Infrastructure Space: Architectural Practice and Operational Logics in the 21st Century

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In the modern city paradigm, there is an objectification of urban means and instruments by differentiation: between server and served spaces, between structural and supported elements, between urban structure and infrastructure. This dissociation of elements may result in a simplified vision when it comes to understanding the dynamics of the city. However, it also allows us to understand the different systems as autonomous entities, susceptible to be analyzed in an isolated way and obtain alternative forms of mediating the context. This is the case of infrastructure.

The purpose of this paper is, in the first place, to review the current definition and meaning of the idea of infrastructure. From there, to explain Keller Easterling's concept of "infrastructure space"[1], in order to extrapolate it from urban to architectural contexts. This will be explained through five categories that organize infrastructure space within architectural practice, based on examples. Throughout the twentieth century, there are many architectural precedents that show an interest in incorporating infrastructural thinking into the project[2]. However, these experiences are usually characterized by an approach based on utopias, resulting in theoretical projects. This research's originality lies in the identification of a contemporary infrastructural architecture characterized by its pragmatic approach. This distinctive feature allows practice to be free from infrastructural non-operational aspects—such as large scale works and the idea of mega-structure—and consolidate new strategies to think architecture from a relational point of view.

The term infrastructure emerged at the end of the nineteenth century as a way to call the works carried out on the land before railway installations. From the beginning, the term refers to a set of different actions and not to something specific. Three matters characterize the conception of infrastructure. Firstly, its condition of 'infra' which implies the spatio-temporal idea of being inside, under, and before a higher order. In the second place, its development as an open structure with utilitarian purposes, which defines incremental growth potentialities. Last, its generic material manifestation was produced as well, with the goal of being replicable regardless of context.

Infrastructure is conceived as a technology for urbanization and environmental control, a mechanism for regulating the flows of energy, people, and the media[3]. It does not define something specific or limited, but a heterogeneous system of relations and actions. Motivated by this, in the second half of the twentieth century, its physical condition was suspended to make space for construction in its conceptual dimension. Therefore, infrastructure is transformed from a material system into a material-conceptual system, applicable in different contexts and fields.

This transformation occurs, first in the field of sociology through the social theory of the 60s[4], followed by economy and politics[5]. Originally, from the field of engineering and with a technical meaning, the human sciences appropriated this term and opened it up to a polysemic understanding of infrastructure. However, its double material–abstract condition always remains. To understand fully the current idea of infrastructure, it is important to review concepts such as ecology, media, and apparatus, which help to understand the true magnitude of its meaning and impact on the built environment as well as in the society.

To speak about infrastructure, it is necessary to position oneself within the ecological paradigm[6]. The translation of ecology to the urban context urges for an understanding of the city based on overlapping systems in permanent transformation. From this point of view, infrastructure is an open concept, inviting us to think the city as a living, relational system and in tension, with a physical counterpart materialized in concrete elements[7].

Infrastructure's main working mechanism is mediation. It works as a 'medium' of growth and control over the environment. In the most utilitarian sense, it operates as a means of urbanization, with all the economic and political implications that this entails. However, by understanding infrastructure as postulated by Marshall McLuhan, we can also see the symbolic dimension it has. The famous statement "the medium is the message" suggests, firstly, a distinction between medium and message, and secondly, it raises the question of what infrastructure says it does and what it actually does[8].

Finally, infrastructure is a device, an 'apparatus', in the words of Michel Foucault and later revised by Giorgio Agamben. This statement affirms that an apparatus is a "heterogeneous set consisting of discourses, institutions, architectural forms, regulatory decisions, laws, administrative measures, scientific statements, philosophical, moral, and philanthropic propositions"[9]. It arises from the intersection of relations of power and knowledge and always has a specific strategic function. From this point of view, infrastructure is not only a physical network, it is the entire political, social, administrative, economic, urban, and regulatory scaffolding, which frames and ensures its operability. For Agamben, the apparatus is a governing machine, which produces subjectivities whose objective is to manage, govern, control, and guide people's thoughts, behaviors, and actions, with the negative implications this entails.

Infrastructure space

Since the late 90s, we have heard more or less explicit references and inquiries into infrastructure in the field of architectural theory. However, it has only been in the last ten years when a high number of academic publications on the subject have appeared. At the beginning, it was more provocative than scientific work. We can find publications by Rem Koolhaas or Stan Allen and, in the mid 2010s, more systematic contributions by Neil Brenner, Pierre Bélanger, Jesse Lecavalier, Marc Angélil, or the more recent works of Rosalind Williams, to mention just a few. In this scenario, Keller Easterling stands out. She is the one who introduces the concept of infrastructure space.

