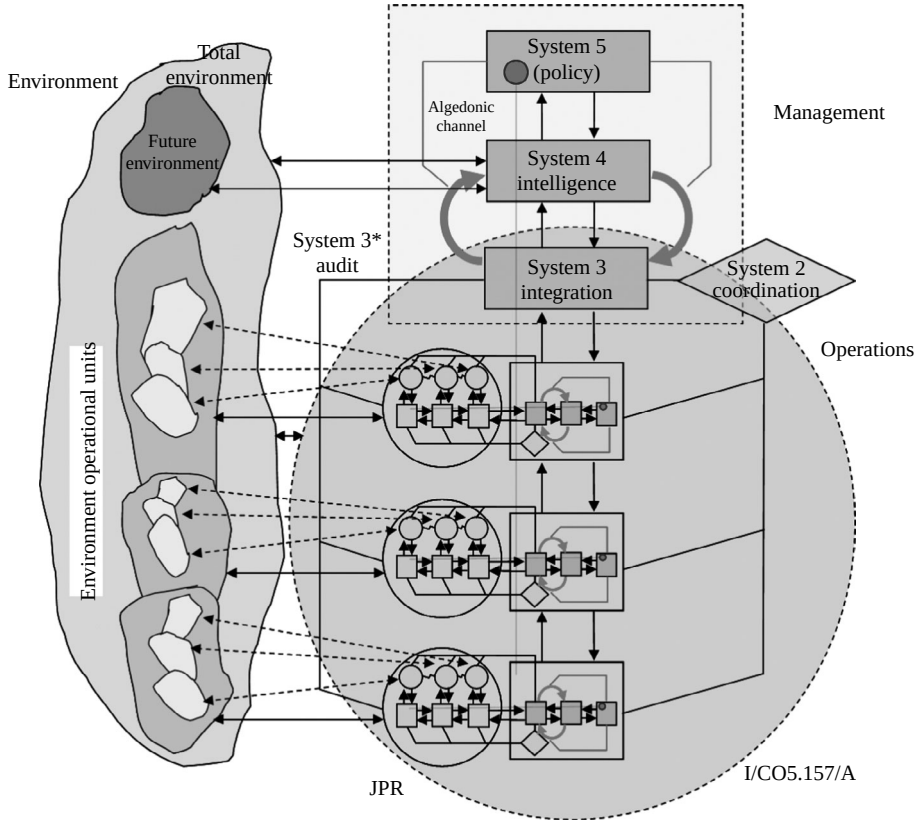


Figure 1.
Viable system model

Sources: Adapted from Beer (1985); Pérez Ríos (2008d)

up of three elemental operational units (Op. Unit 1, 2 and 3), which can be divisions of a company, sub-organizations, etc. The main role of System 2 is to guarantee a harmonic functioning of the organizational units, which compose System 1. System 3 is responsible for optimizing the functioning of the whole set of System 1, made up of the different operational units. We can say that it is responsible for the "here and now" of the organization. The chief responsibility of System 4 has is to monitor the overall environment of the organization. It takes care of the "outside and then" of the organization, with the aim of maintaining it in constant readiness to change. Models of the organization's behaviour built with Forrester's system dynamics (Schwaninger and Pérez Ríos, 2008a) are proven instruments for exploring the possible implications that different strategies, under different scenarios, may have for the organization. System 5 takes care of normative decisions, and is responsible for defining the ethos, the vision and the identity of the organization. Communication channels are responsible for connecting all those systems or functions, as well as linking the organization with its environment. Particularly relevant are the algedonic channels, whose role is collecting and transmitting to System 5 information critical for the viability of the organization.

(6) *Recursive character of the VSM.* Another fundamental aspect of the VSM is the recursive character of viable systems. All viable systems contain viable systems and are themselves contained in viable systems. In Figure 2, we can see how, inside the ellipses and rectangles, which represent the elemental operational



Sources: Adapted from Beer (1985); Pérez Ríos (2008d)

Figure 2.
Viable system model, showing a second level of recursion

units, an exact replica of the system in focus is contained (turned 90°). The most important aspect of the recursive conception of viable systems is that no matter which place they occupy within the chain of systems, they must always, in order to be viable, contain the five systems or functions that determine viability.

(7) *Organizational pathologies.* We have summarised the main elements of the VSM. We must now indicate that any shortage within the five systems, due either to some of them being absent, or to a malfunction in any one of them, or to deficient design of the communication channels that connect them, will produce an organizational pathology: the organization either will not work properly or even disappear, at least as an independent entity. The variety of pathologies which most frequently appear in organizations have been analyzed by Beer (1989), Schwaninger (2005) and Hetzler (2008), and have been classified comprehensively by Pérez Ríos (2008c and d) into three main groups:

- structural pathologies;
- functional pathologies; and
- informational pathologies.

Once one is familiar with the main components of OC, one can begin to see how it can be applied to the diagnosis and design of an organization from the point of view of its viability.

3. Framework for the diagnosis and design of organizations

The use of the VSM for the diagnosis or design of organizations has been explored by various authors in addition to Beer (1979, 1981, 1985, 1989). These include, among others, Clemson (1984), Espejo and Harnden (1989), Flood and Jackson (1991), Espejo and Schwaninger (1993, 1997), Espejo *et al.* (1996, 1999), Yolles (1999), Jackson (2000), Schwaninger (2009) and Pérez Ríos (2008d).

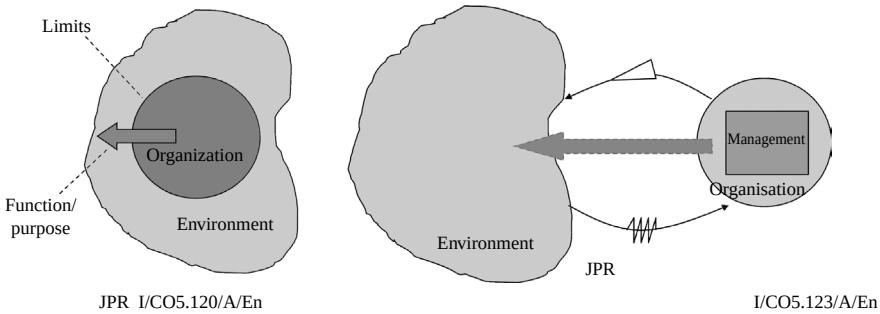
In addition to the authors mentioned, and others who might also be cited, several scientific journals as *Kybernetes*, *Systems Research and Behavioral Science* and *Systemic Practice and Action Research* have dedicated special issues to this matter. Among the most recent special issues are the double issue entitled "cybernetics in focus" in the *International Journal of Applied Systemic Studies* (Guest Editors: Pérez Ríos and Schwaninger, 2008) Vol. 2, Nos 1/2, 2008 and the special issue on "Action research in organisational cybernetics" in *Systemic Practice and Action Research* Vol. 22, No. 4, August 2009 (Guest Editors: A. Espinosa and A. Leonard).

