Cybernetically sound organizational structures II

Relating de Sitter's design theory to Beer's viable system model

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Abstract

Purpose – The purpose of this paper is to show how the viable system model (VSM) and de Sitter's design theory can complement each other in the context of the diagnosis and design of viable organizations.

Design/methodology/approach – Key concepts from Beer's model and de Sitter's design theory are introduced and analyzed in order to show how they relate.

Findings – The VSM provides insight into the related systems necessary and sufficient for viability. As such, it specifies criteria supporting the diagnosis and design of organizational infrastructures, i.e. of organizational structures, HR systems, and technology. However, it does not explicitly conceptualize and provide a detailed heuristic for the design of organizational structures. De Sitter's theory fills in this gap.

Originality/value – The paper illustrates how, based on a rudimentary model of organizational viability, de Sitter's design theory positively addresses the question of how to diagnose and design organizational structures that add to the viability of organizations.

Keywords Organizational structures, Organizational design, Cybernetics

Paper type Research paper

1. Introduction

This is the second paper of a two-paper series presenting a cybernetic perspective on designing organizational structures. In the first paper in this special issue, we introduced de Sitter's design theory as a theory that can support the diagnosis and design of "cybernetically sound organizational structures", i.e. structures that attenuate disturbances and amplify regulatory potentials relative to a set of functional requirements related to organizational viability (de Sitter, 1994; de Sitter *et al.*, 1997).

In this (second) paper, we want to relate de Sitter's ideas to another important cybernetic model of organizations: Beer's (1995, 1996) viable system model (VSM). More in particular, we want to show how these models might complement each other.

The VSM, just like de Sitter's theory, is based on cybernetic notions, such as, Ashby's Law of Requisite Variety, the idea of attenuation and amplification, and the concept of recursion. Moreover, just like de Sitter's theory, the VSM can be used for the purpose of diagnosing and designing organizations. However, the VSM is exceptional because it defines the necessary and sufficient systems (and their relations) required for organizational viability.

Unlike de Sitter's theory, the VSM does not seem to focus on the problem of the conceptualization and design of organizational structures that can support an organization's capacity for survival. Although it defines what is wanted of these structures in terms of variety engineering and desired effects, it does not in our view

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specify what organizational structures should look like in order to realize the systems necessary and sufficient for organizational viability.

Therefore, we seem to be confronted with a design theory and a model of systemic viability that both start from similar cybernetic notions and can be used for the purpose of engineering complexity in the context of organizational diagnosis and design. However, each of them seems to have its own focus. The VSM specifies the necessary systems and their relations needed for viability. de Sitter's theory focuses on organizational structures supporting organizational viability.

Given this preliminary indication of the focus of both models, the question how they can complement each other becomes relevant. Beer provides a highly detailed model of the related systems needed for viability and de Sitter's theory specifies what kind of organizational structures are needed in order to enable an organization to do what is needed for viability. Joined together, Beer's model and de Sitter's theory might be more powerful than each of them is in isolation, allowing for detailed systemic *and* structural analyses of organizational viability.

In order to explore if and how Beer's VSM and de Sitter's design theory can complement each other, we organized the rest of this paper in four sections.

In Section 2, we briefly introduce the VSM. Moreover, we explain that it can be viewed as a "functional model" of viability. Finally, we explain why, in addition to the VSM, knowledge about, for instance, organizational structures, is needed in order to diagnose and design viable organizations.

Section 3 discusses this additional knowledge about cybernetically sound organizational structures by summarizing de Sitter's design theory. In this section, we briefly discuss de Sitter's concept of viability, his conceptualization of organizational structures, and the way he relates organizational structures to organizational viability.

In Section 4, we explore how the VSM and de Sitter's design theory can complement each other. We do this in two steps. First, we compare Beer and de Sitter's functional models of viability and indicate in what sense Beer's model might be viewed as an improvement on de Sitter's model. Second, we give an impression of how the principles for the design of cybernetically sound organizational structures defined by de Sitter can complement Beer's VSM by providing a theory about how organizational structures can contribute to the realization of the functions necessary and sufficient for viability specified by Beer.

In Section 5, we discuss the findings of this paper. These findings may be summarized as follows:

- the VSM defines the necessary and sufficient "functions" needed for viability;
- in isolation, the VSM may not be sufficient for diagnosing and designing organizational structures; and
- de Sitter's design theory makes apparent how organizational structures can help to realize the functions specified by Beer.

