

Encounters with infrastructure. The Sants rail corridor and the Borough Market of Southwark.

Abstract

Occasionally, the different forms of construction in the city and its consolidated scenarios converge at unplanned times and places. Different histories intersect, giving rise to a compatibility problem. Sometimes, the solution to the conflict produces surprising relationships, generated by the interaction between elements from very different origins. The case of the Sants rail corridor and the Borough Market of London are two clear examples of these forced encounters between architecture and city infrastructure. Today, they are examples of the type of landscape that can be created at such intersections. When seen from a historic viewpoint, it is understood that the current trend must leverage the qualities provided by the infrastructure to design the encounter between the different stories that make up the city, seeking new story lines that can give new meaning to the past, present and future of the environment in which we live.

Keywords

infrastructure; intersection; compatibility; line; Borough Market; Sants

Background and figure

From Le Corbusier's proposals for South America to the writings and projects of Team 10¹, the ability of infrastructure to bring order to the urban and architectural design process has manifested at different times. The large infrastructure brings a new order to virgin territory or crowded city alike that forces its growth. The compatibility between background and figure is resolved through development of the project. It is in that dialogue where design tactics and strategies reside, at different times and on different scales. In the case of linear infrastructures, such as the Sants rail corridor in Barcelona or the Borough Market in London, the straight line is a good method for generating structure in the city. It is precisely their quality as infrastructures from which arises their capacity to create a new story line, creating a line that is able to give new meaning to the stories and scenarios it crosses. Both case studies, one in Barcelona and the other in London, succeed in weaving together a series of initially disconnected stories in the city, each one in its own context.

Both the Sants rail corridor and the Borough Market can be compared with the great bridges that, in the course of history, have spanned rivers in the main cities, not dividing but consolidating the preexisting scenario. As an example of linear infrastructures, bridges have always been associated with exchange between communities; they are places of crossing, commerce, wars and frontiers. Many times their exact position on the map becomes consolidated because they give rise to new growth structures or guide lines for crucial relationships between different communities and within the same community. They are infrastructural lines that articulate stories and provide connections for going from one place to another.

The inhabited bridge is one of the clearest historical models of the relationship between architecture and infrastructure. In 1996, the *Living bridges: the inhabited bridge, past, present and future* exhibition presented an anthology of inhabited bridge typologies that later culminated in the public competition for a new bridge over the river Thames. The breadth of the historical review provided by this exhibition brings home the importance that this typology has had in the course of architectural history, as well as its potential in the future. The interest of the inhabited bridge lies in its quality as an infrastructure, providing a means for articulating multiple aspects related with urban life. As Jean Deathier said:

*"It can become a realistic instrument of reconciliation between architecture, town planning and engineering, between functionalism and conviviality, between efficiency and attractiveness, between technology and humanism. The urbanized bridge is a symbol of a quality of urban life that has to be reconquered and revived."*²

One clear example of a line that divides a territory is an allusion to the Ponte Vecchio in Florence. It is the commission received by Paul Rudolph in 1967 from the Ford Foundation to analyse the residual spaces resulting from the future construction of the Lower Manhattan Expressway in New York³(figure 1). He focused his study on the boundaries surrounding the potential cut generated by this infrastructural line in the city. His proposal was a clear declaration of intent of a combination of infrastructure and architectural design, encompassed within the vague field of *megastructures*:

"Rudolph: *A lot of people have worked with megastructures. The best model I have found is the bridge in Florence.*

Cook: *Ponte Vecchio.*

Rudolph: *The Ponte Vecchio: the shops on the street and, above them, marvellous houses. The scale of the columns harmonises with the street and then there is a reduction of scale. Nothing is new. Here we have a megastructure, probably the purest example of it in traditional architecture..."*⁴

In his book, Reyner Banham quoted the conversation between John Cook and Paul Rudolph when the latter was asked to give an example that could be used to develop the concept of *megastructure*. Citing the example of the Ponte Vecchio in Florence, Paul Rudolph used history to justify or construct an image. In the same publication, Banham says that English architects could use the Old London Bridge as an example. Both the Florentine and London bridges are archetypes of inhabited bridges as well as *megastructures*. Their connection lies in the relationship between infrastructure and architecture.