In what follows, I will present how the proposed framework may help us in either designing a new organization or in the diagnosing an already existing one, from the point of view of its viability. This process is structured in four main steps.

The first step will be to identify the identity and purpose of the organization. In it, we will try to assess what the organization is (and also what it is not), and what its purpose is or should be. In a second step, we will see how the organization faces its total environmental complexity (variety) by means of creating a vertical structure made up of sub-organizations, where each will be in charge of the different sub-environments of the entire context. In a third step, we explore each of those vertical levels, examining them for all the necessary and sufficient elements identified as such by OC and VSM, to see that they are adequately represented in all the organizations, sub-organizations, sub-sub-organizations, etc. in which we have unfolded the initial organization. The fourth and last step entails checking the degree of coupling among all organizations, sub-organizations, etc. at all recursion levels, with respect to the coherence among their respective identities and purposes. Owing to space limitations, I shall concentrate in this paper mainly on the first and second steps.

3.1 Identity recognition

The foundational step is to identify the organization we wish to study/create, which means making explicit its identity and purpose (Figure 3). The question of what an organization or system is, however, whether we design or study it, may be not easy. A clear answer to that question also means specifying what the organization or company is not (Schwaninger, 2009, p. 151). Both aspects will help us to clarify what belongs to the organization and what is in its environment. In the current business world, where in many cases some activities of a company (like R&D, design, manufacturing, distribution, etc.) are located in different places around the world, the clear delimitation of what belongs to the company and what to the environment may be difficult to discern. However, such a boundary definition is necessary in distinguishing identity and purpose. Concerning the organizational purpose, Beer's dictum, that "the



Note: Interaction between the organization, with its management, and the environment

Figure 3.
The organization in its environment

purpose of the system is what it does", reminds us that different observers may attribute different purposes to the same organization (or system). Authors such as Checkland (1981), Checkland and Scholes (1990) and Espejo *et al.* (1999), among others, have dealt with this particular issue.

Once the boundaries of the organization, along with its identity and purpose, have been clarified, the next step is to identify the relevant environment where our organization carries on its activities. In relation to this aspect, we must bear in mind that we need to get information not only about the *present* environment, but also the *future* one. In this case, issues like those related to technological changes, legislation, ecological considerations, new potential competitors, markets, products, etc. may have to be taken into consideration.

To summarize, we can say that in relation to the environment we should:

- identify the environmental areas relevant for our particular organization;
- for each area, differentiate the information related to the present from that related to the future;
- identify information sources, as well as the temporal cadence for capturing data in each case;
- define the "sensors" that will be used to capture the information in a continuous mode related to each of those areas; and
- clarify the communication channels which will be used in each case and where and how the information obtained will be shown inside the organization.

Once we have identified the organization, its limits and the environment (present and future) in which it operates, and have also reviewed the necessary elements for capturing, transmitting and visualizing the information related to those environmental aspects relevant (residual variety) to the organization (Espejo, 1989), we are in a position to study the organization and evaluate its capacity to meet its purposes, or (if we are dealing with a new organization) to design it.

To help us in either task, we will use two specific dimensions, the vertical and horizontal (Figure 4).

In the vertical dimension, we deal with the total environmental variety (complexity) faced by the organization, by identifying sub-environments within the total environment, and, if necessary, sub-sub-environments, etc. At the same time, we will

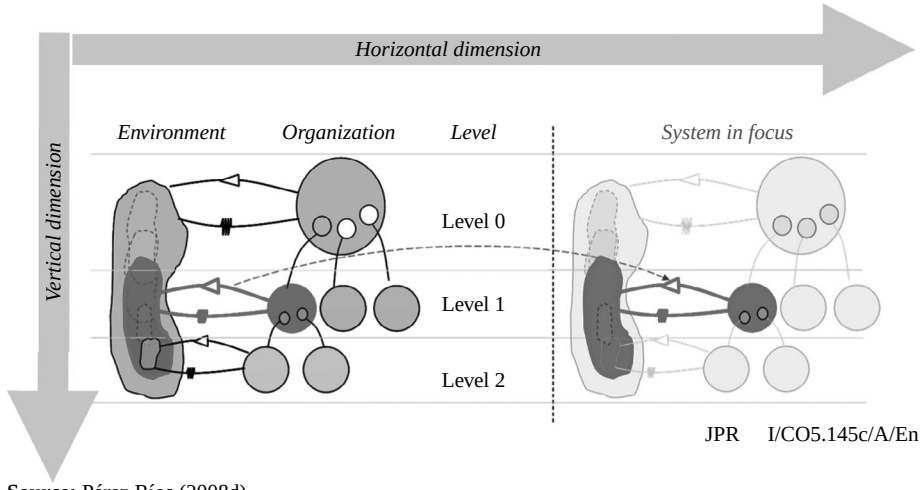


Figure 4.
Vertical and horizontal dimensions of the system object of study

Source: Pérez Ríos (2008d)

identify (or create) the corresponding organizations, which will handle the varieties of each of those sub-environments. This process is called by Espejo (1989) "complexity unfolding". The idea of this process is to enhance the capacity of the organization to absorb complexity is in consonance with the complexity faced.

In the horizontal dimension, we focus on the different levels at which the organization in its environment unfold. Once we have selected a particular level, we identify the particular environment and the organizational unit that will operate in it, i.e. the "organization in focus" (or "system-in-focus"). When studying that organization in detail, we must examine its environment, the organization itself, its management and the relationships among them.

In what follows, we shall explore the unfolding of an organization in the vertical dimension.

3.2 Criteria and recursion levels. Complexity unfolding

Once the purpose of the organization and the environment in which it operates or will operate are clarified, we must see if the organization is able to deploy an amount of variety at least equal to the variety of the relevant environment (Ashby's law). As vertical complexity unfolds, the smaller complexity (variety) of the sub-environments can be matched by the smaller organizations at the different levels.

This vertical unfolding will determine which sub-environments are of interest, and which organizations will handle these environments (Figure 5).