For this reason, de Sitter's theory might be a relevant complement to the VSM, supporting the engineering of complexity with regard to viable organizational structures.

2. Beer's VSM: a functional model of viability?

Beer's VSM is such an important contribution to cybernetics because it derives the necessary and sufficient sub-systems needed for a system to be viable. Below, we start by a brief overview of what, according to Beer, these sub-systems are and how they are related to viability. Based on this overview, we can explain what it means that the VSM is a functional model of viability and how such a model can support the diagnosis and design of organizations as a particular class of viable systems. Moreover, we explain why complementary knowledge, for instance, about the structure of organizations, might be useful to diagnose and design viable organizations.

2.1 Five systems supporting viability

Beer's VSM may be regarded as an answer to two questions:

(1) How should variety be managed if a system is to be viable?

(2) Which sub-systems and relations between them are necessary and sufficient if a system is to be viable?

By answering these questions, Beer formulates a perfectly general model that specifies the necessary and sufficient conditions for the viability of any (viable) system, be it, for instance, a simple organism, an animal, a human being, or an organization. Given the purpose of this paper, we will only focus on the second question concerning the related systems that in Beer's view are necessary and sufficient for viability (for the management of variety, see for instance, Beer, 1995; Espejo *et al.*, 1996; Achterbergh and Vriens, 2010). These related systems are: the primary activities, coordination, control, intelligence, and policy. Below, we will discuss them in the context of organizations (Espejo *et al.*, 1996).

System 1: primary activities. To begin with, each viable organization needs to perform the operations that constitute its *raison d'être* and identity. Espejo *et al.* (1996) call these operations the organization's primary activities. For instance, in the case of an energy producing organization, these primary activities may be the production and distribution of:

- wind energy;
- solar energy; and
- water energy.

Together, these primary activities constitute the identity of the energy producing organization. Beer also calls the collection of primary activities: "System 1". Each of the primary activities constituting system one, may, in turn, be viewed as a viable system, containing the five systems needed for its viability.

System 2: coordination. The primary activities may share all kinds of resources or may be active in overlapping parts of the environment. Because of this, interdependencies between the primary activities may arise. For instance, the three primary activities of the energy producing organization may share human resources specialized in high-voltage energy. Because of this shared resource, the primary activities become interdependent. If disturbances that might result from this interdependency are to be attenuated (e.g. a specialist is allocated to two separate primary activities at the same time), some form of coordination is required between the primary activities (e.g. by means of a planning system used by the primary activities, allowing for the allocation of specialists to the primary activities). This means that on top of the primary activities, a second system is needed. Espejo *et al.* (1996) call this system: *coordination*. Its role is to attenuate possible disturbances flowing from interdependencies between the primary activities.

System 3: control. If a system, in this case, an organization, is to be viable, its primary activities need to contribute to the viability of the whole. In order to manage this contribution of the primary activities, a third system is needed: the *control system*. This system manages the functioning of the viable system *inside* and *now*. Beer also calls it a *synoptic* and *synergetic* system because it keeps an overview over and manages the contribution of the primary activities to the viability of the system as a whole. In *The Heart of Enterprise*, Beer (1995) lists different sub-systems by means of which control discharges of its task. For the sake of brevity, we will not go into these sub-systems here.

System 4: intelligence. By means of the primary activities, the coordination and the control systems, a viable system is able to maintain its *current* identity. However, in order to be viable, a system also needs to be adaptive to changes in its environment: it needs to be able to *change* its mode of operation or its identity. To this purpose, a fourth system is required: *intelligence*. In organizations, the intelligence system focuses, as Beer calls it, on the *outside* and *then* of the organization, i.e. it scans the organization's relevant environment and initiates plans for innovation.

In order to elaborate these plans and to increase their feasibility and probability of success, intelligence and control need to discuss the plans for innovation in detail. In this discussion, each of these systems has its own role. Intelligence brings in its knowledge about the outside and then. Control brings in its knowledge about the inside and now of the organization. This means that in addition to its contribution to the functioning of the viable system inside and now, the control function is also involved in the adaptation of the viable system; in the shaping of its future.

System 5: policy. Above, we indicated that in order to elaborate plans for innovation, intelligence and control need to discuss these plans in detail. The quality of this discussion is crucial for the viability of the system as a whole. For instance, if it is dominated by intelligence, plans might be formulated that are difficult to implement by the primary activities. This means that a fifth system is needed. Beer calls this system *policy*. Its task is to support and coordinate the discussion between intelligence and control about the future of the organization and to consolidate its results.