In Paul Rudolph's proposal, presented in 1972 with the title "New forms of the Evolving City", we find a certain connection with the fundamental ideas of the Japanese *metabolists*. Ideas such as the city as a living being combined with his interest in technology's modernising power render infrastructure capable of becoming an active integrating element for the society and its environment. According to Fumihiko Maki, one of the great promises of *megastructures* was that of infrastructure as a public investment:

*"Infra-structure as public investment: substantial public investment can be made in infra-structures (The skeleton of megastructures) in order to guide and stimulate public structures around them. This strategy can be further extended to a new three dimensional concept of land use where public offices will maintain the ownership and upkeep for both horizontal and vertical circulation systems"*⁵.

This public vision of the infrastructure forms part of the essence of the *metabolist* movement. If we consider the emergence of metabolism as one of the last periods in which architecture was

more of a public issue than a private issue⁶, there is a clear connection with the social aspect involved in the infrastructure's impact on the city. It often happens that the rewards brought by the creation of a new infrastructure in the city sanctify its benefits and the impact of its footprint is largely forgotten. The infrastructure's social potential includes the participation of multiple players within the community. Architects are just another piece of the movement required to appropriate them. However, they play a key role in bringing about a change in how they are understood.

Bjarke Ingels proposes the restoration of industrial infrastructures as engines for urban and social regeneration. These modern ruins, lying outside of the current social and cultural framework, should help support new programs that could structure the city. Designing new infrastructures from this point of view, he suggests that the investment for the benefit of a few could ultimately lead to the enjoyment of many⁷.

Two cases and their surroundings

In 1859, the Cerdà masterplan for the extension of Barcelona begins to swallow up the townships that surrounded the city centre. Sants, located 2km from the city walls, starts to experience population and urban growth linked to the development of industry and the railway. Factories such as *Vapor Vell* (Güell, Ramis y Cia) and *Vapor Nou* (España Industrial)⁸ led to the construction of the Sants Railway Station and the arrival of trains from Martorell. From then onwards, the neighbourhood would be closely tied to the railway infrastructure (figure 2).

The layout of the railway tracks was drawn on a practically blank sheet. They were built on apparently empty territory in which the geography and the points to be connected were the only constraints. That is why the route chosen followed the flattest section, as seen in the altitude recordings of the streets Riera Blanca, Rambla Badal and Riera de Tena. Probably due to their origin as waterways, these three lines are still today the three crossing points that connect the neighbourhood from the sea toward the mountain. This group of infrastructural lines, half natural and half artificial, created a new backdrop on which the city would continue to grow. At that time, the line that future buildings had to follow was determined by this new infrastructure and its relationship with the existing grid on which it was laid. From this point onwards, development of the area would be conditioned by this great figure imposed on the territory:

"Infrastructures constitute an artificial environment, channeling and/or reproducing those properties of the natural environment that we find most useful and comfortable; providing others that the natural environment cannot; and eliminating features we find dangerous, uncomfortable, or merely inconvenient"⁹.

The second case study, which responds to the definition of an elevated linear infrastructure, is related to the Old London Bridge, dating back to Roman times. Containing a great urban intensity between 1209 and 1762, the beginnings of the inhabited Old London Bridge go as far back as 1176¹⁰ when chaplain Peter of St Mary Cole church built the first stone bridge. The infrastructure supported housing, shops, a chapel, a prison and all manner of activities. Therefore, it is hardly surprising that the Borough Market would emerge in such a strategic location (figure 3).

Between 1758 and 1762, the buildings that topped the Old London Bridge were demolished and the bridge itself was rebuilt by Sir John Rennie from 1823 to 1831. However, the Borough Market's relationship with the bridge infrastructure did not end with the disappearance of the original bridge. The market had already been moved off the inhabited bridge long before its reconstruction due to the traffic congestion that it generated. Through an Act of Parliament in 1755, the market was abolished and the Parish of St. Saviour of Southwark was given power to relocate Borough Market¹¹. The residents bought some land south of Southwark Cathedral that is still the centre of gravity of the market known as the *Triangle*. This location would later condition the future encounter with the railway viaducts.

Starting in the 19th century with the beginning of the railway boom, decades of great changes would reshape the city landscape and the life of its citizens. As one of the main symbols of modernity in the culture of the time, frantic construction of railway lines was a priority. After the London Bridge Station was opened, a vast quantity of railway lines destined to connect London to the rest of the territory started to accumulate in that area. In this second stage marked by the railway boom, the Borough Market's relationship with the adjacent infrastructure is forced by the sheer magnitude of events. The viaducts that were needed to connect this new train station with Cannon Street or Charing Cross irremediably had to intersect the market. From that moment on, the market's relationship with these infrastructure lines is practicably unbreakable.