As we follow the unfolding process, all organizations that appear are (or should be) complete viable systems. The unfolding process must not be confused with a mere increase in the "resolution level" in photographic terms. The organizations in focus are not functional parts of the previous organization, but fully viable organizations as defined by the VSM. The diagram in Figure 5 shows four recursion levels, and how the second of the three units at recursion Level 1 unfolds in Levels 2 and 3.

The process of vertical unfolding can be carried out following different "criteria", depending upon the purpose of the study or intervention (i.e. geographical, commercial,

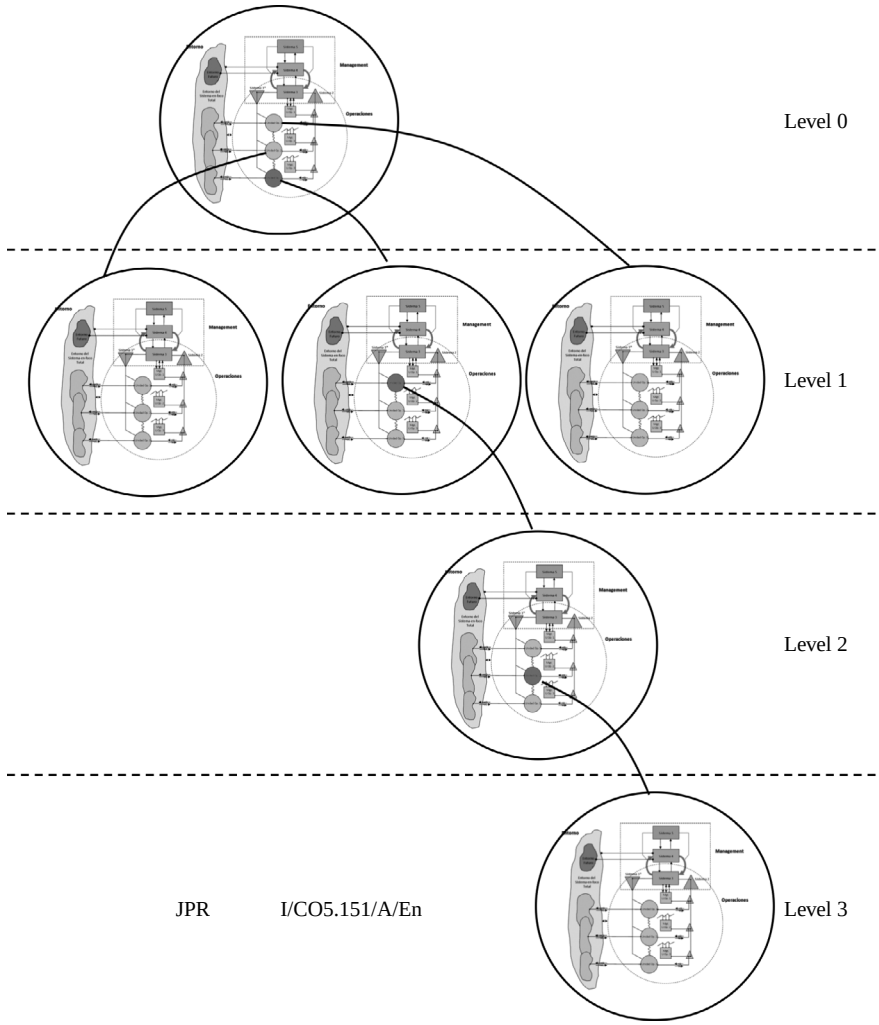


Figure 5.
Recursive structure of the VSM

political, etc.). The system-in-focus may also be in an intermediate position where several dimensions (recursion criteria) cross. The idea of visualizing the system-in-focus, as the centre of a sphere where the diameters are equivalent to dimensions, provides a "visual image" of an organization's global structure (Figure 6).

In relation to the multidimensional recursive character of the VSM, see the works of Beer (1989, pp. 227-55), Leonard (1989, p. 176) and Schwaninger (2009, p. 88).

If we select more than one recursion criterion, we find several vertical disaggregation paths. But it may also happen that in going down the recursion levels, and following a criterion, we may find it convenient to use different recursion criteria at different stages. This means that we would act as we were changing the "dimension" (recursion criterion). The same could happen later on with this new dimension, etc. I make this observation in