In her book *Extrastatecraft: The Power of Infrastructure Space*, Easterling revisits the idea that infrastructure not only refers to a physical network or the means of urban cohesion. Infrastructure is also the set of shared standards. A control mechanism that constitutes the access point to all of them. The rules that govern the space of our daily life. Additionally, she develops the concept of "infrastructure space", which she defines as an operating system: an updating platform that spreads across time to deal with new circumstances, codify the relationships between buildings, or regulate exchange logistics. A matrix full of details and repetitive formulas that determine the spatial sequences of contemporary cities[10].

Infrastructure space is the conceptualization of infrastructure. It is the abstraction of infrastructure as logic. It is the extraction of ordering principles of infrastructure material: the rules that organize space through protocols. Thus, infrastructure space can be understood as the transformation of infrastructure into an abstract tool, applicable to the architectural project. If infrastructure in the city are the devices, the terminals, the circuits, the standards, the media, or linking circuits among objects; then, infrastructure space is the source code, the matrix that establishes the relations. Easterling states that we live in the infrastructure space and this can be clearly seen in the urban sequences repeated in cities all over the world. Yet fundamentally, infrastructure space is space: to inhabit, to empower, to control, to design.

The aim of this article is to prove that the process of abstraction performed on infrastructure, defined as infrastructure space, can be observed also in the practice of contemporary architecture. For that purpose, it is necessary to carry out an extrapolation of infrastructure, as defined by Easterling, from the urban scale to the architectural one. The hypothesis is that infrastructure space—understood as the proceedings extracted from infrastructure and undergone a conceptualization process—has become a project tool for architecture. The passage presented by Easterling, from infrastructure as a concrete system to infrastructure space as a concrete–abstract system, is not explicit, so a possible translation of principles, which operate in the first and have effect in the second, is proposed here:

Infrastructure is a system; infrastructure space is an 'operating system'. This distinction does not imply a mere qualification of the system. It is not a characterization. An operating system is a program that makes the system work and determines its qualities and potentialities.

Infrastructure is more than just a physical network, but it never stops being such. Infrastructure space is the combination of this physical network with an 'active network'. It operates and conditions the physical network from the abstract idea of flows, multi-scalarity, and programmatic hybridization, typical of conceptual diagrams. Infrastructure possesses action protocols and the standardization of elements. Infrastructure space possesses 'strategic protocols'. This means that it does not standardize everything by default but discriminates generic and specific aspects for each action.

Infrastructure is a medium of communication; infrastructure space is a 'medium of information'. Infrastructure presents itself as a neutral entity, controlling communications, people, and energy flows on demand. Infrastructure space becomes a power niche. It has the potential to define what is on and off the network and its scope.

Infrastructure is an urban agency; infrastructure space is a 'socio-technical agency'. Infrastructure is conceived, designed, and built within specialized technical offices, with authority granted by the administration. Infrastructure space implies social participation. It is a governance space represented by the administration and required by society to define the model for mediation and resource exploitation on behalf of the population.

These five concepts, put forward generically here, can be observed in a more comprehensive way in various functional structures of society, including architecture. To continue with this logic, from the concrete to the concrete–abstract, we will analyze five categories present in architectural projects built in the twenty-first century, starting with a manifest-project pavilion from the year 2000 itself.

Infrastructure space and architectural practice

To the premise "Holland Creates Space", proposed as the theme for the Netherlands Pavilion for the 2000 Expo in Hannover, the Dutch office MVRDV responds with the project Stacked Landscape, which swiftly becomes the paradigmatic architectural project of 2000 [Fig. 01]. It makes one wonder: which paradigm? What could have been interpreted at the time, as a defense of nature in the city, or vice versa, from our point of view, constitutes a true

manifesto that anticipates the production of infrastructure space in architecture. *Arquitectura Viva*'s monographic publication about the World Expo in Hannover, released the same year of the event, states: "The density and diversity of the different functions generates new relations, becoming a symbol of contemporary life"[11].

The pavilion is a succession of heterogeneous layers—even though the floor plan is perfectly square—overlaying different ecosystems and technologies. The main objective is to make mediation visible, which the infrastructure makes of nature [Fig. 02]. Different from the other participants in the Expo, the Dutch office presents this pavilion as an acceptance manifesto of a natural environment mediated by technology. There is no longing for a lost nature nor a fascination with future engineering. It is a manifestation of reality at the turn of the century, where nature is no longer limited exclusively to outside the city, nor are cities built as armored fortresses. The scale of twenty-first-century urbanization, hand in hand with the spread of communications and global commerce, is the infrastructural scale. Infrastructure is atomized and transformed into infrastructure space, susceptible of being designed at a planetary or architectural scale. This manifesto, ephemeral as it may seem, explicitly reveals in an anticipated way, questions that can be observed in other more canonical, contemporary architectural projects, showing the question of infrastructure as a technical, spatial, and social problem. In the words of its authors: "Expo 2000 is as a symbol for the multi-faceted nature of society: it presents the paradoxical notion that as diversity increases, so too might cohesion"[12] between the society and the systems which sustain it.