In contrast to this forced dialogue between a consolidated background and an imposed figure (the arrival of the railway lines on the Borough Market Triangle), the case study of Sants emerges from an encounter between a preexisting line and a city that is coming inexorably closer. The train line is surrounded by the expansion of the neighbourhood and can do nothing to avoid it. If one studies the evolving plans of the area, aside from the consolidation lines, one can see there pulsion effect created by the presence of this infrastructure. As if it were an open wound, the empty spaces along the cut produced in the neighbourhood can be perfectly seen. From the beginnings of the 20th century to the early years of the 21st century, the cohabitation

between the bed of rail tracks and the neighbourhood's residents becomes explicit and unavoidable (figure 4).

The problems resulting from preexistence of the infrastructure on the site can be easily explained with some facts. We could mention the 7metre separation between the infrastructure and the opposite façade of the Antoni Capmany Street or the acoustic impact of 67-74 dB against the maximum of 55-65 dB that were legally permitted¹². The life of the residents of Sants was divided by a 35-metre wide cut consisting of 8 tracks, 6 belonging to the railway and 2 to the Metro. For just under one hundred years, infrastructure and community have lived together.

Following the line proposed by Bjarke Ingels, in order to understand the social aspect of the Sants infrastructure, it is crucial to understand the historic ties between the neighbourhood and its industrial culture. The organisation of the working class has evolved and consolidated throughout history, creating one of the city's most vindicatory and articulated social bases. This associative culture enabled residents to participate with the city council in the decision-making process to put the tracks underground. This time, the railway infrastructure, to which the neighbourhood owes its birth and its history, lies in the hands of the people who live there. What was once profit for a few and suffering for many could now become a common good for all of the area's inhabitants.

With commencement in 2001 of the project to cover the Sants railway tracks, the residents began to see that their relationship with the infrastructure could change. Fuelled by their associative, cooperativist and self-management culture, participation and scrutinising platforms were created around the city council's decisions. Although they did not succeed in their goal to put the entire line underground due to economic and technical constraints, they did manage to agree with the local government that the area gained would be restored as a park. Furthermore, the two high speed train lines on the west side have been placed underground, thus broadening the narrow section of Antoni Capmany Street from 7 to 20 metres. Today, an envelope in the shape of a lattice-like structure of prefabricated beams covers the tracks and the project is in its urbanization phase (figure 5).

Comparing once again the case of Barcelona with that of London, both social contexts are key in the initial attitude towards the conflict with the infrastructure. On one hand, in Sants there is a head-on rejection of the railway line that had divided the neighbourhood into two parts for decades and which generated an active struggle within the community to bring about a substantial change in its relationship with the infrastructure. On the other hand, in the case of Southwark, the residents and users of the Borough Market view the presence of the infrastructure with resignation, which leads them to view coexistence as the only option.

In Barcelona, the dialogue between government and residents has resulted in a project that seeks to solve problems associated with daily life, while at the same time offering a proposal on a metropolitan scale, with all the advantages that the infrastructure contributes to the neighbourhood. The inclusion of this proposal within the Cornisa Verde masterplan, a plan to generate a 1200-metre long green corridor from Sants to Cornellà, shows the desire to take the opportunity offered by working on an urban element of this nature. On the other hand, the fact that the solution takes the shape of an elevated park which spills over the edges in the form of slopes that fill residual spaces and connection gaps with the city has been extensively criticised from different spheres, not least for the lack of stringency given the enormous complexity of the site (figure 6). Working with the programme beyond its use as a park, or the decision to work on smaller scales that complement the urbanization and the large-scale methods are some of the proposals made from different platforms.

At the Architecture School of Barcelona (ETSAB), the final thesis line led by Jaime Coll and Cristina Jover proposed in 2011-2012 an investigation of architectural alternatives to the barrier effect produced by the Sants infrastructure. Based on a detailed analysis of the frontiers created by the location, the state of affairs at that time was accepted as given and a solution for the infrastructure was sought through architecture. The outcome was a publication¹³ and an exhibition of projects that offered residents and institutions other proposals for appropriating, utilizing and surmounting an infrastructure (figure 7).