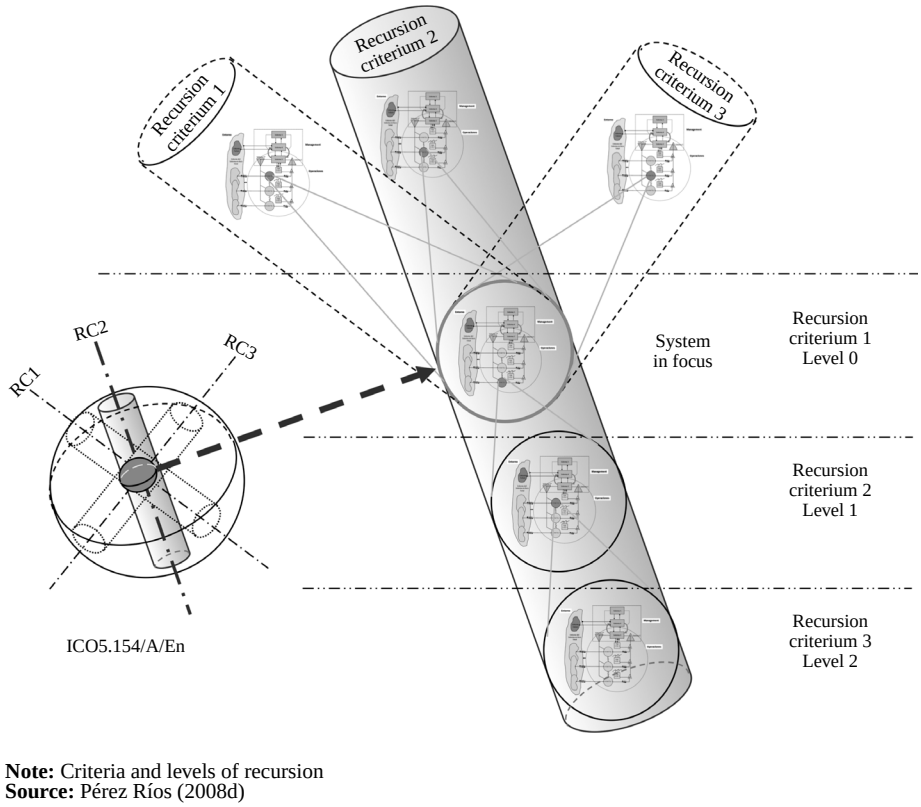


Figure 6.
The system-in-focus as centre of multiple dimensions

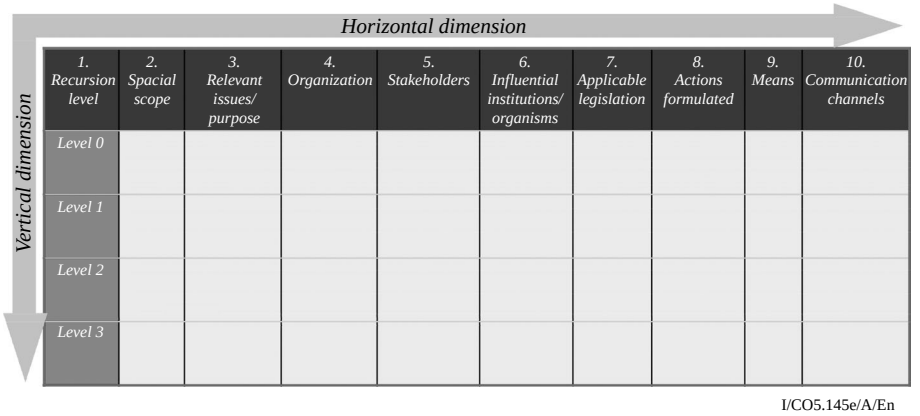
Note: Criteria and levels of recursion
Source: Pérez Ríos (2008d)

order to signal the difficulty that a VSM study may reach if the organization is big and complex. This difficulty can be eased by using specialized software, such as VSMod®, which facilitates this structure-creation and navigation process (Pérez Ríos, 2003, 2006, 2008a, b, c, d).

3.3 Recursion levels-critical factors matrix

Once we have accomplished the vertical unfolding of complexity, the next step will be to identify the main elements of the structure to be taken into consideration at each recursion level. This will allow us to clarify the specific purpose of the organization at each level, helping to guarantee that each of those particular purposes is recursively coherent with those of previous levels, up to the broad general purpose of the whole organization, and to make explicit the particular aspects to be taken into consideration at each recursion level. For that, we need first to select the recursion criteria that we are interested in and then build the matrix (Figure 7), which I call the *Recursion Levels-Key Factors Matrix*. Its rows show the recursion levels for the recursion criterion selected, and the columns show the main relevant issues to be considered at each level.

In the following list, some typical aspects to be included as components of the columns are enumerated. This is a kind of guiding "Decalogue" to help in applying the VSM. The number of columns and their content may vary, depending on the type of



Note: Critical factors matrix

Figure 7.
Recursion levels

study and organization. For each of the recursion levels (rows), the following structural aspects should be related (columns):

(1) Identification of the recursion levels (number and description).

(2) Identification of the specific environment for each organizational unit.

(3) Issues particularly relevant to be considered for the specific environment.

(4) Explicit description of the organization's purpose at the different levels.

(5) Identification of the relevant stakeholders.

(6) Identification of external agents whose decisions may favour or impede the execution of an organization's decisions as it aims to achieve its purpose.

(7) Individualization and description of the norms, regulations, legislation, etc. that establish and regulate the framework for actions at each level.

(8) Description of actions to be undertaken at each level. Here, one must differentiate if one is in a design or in a diagnosis mode. In the first case, the action should allow us to materialize the organizational purpose (at each level). In the second case, one can evaluate the adequacy of actions in process.

(9) Each action should be accompanied by the identification of the required means (what, who, how, when, where, by which means, at which cost, with which requirements, etc.).

(10) Description of the main communication channels that will be used to communicate with the environment. In particular, one should identify and check:

- the content of the information to be transmitted;
- the medium used;
- the existence of the communication channels; and
- if each communication channel has all the elements for proper function (sender, receiver, transducers, channels, etc. downstream and upstream, and all with enough capacity for the amount of information to be transmitted). For details, see Pérez Ríos (2008d).

3.4 An application

As an illustration of how the *Recursion Levels-Key Factors Matrix* can be used, we shall show some results of the application of the VSM at the top management level of a highly complex organization – a public university, specifically A Coruña University (UDC) situated in Galicia, Spain. The VSM and in particular the *Recursion Levels-Key Factors Matrix* have been used (and still are being used) by the Vice-Rector of Infrastructure and Environmental Management of that university, to shape the vice-rectorship's vision of the university, and to inspire its strategic, tactical and operational policies. A more detailed description of this work is documented in Pérez Ríos and Martínez Suárez (2007).

The work started in January 2004, when a new rectorate team took charge of the government responsibilities of the UDC, in particular with the designation of Dr Martínez Suárez (Architect and Urban Planning Professor) as the new Infrastructure and Environmental Managing Vice-Rector.

The application of VSM got underway by defining the purpose of the UDC and the geographic frame in which it should operate. The identification of the necessary recursion levels made possible the study and design of the required policies for each of them.

After defining the purpose of the UDC, its relevant environment (geographic area, institutional frame, etc.) was identified. The consideration of such aspects as, among others, the accessibility of the potential students living in this geographical area, or the university's cultural, social and economic integration in the urban region, indicated the use of five recursion levels: L-0 (Region of Galicia, Spain), L-1 (UDC's geographic region of preference service), L-2 (the A Coruña and Ferrol areas), L-3 (the A Coruña and Ferrol campuses) and L-4 (UDC's centres/buildings/facilities).

At each recursion level, the purpose (obviously framed by that of the UDC), the specific environment and all other key factors relevant for the case were identified (town-planning legislation, the existence of administrative structures for making decisions at that level, public or private enterprises with the capability to facilitate or impede attaining the purposes of the UDC, etc.).

Once the problem was structured and the information on the starting point was collected, from an institutional, town planning and ground and buildings use point of view, a first group of action proposals was elaborated (17 actions on town planning and 17 more on architecture).

With regard to the concrete actions stated so far, related in particular to the town-planning field, some of them appear in Table I, which shows how the *Recursion Levels-Key Factors Matrix* was used. The various recursion levels considered pertinent in that study are visible in the rows, while in the columns appear some of the components related to each key factor analyzed at the respective recursion levels. Since the project was still under development when the work (Pérez Ríos and Martínez Suárez, 2007) was published, some of the columns could not yet be specified in detail. In this example of the matrix, only one recursion criterion is shown (geographical space). Figure 7 shows a bi-dimensional image of the *Recursion Levels-Key Factors Matrix* containing the key factors (columns) that correspond to each recursion level (rows), but with only one recursion criterion being selected. Nonetheless, as noted before, another recursion criterion could be selected, and so we could build a matrix with more "depth", containing as many layers as there are recursion criteria. To make things even more complicated, we could change the recursion criterion at a certain recursion level, which would result in a complex image which cannot be represented two-dimensionally here.

