

Developing S. Beer's Ideas: Social Responsibility and Reflexion in Viable Systems Approach

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Abstract

In this paper we try to develop S. Beer's ideas for the case of polysubject socio-cultural systems and enrich cybernetics by the concepts of social responsibility and reflexion. We consider this way of thinking as the kind of Viable Systems Approach (VSA).

In order to generalize VSA for this case we use the following logic.

1. Both N. Wiener's concept of feedback and S. Beer's VSM (based on it) are constructed within Hard Systems Thinking framework and assumes technical-cybernetic approach to governing (Control & Administration). So we refer VSM to the 1st column of M. Jackson's SOSM grid.
2. Within this "vertical" model the hierarchical relations are considered as including bilateral ("direct" and "return") communications (or cyber-systemic conversations – R. Espejo).
3. The "horizontal" (e.g. contractual, informal etc.) relations are also considered as including impacts and feedbacks based on bilateral communications.
4. Both "vertical"/hierarchical, and the "horizontal" relations with bilateral communications include application of joint decision making based on communicative methods. So our instruments should be shifted to Team Syntegrity and similar methodologies which refer to the 3rd column of M. Jackson's SOSM grid (it corresponds with "third-order cybernetics").
5. In the case of polysubject socio-cultural systems social responsibility is always responsibility for the Whole in condition of a few decision-making actors. In order to be responsible they should be reflexive. It allows them to co-ordinate their purposes and actions. Hence, we obtain polysubject reflexive-active environment.

Keywords: social responsibility, reflexion, Viable Systems Approach (VSA), polysubject socio-cultural systems, "direct" and "return" communications, third-order cybernetics.

Razvijanje idej S. Beera: Družbena odgovornost in refleksija po pristopu viabilnih sistemov



Povzetek

V prispevku skušamo razviti ideje Stafford Beer-a na primeru poli-konstrukcijskih družbeno-kulturnih sistemov in obogatiti kibernetiko s koncepti družbene odgovornosti in refleksije.

Ta način razmišljanja razumemo kot vrsto pristopa za Viable Systems Approach (VSA).

Za posplošitev VSA za ta primer uporabimo naslednjo logiko.

1. Oba koncepta povratne informacije N. Wiener in Viable Systems Model (VSM) S. Beerja (na njeni podlagi) sta zgrajena v okviru Hard System Thinking in prevzema tehnično-kibernetiki pristop k upravljanju (Control & Administration). Zato napotimo VSM na 1. stolpec SOSM mreže M. Jackson.

2. V okviru tega "vertikalnega" modela velja, da hierarhični odnosi vključujejo dvostranske ("neposredne" in "povratne" komunikacije) (ali kiber-sistemske pogovore - R. Espejo).

3. Šteje se, da „horizontalni“ (npr. Pogodbeni, neformalni itd.) odnosi vključujejo učinke in povratne informacije na podlagi dvostranskih komunikacij.

4. »vertikalni« / hierarhični in »horizontalni« odnosi z dvostranskimi komunikacijami vključujejo uporabo skupnega odločanja, ki temelji na komunikacijskih metodah. Zato je treba naše instrumente preusmeriti na Team Syntegrity in podobne metodologije, ki se nanašajo na 3. stolpec SOSM mreže M. Jackson (ustreza "kibernetiki tretjega reda").

5. V primeru poli-subjektivnih družbeno-kulturnih sistemov je družbena odgovornost vedno odgovorna za celoto v pogojih nekaj akterjev odločanja. Da bi bili odgovorni, bi morali biti refleksivni. Omogoča jim usklajevanje njihovih namenov in dejanj. Tako dobimo poli-subjekt refleksivno-aktivno okolje.

Ključne besede: družbena odgovornost, refleksija, Viable Systems Approach (VSA), poli-subjektivni sociokulturni sistemi, »neposredne« in »povratne« komunikacije, kibernetika tretjega reda.

1. Introduction

In this paper we try to develop S. Beer's ideas for the case of polysubject socio-cultural systems and enrich cybernetics by the concepts of social responsibility and reflexion. In the case of monosubject socio-cultural systems social responsibility is the function of a decision-maker to whom society voluntarily or forcibly delegates this responsibility. But in the case of polysubject socio-cultural systems social responsibility is always responsibility for the Whole in condition of a few decision-making actors. In order to be responsible they should be reflexive. It allows them to co-ordinate their purposes and actions, taking into account the grounds from which each actor comes. Hence, we obtain polysubject reflexive-active environment (Lepskiy, 2018b).