In the infrastructure space exemplified by the pavilion, the 'system' is the structure construction while the 'operating system' is the strategy of technified overlapping platforms. These are susceptible to be inhabited and configured with total freedom. A structural and working code, which is inserted in the structural network, is proposed. Nature mediation technology is explicit and expresses the system's internal synergy and its connection with a higher order. Other architectural works give continuity to the infrastructural system they are connected to and make it part of their programmatic condition. In the Dee and Charles Wyly Theater [Fig. 03], designed in 2001 and opened in 2009, OMA + REX also propose an overlapping of mechanized layers. Technified platforms do not only constitute the space but also, at the same time, are capable of movement to adapt the space. The building works as an operating system module, which is built in continuity to the people's movement. This is channeled, in the first place, by means of the collapse of the access platform that leads to the interior of the device. Secondly, the elevators, located on the main façade, make the platforms independent. Finally, the internal structure itself adapts by configuring and reconfiguring the space through slabs, walkways, floors, and moveable furniture. From the authors'

project description: "No longer shielded by transitional and technical areas—foyer, ticket counters, backstage facilities—this reimagining of the theatre typology exposes the auditorium to the city on all sides"[13]. The design of this project as infrastructure space generates an innovation both for the program mechanization and for its exposure through the façade. It regulates, on demand, the condition of theatrical black box and transforms the material and abstract features of the cultural program, traditionally enclosed in a permeable structure.

Infrastructure space has a 'physical network' and in the case of the pavilion it is the square floor platform, which is stacked leaving air and space to allow an 'active network'. This is what determines the spatial qualities and the potentiality of inhabitation of each space. This is a recurrent mechanism of infrastructure space: the oversized structure that makes it capable of adapting to the different contingencies of the activities that may be required over time. The case of the 1111 Lincoln Road building, designed in 2005 by the Swiss studio Herzog & de Meuron and opened in 2008, is an example of the dialectics between the physical network and the active one. The physical network is a system of open platforms—literally without an envelope or façade—that directs the flow of vehicles and pedestrian movement in continuity with the infrastructure system on which it is located. Additionally, each platform is susceptible to adaptation for temporary or permanent uses according to the programmatic needs to which it must respond. The authors understand the main parking program as a "public facility, like a train station or an airport, where people change from one mode of transportation to another"[14]. Housing, commercial stores, events, and car parks are the active network that twists the plans, unwraps the façade's envelope, and determines its free spaces.

The 'protocol' issue appears in two ways in the infrastructure space. Firstly, in the total negation of theory as a project premise. The practice, with its immediate constraints and direct consequences, is what justifies the decisions and determines the design. Secondly, in the pragmatism that can be seen in constructive standardization, many times importing prototypical elements directly to the architecture, as well as in the application of rules for spatial structuring and growth. An emblematic example of the infrastructural protocol application to the architectural project is the building for the Nantes School of Architecture, designed in 2003 by the French studio Lacaton & Vassal and opened in 2009. The concrete load-bearing structure is the same one used for parking, both in structure and element dimensions. The ramp that runs through all the platforms to the roof is even calculated, both in its bearing capacity and in its dimensions, for the circulation of vehicles. This pragmatism is explained in the project description as a strategy to achieve a resource economy and, in this way, maximize the built space that is possible. Interior partitions are also standardized. Its organization is determined by the active form, which defines the degree and type

of available space appropriation in each platform. In the words of its authors: "We wanted to put into practice a constructive system comparable to a Meccano. Just like an IKEA or an Auchan"[15]. However, as with the pavilion, the protocol is applied in a strategic way. Prototypical elements or systems are imported, but the capability to adapt to people and their appropriation remains. This is given by the proportion between programmed and free space, present in the building floors, the rooftop, or the ramp deployed across the façade.

