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sinergia em ação: processo de projeto colaborativo

synergy in action: the collaborative design process

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Abstract:

This article is the result of the master's research in the Institute of Architecture and Urbanism of the University of São Paulo. The investigation led us through cybernetic subtheories that corroborate with collaborative architectural design process. For the understanding of the conceptual bases, we studied the Viable System Model, as well as Team Syntegrity, by the cyberneticist Stafford Beer. The strategies for management against cybernetic resources showed us another way of observing the processes culminating in possible indicators for collaboration in Architecture.

Keywords: Architectural design, Collaboration, Cybernetics, Synergy

1 Introduction

Currently, the architectural design process has been revised in order to discuss the importance of factors and agents involved in the design course. With the advancement of collaborative concepts like BIM (Building Information Modeling) for architectural design process, the relevance of understanding observation and organization of progress has led us to Cybernetics. Cybernetics emerged in the 1940s with the first investigations of information processing related to the human brain, developed by William Ross Ashby[1] (1960) in his book Design for a Brain, becoming the First Order Cybernetics. In 1960, with the emergence of the General Systems Theory by Ludwig von Bertalanffy[2] (1969), Cybernetics enters the Second Order, covering the field of process observation to a more holistic extent. In Second Order Cybernetics there were advances in critical thinking and proposals of social organizations, as was the strategies outlined by Anthony Stafford Beer[3], reverberating in the investigation of this article.

Cybernetics was built in an interdisciplinary way, with the development of theories and concepts from different areas. The transdisciplinary complementarity has brought aspects to Cybernetics that allows us to retransmit ideals for the architectural design process, with approaches that we need, such as information processing and collaborative organizations.

Based on this imposition, we return our investigation to both organizational and collaborative cybernetic strategies, developed by Stafford Beer. Beer studied throughout his life mathematical and biological patterns, initially through analyzes of the brain and the human nervous system. The VSM (Viable System Model), elaborated between 1972 and 1985, is an organizational system realized through the human nervous system.

Through the publication of three main books on VSM, Brain of the Firm (Beer, 1972, 1981), The Heart of Enterprise (Beer, 1979) and Diagnosing the system for organizations (Beer, 1985), Beer raised a systemic thought for the structuring of self-organized social coordination. The VSM feature was designed to structure companies, both in operation and in organization, through five interconnected subsystems.

However, Beer denoted that the connection between subsystem 3 and 4 was insufficient for the advance of the whole system. The subsystem 3 is responsible for managing the running process, while subsystem 4 is responsible for the projection of any system in a future scope.

2 Synergy in the Viable System Model

Beer realized that the Viable System Model needed to integrate other aspects to respond to increasing challenges of complex organizations, since VSM was limited in building a group with collective consciousness and with collaborative participants. He set out from a three-dimensional geometric form to solve what he considered the soul of the VSM:

> The cybernetics expressed by the VSM is available to help.And if, as has been argued, the primary problem is the proper functioning of the Three-Four homeostat, then that would be a good place to start. We need to metabolize the creative and the synergetic resources of the enterprise. The directive management team of an enterprise is perhaps the most virile example of an infoset with which society is familiar (Beer, 1994, p.159).

In this case, Beer considered that the relationship between subsystems 3 and 4 was relevant for the operation of the whole company and decided that this issue needed to be solved differently (Ríos, 2011, p.201):

> The need of a tool for facilitating communication between System 4 and System 3 in an organisation was made clear by Beer himself when the VSM was introduced. Its last innovation, termed Team Syntegrity (TS) (Beer, 1994), was duly developed in order to help these two systems to communicate adequately and, as a result, to contribute to the smooth running of the System 4-System 3 homeostat, which, as we know, is critical for ensuring the organisation’s adaptation and viability (Ríos, 2011, p.201).