In his work, Beer extensively discusses these five systems and their relations. For our present purposes, it suffices to underline that he views them as necessary and sufficient for viability. The following argument might support this view.

Viability means: being able to maintain a separate existence. In order to maintain a separate existence, a viable system must be able to *realize* and *adapt* the goals that define its identity in its continuously changing environment. In order to *realize* its identity, the viable system needs the primary activities, the coordination, and the control system. These systems, contribute to the realization of the goals that define the current identity of the system. In order to *adapt* its identity, the viable system needs the intelligence, the control, and the policy systems. These systems contribute to the viable system's potential to adapt the goals that define its identity and *raison d'être*. Thus, the five systems support the realization and adaptation processes needed for viability. If any of them would be missing, viability would be threatened. In this sense, the five systems may be regarded as *necessary* for viability. Moreover, it seems that no more than these five systems are needed for a system to be viable. In this sense, they may be regarded as sufficient (Beer, 1995, p. 115 and 262 ff. on sufficiency).

2.2 Functional models and additional knowledge about systemic infrastructures

In the preceding discussion of the VSM, it was not our intention to provide an elaborate exposition of that model. We rather wanted to give an impression of the *kind* of model, the VSM is. For, if we zoom in on *how* Beer defines the five systems supporting viability, it may be noticed that he does this by specifying WHAT these systems should DO in order to contribute to viability. For instance, coordination should enable the attenuation of possible disturbances resulting from interdependencies between the primary activities. Control should keep an overview over and manage the contribution of the primary activities to the viability of the system as a whole. Intelligence should scan the relevant environment of the viable system, and policy should support the interaction between intelligence and control. This description of the contribution of the five systems in terms of what they should do makes the VSM into a *functional model* of viability.

To explain what a functional model is and what its possible uses are, we define a *function* as a rule that enables one to relate a manifold to a unity (Luhmann, 1991, p. 14). Its general form is: "[. . .] is X". An example might be, "[. . .] is blue". This unfinished proposition may be used as a rule to relate a manifold, e.g. the eyes of the dentist's assistant, this wall, my car, to a unity; the property of being blue. The rule is that the objects selected to finish the proposition are selected in such a way that the proposition remains true. The objects that meet this criterion are called *functionally equivalent*.

The idea of functions and functional equivalents is important in the context of diagnosis and design. In this context, we are interested in:

- Infrastructures (the manifold) that may cause a particular desired effect (the unity): "[. . .] can cause X". For instance, if we want to design a chair, we are interested in infrastructures that can cause the desired effect of allowing someone to sit comfortably.
- Desired effects (the manifold) that may be caused by a particular infrastructure (the unity): "[. . .] may be caused by X". For instance, if we stumble on a new substance, we may want to find out for which purposes it can be used.

In the actual practice of diagnosis and design, we constantly switch between these perspectives. For instance, we select a desired effect and search for infrastructures that can cause it. Or, we select an infrastructure and search for effects that it can cause.

Based on these ideas two types of functions can be distinguished in the context of diagnosis and design. The first type takes a desired effect X as an invariant and specifies that the proposition "[. . .] can cause X" must remain true. It opens a space of functionally equivalent infrastructures that can cause X". The second type takes a particular infrastructure Y as an invariant and specifies that the proposition "[. . .] can be caused by Y" must remain true. This function opens a space of possible effects that can be caused by Y.

Moreover, we can define what we understand by a *functional model*: a functional model of something describes that something in terms of one or more functions of either the first or the second type. For instance, a chair can be described in terms of a function of the first type as something that allows someone to sit comfortably. It can also be described in terms of a function of the second type. In this case, possible effects that can be realized by means of a chair are listed (e.g. something that can be used to stand on, to hit someone, to barricade the door, etc.).

Given these distinctions, we can go back to the VSM. As indicated above, this model describes the systems required for viability in terms of what they should do if a system is to be viable. More in particular, it specifies:

- The overall desired effect "viability" – being able to maintain a separate existence.
- Two desired effects implied in this overall effect – being able to realize and adapt goals that define the identity of the system.
- Desired effects related to the desired "realization effect" – primary activities, coordination, and control, and desired effects related to the "adaptation effect": intelligence, control, and policy.