We hypothesize that social responsibility in polysubject socio-cultural systems existing in reflexive-active environments requires third-order cybernetics governance tools (Lepskiy, 2018a), corresponding to the 3rd column of M. Jackson's System of Systems Methodologies (SOSM) grid (Jackson, 2003). Within the framework of this grid, S. Beer's systems methodologies have a unique position, referring both to the 1st column (Organizational Cybernetics (Beer, 1972)) and to the 3rd one (Team Syntegrity (Beer, 1994)). In the context of our hypothesis, they seem especially promising for countries whose power and government systems are in the process of transition from mono-subject socio-cultural systems with a "vertical" goal-setting and decision-making procedures to polysubject.



Such a “right shift” in the SOSM grid, keeping the main ideas of VSM about the autonomy of the controlled system, system homomorphism, recursion and communicative interaction of the subsystems along the “vertical” and “horizontal” axes of organization, we call the “approach based on the idea of system viability”, or Viable Systems Approach – VSA. Applying this approach to the problems of social responsibility in polysubject socio-cultural systems, we show that an important characteristic of such systems is reflexive communication, which can give rise to disputes about the “rules of the game”, that is, about the institutional basis of human activity.

The resolution of such disputes takes place in reflexive-active environments, which makes it necessary to supplement VSM with the concepts of reflexion, reflexive communication, and reflexive-active environments. At the same time, the proposed development of S. Beer's ideas within the VSA, turning it into an integrative systems approach using governance tools of various systems methodologies, retains a genetic link with VSM as a model offers a sophisticated and comprehensive understanding of evolutionary strategies to manage complexity for a long-term viability of the system (Espejo, 2004). In this context, social responsibility for the Whole in polysubject socio-cultural systems is responsibility for their long-term viability.

2. Two differences of organizational cybernetics from technical one in social responsibility problem context

The concept of feedback is obliged by its origin to cybernetics and systems approach. Have been entered by N. Wiener within the cybernetic model of system with negative feedback (Wiener, 1948), this concept has got a key role in L. von Bertalanffy's representation of a biological organism as an open system (von Bertalanffy, 1968). Principles of cybernetics and the first version of systems approach was similar because in the first case negative feedback allows technical system to approach the external goal for the sake of which it is created, and in the second it provides to an organism as whole (system) to operate the subsystems for the best adaptation to external environment and viability increases.

Specific feature of polysubject socio-cultural systems is their social and organizational character. Similarity of the feedback mechanism structure in technical and organizational systems is both have “a control cycle”: identification of deviations from the goal, an assessment of their criticality, timely decision making for the correcting influences and their implementation. However in many cases of organizational systems governance practical correction (updating) of the goals in compliance with newly discovered circumstances is required. For this purpose the feedback mechanism structure in organizational systems, unlike technical, has to include a communication of governing and governed systems. It is important to note that the term “communication” is mentioned in the title of N. Wiener's foundational work: “Cybernetics: or the Control and Communication in the Animal and the Machine”. However, in the context of control in the world of animals and machines, this term means “communication as exchange of information”, whereas in relation to organizational and social control and governance, it also means “intercommunication, dialogue”.

The second important difference of organizational and technical cybernetics is the principle of two-channel (generally – multichannel) organization of feedback mechanism. For ensuring operability of such system the classical Wiener's model of the system with one negative



feedback should be added with independent feedback (Wiener, 1948). Otherwise we will face all colors of bureaucratization problems in governance. An independent feedback channel allows not only to deliver undistorted information to the governing system, but also to co-ordinate the purposes and actions of the actors of the governed system, if it has a multi-subject nature.

