Grey Box City

Building cybernetic urban systems for smarter simulations

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In this paper we approach the concept of grey box model to understand the subjectivity and objectivity of urban design. From the beginning of the insertion of computational systems in the systems management, we understand that some simulations and the understanding of the city itself were partial: we do not understand the city and its spatial complexity and we have the pretension to do urban design thinking that we understand the urban life . Here we will address some categories of how we can simulate and create our urban systems using a more tactile cybernetics.

Keywords: *Grey Box, Cybernetics, Smart City, Information Technology*

INTRODUCTION

Many of the socio-spatial manifestations that take place in 21st century is organized by virtual and urban spaces interactions in a constant sensing surveillance between (Claudel; Ratti, 2016). Information is a fundamental element in this process because it connects these two spaces, formalized through signals and language systems that allow different actors to interact. These connections are important both in the predictability exercise (simulation and possibilities) and design (simulation and projects). With Information, we can have more than cognitive processes, we will be able to formalize the matter in complex ways, instrumentalizing the perception of information in a set of intelligent systems, conversing with physical space. In this paper we will address more about these connection processes using the cybernetic concept of a box.

For this, however, it is necessary to understand the process of the systematizations of the urban project. As cities and science there are several approaches (using the technical domain in its conceptual core) we can interpret the advent of technique as a means of expressing information. We understand this process in the technologies of Geographic Information System (GIS) and Information and Communication Technologies (ICTs) in geoprocessing urban networks, all of which are now recognized as tools of interaction and spatial agency. Cybernetics is important because it is the conceptual framework of computational technologies, where networks, design agents and the space talk and exchange information in the virtuality of cyberspace and cybercity.

"If a city can be seen with what is configured in space through exchanges of communication and transport of matter and energy, cyberspace can enhance and even complicate our vision and interaction with the space we inhabit. It can create community synergies, assist the planning and execution of joint designs, create effective channels with pub-

lic authorities and, perhaps, reheat the real spaces through greater citizen participation. Networks can, and have already shown, serve as a vector for the empowerment of free and democratic communicative forms. " (Lemos, 2004)

Digital technology is an important paradigm in the intense flow of information because designers, planners and agents can have the ability to build a peer-to-peer, feedback-optimized systems to address city problems. The intelligent system, we can understand, is a system of intelligent agents that evolve and talk through feedback phenomena. Feedback is one of the important actions in a sustainable constitution of urban space, both in the efficient use of its resources and in the good maintenance of the system. The urban structures, to which these systems are attached, begin in this approach with the basic action of cybernetic mechanisms: input the information, which made all urban systems constitutions a planning conception. What we then constitute as a space in which we live is the result, through the cybernetic perspective, a cognitive apprehension that use informational processes: we interpret data, and we do the information, generating new information and new data.

The performance of design and planning, as Paul Pangaro says, is the intelligence to deal with the complexities that we generate of a systematization of several intelligent agents (Pangaro, 2015). The system is a design that seeks conversation. We have the greatest control when the conversation, confronting entropy, that is, the state of disorder of nature itself, is faced by the feedback process, the effort of what exists between the initial state and the modified state. Whether we are socialbiological, mathematical, linguistic, urbanistic or architectural, the tendency of a system always to tend to the nature entropy, and that must be reversed - generating syntropy by means different search for the own evolution. There lies the concept of intelligence inherent in urban systems. In this we consider that boxes, delimitations of scopes where the components form a joint characteristic, is a cybernetic system.

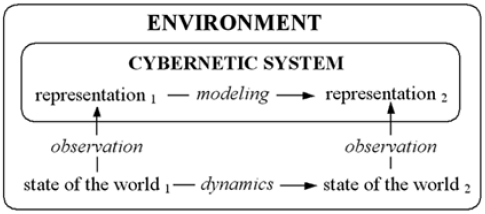


Figure 1
The Burtsev's Evolutionary Cybernetic System

On the urban scale we have some levels of analogous information developments in which we use cybernetics for building boxes. For systematization purposes, we will present relevant points of the cybernetic systems in the urban context exemplified by Claudel and Ratti (2016) and we will focus on what later develops as grey box, a model of performance and simulation. Boxes are strategies of analogies through which we construct strategies to perceive the complexities of systems, and use them as:

- Instrumentation: the ability of systems to measure information by means of sensing tools. It is the first movement of action against entropy. We consider this point as the principle of the movements formulator whether they are designable or not. Examples are locative media (LBM), georeferencing (GIS) and remote sensing. Environmental, energy, social and political sensors serve as parameters.
- Analytics: the form of see and interpret the information acquired are, in accordance with logic, the atribute of a analysis system. In an urban design, parametric methods are best known as BIM (Building Information Modeling), SIM (System Information Modelling) methodologies and the performance management (PM).
- Actuators: when the systems act physically in the agency of the city. Whether in planning, management or project assignments, the active systems that transform the city in real time or other deadlines are what architects generally relate to in the city's parametric management. Batch issues, use and parceling, templates, landscape projections,

and models of mobility and energy systems are some of the driving examples we will see below.