In this way, the VSM is a functional model of whatever is a viable system. The related desired effects specified by the VSM can be regarded as an *invariant* that can be used in a function of the first type: "[...] can cause the desired effects necessary and sufficient for viability". This function, then, can be used to search for infrastructures that can cause these desired effects (because the VSM is a functional model, some authors, e.g. Espejo *et al.*, 1996; Achterbergh and Vriens, 2010, actually explain it in terms of functions). Whatever the "materiality" of the system, be it an organism, an animal, a human being, or an organization, if it is to be viable, its organic or infrastructure must be able to produce the desired effects associated with viability.

Based on this indication of what it means to be a functional model of viability, it can be explained what to expect from such a model in the context of organizational diagnosis and design.

In the case of diagnosis, the VSM allows for the examination of systemic dysfunctions in the organization's infrastructure. That is, it allows for the diagnosis of the organizational structure; the organization's human resources and the systems to manage them, and the organization's technology. It allows assessing the quality of the resources and relations producing the organization.

Given the desired effects needed for viability, actual effects produced by the system may be examined and compared to desired effects. The desired effects are taken as "norms" and the actual effects are taken as "facts". "Dysfunctions", then, can be defined as the difference between norms and facts. For instance, based on the VSM, we know that possible disturbances flowing from interdependencies between the primary activities should be attenuated. Using this desired effect as a norm, we can, for instance, examine the sharing of resources between primary activities. From this examination, it may appear that all kinds of planning problems exist regarding these resources. This, in turn, may incite a further inquiry as to why these problems exist; is it the organizational structure, the competencies of human resources, or the technological support of the planning process?

In the case of design, a functional model of viability is important, for it specifies what is wanted. It specifies what the system under design should be able to do if it is to be a viable system. Without such a functional specification a designer, for instance, of a tool supporting the conversations between intelligence and control, would not have a clue of what is wanted of this tool. In this way, the VSM defines the *causa finalis* of the design process.

However, given the explanation of what it means to be a functional model, we can also explain what *not* to expect from the VSM.

Because the VSM is an invariant, specifying the effects desired for the viability of all possible viable systems, it abstracts from the "materiality" of these systems. It abstracts from their "flesh" and "metal". For instance, both an organism and an organization may be modeled as viable systems. Taken *as* viable systems, they both realize the same set of desired effects. However, they do this by means of quite different infrastructures. These infrastructures are peculiar to their own make-up *as* organic and social systems, respectively. In short, *as* viable systems, organisms and organizations have to produce the same desired effects. However, *as* organic and social systems, they do this in their own particular way and by means of their own particular infrastructures. The VSM does not positively conceptualize all these infrastructures and their design.

This point has consequences for the use of the VSM in the context of organizational diagnosis and design.

Suppose that an organization is diagnosed using the VSM. Further, suppose that a dysfunction is found: disturbances resulting from interdependencies between the primary activities are not sufficiently attenuated. Finding this dysfunction is only a first step in the diagnostic process. In order to be able to "repair" it, one also has to know what causes it. Was the task of attenuating disturbances resulting from interdependencies not properly allocated? Are the organizational members that perform coordination activities incompetent? Does the supporting technology not function well? More general, what is it in the organization's infrastructure, i.e. its organizational structure, its human resources and the systems to manage them, or its technology, that causes the dysfunction?

Something similar can be said in the case of organization design. If one wants to design an organization that can maintain its separate existence, it may not sufficient to know the desired effects needed for viability. One also needs to know what types of infrastructures can produce these desired effects. What types of organizational structures are conducive to the effects associated with viability? What types of HR systems and what kind of technology can support viability?

In general, to diagnose and design organizations in such a way that they can produce the desired effects specified by the VSM, in addition to a functional model of viability, knowledge about infrastructures that can cause the effects specified by the functional model seems to be required. It is for this reason that de Sitter's theory about the design of cybernetically sound organizational structures might be a complement to the VSM. As will be argued, it provides a theory that explains how the organizational structure, as one of the dimensions of the infrastructure of organizations, can contribute to organizational viability.

3. de Sitter's design theory: organizational structures supporting viability

Earlier in this issue, de Sitter's design theory has been discussed *in extenso. Here,* we only want to highlight those aspects of his theory that are needed in order to both relate this theory to the VSM and to show how it and the VSM might be complementary. To this purpose, we briefly discuss the desired effects implied in de Sitter's design theory and their relation to the parameters of the organizational structure that affect the realization of these desired effects.