The differences between organizational and technical cybernetics, and problems mentioned above are considered by organizational-cybernetic Viable System Model (VSM) (Beer, 1972) which borrows the principles of neurophysiologic management based on live systems research, and also communicative methods of joint decision-making. The history of VSM contains a set of cases of its practical application. A number of the consulting companies worked together with S. Beer at corporate level, and now they continue to work successfully: Syncho Ltd (Great Britain), Team Syntegrity Inc. (Canada), Malik Management Zentrum, St. Gallen (Switzerland). Several scientific centers are engaged in theoretical developments and applied aspects of VSM implementation. The CyberSyn project (Cybernetics+Synergy) which implementation has begun in 1971 in Chile by the invitation of President Salvador Allende was the largest and most known case of experiment to try use VSM at the government level. Within this project total reorganization of government regulation in economic policy has been offered. Unfortunately, the military coup of 1973 hasn't allowed to complete this experiment (Beer, 1972; Espejo, 2014).

3. The position of S. Beer's Organizational Cybernetics in SOSM. From VSM to VSA

In his System of Systems Methodologies (SOSM) M. Jackson places S. Beer's Organizational Cybernetics of into the first column of the SOSM grid, corresponding to Hard Systems Thinking (Jackson, 2003). The difference of its position in comparison with the place of N. Wiener's classical cybernetics and such "hard" methodologies as Operations Research, Systems Analysis and Systems Engineering is that Organizational Cybernetics is placed in the bottom cell of the first column corresponding to complex systems, near System Dynamics and Complexity Theory.

But even such a neighborhood of Organizational Cybernetics requires reservations. Jackson himself in some of his later presentations distinguishes Complicated and Complex systems, relating Organizational Cybernetics to the latter type. However, described improvement in the SOSM grid does not remove the qualitative difference between its columns. The systems methodologies of the first column are built within the framework of classical rationality (Maracha, 2015), suggesting a subject-object categorical relation and operating with models of the natural science type. This is precisely the limitation of Hard Systems Thinking: it successfully works only in problematic contexts with homogeneous (Unitary) participants and monosubject goal-setting and decision-making (Jackson, 2003).

But, first, in VSM a governed system is considered to have autonomy. Secondly, it can include dissimilar actors. And, thirdly, in S. Beer organizational cybernetics the feedback mechanisms, described in N. Wiener's classical cybernetics, are rethought as communication mechanisms between the governing and the governed systems, as well as in the framework of "horizontal" co-ordination (Maracha, 2016). Already in the "vertical" VSM hierarchical relations are considered to include bilateral communications, or, as Raul Espejo calls them, cyber-system conversations.



Thus, participants of a viable system cannot be presumed as fully homogeneous (Unitary), and goal-setting and decision-making process in such systems cannot be considered as mono-subject. Therefore, the problem context of VSM goes beyond the first column of the SOSM grid. Both “vertical” and “horizontal” relationships with bilateral or multilateral communications between participants in a viable system include the practice of collaborative decision-making based on communicative methods (Beer, 1972). But while some participants may be in a hierarchical relationship, so they cannot be considered equal. Consequently, our governance tools must be “shifted” towards Team Syntegrity and similar methodologies that relate to the 3rd column of the SOSM grid. This corresponds to the transition towards Emancipative Systems Thinking and third-order cybernetics. The integrative approach, in which a similar “right-shift” in the SOSM grid and the implementation of tools from different system methodologies are used, was called Viable Systems Approach (VSA) above.

4. Polysubject socio-cultural systems in the typology of systems thinking and cybernetics

Analyzing the place of S. Beer’s organizational cybernetics in SOSM, we came to the conclusion that in the problem context of social responsibility in polysubject socio-cultural systems, the division of the SOSM grid into columns, corresponding to the typology of system thinking and cybernetics, is more significant. This correspondence is shown in Table 1, where the difference in the types of systems thinking and cybernetics (the second column of the table) is correlated with the difference in the composition of the problem situation participants, which determines the division of the SOSM grid into columns (the first column of the table).

Since the main application of cybernetics, as well as applied systems thinking, are control and governance problems, we can put each type of system thinking and cybernetics in accordance with a special type of governing (third column) (Maracha, 2012; Lepskiy, 2015). The examples of systems given in the fourth column indicate not only the allowable areas of application of each system thinking type, but also their ontological foundations (the third column): for the first type, it is the Ontology of Nature (“things” in the Aristotelian sense), for the second – Ontology of Human Activity, for the third – Socio-Cultural Ontology.