A communication way was important to facilitate the interaction between System 3 and 4 becoming essential to keep VSM viable, thus reflecting the interconnectivity between VSM and Team Syntegrity. Therefore, in 1994 Beer proposed the Team Syntegrity to provide the collaboration between the two subsystems. So, the objectives of a communicative way should have the following premises:

> – To generate a high level of participation among the individuals concerned; – To provide a structure and a system of communication that guarantee the nonhierarchical nature of the process; – To benefit from the variety and wealth of knowledge supplied by each individual within the group, putting into practice the synergies derived from the interaction among all its members; – To create a collective awareness, if possible shared among all the members of the group, regarding the central issue being considered and analysed (Ríos, 2011, p.205).

Concerning this, Beer believed to build a collaborative team system in which there was a synergy between all the participants of the process, generating a high variety due to diversity of people and collaboration from a non-hierarchical collective consciousness. For the idealization of this structure, Beer resorted to the North American architect Richard Buckminster Fuller[4], when he said that:

> Then I stumbled on an old gift from Buckminster Fuller - an inscribed time map of his own life - and started to think more about his geodesics. [...]. And I heard again in my own head Bucky's dictum: all systems are polyhedra. It is an amazing insight (Beer, 1994, p.12).

Defined by Fuller as the "[...] behavior of integral, aggregate, whole systems unpredicted by behaviors of any of their components or subassemblies of their components taken separately from the whole" (Fuller, 1975-79, p.102.00). Which means, the parts jointly make up a system that can determine the characteristics of the whole, however, separated, may not exhibit the same behavior.

Beer relies on the principles of the homeostatic machine, applied to the interaction and connection between people. He establishes a structure of relationships called SYNTEGRITY[5]:

> The structure that we seek must reflect the notion of a perfect democracy, as was argued before. It surely means that no individual, and initially no cause, should have ascendance over any other. Then in looking for polyhedra on which to construct democratic tensegrity models, we must consider only regular polyhedra: figures which have no top, no bottom, no sides - indeed no features by which they may be specially oriented at all (Beer, 1994, p.14).

Beer proposed a non-hierarchical and democratically perfect structure to face the challenges (Beer, 1994, p.12), adopting the form of geodesic domes.

The word tensegrity used by Beer comes from Fuller's explanation about tension and compression forms, as well as the geodesic behavior. Therefore:

> […] the wholeness, the INTEGRITY, of the structure is guaranteed not by local compressive stresses where structural members are joined together, but by the overall tensile stresses of the entire system. Hence came the portmanteau for Tensile Integrity: TENSEGRITY (Beer, 1994, p.13).

Therefore, Beer was based on the integrity of the tension of a system as a whole, in which a unity of social organization was observed. In addition, Beer also understood that these forces of compression and tension promoted other structural questions, when he said that:

Fuller formulated the idea that nature exists in an equilibrial balance between the forces of compression and tension. Obviously the existence of both forces was already known, but their collaborative coexistence in all physical systems had not been emphasized (Beer, 1994, p.12).

Hence, Beer understood the icosahedron, the geometric basis of the geodesic, as a form founded on balanced forces of compression and tension and he used to reformulate the model of organization, when he said:

> I decided to base my major experiments on the icosahedron, and to consider the edges as representing infosets members (namely 30) and the vertices as representing topics or key issues (namely 12), with the result that the edges conjoining at each vertex (namely 5) would be protagonists for each topic (Beer, 1994, pp.14-15).

From then on, Beer began to consider the geometric form of the icosahedron to compose his social organization. An icosahedron has 12 vertices, out of which 5 edges, totaling 30 edges. Beer regarded the vertices as discussion topics and the edges as the people involved, so 30 people would discuss 12 topics. Beer took into account the icosahedron as a whole and called it Infoset. Therefore, his Infoset would consist of a group of 30 individuals and 12 topics, in which five people would directly discuss a topic.

Figure 1 can show to us all possible connections within a Team Syntegrity, which is composed by direct links, those structured by team members who discuss a topic, and indirect links, composed by the critics of the topics generated by opposite face of the discussed vertices.

