TECHNOLOGICAL RESEARCH AND ARTISTIC PRACTICE. THE *TELEFONÍAS* PROJECT

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Who really knows how a telephone works? I have a theory:
Every time we dial a number and receive an answer it is
because God has intervened and has put His omnipotence into action
to bring about something that would otherwise never occur naturally.
César Aira[1]

The proposal

The *Telefonías* project was launched in 2004. The proposal involved conducting a research project designed to analyze the flow of calls at the Central Juncal telephone exchange with a view to materializing—through a series of aesthetic strategies—the invisible dynamics of the digital telecommunications that cross the building housing Espacio Fundación Telefónica (EFT).

The project underwent several stages. Initially, a number of employees from different telephone exchanges of Telefónica de Argentina were interviewed in order to delve into the social and historical aspects of telecommunications technologies. In parallel, studies were carried out with the cooperation of Leo Núñez in order to determine the manner of obtaining information on the dynamics of the Central Juncal exchange in real time. This was followed by a series of tests designed after an agreement was arrived at with Julio Bunetta and Fabio García of CSRTA (Centro Superior de Red de Telefónica de Argentina), with whom the feasibility of the project was analyzed from the perspective of telecommunications. Bunetta and García joined the project by designing the network and processing the data furnished by the Central Juncal exchange to be used in fueling the works exhibited in EFT. Finally, the team was enlarged with assistants in different areas: Diego Rusjan in technological production and Nicolás Bacal in the sound design. This group of professionals, under the direction of Mariano Sardón and with Victoria Messi acting as research assistant, were at the core of the development of the *Telefonías* project.

Basically, the proposal consisted in intervening the Juncal Building, that houses both Espacio Fundación Telefónica and the Central Juncal telephone exchange, by operating on the relationship existing between its cultural, educational and artistic activities and the communication technologies functioning within it to provide telecommunication switching and distribution services to the surrounding area.

The Central Juncal telephone exchange occupies a key location in the Recoleta neighborhood and maintains close ties with its adjacent area.[2] Its history developed on a par with the significant technological and social changes that took place during the last century. The old telecommunications devices used inside the building were systematically replaced by new technologies that increasingly tended to remove from direct perception the communicational process. Digital technology provided mass access to complex systems that were easily assimilated into everyday life, but even today their inner working is a mystery for most of us.

Despite its short history, EFT has become a significant node of cultural exchange,[3] enabling the exploration of the multiple relationships between art, technology and the community through the different activities that take place within it.

The *Telefonías* project was aimed at bringing together both spaces and examining technological processes from a reflective, ludic and aesthetic perspective. Through the works that form part of this project, the enormous amount of events that run through the building at every instant reveal themselves and become tangible in a visual and sound experience. EFT becomes the source and the recipient of electronic events that we are not normally aware of. As the hidden dynamics emerge, the viewers experience space as a larger, different and hitherto unimagined dimension.

Day after day, the Central Juncal telephone exchange transmits information via networks that connect a large number of users. Countless events take place in the building harboring both the exchange and EFT. Time and space unfold in intangible phenomena that surround yet elude us.

Information flows through the cabling in the building as if it were the nervous system of a living organism.

The exhibition materializes and embodies artistically the flows of information and the electronic events that take place within the building. The resulting works present these phenomena by means of channels of colored water accompanied by a mechanical and electronic sound track in close harmony with the architectural structure of the building.

These productions are permeated strongly by the notions of event, time, duration and simultaneity as focal points of the interaction between the Telephone Exchange and Espacio Fundación Telefónica, and offer insight into the multiple dimensions of the contemporary vital experience marked by the daily interaction with large volumes of information.

Electronic activity and architectural space

The *Telefonías* project brings to light a series of phenomena that the advent of new technological paradigms has rendered increasingly invisible. The installations operate as interfaces between the nonvisible internal world of the telephone exchange and the liquids and sounds that flow through EFT.

In his article "The Anti-Sublime Ideal in Data Art,"[4] Lev Manovich points out that in the first decades of the 20th century modernist artists mapped the visual chaos of the metropolitan experience into simple geometric images. Nowadays, data visualization artists and scientists transform the informational chaos of data packets moving through the network into clear and orderly forms such as visual and sound forms.[5] This practice allows us to see patterns and structures behind the vast and seemingly random data sets. Along these lines, the works in this exhibition make visible data and processes the scale and complexity of which seem unfathomable to us.

At present, architectural spaces are equipped with a vast array of digital communication and network technologies. Electronic technology—and telecommunications in particular—can establish links with real space through the diversity of applications afforded by computing and data processing. The purpose of giving material form to this activity consists in revealing the virtual architectures that are under constant construction and change as a result of the interaction between the Central Juncal exchange and its neighbors.

Historically, the areas in the building dedicated to communications were off-bounds for the public. Nowadays, the two spheres of activities that take place in the Juncal Building are kept distinct and separate. The possibility of combining electronic spaces with architecture through an aesthetic experience allows us to develop new relationships with this place.