In a nutshell, de Sitter's design theory specifies how organizational structures should look like in order to: attenuate as much as possible the probability of the occurrence and dispersion of disturbances and amplify as much as needed the regulatory potential to deal with disturbances that do occur, thereby allowing for the realization of the desired effects needed for viability.

As has been argued, de Sitter lists three classes of so-called functional requirements (desired effects) an organization should realize in order to be viable: quality of organization, quality of work, and quality of working relations. Implied in the first class of requirements – quality of organization – are the two desired effects that also seem to be crucial to Beer's concept of viability. The first is the potential to realize the goals that define an organization's identity. de Sitter deals with this desired effect in terms of the requirements of "order flexibility" and "control over production processes". The second is the potential to adapt the goals that define an organization's identity: the organization's "potential for innovation".

Given this crude functional model of viability (below, we will show that de Sitter derives a more elaborate model of organizational viability), de Sitter, in a next step, derives a theory of what organizational structures should look like, if organizations are to be able to maintain a separate existence in their environment, i.e. if they are to be able to support the realization and adaptation of organizational goals.

To this purpose, he defines the concept of organizational structure as the combination of the organization's production structure and its control structure. Moreover, he defines what he understands by the production and control structures. And finally, he defines seven parameters that allow for a description of the production structure of organizations, their control structure, and the relation between their production and the control structure.

Given these parameters, he explores what their values should be if an organization, *by means of its structural design* is to attenuate the probability of the occurrence and dispersion of disturbances as much as possible and amplify the chances for regulation as much as needed in order to be in the best possible condition to realize the three functional requirements needed for organizational viability. As has been argued in the earlier paper in this issue of Kybernetes, the values of these seven parameters should be low. In this case, the organizational structure contributes as much as possible to the organization's potential to maintain a separate existence in its environment.

Finally, de Sitter provides design criteria, design principles, and design strategies that, in different circumstances, can help to design organizational structures with low parameter values.

In sum, de Sitter's design theory explicitly relates the design of the organizational structure – in terms of the value of parameters describing that structure – to the organization's potential to realize desired effects needed for organizational viability. High parameter value structures are disablers for organizational survival. Low parameter value structures are enablers.

As might be clear, such a theory is relevant for diagnostic purposes. It allows not only finding dysfunctions in terms of the difference between desired effects and actual effects produced by the organization; it also allows the search for structure-related causes of dysfunctions that, then, may be repaired by means of a redesign of the organizational structure. Moreover, it supports design. Unlike the VSM, it not only describes what the desired effects of the design are, but it also provides detailed design rules for organizational structures that support organizational viability.

In general, de Sitter's design theory provides knowledge about how an important part of the infrastructure of organizations, i.e. the organizational structure, should be designed in order to realize desired effects associated with viability. For this reason, we consider it as a theory that provides relevant knowledge that might be used as a complement to the VSM. In the next section, we explore this hypothesis one step further.

4. Relating de Sitter's design theory to Beer's VSM

In order to explore how the VSM and de Sitter's design theory might be complementary, we proceed in two steps. First, we compare the two in terms of the functional models underpinning them. Such a comparison is relevant, because if Beer and de Sitter's are to be complementary in the context of organizational diagnosis and design, some shared understanding of what is wanted, of the desired effects that need to be produced by the organizations that are the object of diagnosis or design, seems to be required. Second, we provide an impression of how de Sitter's design theory may complement Beer's VSM.

4.1 Beer and de Sitter: functions associated with viability

It is apparent from the above explanations that both Beer's model and de Sitter's theory share basic cybernetic notions about variety engineering and that they both start from the idea that (organizational) viability is the desired effect of this type of engineering. Beer's VSM further develops this desired effect in terms of an elaborate functional model comprising: primary activities, coordination, control, intelligence, policy, and their relations.

Until now, we have just mentioned that de Sitter's lists three functional requirements related to organizational viability. Moreover, we argued that the first requirement, quality of organization, is equivalent to Beer's requirement that viable systems – or more particular, viable organizations – should be able to realize and adapt the goals defining their identity.

However, for reasons of brevity, we did not yet mention that de Sitter, just like Beer, develops a functional model specifying desired effects that must be realized, if organizations are to be able to realize and adjust their goals. And, what is more, we did not yet mention that he develops a model of organizational viability that is different from Beer's.