As the pavilion shows, exposing the infrastructure not only 'communicates' in a physical-functional sense, but also in a symbolic one. The infrastructure as a means of supply and connection possesses a relative social prestige associated with the idea of progress, urban consolidation, and resource democratization. In recent years, this idea has been undermined due to the enormous environmental impact of urbanization and the exploitation of natural resources all around the world. For this reason, the pavilion project, ahead of its time and understanding that infrastructure space is a means of powerful information, does not convey generic infrastructure but a self-sustaining infrastructure. In the Mountain Dwellings building [Fig. 04], developed by the Danish studio BIG in 2007, we can see the ambivalence of infrastructure on a social level today. The dwellings, aerial and green, are placed on a mountain of ramps and platforms designed for vehicle circulation and parking. Specifically, a third of the program is made up of dwellings and two thirds is dedicated to parking, understood in the project description as the "foundation of the homes"[16]. The mountain, far from being a naturally formed landscape—as represented in the billboard around the façade—, is a stacked infrastructure. The project materializes the paradox of what infrastructure is and what it says it is.

Finally, infrastructure, due to its condition of 'urban agency' and its utilitarian functions, establishes a direct contact with people. The access to infrastructure is a practical but also symbolic question, based on its potential as an economic driver and its capability of directing territory urbanization. In infrastructure space, this problematic question still remains and becomes more complex when the social agency is added to the urban one. In the pavilion, it is evident that this question derives from the proper expository function it responds to; the structure is open, in a physical and abstract sense. There is no façade, and it is possible to enter programmatic spaces via stairs directly from the exterior. In recent public architecture, we frequently find this combination of an open-envelope structure and access points in continuity with the urban space, with no mediation of a foyer or halls. The Public Condenser [Fig. 05], designed by Studio Muoto in 2016, is an example of this strategy. Once again, the building is composed of several platforms stacked in height, a "stack of activities piled vertically"[17], with direct access from the exterior, whose objective is to make its uses independent and increase

the building activity time, day and night. The project is shown as "a fragment of the city [...]: commercial ground floors, open circulation systems which work as streets and sidewalks open all the time and overlapping activities"[18]. In turn, except for the rooms that require acclimatization due to their use, they are outdoor spaces. However, even in the case of enclosed uses, the programmatic volume is surrounded by a de-programmed volume in direct communication with the city, by means of staircases that connect all the levels with the urban space.

Conclusions

Architecture conceived and designed as infrastructure space is configured as an open matrix. This condition can materialize in various ways: functioning as an operating system, building a flexibility determined by the active network of use, implementing strategic protocols as a design guideline, presenting itself as a means of information, or consolidating a continuity with the public. The condition of 'open' is not a metaphor. Its public essence and massive use, which drives drives infrastructure, is the same that is seen in infrastructure space. However, all the cases frame degrees of freedom and adaptation to contingencies in regular formal structures, rectangular plans, and the layering of horizontal levels.

The architectural examples used could easily change category and would still serve to explain these concepts. What, in other research fields could become a problem, in this case, constitutes a virtue. As shown previously, infrastructure space is an operational-theoretical method, derived from the infrastructural praxis. The categories proposed are an attempt to show the project mechanisms used by architectural practice to produce infrastructure space at a building scale. For this reason, the fact that this architecture produces analogous projects is, perhaps, the most effective testing method for the hypothesis of this piece of research.

Finally, it is important to highlight that this architecture is built within an infrastructural understanding of the environment. Nowadays, this vision is going through a deep crisis due to extensive urbanization, which has accelerated in the last decades on a global scale, with the environmental impact this entails. Even if infrastructural architecture, applied on occasion, seems to increase people's degree of freedom, the public imagination in which it exists is a governing apparatus of power and exploitation. In this sense, it is vital to consider how the architectural project is re-signified, either by consolidating continuity with mass urbanization models or as a disruptive element of criticism.