In the case of the Borough Market, the fact that a lobby had been formed to protect the market's interests before the railway lines arrived has conditioned to a great extent the actions carried out in this location in its relationship with the infrastructure. After the agreement in the 19th century, in which a number of buildings were lost in exchange for an expansion of the market and maintaining its trade activities under the viaducts, the latest intervention has followed a similar pattern. Although the compensatory tradition has been continued, this time with respect to management of the cultural and historical heritage, the improvements of the infrastructure and the intervention in the market have been carried out jointly with a renovation plan designed to counteract the deterioration of the area.

The latest transformations framed within the Thameslink 2000 masterplan have been developed with the aim of improving the connections with London Bridge Station. The width of the train bridge leading to Charing Cross was increased from two to four lanes in an effort to improve the transport capacity of the north-south axis. With this approach, a project was developed involving a multitude of agents and resources for its design and execution. In 1995, a board of trustees in charge of revitalising the development of London's Borough Market summoned a competition through the RIBA for its renovation. The winning architects, Greig&Stephenson, were able to intervene in this old intersection between architecture and infrastructure with an

urban reclassification scheme. While the relationship with the rail viaducts in the 19th century arose from an unexpected but forced situation, the relationship in the 20th century offered the possibility of managing this conflict in a more cohesive manner. After five years of data analysis, the architects implemented their proposal, based on the street directions, and the fluxes and routes generated by the market and its users. The infrastructural character of the Borough Market has determined the intervention in several ways. In this case, not only do the railway lines intersect with the city's architecture but also with the infrastructure of the market itself. The rail viaducts are regarded as important figures in the configuration of the space generated, uniting efforts to create a spatial continuity on the ground floor of the city. The resulting ecosystem, fed by the market's activity, extends throughout the complex, even going beyond its streets in the form of courtyards, alleys and inhabited arches (figures 8 and 9).

Threaded tales on several scales

However, considering the size of the two interventions, it is difficult to comprehend them without looking at them on different scales. Just as both projects can be read as part of a bigger plan, like the case of Barcelona's Green Corridor or London's Thameslink masterplan, there is another reading, much more local, that has to do with the construction of the city's architecture. The infrastructure's repercussion on preexisting buildings sometimes reveals a certain friction not only architecturally but also historically and culturally.

In Sants, apart from the block of flats located at the confluence between Burgos Street and Rambla del Badal, some of whose windows are only 2 metres away from the rail corridor, there is also Ca'n Vies. The importance of this construction goes beyond the mere space it occupies in the urban landscape. Built in 1879 as a warehouse during construction of the Metro, its use has since been tied to different types of associations, becoming the social centre of the Metro workers during the Spanish Civil War, later the headquarters of the 'Sindicato Vertical' during Franco's regime and finally a self-managed social centre after being appropriated by the residents in 1997. Its location is strategic, built at the intersection of the rail corridor with Jocs Florals Street, from which a bridge originally emerged to cross the train tracks. The local council planned to demolish it as part of the project to overlay the train tracks in order to create a public space. The construction of the rail corridor left the building untouched but in 2014 the process of demolition began (figure 10). There was an immediate outcry amongst the residents and soon after part of it was demolished, the residents themselves started to rebuild it. Today, part of the building still stands and it seems that the residents will continue to defend this symbolic building that is so closely tied to the history and the infrastructure that crosses the neighbourhood.

At the Borough Market, there is a 157mm gap separating the viaduct from one of the neighbouring buildings (figure 11). English Heritage, a state body, has been involved from the start in analysing the impact of the plans proposed by the Thameslink programme. Some of the buildings have eluded demolition by being listed, but others have had to be demolished, as in the past. Among those worth mentioning, aside from the constructions adjacent to the viaducts, there is the Globe Tavern, built in 1872 by the architect Henry Jarvis. Today, the building is found slotted in the interstitial space left between two viaducts, as tangible witness to the changes that the surroundings have experienced throughout history. Another example present at the site is the Floral Hall, brought from Covent Garden and relocated to Stoney Street by the architects Greig&Stephenson, in an act of historic recycling¹⁴.