1. Recursion level	2. Spacial scope	3. Relevant issues/purpose	4. Organization	5. Stakeholders	6. Influencial institutions organisms	7. Applicable legislation	8. Actions formulated	9. Means	10. Communication channels
0	Galicia Territorial Scale 1	Social function of the universities Relationship with the urban policy			Xunta de Galicia Consellerías: education, territorial policy, housing, environment and sustained development Universities: A Coruña.; Santiago de Compostela; Vigo	1. Act 10/1995 on Town and Land Planning of Galicia 2. Ground Building Act of Galicia (December 2002) 3. Act 11/1989 on Galicia University System Planning 4. University Act 6/2001 5. UDC Standing Rule	Contribution of the UDC to the Town-Planning Guidelines in Galicia (in progress) URB 16. (Campus Elviña) university residential area		
1	Urban Region A Coruña Ferrol Territorial Scale 2	Accessibility Range (number of potential students) Visibility of the UDC in the cities, small towns and villages Economic and social development of the urban region Connection with the business network			RENFE (Spain's Railway System) Cities: A Coruña; Ferrol and all the rest in the urban region UDC Xunta de Galicia (Commuting)		URB 1 Territorial accessibility: shire public transport suburban trains, and coach network URB 12 Parking lots Parking lots at railway stations URB 13 Bus, train station Campus Elviña URB 15 Research area Creation of new enterprises		

(*continued*)

Table I.
Recursion levels-critical factors matrix

Table I.

1. Recursion level	2. Spacial scope	3. Relevant issues/purpose	4. Organization	5. Stakeholders	6. Influencial institutions organisms	7. Applicable legislation	8. Actions formulated	9. Means	10. Communication channels
2	(a) Urban A Coruña	Accessibility Integration university/city			Cities of A Coruña UDC	Urban Master Plan of A Coruña (1995)	URB 2 Enlargement of urban coaches network		
	(b) Urban Ferrol	Cohesion university city Structuring of public equipments and urban services with the university			City of Ferrol	Urban Master Plan of Ferrol	URB 17 Bicycle lane pedestrian path from the city-centre to the campus		
3	(a) Campus A Coruña	Adaptation to the European Union directives on universities degrees Urban attraction Urban and architectonic referent (model of sustained development)			UDC City of A Coruña	Urban Plan for Elviña – A Zapateira Campus (1991) and its modification in 2002 Environment Plan	URB 11 Campus Centre URB 10 Area 30. Elviña Campus Coach URB 8 Redesign of Zapateira Square URB 9 Scientific-Technological Park Botanical Park URB 16 University residential area (Campus Elviña)		
4	Single buildings	Functionality Comfort and environment managing Optimizing spaces			UDC Institution Board		Actions at each particular centre		

Note: Universidade da Coruña (UDC)
Source: Pérez Ríos and Martínez Suárez (2007)

Fortunately, technology can help here, by replacing flat paper with a computer screen with the appropriate software, letting us visualize whatever level and recursion criterion we wish. This is what the VSMod® software (Pérez Ríos, 2003, 2006, 2008a, b, c, d) allows us to do[1].

In Figures 8 and 9, we have screenshots of this software. In Figure 8, the first column at left shows the recursion levels following the recursion criterion signalled at the right top corner of the column at right. That column allows the selection at any recursion level of the desired recursion criterion, so one can choose the *Recursion Levels-Key Factors Matrix* one wishes to show.

In Figure 9, the matrix selected we have it at the left and the tri-dimensional image of the total system structure is represented at the right. In the image at the right, the *x*-axis shows recursion criteria (at any recursion level). The *y*-axis refers to the organizational units at a certain recursion level, and the *z*-axis to the recursion levels.

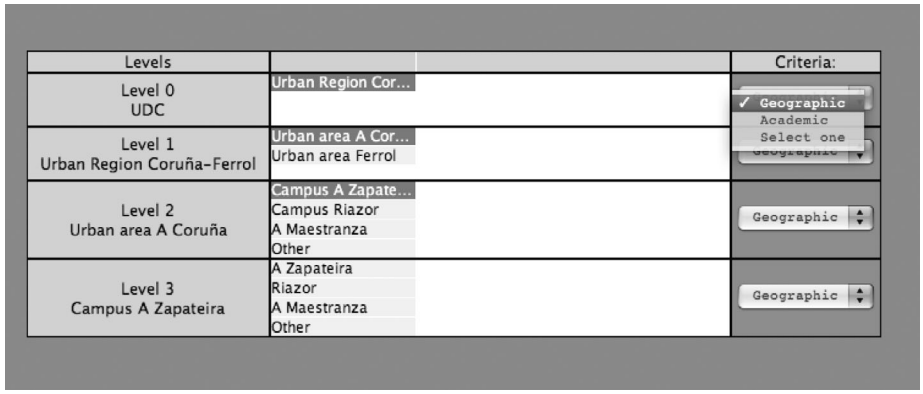


Figure 8.
Recursion levels and criteria selection

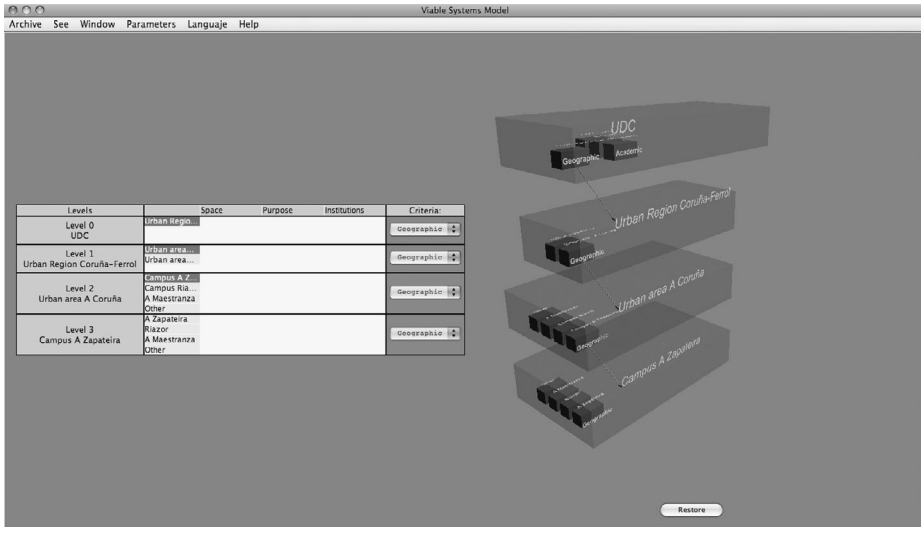


Figure 9.
Recursion Levels-Key Factors Matrix and image of the total structure

Simply by clicking on any element one can navigate through the multidimensional space and visualize any part thereof.