In order to explore how Beer's model and de Sitter's design theory might complement each other, it is useful to further explore de Sitter's functional model of viability. For if this model also specified the necessary and sufficient functions for viability, de Sitter's theory alone could be used for both functional *and* structural analyses of organizations.

Therefore, the question becomes, what, according to de Sitter, is needed if an organization is to be able to realize and adapt the goals defining its identity?

Instead of the five systems mentioned by Beer, de Sitter lists four requirements. The organization has to be able to perform its primary transformations as well as three types of regulatory functions: strategic regulation, regulation by design, and operational regulation. In this way, de Sitter links up with Ashby's (1958, 1960) triplet of control: *defining* goals, *designing* by selecting the mechanism to realize goals, and *regulating* the realization of goals, given a selected mechanism.

de Sitter's primary transformations realize the goals for the purpose of which the organization is designed. They have the same function as the primary activities in Beer's model. Moreover, just like in Beer's model, they can be recursively modeled as comprising primary transformations and the three types of regulatory functions. Operational regulation regulates the realization of the primary transformations. Together, the primary transformations and operational regulation take care of the realization of organizational goals defining the identity of the organization.

Strategic regulation formulates the goals defining the identity of the organization. Regulation by design takes care of the design of the infrastructure that is needed to:

define goals, to design infrastructures, to operationally regulate primary transformations, and to perform the primary activities. Together, strategic regulation and regulation by design take care of the adaptation of both the organization's goals and its infrastructure.

For the purpose of easy comparison of Beer and de Sitter's functional models of (organizational) viability, we inserted Table I.

By comparing these models, it can be argued that they both provide a conceptual analysis of viability in terms of desired effects, i.e. they both provide a functional model of viability. However, it must be admitted, that the model specified by Beer is more elaborate than the one presented by de Sitter. Because it is impossible to give a complete, in depth, comparison here, we just want to mention two important advantages of the VSM.

First, by means of the control, coordination, and policy systems, Beer's functional model pays more attention to, respectively, the cohesion of the contribution of the primary activities to the viability of the organization as a whole and the complexities involved in the adaptation process. In de Sitter's model, the cohesive activities of control and coordination are presupposed in operational regulation and regulation by design. Supporting and consolidating the discussion between intelligence and control in de Sitter's model is presupposed in strategic regulation and regulation by design.

Second, Beer's model of viability pays more attention to the desired relations between the systems needed for viability. It provides a (prescriptive) model of the required communication between the different systems that can be used for the purpose of diagnosis and design. In his functional model, de Sitter pays relatively little explicit attention to the required communication between the primary activities, strategic regulation, regulation by design, and operational regulation.

Of course, it is theoretically possible to improve de Sitter's functional model by bringing in ideas taken from Beer's VSM. In this way, Beer's functional model might complement de Sitter's functional model of (organizational) viability. However, this is not the road we want to take here. For now, we select Beer's functional model of viability as a point of departure and ask how de Sitter's ideas about structures can help to design organizational structures that support the realization of the desired effects specified by Beer's VSM.

4.2 de Sitter's organizational structures supporting Beer's viability: an impression

To show how de Sitter's organizational structures can support the realization of the desired effects specified in the VSM, we describe how low parameter-value structures attenuate regulatory pressures and amplify regulatory potentials, thereby increasing

Beer		de Sitter	
Viability: being able to maintain a separate existence			
Adapting goals defining the identity of the viable system	Policy Intelligence Control	Adapting goals defining the identity of the organization	Strategic regulation Regulation by design
Realizing goals defining the identity of the viable system	Control Coordination Primary activities	Realizing goals defining the identity of the organization	Operational regulation Performing primary transformations

Table I.
Beer and de Sitter's functional models of viability

the probability of the realization of the desired effects of the primary activities, coordination, control, intelligence, and policy. Please note that we can only give an impression here of how de Sitter's organizational structures might support the realization of Beer's desired effects for viability. A full elaboration of their relation would imply a quite technical exposé about de Sitter's design theory.

For the purpose of this impression, let us suppose that the parameter described by de Sitter all have low values.