Upon observing the intervention with respect to the immediate context in both cases, the environment conditioned by the inhabited, consolidated city is particularly apparent. With the construction of both projects, the magnitude of the management and logistics aspects of the infrastructure is readily seen, but also the historical, social and cultural weight of the environment. Because of the buildings on Antoni Capmany Street, near Sants Square on the west (mountain) side, part of the rail corridor had to be built using the infrastructure itself. In the case of the Borough Market, the room for manoeuvre was even more limited; if to this we add the fact that the market is open to the public, the listed buildings, tunnels under the surface and archaeological remains, the situation becomes enormously complex. One image that is particularly apt for this difficult project was the weekend of the Royal Wedding, when the viaduct over the market was used as a shuttle to build the bridge over Borough High Street¹⁵. As in Barcelona, the infrastructure itself was used to execute part of the project; the infrastructure was used to cure itself.

In both cases, the large scale represented by the infrastructure impacted on a small scale on the city's day-to-day architecture. Furthermore, the Underground L1 power substation, what is considered the largest building in Barcelona (700 metres and 55,800 m² of urban space), together with Ca'n Vies, and the city surrounding it, form a whole composed of perspectives on different space-time scales in which the infrastructure acts as a nexus between them. The same happens with the 2,000 m² of the Borough Market and the 2,500 m² of abandoned, underground cellars, the two former cells, the Globe Tavern and all of the city's architecture around them.

Infrastructures exist in historic time¹⁶. Chronologically, the sections comprising the infrastructure can be read on different levels, recomposing themselves as if they were frames of a film, telling different stories depending on the order in which they are shown. The infrastructure is the core that agglutinates the different stories that make up each case. The fact that they are also infrastructure lines brings out even more their magnetism with the

convergence on them of the surrounding scenario. The analytic study of the infrastructure must be built on a sum of differential sections with different space and time scales. Both infrastructures must be understood, not as frontiers or divisions for the city, but as a glue that binds together everything around them, joining together different scales and story lines, even diverse programmes that only share in common the large infrastructure that brings them together. A multitude of programmes can take place in scenarios that are tangential to the major infrastructure. And while the activities may be independent, a common thread runs through them all, forced by the infrastructure line.

To illustrate this conception of infrastructure as a line that brings together fragments from around it, one example springs to mind: a case based, in part, on a time-space reflection, the New York High Line. The project proposes a new look for a ruin of the infrastructures of modernity. By turning it into an elevated park, it reorganises how the city is perceived. Contextual differences apart, it is not unlike what is being tried in Sants or at the Viaduc des Arts in Paris with the Promenade Planteé. In all three cases, some more than others, strategies applied on different scales have an additive effect, using the infrastructure as a base, reusing and reappropriating inactive pieces around the infrastructure and which, by being joined, reorganise the city's time-space reading (figure 12).

*"It is time for architects to understand that the structures of infrastructural modernity are just so many ruins and, in conceiving of new infrastructures for the millennium, to learn how to embrace the new modulated world of invisible fields."*¹⁷

With this allusion, Varnellis is referring to the aeriels disguised as palm trees or Internet server stations on housing blocks, some of the camouflages that are a symptom of the presence that another type of infrastructure is starting to have in the city. Our gaze is pulled towards these new infrastructures, whose impact is perhaps not as direct and visible as the impact that railway lines may have but equally real and constraining. Following in the wake of Stan Allen¹⁸, interest in infrastructures and their relationship with the city is a key issue in architecture's outreach to urbanism and vice-versa. Architects capitalise the advantages offered by urban situations such as Sants, the Borough Market or any other type of infrastructure that may help articulate new relationships between disconnected strata of the city. Like a living being, the city will feed off all the ecosystems on different space and time scales that make up its body.

Concealment only serves to disregard or waste infrastructures whose properties may be useful for the city. In Sants, the cut is healed with a large green blanket that hides a concrete dragon. In the Borough Market, the option chosen is to feed and create a dense web of expansive activity that goes beyond the market stalls (figure 13): indeed, the height to which the viaduct has been elevated offers perfect conditions for holding a market under its arches. The large scale ceases

to be an impediment and becomes a necessary condition for the existence of *what is new*. On one hand, a partial camouflage of the railway line to generate continuity on top of a cut that splits the neighbourhood into two. On the other hand, an active recognition of the viaduct that soars over the market, with integration becoming a strategy to enable the two to coexist. Two approaches, one covering above and the other filling in below, that express the same search for compatibility in the intersection between architecture and infrastructure. Although it is true that certain potentials are lost and the projects arise from a situation of forced action, both cases are examples of the importance of the interaction with infrastructure in building the city. Attitudes of effective use, appropriation and, in short, construction of a new common outlook are key for addressing past, present and future encounters between architecture and infrastructure.