3.5 System in focus

Up to now, we have been studying the vertical dimension, exploring how an organization faces the total complexity by dividing itself into sub-organizations, each of which takes care of a portion of the relevant environmental complexity. We have seen how complicated this task can become when several recursion criteria must be used and the number of recursion levels is significant.

The next step in the process of applying the VSM consists in exploring in detail the horizontal dimension at each recursion level. As we signalled in Figure 2, this means verifying that each set of environment and organization fulfils the VSM viability requirements. The general term for an organization (or system) chosen for a detailed study is organization-in-focus (or system-in-focus). In a deep study of the organization-in-focus, with particular attention to the guarantee of viability, one should check to see that all necessary and sufficient elements specified by the VSM are present and working adequately. Specifically, each element will have to be checked as follows (Pérez Ríos, 2008d): System 1, System 2, System 3, System 3*, System 4, System 5, communication channels, algedonic channels (Figure 1), components of each channel, present and future environment contents, information capturing systems, etc.:

- In the first place, check to see that the element exists in the organization.
- Second, we must evaluate its quality. By this, we mean that once we have confirmed its presence, we must assess its degree of development that is to say to check if it has enough capacity to carry out its function.
- Third, we must confirm that, besides existing and having the capacity to carry out its task, that it really does it. This road test ascertains whether it accomplishes its function.

While the limitations of this paper prevent me from going further into detail, as well as describing the fourth step of the framework (checking the degree of coupling among all organizations at all recursion levels), there nonetheless exists a thorough description of the complete study process in Pérez Ríos (2008d).

4. Organizational pathologies

Once we have understood both the basic cybernetic principles and the main elements of the VSM, and have checked on how the organization faces the total relevant complexity of its environment with the help of the heuristic described in the previous section, we are in a position to diagnose the organization's health from the viewpoint of its viability.

Identifying a pathology is a prerequisite to prescribing any treatment for the diagnosed deficiency.

One finds examples within other systemic-thinking approaches of helpful guides to identifying problems, most notably the use of frequently found structural "archetypes", i.e. typical structural configurations (Senge, 1990). In the field of OC, a small number of works about organizational archetypes have elaborated on the pathologies of organizations (Beer, 1989; Schwaninger, 2005; Espejo, 2008; Hetzler, 2008). A rather comprehensive survey of the pathologies frequently found in organizations has been presented by Pérez Ríos (2008b, c), where they are classified in three main groups.

The first group includes pathologies related to organizations' structural design, and to how the organization copes with its total environmental complexity by creating the necessary sub-organizations. These are named structural pathologies.

The second group includes pathologies related to the adequacy of the organizations (at all recursion levels) to the prescription made by the VSM about functional subsystems and their relations. These are called functional pathologies. The third group subsumes information system and communication channel pathologies.

I must limit myself to giving an overview of the 26 pathologies. More detailed descriptions are found in Pérez Ríos (2008c, d).

I. Structural pathologies

The pathologies included in this group are related to an inadequate treatment of the total complexity faced by an organization. The organization and its relevant environment may indicate a division of the environment into sub-environments, and the same with the organization. This vertical unfolding of complexity enables it to comply with Ashby's law, each sub-organization having to deal with less complexity (variety).

The frequent pathologies in this context are related either to a lack of adequate complexity unfolding, or to the absence of organizations for handling the intermediate environment levels, or to unclear relations among organizations. The pathologies identified in this group are:

- *I1. Non-existence of vertical unfolding.* The lack of an adequate vertical unfolding, when needed, renders it difficult or impossible for a single large organization to deal with the total variety it faces.
- *I2. Lack of recursion levels (first level).* Vertical unfolding is accomplished, but the first recursion level is left empty. This leaves part of the total environmental variety unattended.
- *I3. Lack of recursion levels (middle levels).* Vertical unfolding is accomplished, but intermediate recursion levels are left empty. This leaves the corresponding environmental variety to be dealt with at either the next or the previous recursion level (which is difficult or impossible) or, even worse, to be handled by no one at all.
- *I4. Entangled vertical unfolding. Various interrelated level memberships.* Inadequate integration/communication between recursion levels when multiple memberships are present.

II. Functional pathologies

This group includes pathologies related to each of the organizations that compose the total organization. In each unit, one must check to see that all the essential functions (systems) necessary for the organization's viability exist and work adequately.

The following list enumerates the more frequent pathologies affecting each of the VSM functions (systems) as well as the whole organization (System 5, System 4, System 3, System 3*, Homeostat 4-3, System 2 and System 1). These functional pathologies are as follows:

- Pathologies related to System 5. Identity not defined or ill defined.
- *II1. Ill-defined identity.* Identity has not been sufficiently clarified or defined ("I do not know who I am").

- *II2. Institutional schizophrenia.* Two or more different identity conceptions produce conflict within an organization.
- *II3. System 5 collapses into System 3 (Non-existing metasystem).* System 5 intervenes undesirably in the affairs of System 3.
- *II4. Inadequate representation vis-à-vis higher levels.* Poor connection between System 5s organisations pertaining to different recursion levels within the same global organization.
- Pathologies related to System 4.
- *II5. "Headless chicken".* System 4 is missing or, if it does exist, does not work properly.
- *II6. Dissociation of System 4 and System 3.* The homeostat System 4 – System 3 does not work properly. Each component system carries out its function separately but does not communicate and interact as it should with the other system.
- Pathologies related to System 3.
- *II7. Inadequate management style.* System 3 intervenes excessively or inadequately in the management affairs of System 1. For example, an authoritarian management style constrains System 1's autonomy.
- *II8. Schizophrenic System 3.* Conflict arises between the roles of System 3 due to its simultaneous inclusion both in the system (operations) and the metasystem (management).
- *II9. Weak connection between System 3 and System 1.* The operational units composing System 1 work separately without being adequately integrated by System 3.
- *II10. Hypertrophy of System 3.* System 3 arrogates to itself too much activity, some of which should be carried out by System 3*, System 2 and System 1 directly.
- Pathologies related to System 3*.
- *II11. Lack or insufficient development of System 3 **.* The lack or insufficient development of a System 3* allows that undesirable behaviour and/or activities go on in System 1.
- Pathologies related to System 2.
- *II12. Disjointed behaviour within System 1.* A lack of adequate interrelations between the elemental operating units that conform to System 1 lead to their fragmentary behaviour.
- *II13. Authoritarian System 2.* System 2 shifts from a service orientation towards authoritarian behaviour.
- Pathologies related to System 1.
- *II14. Autopoietic "beasts".* Elemental operating units constituting System 1 behave as if their individual goals are the only reason for being. Regardless of any considerations transcending their interests, they ignore the need to harmonize their individual goals within an integrated System 1.