The *Telefonías* project presents us with an experience of the architectural space, both static and solid, crisscrossed by the volatile and ethereal electronic activity that travels through walls and floors like an invisible mesh. This material and static space becomes transformable and dynamic by the operation of the electronic flows and communications that take place within it. The works that form part of this project are based on the notions of event and simultaneity, since the changes and transformations occur in real time. These changes and transformations represent variations in the parameters of the activities carried out in the same premises where the works are set up.

Historical research into communication technologies

The project was supported by historical research into the communication technologies employed at the telephone exchange. This research probed into the memories and experiences of people who had worked there. The recollections of some of the company's employees enabled the reconstruction of the past and cast light on the changing relationship with technology.

In the old telephone exchanges, the employees had a ludic perception of the technological processes. They were in direct contact with both visual and sound events and the chaotic and rhythmic structures of communications. Their accounts are filled with aesthetic and phenomenal approaches to technology. In contrast, the growing abstraction and remoteness of technology nowadays transforms people into mere users of black boxes. The research conducted in connection with the *Telefonías* project comprised an analysis not only of the communications machinery,

devices and techniques in place in the building, but also of the impact that these technologies had on the people operating them.

The manual telephone exchanges of the early 20th century gave way to the first automatic telephone exchanges that were set up in Buenos Aires in the 1920s. From the very beginning, the telephone exchange buildings were named after the neighborhoods or streets where they were located. In those early days, the Central Juncal exchange was equipped with the rotary stepping selectors of Strowger's electromechanical switching system that were hand-operated. Both engineers and workers were in close contact with the different mechanisms, a situation which is now quite unthinkable.

Some time later, the introduction of the 100MD system with local control was followed by remotely-controlled exchanges. Both cases involved electromechanical selectors, but they functioned in a different way: in the 100MD system, the communication was established as the subscriber dialed, while in the remotely-controlled exchanges, the office received the dialed digits, which were accumulated and analyzed, after which the communication was channeled accordingly. Though the speed of the processes increased with the new technology, the processes themselves were still legible. The mechanical and metallic pieces that performed different functions in the exchange produced specific sound patterns during the dialing process. The persons in charge of the maintenance of these machines could actually see and follow the communication process and were fully aware of the volume of calls in the area.

From 1910 up to the mid-1960s, there were no major breakthroughs in the telecommunications industry. As of the 1960s, the quickening pace of technological change led to several generations of exchanges. The passage from electromechanical to digital exchanges was preceded by the use of semielectronic exchanges that still worked with analog signals but depended on electronic components to perform system control functions. These were the first devices that established a distinction between switching and control functions, and represented a new landmark in the growing complexity of telecommunications. The first two exchanges of this kind set up in Argentina were imported towards the end of the 1970s. However, their implementation was limited because they were superseded by fully electronic exchanges[6] a few years later.

Digital technology was finally introduced in 1987. The use of microprocessors brought about a profound change in the way work was performed but, above all, it eliminated all possibility of following directly the processes involved in establishing a communication.

Towards the end of the 1980s it became imperative to make a technological leap and digitalize the entire telecommunications network. The final introduction of digital technology coincided with the privatization of the telecommunications industry. Technological changes were accompanied by institutional transformations. Digitalization and privatization came hand in hand and brought about modifications in both the profile and number of the workforce employed, the technological training required, the productive processes, the distribution of work spaces and the characteristics of both the network and the products.[7]

As part of this research, an interview was conducted with Javier Amato and Walter Acosta, telephone switch operators of Telefónica de Argentina's Área Múltiple Buenos Aires Sur (AMBA Sur) in October 2006. They described how the telephone exchanges functioned thirty years ago, when they were electromechanical. They explained that it was possible to perceive the intensity of the traffic of calls processed by the exchange by the noise they generated in the switching equipment. The noise increased or decreased depending on the time of the day or night:

> *In the past, the dial impulse was produced by the opening and closing of a circuit; when the impulse was received by the exchange, the switching system was triggered. There was a constant tapping noise. At the time, a telephone exchange had ten thousand subscribers. Though they never all called at the same time, as long as ten per cent of them were dialing at a given moment, it was enough for the movement of the switching equipment to make a terrible din. In contrast, the situation is completely the opposite in digital exchanges: there is no sound whatsoever.*[8]

Intense activity brought about the visible wear and tear of the equipment:

> *For example, during the first quiz shows, people used to dial in a hurry and often got an in-use signal after they had only dialed two or three digits. Nevertheless, they kept on dialing and the constant hammering made the equipment fall apart. The wipers, the screws, everything came loose. And everything fell to bits. The whole assembly was mechanical. It was just terrible.*

As part of their work, the exchange employees were in charge of the maintenance of the equipment. The engineers were responsible for repairing and oiling the contacts. Since dampness made the materials contract or expand, the engineers had to listen to the sound they made and adjust them as if they were tuning an instrument. "*I worked at the Nuevo Orden telephone exchange on Salta Street, an exchange that dated back to 1923. Everything there was hand-operated, mechanical, and there were often no spare parts… We had to fix things with a piece of string or wire to keep them going.*" Nowadays, the equipment is hermetically sealed and is kept out of reach in air-conditioned rooms, and must be repaired by a specialist.