1. The concept "infrastructure space" put forward by Keller Easterling in her book *Extrastatecraft: The Power of Infrastructure Space* (London: Verso, 2016), 11-23.
2. To mention the ones that are closest in time and that have had the most influence on the current panorama, it is worth highlighting the experience of Team X in the production of the megastructures in the 1960s or Rem Koolhaas and the free plan using high-rise buildings as a model. To deepen into these two experiences, see the doctoral research: Fernando Rodríguez, "Un entendimiento infraestructural del proyecto", UPM, 2015; and Joaquín Mosquera, "Conectividad urbana en Rem Koolhaas", UPM, 2017.
3. For a deeper view into the linguistic origin of the term infrastructure see: Ashley Carse. "Keyword: Infrastructure. How a humble French engineering term shaped the modern world", in *Infrastructures and Social Complexity. A companion*, ed. Penny Harvey, Casper Bruun Jensen, Atsuro Morita (New York: Routledge, 2017), 27-39.
4. In reference to the work in the social and human sciences developed over the post-war decades, largely determined by the notion of 'structure' and encompassed in generic terms such as 'structuralism'.
5. Ashley Carse, Op. cit., 35.
6. See Kathy Velikov and Thün Geoffrey, "Territorial Infrastructures: Recognizing Politico-Environmental Ecologies" in Ilka Ruby and Andreas Ruby (eds.), *Infrastructure Space* (Berlin: Ruby Press, 2017), 195.
7. For more on the conceptions of urban ecology see: Ian Mc Harg. *Design with Nature* (Nueva York, Natural History Press, 1969); Charles Waldheim. *Landscape as Urbanism: A General Theory* (Princeton: Princeton University Press, 2016); and Paolo Soleri. *Arcology: The City in the Image of Man* (Massachusetts, MIT Press, 1969).
8. Easterling, Op. cit., 13.
9. Giorgio Agamben. *What is an Apparatus? And Other Essays* (Stanford: Stanford University Press, 2009), 2.
10. Keller Easterling, "Split Screen", in *Infrastructure Space*, Op. cit., 264-272.
11. Luis Fernández Galiano (ed.). "MVRDV Holanda", *Arquitectura Viva 'Hannover 2000'*, no.72 (May 2000): 48-53. https://arquitecturaviva.com/obras/pabellon-de-los-paises-bajos-en-la-expo-2000
12. MVRDV, extract from the project description published by the authors on their official website: https://www.mvrdv.nl/projects/158/expo-2000
13. OMA, extract from the project description published by the authors on their official website: https://www.oma.com/projects/dee-and-charles-wyly-theater
14. Herzog & de Meuron, extract from the project description published by the authors on their official website: https://www.herzogdemeuron.com/index/projects/complete-works/276-300/279-1111-lincoln-road.html
15. Anne Lacaton & Jean-Philippe Vassal. "Materia al desnudo. La escuela de Arquitectura de Nantes explicada por sus autores", *Arquitectura Viva*, no. 124, 'Banda ancha. Obras digitales: de la estructura a la piel' (2009): 84-85.
16. Quote from the project description: "What if the parking area became the foundation of the homes?" BIG, project description published by the authors on their official website: https://big.dk/#projects-mtn
17. Gilles Delalex & Yves Moreau. "On Complexity, Studio Muoto. Urban Condenser, Paris-Saclay (France) 2016", *a+t 'Complex Buildings'* no. 48 (2017), 26-35.
18. Javier Agustín Rojas. "Sobre la neutralidad", *PLOT* no. 35 (March 2017).

7. For more on the conceptions of urban ecology see: Ian Mc Harg. *Design with Nature* (Nueva York, Natural History Press, 1969); Charles Waldheim. *Landscape as Urbanism: A General Theory* (Princeton: Princeton University Press, 2016); and Paolo Soleri. *Arcology: The City in the Image of Man* (Massachusetts, MIT Press, 1969).
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13. OMA, extract from the project description published by the authors on their official website: https://www.oma.com/projects/dee-and-charles-wyly-theater
14. Herzog & de Meuron, extract from the project description published by the authors on their official website: https://www.herzogdemeuron.com/index/projects/complete-works/276-300/279-1111-lincoln-road.html
15. Anne Lacaton & Jean-Philippe Vassal. "Materia al desnudo. La escuela de Arquitectura de Nantes explicada por sus autores", *Arquitectura Viva*, no. 124, 'Banda ancha. Obras digitales: de la estructura a la piel' (2009): 84-85.
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17. Gilles Delalex & Yves Moreau. "On Complexity, Studio Muoto. Urban Condenser, Paris-Saclay (France) 2016", *a+t 'Complex Buildings'* no. 48 (2017), 26-35.
18. Javier Agustín Rojas. "Sobre la neutralidad", *PLOT* no. 35 (March 2017).3. For a deeper view into the linguistic origin of the term infrastructure see: Ashley Carse. "Keyword: Infrastructure. How a humble French engineering term shaped the modern world", in *Infrastructures and Social Complexity. A companion*, ed. Penny Harvey, Casper Bruun Jensen, Atsuro Morita (New York: Routledge, 2017), 27-39.
4. In reference to the work in the social and human sciences developed over the post-war decades, largely determined by the notion of 'structure' and encompassed in generic terms such as 'structuralism'.
5. Ashley Carse, Op. cit., 35.
6. See Kathy Velikov and Thün Geoffrey, "Territorial Infrastructures: Recognizing Politico-Environmental Ecologies" in Ilka Ruby and Andreas Ruby (eds.), *Infrastructure Space* (Berlin: Ruby Press, 2017), 195.

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