A low level of *functional concentration* (parameter 1) implies primary activities that are organized into flows that are coupled to separate order types. In his theory, de Sitter devotes quite some attention to the design of flows (1994, pp. 222-90). He distinguishes different heuristics for their design that all have the reduction of interdependency and the reduction of variability of relations between flows as a guiding principle. Moreover, he explicitly includes the possibility of the design of flows within flows or segments within flows. By means of the integration of preparing, supporting, and making activities into these flows, i.e. by means of lowering the level of *differentiation* (parameter 2), each flow has its own preparation and supporting facilities. By lowering the level of *specialization* (parameter 3), "rich" and coherent tasks are designed that reduce the number of relations between tasks. Low levels of *separation, differentiation, and specialization of regulatory transformations*, (parameters 4-7) assure that at all levels of recursion, production flows or segments have the regulatory potential needed to absorb the relevant complexity. Moreover, low levels of separation, differentiation, and specialization assure that the distance between primary transformation, disturbance, and the transformations needed to regulate them is reduced as much as possible.

As has been argued earlier in this special issue, due to the low values of the parameters describing the production structure, both the number of relations between tasks and the variability of these relations drop dramatically, attenuating the structure-related probability of the occurrence and dispersion of disturbances. Low values of the parameters describing the control structure further attenuate the probability of disturbances and amplify potentials for regulation by means of the design of the organizational structure.

If we interpret these "low parameter value organizational structures" from the perspective of the desired effects specified by the VSM, we can see that they support the realization of desired effects specified by the VSM.

Let us start with the desired effects related to the *realization* of organizational goals, i.e. the desired effects related to the primary activities, coordination, and control.

Low parameter-value structures support the *autonomy* of the *primary activities* constituting *System 1*. Flows become semi-autonomous and relatively independent sub-systems within the organization. Each of these flows has its own in-built capacity for support and preparation as well as its own regulatory capacity (strategic, design, and operational regulation) both to deal with disturbances generated in the flow and to coordinate between flows. de Sitter provides detailed heuristics to design so-called semi-autonomous flows, segments, or teams within flows, approximating Beer's idea of autonomous viable systems within autonomous viable system. de Sitter prefers to call such sub-systems "semi-autonomous" rather than "autonomous" because they have to cohere within the larger organization, which to some extent constrains their "absolute" freedom (see Beer, 1995 on freedom and constraint for a similar argumentation). The advantage of de Sitter's theory is that he provides a detailed explanation of how to design such flows, segments, and teams.

The production structure is designed in such a way that flows and segments can function relatively independently. This is already a structural attenuator of the variety that coordination and control need to deal with. Moreover, because of low levels of separation between production and control, and low levels of differentiation and specialization of regulatory transformations, flows, segments, and teams also have semi-autonomy, i.e. the in-built capacity to regulate within and between them. This not only attenuates the probability of the occurrence of disturbances within and between flows, it also amplifies potentials for regulation by coordination and control. Because of the relative autonomy and independence of the flows, segments, and teams, the design of the organizational structure both attenuates the disturbances that *coordination (System 2)* and *control (System 3)* need to deal with and it amplifies their potential for regulation between these flows, segments, or teams.

Low parameter value structures not only contribute to the realization of the desired effects of the primary activities, coordination, and control, they also support the desired effects related to the adaptation of organizational goals.

To begin with, because low parameter value structures attenuate the probability of the occurrence of operational problems and amplify potentials for operational regulation, time and energy are saved that can be devoted to strategic regulation and regulation by design. Or, to phrase this in terms of the VSM, time and energy are saved for the discussions between intelligence and control on shaping the future of the organization.

Moreover, because at each level of recursion, e.g. teams, segments, flows, primary activities have their "own" capacity for strategic regulation and regulation by design, the total problem of adapting the organization to its environment is distributed over the organization. Each flow, segment, or team, within bounds, has the responsibility to shape its own future. In this way, the design of the organizational structure amplifies local potentials for what de Sitter would call strategic regulation and regulation by design, which in Beer's model is analyzed into *intelligence (System 4)*, *control (System 3)*, and *policy (System 5)* activities. Moreover, low parameter value structures attenuate the complexity involved in these regulatory activities, by reducing both the number of relations between regulatory activities geared to shaping the organization's future and the variability on these relations. In this way, the organizational structure functions as an attenuator helping policy to enable the discussion between intelligence and control. In Chapter 10 of "Synergetisch Produceren" that has as a subtitle "The organization of resourcefulness", de Sitter (1994, pp. 354-97) lists the advantages of low parameter value structures for both innovation and process optimization. Moreover, he addresses the question of designing structures for innovation across flows, i.e. relative to the environment of the viable system as a whole, as Beer would call it. These organizational structures provide conditions for the discussion between, what Beer would call intelligence and design. They are amplifiers building intelligence, control, and policy into the organizational structure.