← Opposite Poles →

Topics	Members	Critics	Critics	Critics	Critics	Members	Topics
Team topic Red	Red - Orange	Green	D. Blue	Gold	Yellow	White - Brown	Team topic White
	Red - Gold	Black	Brown	Orange	L. Blue	White - D. Blue	
	Red – L. Blue	Silver	Blue	Gold	Purple	White - Black	
	Red - Yellow	Silver	Brown	Orange	Purple	White - Green	
	Red - Purple	Black	Green	L. Blue	Yellow	White - Silver	
Team topic Black	Black - Orange	Green	Purple	Silver	Yellow	L. Blue - Brown	Tópico Equipe Light Blue
	Black - Silver	Red	Brown	Orange	White	L. Blue - Purple	
	Black - White	Gold	Purple	Silver	D. Blue	L. Blue - Red	
	Black - Yellow	Gold	Brown	White	Yellow	L. Blue - Gold	
	Black - D. Blue	Red	Green	Orange	D. Blue	L. Blue - Green	
Team topic Orange	Orange - Gold	White	Purple	Red	Silver	Brown - D. Blue	Team topic Brown
	Orange - Silver	L. Blue	D. Blue	Black	Gold	Brown - Purple	
	Orange - Yellow	White	L. Blue	Red	Black	Brown - Green	
	Orange - Red	Green	D. Blue	Gold	Yellow	Brown - White	
	Orange - Black	Green	Purple	Silver	Yellow	Brown - L. Blue	
Team topic Green	Green - Gold	Black	Purple	Silver	L. Blue	Yellow - D. Blue	Team topic Yellow
	Green - Silver	Red	D. Blue	Gold	White	Yellow - Purple	
	Green - White	Orange	Purple	Silver	Brown	Yellow - Red	
	Green - L. Blue	Orange	D. Blue	Gold	Brown	Yellow - Black	
	Green - Brown	Red	Black	White	L. Blue	Yellow - Orange	
Team topic Gold	Gold - Silver	Brown	Yellow	Orange	Green	D. Blue - Purple	Team topic Dark Blue
	Gold– L. Blue	White	Yellow	Red	Green	D. Blue - Black	
	Gold - Red	Black	Brown	Orange	L. Blue	D. Blue - White	
	Gold - Orange	White	Purple	Red	Silver	D. Blue - Brown	
	Gold - Green	Black	Purple	Silver	L. Blue	D. Blue - Yellow	
Team topic Silver	Silver - White	L. Blue	Yellow	Black	Green	Purple - Red	Team topic Purple
	Silver - Black	Red	Brown	Orange	White	Purple – L. Blue	
	Silver - Orange	L. Blue	D. Blue	Black	Ouro	Purple - Brown	
	Silver - Green	Red	D. Blue	Ouro	White	Purple - Yellow	
	Silver - Ouro	Brown	Yellow	Orange	Green	Purple - D. Blue	

Fig. 1: Team Syntegrity integrated network. Source: Beer, 1994, pp.138-139.

With this integrated network it is possible to construct the icosahedron and stipulate the direct, indirect and opposite connections for the construction of the synergic structure.

The icosahedron has a unique symmetry, in which there is similarity in any position in which it is being divided, that is, any quadrants will always have the same symmetry that other parts. Thus, we can consider that its vertices always have an opposite pole and therefore we have 6 sets of two vertices that oppose each other. In the following image we can see an icosahedron in which we see and consider its poles as the red and white vertices, being: the red vertex, with its edges represented by red in both the model and the projection. It has the names of the edges with double colors, since the member participates in two topics at the same time. Thus, in the red topic we have the following participants: red-purple, red-yellow, red-orange, red-gold, and red-light blue. These five participants contribute to the discussion of the red topic and the respective topics that interconnect the participants (Figure 2), as explained by Ríos (Ríos, 2011, pp.208-209).