This information flow is an evolutionary process not very clear, a cognitive learning that lies in the intelligence of the city and its agents in the surveillance of urban systems. Sassen argues that technology can emancipate cities and citizens, and in this way, in a contrary surveillance, the process of constant activism of the systems before the flow can have different apprehensions and understandings that we can understand as a gray box, besides of their usual concept. The urban actions predicted here are locally referenced in the configuration of the events to which they are established (mobile, urban, modal or even architectural). These actions help us understand the complexity, that is, how the city structures itself in many other systems.

The systemic use of information in various city organs help us to understand both the organic spectrum of the whole (in governance and urban analysis) and the relations of different scales at the human level in the own urban experience (Sassen, 2010). In this perspective, we can also interpret that we must understand the system in how they are made in different ways at each moment, in a dynamism that goes beyond the assignments of a designer or a planner. In the view of Cybernetics we will configure the system capacity to generate new uses in an environment with conversation and simulation.

SYSTEMS AND THEIR COMPLEXITIES

The relationships made in design and spatial agency are communication structures, fed by information sources, to which planning form the basis of systematization cycle of urban design. Designs are traps of information (Flusser, 2007) that we deal with in logical structure that, in the urban context, has intelligence imbued by the city agents themselves (people, institutions, buildings, open spaces, etc.). This intelligence is the result of the ability of systems to go beyond the technical spectrum itself to an adaptive spectrum. This is the main complexity of systems and their flow of information, the challenges of facing a box.

Whether for sensing or design, any of all complex systems have intelligence as their ability to made feedback. This characteristic is what system makes assume a different and adaptive posture, depending on the environmental and informational conditions. This characteristic can be seen from the self-regulation of small computer systems to the GPS and cybersecurity, such as the Center of Operations Rio de Janeiro (COR). In this example, the system has georeferencing inputs and then, during data interpretation and referencing, these data interact with other intelligent security systems and are measured by operators, creating an accessable database. Thus, this system constitutes a maintenance vigilance of the city integrated to other systems such as CET-Rio, Geo-Rio (to which we can understand GIS) and later institutions like community, the mobility systems and the government itself. These cyclical manifestations of action and reaction on critical data and visualizations are the very cybernetic informational fabric of urban planning and strategy policing (IBM, 2017) that we can gauge as instrumentalization and analysis of the city as a box, city box.

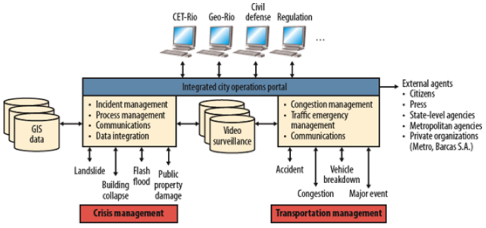


Figure 2
The Center of Operations Rio de Janeiro (COR).

We must always remember, in the first and second instance, that we are assessing the instrumentalization of the complex systems of the city as a cybernetic box. The box emerges as an analogy to a subjective characteristic inherent in urban analyzes, where the instrumentalizations of both people performance and physical systems are put into a database, transforming into parameters. These regu-

lations, in the perception of city-box use, are a strategy today achieved in cases such as COR in Rio de Janeiro, Dubuque in the United States and Bornholm in Denmark, as well as certain urban development regions in the city of Beijing and its technological parks (Long, 2018). For these processes to take place and to extrapolate the objective visions of smart cities to smart systems, we will reflect more on how to open the systems and learn from themselves.