- *II15. Dominance of System 1. Weak metasystem.* The power of System 1 is not handled within the limits set by the metasystem (System 3, System 4 and System 5).
- Pathologies related to the complete system.
- *II16. Organizational autopoietic "beasts".* The uncontrolled growth and activity of some individual parts of the organization put the viability of the whole organization at risk.
- *II17. Lack of metasystem.* Insufficient or missing definitions of identity and purpose. A week or incomplete metasystem shifts the balance between the "outside and future" and the "here and now" management-oriented activities towards the "here and now", leaving adaptation-oriented activities unattended. Inadequate connections exist between organizations at different recursion levels.

III. Pathologies related to information systems and communication channels

Communication channels are crucial components of the VSM, functioning as the main elements that connect all functions/systems in the organization and the persons who compose it, as well as the organization with the different parts of its environment. Each of these communication channels must have all the components that make possible the transmission and reception of the pertinent information in proper working order (transducers, channels capacity and a sender-receiver in both directions).

The pathologies included in this group are the ones related to the existence and constitution of the necessary communication channels and, in wider terms, to the information systems as well. These are:

- *III1. Lack of information systems.* Some of the necessary information systems are missing, insufficiently developed or not working properly.
- *III2. Fragmentation of information systems.* Information systems exist in the organization, but they work in a fragmentary way, with poor or non-existent connections between them.
- *III3. Lack of key communication channels.* Certain required communication channels that should connect the different functions do not exist, or, if they do, are either inadequately designed or work improperly.
- *III4. Lack of or insufficient algedonic channels.* Necessary algedonic channels are missing, or, if they do exist, are poorly designed for their function or do not work properly.
- *III5. Communication channels incomplete or with inadequate capacity.* Necessary communication channels do not have all the necessary elements for transmitting required information (transducers, channels capacity and a sender-receiver in both directions).

5. Conclusions

The amount of complexity that organizations must face today demands from their managers and leaders a commensurate capacity for dealing with this complexity. Managers use models of the problems or systems they pretend to govern, but the quality of their work necessarily will be limited by the quality of their models. In this work, a preliminary framework for studying complex organizations, based on Beer's

managerial cybernetics and his VSM, has been presented. This framework is designed to help in the process of diagnosing and designing organizations.

To recapitulate the framework: first, we try to identify the identity and purpose of the organization. Second, we analyze the way in which the organization creates its structure to deal with the environmentally relevant variety, by means of a vertical unfolding of complexity. This process will generate a set of organizations and sub-organizations, each of which will take care of their corresponding environments. Third, we go through each individual organization to check that all necessary and sufficient conditions, as established by Beer's VSM, are adequately represented and operating. And fourth, we check the degree of coherence between all the internal organizations and their functions (systems) at all recursion levels. This paper has elaborated the first and second steps, while also indicating certain tools that can help to carry on the study process, such as the *Recursion Levels-Key Factors Matrix*, with examples of its application.

We believe that the heuristic contained in this framework can help managers of both public and private organizations cope with the complexity faced by their organizations, by guiding the process of diagnosing and designing of their organizations.

We also believe that this framework may also help fill the gap between the conceptual depth in OC theory, by Beer and other researchers, and the need managers have for a structured facilitated process that can guide its application. The framework presented tries to provide that kind of guide. We believe that it provides a coherent guideline for managers in all their organizational governing tasks, by integrating the different components in those tasks, starting with the clarifications of identity, purposes and boundaries, and going on to the creation of a general structure for the whole organization under study, the diagnosis of each particular organization within it, and the evaluation of the coherence between organizational levels.

Owing to space limitations, only the first two steps of the framework are described. Also beyond the scope of this paper are considerations of time impacts on the framework. Organizations are dynamic systems, so their study would be enriched by making, in addition to structural research, an inquiry into how changes occur between stages.

In conclusion, to emphasize the value of effective diagnostic reviews signalled in this framework, I simply reiterate the tool kit which it provides, that is, the system of pathologies it earmarks: structural pathologies, functional pathologies and pathologies related to communication channels and information systems.

Note

1. VSMod® is available at: www.vsmod.org

References

Ashby, W.R. (1956), *An Introduction to Cybernetics*, Vol. 2, Chapman & Hall, London.

Beer, S. (1979), *The Heart of Enterprise*, Wiley, Chichester.

Beer, S. (1981), *Brain of the Firm*, 2nd ed., Wiley, Chichester.

Beer, S. (1985), *Diagnosing the System for Organizations*, Wiley, Chichester.

Beer, S. (1989), "The viable system model: its provenance, development, methodology and pathology", in Espejo, R. and Harnden, R. (Eds), *The Viable System Model, Interpretations and Applications of Stafford Beer's VSM*, Wiley, Chichester.

Checkland, P. (1981), *Systems Thinking, Systems Practice*, Wiley, Chichester.

Checkland, P. and Scholes, J. (1990), *Soft Systems Methodology in Action*, Wiley, Chichester.

Clemson, B. (1984), *Cybernetics. A New Management Tool,* Abacus Press, Preston.

Conant, R.C. and Ashby, W.R. (1970), "Every good regulator of a system must be model of that system", *International Journal of Systems Science*, Vol. 1 No. 2, pp. 89-97.

Espejo, R. (1989), "The VSM revisited", in Espejo, R. and Harnden, R. (Eds), *The Viable System Model: Interpretations and Applications of Stafford Beer's VSM*, Wiley, Chichester, pp. 77-100.