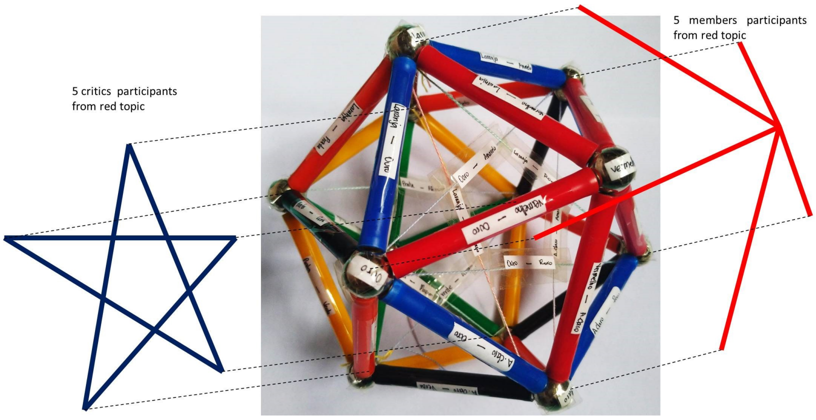

Fig. 2: Icosahedron: members and critics. Source: The authors.

At its opposite pole, being the white in Figure 1 of Beer's table, and drawn in blue in Figure 2, the discussion topics surrounding the white topic form a star with the members that interconnect this face of the icosahedron. In the model these are represented by wires with their names and the projection is in blue. The five participants are black-green, silver-dark blue, black-brown, dark-blue green and silver-brown. These members are connected in a way indirectly to the red topic, acting as external critics of the contributions and evolutions that occur in the topic. The same occurs in the opposite position, the star surrounding the red topic acts as a critic of the white topic and this happens on all faces, as demonstrated by Ríos (2011, pp.208-209).

According to Ríos (2011, p.210), in the red topic discussing act, the five participants contribute directly as members and indirect way as critics. Thus, we have a 10 people group involved in the process, added to 10 observers. The observers are members that connect the red topic direct participants with opposing critics, configuring a 20 people group.They are represented in the model by the orange and black color edges and by the green color projection of Figure 3. In Beer's table, the observers are gold-green, light blue green, light blue-brown, purple-brown, purple-blue, dark-blue, yellow-black, black-orange, silver-orange, and silver-gold.

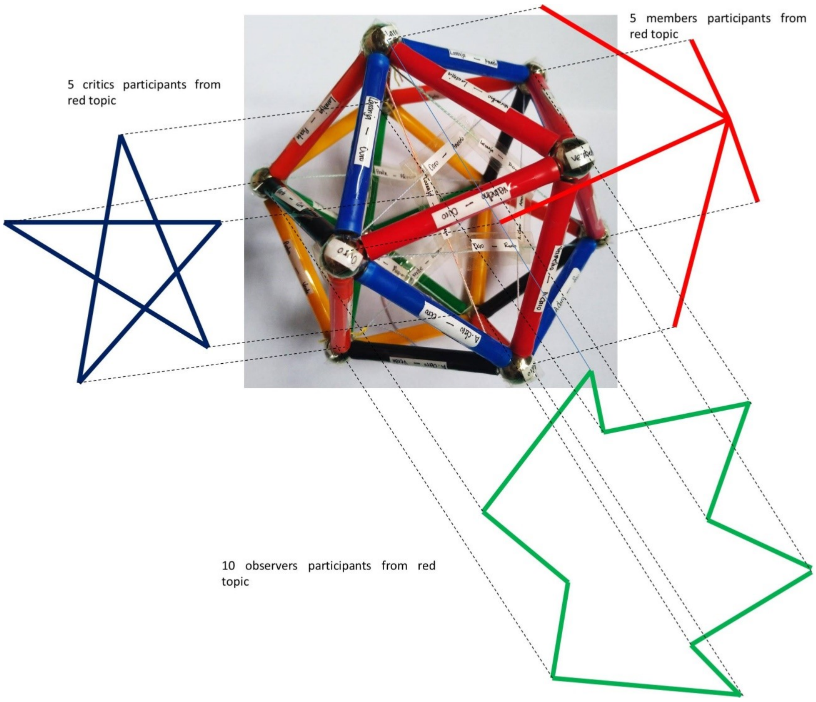

Fig. 2: Icosahedron: observers. Source: The authors.