Table 1: Polysubject socio-cultural systems in the typology of systems thinking and cybernetics

The Composition of the Problem Situation Participants (M. Jackson)	Type of Systems Thinking and Cybernetics (P. Chekland, M. Jackson – G. P. Shchedrovitsky, V. G. Maracha, V. E. Lepskiy)	Type of Governing, Ontology	Cases of Systems
Unitary (Monosubject)	Hard Systems Thinking System-1, Classical Cybernetics	Control & Administration (Directive), Ontology of Nature	Natural and Technical Systems
Pluralist (“Free” Subjects)	Soft Systems Thinking System-2, “Second-Order Cybernetics”	Management, Ontology of Human Activity	Organizational Systems, Economic Systems of “Free Market”
Coercive (Polysubject with)	Emancipative and Postmodern Systems Thinking	Governance (Institutional and Network), Socio-	Polysubject Socio-Economic and Socio-



Coercion)	System-3, "Third-Order Cybernetics"	Cultural Ontology	Cultural Systems
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5. Social responsibility and reflexion within VSA

Having determined the place of polysubject socio-cultural systems in the typology of systems thinking and cybernetics and finding out the ontological basis behind this typology, let us return to the issue of applying VSA to the problems of social responsibility. In the introduction, we have already noted that if in monosubject socio-cultural systems social responsibility is the function of a single "decision-maker", then in polysubject socio-cultural systems social responsibility is the responsibility of each of the actors for the Whole in a situation where there are two or more actors acting as participants (and stakeholders) in the decision-making process.

It would seem that VSM contains a direct indication of the solution to the problem of responsibility: "System-5", endowed by S. Beer functions of "higher brain", bears full responsibility for systems viability in the long term. But after all, someone is responsible for the short-term results, which were the consequences of ill-conceived decisions, as well as for side effects that could not be foreseen. The situation of "higher brain" differs from the classical rationality of Hard Systems Thinking in that it cannot realize the subject-object categorical relation, which contrasts the governing and governed systems. It cannot be considered as simple subject-subject relations, which is enough to examine the problem situation with several positions, to negotiate and co-ordinate goals with a limited number of top managers (this would correspond to non-classical rationality and Soft Systems Thinking).

In practice, a governing system of viable system is not just a polysubject, but also "linked" to a governed system by close relationships of interdependence, which makes talk about "mutual management", i.e. Governance, when each actor interacts with a polysubject environment formed by other actors. This is a case corresponding to post-non-classical rationality (Stepin, 2005). In such a situation, in order to be responsible, the actors must be reflexive. This allows them to co-ordinate their goals and actions, taking into account the grounds from which each actor comes.

Since such a reflexion of the grounds of each other by the actors is mutual, the situation obeys the principle of "reflexive equilibrium," (Rawls, 1985) which ontologically means "recognition of the Other." Compliance with these conditions allows us to set some "rules of the game", in relation to which all actors are equal regardless of their social status and other resources. Ultimately, these "rules of the game" form the institutional basis for collective activity. However, in practice, even the most legitimate "rules of the game" can be violated when one of the actors tries to use their position and solve problems in the spirit of Hard Systems Thinking, ignoring the subjectivity of the others. Thus, the principle of "recognition of the Other" is violated, and inclusiveness is replaced by exclusiveness, i.e. the exclusion of a part of the actors, first from the processes of determining the "rules of the game" and then from the decision-making processes. The irreversibility of such violations ultimately leads to institutional consolidation of the "limited access order", while reversibility allows us to preserve the "open access order" (North et al., 2011).

Maintaining an "open access order" presupposes keeping "reflexive equilibrium" and honesty with regard to the "rules of the game" (Rawls, 1985), while justifying the "limited access



order” requires blocking reflexion. This dilemma is also projected onto social communications: in this context, the right to free speech means a ban on restricting the processes of social reflexion. Thus, in polysubject socio-cultural systems, we have a reflexive-active environment in which not only goals of human activity and concrete decisions are agreed, but there is a dispute (or even struggle) for fair “rules of the game”, for freedom of speech, thought and reflexion, for inclusiveness and against coercion. So the corresponding type of systems thinking is called Emancipative. And social responsibility in polysubject socio-cultural systems should be considered in the context of the institutional order dichotomy described above.