In general, de Sitter's low parameter value organizational structures seem to support the realization of desired effects specified by Beer. But what about the *communicative relations* between the systems needed for viability? Above, we indicated that de Sitter's functional model is not very specific about these relations. However, he makes up for this omission at the level of his structural theory.

First, by attenuating the probability of the occurrence and dispersion of disturbances by means of the design of the production structure, stress on communication is reduced as much as possible. Second, by designing the control structure to amplify regulatory potential as much as needed, communication relations are built into the organizational structure, for according to de Sitter, regulation in organizations involves social interaction. Third, if we zoom in on de Sitter's theory regarding the design of control structures, improving the quality of information appears as the prime requirement (design criterion). In order to meet this requirement, de Sitter introduces the heuristic of the "unity of time, place, and action" as the principle for the design of control structures. According to this principle, the actuality, reliability, completeness, and relevance of information improve by decreasing separation in time and place between the monitoring of the activities that are the object of regulation, the assessment of both the differences between norms and facts and their possible causes, and the action to reduce dysfunction. Based on this criterion and principle, de Sitter provides detailed rules, specifying how to design strategic regulation, regulation by design, and operational regulation within and between flows, segments, teams, and individual jobs in organizations. In this way, his structural theory, in terms of quality of information, contributes to the improvement of communicative relations between systems needed for organizational viability.

Based on the impression provided in this section, we think that an argument can be made for the hypothesis that de Sitter's low parameter value structures provide in-built attenuators and amplifiers contributing to the realization of the desired effects needed for viability specified by Beer. Of course, only a detailed and elaborate coupling of de Sitter's design criteria, principles and strategies to Beer's VSM can substantiate this hypothesis.

5. Conclusion

In this second paper on cybernetically sound organizational structures, we have set out to explore how Beer's VSM and de Sitter's design theory relate and might complement each other.

We have argued that Beer's model is a functional model of viability that specifies criteria for the functioning of systemic infrastructures. As a functional model, it is an invariant. More in particular, in the case of Beer's model, it is an invariant specifying the set of related desired effects necessary and sufficient for viability. Because it specifies these desired effects, the VSM can be used for both diagnostic purposes, enabling the search for dysfunctions and design purposes, defining functional specifications for the design of, for instance, viable organizations. However, as a functional model specifying effects desired for viability, the VSM abstracts from the infrastructures that realize these effects. Applied to organizations, it abstracts from the organizational structures, HR systems, and technology that are needed to realize organizational viability. The VSM lists what viable organizations should do in order to be viable, but it leaves open what kind of infrastructures can be used to accomplish this.

This is where de Sitter's design theory can complement Beer's model. In his theory, de Sitter explicitly relates the design of organizational structures to organizational viability. To this purpose, he first develops his own functional model of organizational viability. This model is less elaborate than Beer's, but aims at the same goal, deducing what is necessary and sufficient for goal realization and adaptation. Second, he conceptualizes organizational structures in terms of parameters. Third – using Ashby's law – he links desired low values of parameters to desired effects needed for organizational viability, and fourth provides detailed heuristics to design low parameter value structures. Based on de Sitter's theory, it becomes possible to diagnose organizations in terms of dysfunctions and structural causes of these dysfunctions. Moreover, de Sitter's theory provides criteria, principles, and heuristics for the design of organizational structures supporting organizational viability.

In sum, Beer's model and de Sitter's theory can be complementary. First, insights from Beer's model might be used to further elaborate de Sitter's functional model of organizational viability. de Sitter's structural theory can then be used to derive organizational structures needed to realize the desired effects specified by this more elaborate functional model. Second, Beer's model may be taken as the functional model specifying the desired effects needed for viability. Then, de Sitter's design theory may be used to specify structural configurations that can help realize the desired effects specified by the VSM.

In Section 4.2, we explored this second option. It provides an impression of how criteria and principles taken from de Sitter's design theory can support de realization of the desired effects specified by Beer. Although this impression is still far away from a fully developed theory, it shows that an integrated functional and structural theory of organizational viability might be a relevant contribution to variety engineering in organizations.

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