Espejo, R. (2008), "Observing organizations: the use of identity and structural archetypes", *International Journal of Applied Systemic Studies*, Vol. 2 Nos 1/2 (special issue: organizational cybernetics in focus, Pérez Ríos, J. and Schwaninger, M. (Guest Editors)).

Espejo, R. and Harnden, R. (Eds) (1989), *The Viable System Model. Interpretations and Applications of Stafford Beer's VSM*, Wiley, Chichester.

Espejo, R. and Schwaninger, M. (Eds) (1993), *Organizational Fitness: Corporate Effectiveness through Management Cybernetics*, Campus, New York, NY.

Espejo, R. and Schwaninger, M. (1997), *To be and not to be that is the System: A Tribute to Stafford Beer*, Carl Auer-Systeme, Wiesbaden [CD-ROM].

Espejo, R., Bowling, D. and Hoverstadt, P. (1999), "The viable system model and the VIPLAN software", *Kybernetes: The International Journal of Systems & Cybernetic*, Vol. 28 Nos 6/7, pp. 661-78.

Espejo, R., Schuhmann, W., Schwaninger, M. and Bilello, U. (Eds) (1996), *Organisational Transformation and Learning*, Wiley, Chichester.

Flood, R.L. and Jackson, M.C. (1991), *Creative Problem Solving: Total Systems Intervention*, Wiley, Chichester.

Hetzler, S. (2008), "Pathological systems", *International Journal of Applied Systemic Studies*, Vol. 2 Nos 1/2 (special issue: organizational cybernetics in focus, Pérez Ríos, J. and Schwaninger, M. (Guest Editors)).

Jackson, M.C. (2000), *Systems Approaches to Management*, Kluwer, New York, NY, pp. 163-6.

Leonard, A. (1989), "Application of VSM to commercial broadcasting in the United States", in Espejo, R. and Harnden, R. (Eds), *The Viable System Model. Interpretations and Applications of Stafford Beer's VSM*, Wiley, Chichester.

Midgley, G. (2000), *Systemic Intervention: Philosophy, Methodology, and Practice*, Kluwer, New York, NY.

Niño Becerra, S. (2009), *El crash del 2010. Toda la verdad sobre la crisis*, Los libros del lince, Auburn, WA.

Pérez Casares, A., Hernández Iglesias, C. and Pérez Ríos, J. (2008), "An agent based model of firms' birth, evolution and extinction", in López Paredes, A. and Hernández, C. (Eds), *Agent Based Modelling in Natural Resource Management*, INSISOC, Madrid.

Pérez Ríos, J. (2001), "Laudatio de Stafford Beer", Investidura de Stafford Beer como "Doctor Honoris Causa" por la Universidad de Valladolid. Universidad de Valladolid. D.L. VA. 57.2002.

Pérez Ríos, J. (2003), "VSMod®: a software tool for the application of the viable system model", paper presented at the 47th Annual Conference of the International Society for the Systems Sciences (ISSS), Heraklion, Crete.

Pérez Ríos, J. (2006), "Communication and information technologies to enable viable organizations", *Kybernetes: The International Journal of Systems & Cybernetic*, Vol. 35 Nos 7/8.

Pérez Ríos, J. (2008a), "Aplicación de la Cibernética Organizacional al estudio de la viabilidad de las organizaciones (Parte I)", *DYNA*, Vol. 83 No. 5.

Pérez Ríos, J. (2008b), "Aplicación de la Cibernética Organizacional al estudio de la viabilidad de las organizaciones. Patologías organizativas frecuentes (Parte II)", *DYNA*, Vol. 83.

Pérez Ríos, J. (2008c), "Diseño y diagnóstico de organizaciones viables. Un enfoque sistémico", *Iberfora 2000*.

Pérez Ríos, J. (2008d), "Supporting organizational cybernetics by communication and information technologies (VSMod®)", *International Journal of Applied Systemic Studies*, Vol. 2 Nos 1/2 (special issue: organizational cybernetics in focus. Perez Rios, J. and Schwaninger, M. (Guest editors)).

Pérez Ríos, J. and Martínez Suárez, X.L. (2007), "Applying VSM in the strategic management of A Coruña University in Galicia, Spain", in Christopher, W.F. (Ed.), *Holistic Management. Managing What Matters for Company Success*, Wiley, Hoboken, NJ, pp. 124-34.

Pérez Ríos, J. and Schwaninger, M. (2008), "Editorial", *International Journal of Applied Systemic Studies*, Vol. 2 Nos 1/2.

Schwaninger, M. (2005), "Design for viable organizations. The diagnostic power of the viable system model", in Matjaz, M., Eva, B. *et al.* (Eds), *Viable Organizations*, WOSC World Organization of Systems and Cybernetics. 13th International Congress of Cybernetics and Systems and ISA International Sociological Association. Research Committee 51 on Sociocybernetics. Maribor, pp. 45-56.

Schwaninger, M. (2009), *Intelligent Organizations. Powerful Models for Systemic Management*, 2nd ed., Springer, Berlin.

Schwaninger, M. and Pérez Ríos, J. (2008a), "Editorial: organizational cybernetics in focus", *International Journal of Applied Systemic Studies*, Vol. 2 Nos 1/2, Pérez Ríos J. and Schwaninger, M. (Guest Editors).

Schwaninger, M. and Pérez Ríos, J. (2008b), "System dynamics and cybernetics: a synergetic pair", *System Dynamics Review*, Vol. 24 No. 2.

Senge, P.M. (1990), *The Fifth Discipline. The Art and Practice of the Learning Organization*, Doubleday/Currency, New York, NY.

Wiener, N. (1948), *Cybernetics or the Control and Communication in the Animal and the Machine*, MIT Press, Cambridge, MA.

Yolles, M. (1999), *Management Systems. A Viable Approach*, Financial Times Pitman, London.

About the author

José Pérez Ríos is a Professor of Business Organization in the University of Valladolid, Spain. His research is focused on the application of system dynamics and management cybernetics to the study of complex systems, and to the development of software tools which can facilitate the application of different systemic approaches as well as knowledge capturing, communications and information exchange. He has been the Technical Director of the HORIZONTE-2000 project, and Founder and Director of the IBERFORA project (sponsored by the BSCH) at the University of Valladolid. He has been also responsible for the creation of the internet-based tool named "Navegador Colón" for the Spanish Foreign Ministry, and Director of Area of International Relations at the University of Valladolid (2000-2006). He has worked in multiple national and international research projects and has more than 80 publications in national and international journals and congresses, including three books. José Pérez Ríos can be contacted at: rios@uva.es