6. The social responsibility of government: the idea of a “viable state”

Separate consideration is the question of the social responsibility of government, which has different answers for the three types of problem situations presented in Table 1. The projection of different types of systems thinking and cybernetics on the problems of public administration allows us to distinguish the ideas of “strong”, “effective” and “inclusive” state (Bespalov & Maracha, 2017). The first of them corresponds to the classical model of “rational bureaucracy”, also called “Weberian” (Weber, 2015). Within its framework, the social responsibility of government is expressed in the fact that it must be “strong” to protect the rights of citizens and national interests (while the monopoly of state power on violence is limited by the principle of the rule of law). In the framework of the second model, called New Public Management, the social responsibility of government is to provide citizens with services, using the public resources entrusted to it as efficiently as possible. It is proposed to do this by changing Control & Administration (column 3 of table 1) to a set of managerial approaches, united by the idea of introducing elements of market relations and business management tools focused on the final result in order to improve the “ineffective” hierarchical structures of government bureaucracy.

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But the use of managerialism in public administration did not meet expectations, in particular, to reduce the bureaucratic apparatus. In addition, consideration of the state as a corporation raises questions about how this takes into account public interests. The answer to these questions was the involvement of public-network structures in which the government delegates some of its powers to other stakeholders and shares responsibility for the results with them. This approach to governing, which considers the participants of the system as interdependent (or mutual coercive), has been called Governance, and the corresponding model of government is New Governance. The social responsibility of the state implementing the New Governance model is to take into account public interests as much as possible, seeking to harmonize them and acting on the principles of participation and partnership. Such a state can be called “inclusive”.

The diversity of public administration models gave rise to the principle of its multimodality, implying the use of tools from different models depending on the problem context. But how, in this case, to avoid methodological eclecticism and the contradictions generated by it in the implementation of governing tools? For this purpose, we offer a “control cycle” scheme, “penetrating” three models, and the idea of a “viable state” (Bespalov & Maracha, 2017), based on the concept of a “viable system” within the framework of the same approach (VSA). In (Maracha, 2016) we describe, how VSA is used to integrate the three models of public administration by building a feedback system in the format of communications. Thus, developing the idea of a “viable state”, we obtain a model of multimodal government,



consistently connecting the requirements of a “strong”, “effective” and “inclusive” state. It should be noted that since the viability of the state presupposes its inclusiveness, the implementation of the “viable state” idea requires an institutional “open access order”.

7. Conclusion

In polysubject socio-cultural systems, social responsibility is responsibility for the Whole in a situation where there are several participants (actors) in the decision-making process co-ordinating their goals and actions in a reflexive-active environment. Such co-ordination is carried out through feedback mechanisms, which are the “vertical” and “horizontal” reflexive communications of actors. Reflexivity allows each of the actors to take into account the grounds from which other actors emanate. Since this kind of reflexion is mutual, polysubject socio-cultural systems obey the principle of “reflexive equilibrium,” which ontologically means “recognition of the Other.” Compliance with these conditions allows us to establish legitimate “rules of the game,” corresponding to the “open access order.” If we strive to preserve (or establish) such an inclusive institutional order, then civil participation is necessary not only in the discussion of specific decisions, but also in the development of fair “rules of the game.” To make this possible, we need guarantees for the rights of citizens and communities, a list of which is presented in the documents of the UN, the Council of Europe and the constitutions of democratic states, but can be expanded to take into account the problems of social responsibility set out above.