''Even if we manage to achieve such optimality with adaptive urban systems, caution must be taken. If we are considering only certain variables for optimization, it does not imply that we are solving a problem completely. [...] Integrating broader set of variables in the development of adaptive system requires the communication between all sectors of society. We are still in the exploratory process for finding efficient ways of achieving such communication and promoting social participation. This would certainly be necessary if we pretend to achieve optimal governance or sustainability. '' (Gershenson; Santi; Ratti, 2016)

Of course, by environmental factors (here not only referring to the natural environment, but also the urban environment itself) we would not be able to establish a possible connection of constant adaptation. Upon materialization this aspect is even less possible still. What we understand is that bringing only optimality, that is, in the strict sense of cybernetics that deals with the functioning of the system fully, would not have city systems over smart and complex agency. For complex systems, cities are unique because they have a large number of gray boxes: at the same time that we have knowledge of them, we will hardly have the ability to measure them or fully understand them by their inherent subjectivity. Thus, in the characteristic of a more actualized and less controlled vision, we will focus on those systems whose most visible aspects andevident aspects.

The case of the urban mobility structure in Zhuzhou in China, Autonomous Rail Rapid Transit (ART), allows us to understand the use of information sensing, feedback and then its new action (Yu; Kong; Yan, 2018). This process is continuous: ART evaluates information through sensing, performs its interpretation and then stipulates, through a critical analysis of the environment, a new performance different from the previous result or other information. This process later happens again, and so the continuity of this cybernetic loop makes the box-system evolve. Thus, not only in the urban system, but the design itself is also stipulated about these constraints: a design strategy where the designer himself has no knowledge of the box or its actions..

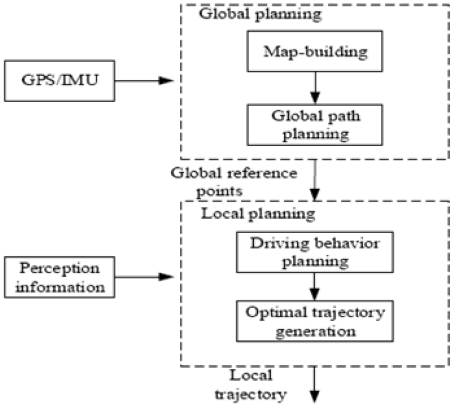


Figure 3
The Autonomous Rail Rapid Transit

The systemic concepts consider that the information constitutes the act of giving shape to the systems themselves. What we perceive is that cyclical processes of information apprehension, in the case of cities, uses smarter data analysis as a catalyst for the interaction between social agents and urban space (Lemos, 2004). We perceive this in the ART itself, which, by measuring a connection between the internal information (of the system itself) and external information (performance of human agents), transforms the direction and profile of the system itself. The intention of ART is to reduce the effort of several travel cycles to optimize certain uses of mobility, for which it constantly analyzes. This can be considered a cybernetic smart system that can be undertaken in other systems.

''Urban space today is pervaded by digital networks and systems, creating information that represents human activity. While most digitally managed urban systems generate operational data for their own purposes, they normally do not share those data directly with other systems or the public. As a result, digital information representing human activity in the city exists in many different places, locked within their specific domain.'' (Kloeckl, 2014)

As Kristian Kloeckl says, every human activity in urban space today has a willingness to be considered information in technological activity. The motto in this question lies in the connections these systems make, and how we deal with them. In the case of Kloeckl, the author analyzes that the interconnecting characteristic of a system and the constant feedbacks do not necessarily cause a destabilization, but make them more efficient from a direct performance point of view. We can address this technological development not only in mobility, but in other boxes that use the systems of analysis-performance in regions or urban agglomerations, areas of environmental interest as well as assemblages of urban traffic or even the expansions of the city, as shown by Beijing City Lab (BCL) research group on Beijing itself.

For the researchers of the BCL, it is necessary to understand, therefore, that the understanding of the system happens in a progression in which it depends on the sensing of equipments and people their due success. Systems are, to a lesser extent, dependent on each other. This statement lies precisely in the holistic characteristic that a system is greater than just its cartesian summation, and it is part of an environment. To clear the black boxes of the city, we need to answer - even if only partially - an urban question of how to bring cyber urban systems closer to human agency and people as a collective sense. Therefore, Cybernetics can become more useful.

BOX CITY

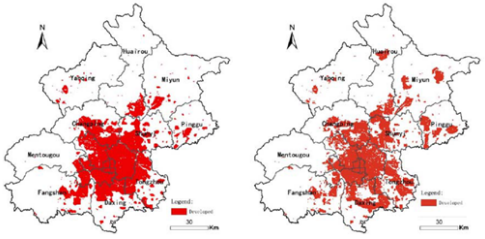
''For the discipline of urbanism, the struggle continues. Both of these trajectories present challenges in terms of infrastructure provision, housing, and socioeconomic development. But planners, policy experts, and economists are no longer the only specialists responding to these challenges. New actors enter the stage and bring new approaches to the field. Perhaps the most significant developments have happened in the domain of data-intense methodologies.'' (Offenhuber; Ratti, 2014)

The sociologist Bruno Latour in Science in Action proposes a broad confrontation that can help in how we can interpret the phenomenon of the complexity of the cities and the science that we understand like black box. We can use technology as a means of disinformation (Virilio, 2006), interpreting the project as a black-box incompleteness tool; or we may think we understand it fully. Digital technologies, by the very use of information that is out of control, can be black-box simulations and Latour understands that scientific complexity is a constantly changing field, and important information lies more in inputs and outputs and less in internal considerations of its operation and use, just as the strict black box is. But we need to try open the boxes.