Beer structured the Infoset and defined this 'information set' according to his perception of the VSM limitations:

> I proposed that what brought people into cohesive groups was the shared information that had changed them into purposive individuals. Data themselves do not supply this cohesion: it is the interpretation of data that procures purpose, and it is the shared interpretation between individuals that procures group cohesion. Thus groups of this kind were nominated as infosets (Beer, 1994, p.10).

To ensure the groups cohesion, people should share information, forming individuals with purposes to ensure the functioning of groups with a collective conscience. Therefore, Beer understood the icosahedron as a means capable of promoting discussion and making the intended cohesion viable. Thus, Beer absorbed and retransmitted the structural properties of the form to reach his proposals. The homeostatic cycle between Subsystem 3 and 4 has been developed to address interpersonal dialogue issues, and works in a way that:

> […] some node within the system propagates an idea, which then bounces round other nodes - and returns (somewhat modified) to hit its progenitors […]. This concept of Reverberation came to mean to me the instrumentality of tensegrity within the Infoset: it generates synergy. […] Boris Freesman suggested that my own emphasis on the synergy attributable to reverberation should be acknowledged. He coined the word syntegrity, which draws together synergetic tensegrity, and Team Syntegrity has been the name for this technique ever since (Beer, 1994, pp.13-14).

The icosahedron use as an organizational structural model has brought to Beer the possibility of establishing a network of synergistic interactions. As the network is constructed through the geometric model, in which 12 topics are discussed simultaneously by 5 individuals. Each individual discusses two topics at the same time and acts also indirectly in another group.The Infoset as a whole is structured with 30 direct connections, added to 30 indirect connections, totalizing a web with 60 connections. Connectivity between individuals and discussions on the subject does not bring about repeated solutions, opening up opportunities for several points of view on the same theme (Beer, 1994, p.15), allowing a high level of variety and thus ensuring decision-making.

The icosahedron structure, in organizational terms, is conceived through protocols, in which the participants are defined, the topics to be addressed, the positions of both topics and people within the icosahedron and the functions assigned to each one.

3 Considerations

The detailing about human organization in Syntegrity is important to emphasize how this strategy evidences the connections between members participating in the process. This enables a synergistic network that makes the process collaborative and promote solution of interpersonal conflicts and discussion of topics without overlapping energies within the system.

The implementation of collaborative systems for the architectural design process can update the way we think. With another look at the design process, Cybernetics allows the restructuring in order to ensure cohesion for the whole system. Also promotes synergy between the parts that compose it, that is, collaboration in function of an evolution of the organizational system.

Therefore, the design process can used cybernetic theories and concepts to encourage collaborative processes and the relevance of other means with advances towards BIM concept implementation.

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1 William Ross Ashby (1903-1972): Born in London, England, graduated in zoology and later specialized in psychiatry, he spent 40 years of his life in a process of understanding the brain and trying to reproduce it as a machine. It is part Cybernetics of First Order (1940 to 1960) in which the objective is to observe the process.

2 Ludwig von Bertalanffy (1901-1972): Born in Vienna, Austria, he studied the organisms and published the book on General Systems Theory in the 1960s, which revolutionized the way of thinking, opening up the evolution of the theories that emerged before of this period, including Cybernetics. Cybernetics of the Second Order (1960-1990) arises through new communication proposals, in which the observer is included in the process.

3 Anthony Stafford Beer (1926-2002): Born in England, he studied philosophy but had to discontinue incorporating the British Army into World War II, was hired by the government of Chile in 1972 to develop a real-time computerized system to manage the social economy, but abandoned the project in 1973. It is part of the Second Order Cybernetics (1960-1990).

4 Richard Buckminster Fuller (1895-1983): Born in the United States, he studied architecture, but can be considered a visionary inventor. He did military service in the period of World War I, in 1932 he had a moment of introspection that changed his way of seeing life and began to propose new ways of living through the use of innovative technologies. It is part of the period prior to the Cybernetics of First Order (1940-1960) and Second Order (1960-1990).

5 Syntegrity: SYNERGY + TENSEGRITY (integrity of tension).