References

- Beer, S. (1972). *Brain of the Firm*. London: Allen Lane.
- Beer, S. (1981). *Brain of the Firm. Second edition*. Chichester, UK: John Wiley & Sons.
- Beer, S. (1994). *Beyond Dispute: The Invention of Team Syntegrity*. Chichester and New York: John Wiley & Sons.
- von Bertalanffy, L. (1968). *General System Theory*. Harmondsworth, UK: Penguin.
- Bespalov, S., Maracha, V. (2017). Strategic Cycle of Public Administration in the Context of the Multimodality Principle and the Idea of a “Viable” State. *Public Administration*, Vol 19, No. 4 (108), pp. 25–31.
- Espejo, R. (2004). The Footprint of Complexity: The Embodiment of Social Systems. *Kybernetes*, March 2004, DOI: 10.1108/03684920410523643.
- Espejo, R. (2014). The Cybernetics of Governance: The Project Cybersyn 1971–1973. G.S. Metcalf (ed.). *Social Systems and Design*. Tokyo, Heidelberg: Springer, pp.71–90.
- Jackson, M. (2003). *Systems Thinking: Creative Holism for Managers*. Chichester, UK: John Wiley & Sons. 352 p.
- Lepskiy, V. (2015). *Evoliutsiia Predstavlenii ob Upravlenii (Metodologicheskii i Filosofskii Analiz)*. [The Evolution of Ideas about Management (Methodological and Philosophical Analysis)]. Moscow: Cogito-Center. 107 p.
- Lepskiy, V. (2018a). Evolution of Cybernetics: Philosophical and Methodological Analysis. *Kybernetes*, Vol. 47, Issue: 2, pp. 249–261. DOI: 10.1108/K-03-2017-0120.
- Lepskiy, V. (2018b). Decision Support Ontologies in Self-Developing Reflexive-Active Environments // *IFAC PapersOnLine* 51–30, pp. 504–509. DOI: 10.1016/j.ifacol.2018.11.276.
- Maracha, V. (2013). Otlichitel'nye Cherty Metodologicheskogo Myshleniia, Opredeleiushchie Osobennosti MMK kak Intellekturnoi Traditsii [Distinctive Features of Methodological Thinking, Defining Peculiarities of MMC as an Intellectual Tradition]. Proskournin, V. (ed.). *Metodologiya MMK i Osobennosti Metodologicheskogo Myshleniia*.



- Materialy Konferentsii*. 1 Iiunia 2012 g. [MMC Methodology and Peculiarities of Methodological Thinking. Conference Proceedings. June 1, 2012]. Moscow: Non-commercial Research Foundation "Shchedrovitsky Institute for Development".
- Maracha, V. (2015). Sistemnoe Myshlenie, Refleksii i Sovremennaya Ratsionalnost': Sootnesenie Tipologii [Systems Thinking, Reflexion and Contemporary Rationality: Correlation of Typologies]. Lepskiy, V. (ed.). *Refleksivnye Protsessy i Upravlenie. Sbornik Materialov X Mezhdunarodnogo Simpoziuma*. 15–16 Oktiabria 2015 g. [Reflexive Processes and Control. Materials of the X International Symposium. October 15–16, 2015]. Moscow: Cogito-Center, pp. 59–63.
- Maracha, V. (2016). Feedback Mechanisms in Public Administration System: VSM Application and Institutional Factors. Caputo F. (ed.). *Governing Business Systems. Theories and Challenges for Systems Thinking in Practice*. Book of Abstracts. 4th Business Systems Laboratory International Symposium. August 24–26, 2016. Vilnius: Mykolas Romeris University, pp. 25–29.
- Maracha, V., Krasnikova, T. (2019). Rol' Setevykh Soobshchestv v Strategicheskoy Razvitiy Gorodov i Regionov [The Role of Network Communities in the Strategic Development of Cities and Regions]. *Regional'naya Ekonomika. Yug Rossii [Regional Economy. South of Russia]*, Vol. 7, No. 1, pp. 66–78. DOI: 10.15688/re.volsu.2019.1.6.
- North, D., Wallis, J., Weingast, B. (2009). *Violence and Social Orders. A Conceptual Framework for Interpreting Recorded Human History*. New York: Cambridge University Press.
- Rawls, J. (1985). Justice as Fairness: Political not Metaphysical. *Philosophy and Public Affairs*, Vol. 14, pp. 223–251.
- Stepin, V. (2005). *Theoretical Knowledge*. Dordrecht, Netherlands: Springer. 412 p.
- Weber, M. (2015). Bureaucracy. *Weber's Rationalism and Modern Society: New Translations on Politics, Bureaucracy, and Social Stratification*. Edited and translated by Tony Waters and Dagmar Waters. New York: Palgrave MacMillan, pp. 73–127.
- Wiener, N. (1948). *Cybernetics: or the Control and Communication in the Animal and the Machine*. New York: John Wiley & Sons.