*"The co-construction of technology and modernity can be seen with exceptional clarity in the case of infrastructure."*¹⁹

¹ Smithson, Alison Margaret: *Team 10 Primer*. Cambridge (Massachusetts): The MIT Press, 1974.

² Dethier, Jean; Eaton, Ruth: "Past and present of inhabited bridges". In *Rassegna*. "Inhabited bridges". December 1991, N°48. Milan: Cippa, 1979. pp. 10–19.

³ Monk, Tony: *The Art and architecture of Paul Rudolph*. Chichester (England): Wiley-Academy, 1999.

⁴ Banham, Reyner: *Megaestructuras. Futuro Urbano Del Pasado Reciente*. Barcelona : Gustavo Gili, 1978.

⁵ Banham, Reyner: *Megaestructuras. Futuro Urbano Del Pasado Reciente*. Barcelona : Gustavo Gili, 1978.

⁶ Koolhaas, Rem; Obrist, Hans-Ulrich; Ota, Kayoko; Westcott, James: *Project Japan : Metabolism Talks*. Köln : Taschen, 2011.

⁷ Ingels, Bjarke. "BjarkeIngels: Rethinking Social Infrastructure." Special CNN, 2012. Available from World Wide Web: <<http://edition.cnn.com/2012/04/22/tech/rethinking-social-infrastructure/index.html>>

⁸ Dalmau Torvà, Marc; Miró i Acedo, Ivan; Marín, Dolores: *Les cooperatives obreres de Sants : autogestió proletària en un barri de Barcelona (1870-1939)*. Barcelona : La Ciutat Invisible Edicions, 2010.

⁹ N. Edwards, Paul: "Infrastructure and modernity: force, time, and social organization in the history of sociotechnical systems". In Thomas, Misa; Brey, Philip; Feenberg, Andrew: *Modernity and Technology*. Cambridge: MIT Press, 2003. pp.185–225.

¹⁰ Murray, Peter; Stevens, Mary Anne; Cadman, David: *Living bridges : the inhabited bridge, past, present and future*. New York : Prestel, 1996.

¹¹ Halliday, Stephen: "Underneath the Arches: Celebrating Borough Market." In *History Today* Abril 2014 vol.64 n°4.[citado 2014-03-02] Available from: <<http://www.historytoday.com/stephen-halliday/underneath-arches-celebrating-borough-market>>

¹² Godia, Sergi: *Un Edificio Para El Tren, Un Paseo Para La Ciudad (2002-2012)*. Barcelona : Intermedio Ediciones, 2012.

¹³ Coll, Jaime y otros. *Proyecto y proceso. Corredor ferroviario en Sants*. Barcelona: Edicions ETSAB, 2013.

¹⁴ Finch, Paul. "Market Renewal: Borough Market, on the South Side of the Thames, Has Won a New Lease of Life in Recent Years." In *Architectural review*. Noviembre 2005, N°1305. Londres: EMAP Publishing, 1896. pp. 80–83.

¹⁵ Lane, Thomas: “The London Bridge viaduct: The missing link.” In *Building*.Nº276. Londres: Publishing Office,1843. pp 32–37.

¹⁶ N. Edwards, Paul: “Infrastructure and modernity: force, time, and social organization in the history of sociotechnical systems”. In Thomas, Misa; Brey, Philip; Feenberg, Andrew: *Modernity and Technology*. Cambridge: MIT Press, 2003. pp.185–225. p 194.

¹⁷Varnelis, Kazys: “Camps Infrastructurals.” In *Quaderns d’arquitectura i urbanisme*. 2001, Nº261. Barcelona: Col·legi d’Arquitectes de Catalunya,1981.pp 57–60.

¹⁸ Allen, Stan: *Points+ Lines: Diagrams and Projects for the City*. New York: Princeton Architectural Press, 1999. pp. 48–57.

¹⁹ N. Edwards, Paul: “Infrastructure and modernity: force, time, and social organization in the history of sociotechnical systems”. In Thomas, Misa; Brey, Philip; Feenberg, Andrew: *Modernity and Technology*. Cambridge: MIT Press, 2003. pp.185–225. p 191.