Opening is not easy. The undersntading of black boxes allows you to extend the very structure that complexity can have. We care about feedbacks and inputs, and we look more sensitively at the behavior of the city compared to its systems and inhabitants. The algorithm is part of the systematization of the box, of course, where this system is integrated by the dynamic relationship with feedback (Claudel; Ratti, 2016), but it is only a look at its behavior. This look that escapes subjective control is the result of reactions and interactions that the systems, environment and individuals to which they are inserted in these free spaces suffer. If science and the urban design are treated as a power catalyst, we can see them as unfinished perspective of a clear, comprehensible white box and the then incomprehension of a black box model. The city is in a continuous autopoietic (Maturana way) evolution and the design simulation is a criticism about reality.

''The impossible task of opening the black box is made feasible (if not easy) by moving in time and

space until one finds the controversial topic on which scientists and engineers are busy at work. This is the first decision we have to make: our entry into science and technology will be through the back door of science in the making, not through the more grandiose entrance of ready made science." (Latour, 1988)



The box strategy is a process of stimulate responses and conversations with the environment and the community. This process, of course, is an interpretation to which the observer is made before the system: a parametric process, for example, is more suited to a proposal of varied parameters (actuators) than a process of instrumentalization and remote analysis such as COR in Rio de Janeiro. Therefore, better the conjunctures of a city to understand its information, better we deal to the indeterminate information, eliminating stochastic structures. The positions follow empirical logic, it is not a question here of stricto sensu composing neither a programmed city simulation, but designers can and must use more information and informational means to deal with the demands and potentials we already know be of little control. One example of this is the use of stochastic and deterministic elements in the BUDEM system in Beijing.

The box city then becomes continuum between the aleatory and deterministic, permeating randomities stochastic equations of black box models and the deterministic logics of the cellular automata of the more transparent boxes. Urban analysis around black boxes has now become relevant now, especially with the development of AI as well as the progression in satellite data visualization and information and communication technologies, but it becomes problematic if used unilaterally. These progressions are important, of course, but we can influence ourselves more by taking advantage of other cybernetic studies as well as of ecology to understand more about the constitution of the gray boxes as a semi-transparent spectrum of problems, reflecting on the critical theory of the subjectivity of urban settlements and also of the sociology of space as a constant non-tree construction (Claudel; Ratti, 2014).

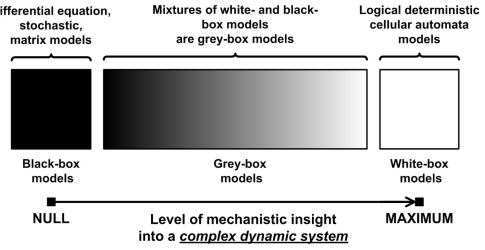
Far from the capitalist pretension that was promoted by smart city or the cold automatism of certain information devices (Costa, 2018) what we need to understand here is how grey boxes can help us in this city agency. We do not just need to computerize by creating algorithms for projects, but we need to interpret feedback from systems (input and output) and view information more in communities. We have already seen this mixed way of visualization and subjectivity in Senseable City Lab essays, like Real-Time Rome and, more recently, Gangnam Poop. In the Real-Time Rome project, for example, data visualization and information actions narrow the gap between spatial problems and representational problems that cybernetics could not previously achieve. These actions, metaphors of complexity and human subjectivity (such as a feedback between a Madonna's concert x texting) run away from the functionalist pretension of using digital technologies, which we have said before need to be refuted, since they are not fundamental but rather partial in systems of governance and development. The representation of information makes the communication of these systems themselves also an instrument of citizenship and citizen ownership of the use of digital technologies (Claudel; Ratti, 2016).

"Adaptive cities have the potential of increasing quality of life for citizens. But how equitable this increase of quality of life will be? Will all citizens benefit? At what cost? This is relevant, because even when cities accumulate most of the wealth of the planet, they are also the loci of greatest inequality. The answers to these questions will de-

Figure 4
Simulations using the system BUDEM made by Tsinghua University for Beijing

pend on how the adaptive urban technology is implemented, regulated, and managed in each city, and how this technology relates to citizens. This will require the effective interaction of governments, companies, academia, and society, as each sector may have different perceptions of the best way of managing cities." (Gershenson; Santi; Ratti, 2016)

Figure 5
The complex dynamic system continuum



On these points Cybernetics needs to be an important but more actively interactive path. We still need to understand how to reduce the persistent noises in the conversations between objective systems and human systems involving urban characteristics (Offenhuber; Ratti, 2014). However, the information is in this act of informing and shaping, the basic constitution of our conversations, it is the inclusion of the potential dynamism design, action or planning the city. Today, artificial intelligence contained in parametric softwares for modeling and visualization of information is potential in this experimentation, tracing efficient and dynamic strategies in the result of urban actions, but we can move forward in bringing the subjectivity to a party of urban analysis. Here, then, we need to place ourselves as a bridge between the stance influenced by science as a narrative technology phenomenon and how we can look at the action practices of urban planners and architects in the face of the liberation of Cartesianism.

CONCLUSIONS

For designers or planners, the complexity of dealing with the subjectivity and the intense dynamism of cities enables us to create new strategies and approaches to get the subjetive information and use it correctly with the culture. This characteristic possibility of the urban systems, to enable formal-spatial strategies, are what lead softwares and technology to search correlations between the city information and their potentialities. This is a way, as described by Ratti and Claudel, of interacting with the contemporary city smartly and dynamically. It is the question of the of cybernetic planning, a dynamic interaction between agents and systems, in a systematization of monitoring and ecology transformation, natural or not (Claudel; Ratti, 2016), social or not. But, other question is: to what extent will we be cybernetically smarter?

"The connection between spatial and temporal scales evident in ecological processes may prove useful analytically to approach some of these questions in the case of cities. What may be negative in a small spatial scale or a short-time frame may be positive in a larger scale or longer time frame. For a given set of disturbances, different spatio-temporal scales may elicit different responses from ecosystems. [...] This raises a question as to whether a city needs a larger system in place to neutralize the impact on the overall city system of major disturbances within the city. [...] Unstable systems come to be seen as stable, bottom-up control turns into top-down control, and competition becomes less important. This also tends to suggest thinking of cities as the solution to many types of environmental damage. What are the scales at which we can understand the city as contributing solutions to the environmental crisis¿' (Sassen, 2010)

It is clear that the design isfaded to be imperfect and suffer other subjective issues, but in the teleological and technical consciousness we can make systems and cities more adaptive, and deal with evolutionary organisms, not stable organisms. A designer needs to establish cybernetic action in systems to create a network of communication and control. The persistence of an urban system is not necessarily stable but resilient. Researches in European cities such as Amsterdam and London show that the big-time agency and city-planning relationships between control agents and communication agents,

users, demonstrate increased system efficiency in future participative design. We can verify that the structural systems with urban systems, parallel or not, create a dynamic network of different actors that proposes, at the same time, to potentiate spatial distributions of the city in an environment of distributive systems of information as well as to create a system of surveillance and control.

What would be the perspective of the smart city? Can we interpret them as data, measuring these elements in a hermetic way? No. Of course, we find evidence from Toronto to Sao Paulo, Amsterdam to Hong Kong, but we must interpret these examples as critical interpretations of the full urban experience as ways of interacting with the city systems. However, we can not fall into the stylistic forgiveness, translating as a remote sensing where parametric economic magnitudes can dictate the urban design. A cybernetic action in the city is an action where new processes of transformation and conversation take place, a more distributive dynamism, less centralized in the designer and more transpositive where it becomes increasingly important to mediate relationships for our community goals. The design process is in the communication between the constructed spaces, the virtual ones (simulation, virtual sensing) and the relation of the subject, being the use of cyberspace a connection point - dangerous - in this equation. What we must understand is that we should treat information as a process of formation and constitution of design beyond planning, neither as mere supporting data.

Digital technology in the city has been paradigmatic since its inception as a box, being able to modify how we see our intelligent organisms and our feedbacks. And this is not a purely building issue, it is the evolutionary and ecological answer of how we can integrate the complexity that we are facing with the digital information society. This discussion creates a theoretical path for new technological practices, and aims to establish a more critical research line forming the different framework on digital technology, representation, complex systems and design.

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