Communication processes have undergone a gradual yet constant increase in speed, flexibility and complexity. Technologies have become growingly complex, processes more difficult to follow, systems more hermetic and, consequently, the perception of events has become increasingly abstract. A fragment of the dialogue exchanged with Javier Amato and Walter Acosta is reproduced below:

> **Interviewer:** *There was a time when the act of establishing a communication was something visible…*
> **Javier Amato:** *Quite true. In an electromechanical exchange one could follow a succession of movements triggered by the numbers as they were dialed. When the subscriber dialed the last two digits, the final selector stepped up, then round according to those digits. One could follow the communication and determine the number of the maker and the recipient of the call.*
> **Walter Acosta:** *These were replaced by remotely-controlled exchanges.*
> **I:** *In this case, was there any sort of visualization device or possibility of viewing the entire process?*
> **WA:** *One could view the process, though it was much faster and difficult to follow. These exchanges were more complex, more elaborate.*
> **JA:** *During the electromechanical stage, one could follow the communication visually. However, things changed with the advent of digital technology.*
> **I:** *That's another story altogether…*
> **JA:** *There was a hybrid of semielectronic technology before the arrival of digital technology, but it only lasted a short while.*
> **WA:** *The incorporation of microprocessors in the exchanges was a big leap since they involved fully electronic systems with no electromechanical components.*
> **I:** *Was it then that you lost control over the process?*
> **WA:** *Yes. One could follow the process, but at another level. There were exchanges that were equipped with devices that allowed calls to be detected, and one could follow the course of the communication in the exchange.*
> **JA:** *One could trace the route of the communication…*
> **WA:** *It was quite a basic computerlike terminal. A PC that traced a flow chart of the communication, but the process did not occur before one's eyes as in the electromechanical exchanges.*

The full digitalization of the network definitely deprived the workers of the exchanges from having direct access to the phenomena by greatly reducing human intervention and eliminating the possibility of following the processes in a direct and hands-on manner. This brought about a high degree of abstraction from the real referent in the communication process, to the extent that even the people working in the telecommunications sector found it difficult to follow and understand its mechanisms. This is the situation currently prevailing in the telephone exchanges throughout the country.

Structure of the Central Juncal telephone exchange

The following text is a transcript of the interview conducted with Julio Bunetta, Events, Networks and Services Supervision head, and Fabio García, Telefónica's Cutoff, Interconnection and Media Control Plans head, at CSRTA (Centro Superior de Red de Telefónica de Argentina):

Cable Tunnel

A cable tunnel in a central telecommunications building is the underground entrance tunnel. It contains all the copper cables leading to the subscribers and the optical fibers that communicate this telephone exchange with others. All these cables are grouped in trunk cables that go in and out of the exchange. A distribution frame terminates the cables leading to subscribers on the one hand, and the cables leading to the telephone exchange on the other. There is always a distribution frame above a bunch of cables.

Switching and distribution exchanges

For some time, switching exchanges were electromechanical. When a number was dialed, experienced engineers at the exchange could in some cases figure out where the communication was going by the sound made by the pieces moving in the exchange.

Telephone exchange engineers had to clean and adjust the contacts. They would listen to the sound the contacts made as if they were tuning a piano. Nowadays, the situation is comparable to the relationship existing between a piano tuner and the person servicing a digital keyboard. Nothing stretches, nothing is affected by dampness. Things are handled differently and our intervention takes place in a different way. In the past, there was something more primary, one could actually "touch the communications." In an analog exchange, one could follow the movement of the mechanisms as the person dialed. Nowadays, everything is reduced to a black box.

Then came the electronic exchanges. Towards the end of the 1970s, a pilot project was implemented with a view to digitalizing everything. A fiber optic belt was built around Buenos Aires to relieve communications. It was a sort of digital insertion into an analog network and, though the idea was good, the translation process failed. This occurred before the advent of digital technology, during the period when telecommunications were operated by the state-owned utility company ENTel, and when everything was analog.

The early 1990s witnessed a complete shift towards digital technology. The breakthrough in telecommunications occurred at that point, because the new technology enabled the incorporation of services. The speed of communications increased and the agility of processes and the quality of the signal improved.

An analog exchange could not be reconverted. It could only be used for telephone calls and could not be adapted to provide additional services. We were only able to rescue a few pieces of these exchanges that are now in the museum. But, for the most part, these analog telephone exchanges were demolished, there was no way out.

Nowadays, telephone exchanges are very much like a PC. They are cabinets equipped with shelves and chips and easily exchangeable electronic components. When new services are incorporated, new chips are added. The chips are state of the art and can support a large number of subscribers, but there is nothing to be seen beyond the chips themselves. One has to log on to a PC to interact with the exchange, since these exchanges are large, telecommunication-specific PCs. Exchanges are equipped with a central processor, peripherals that are connected to it and specific components designed to enable communications between subscribers.

Laying of the network:

In the past, telephone exchanges were kept spic and span and were well serviced, but progress in communications was well-nigh imperceptible. The system (cabling) was overburdened. Until recently, the only way to reach households was through copper cables. Nowadays, for example, DLC (Digital Loop Carrier) technology uses fiber optic cables to extend the range of the traditional copper cables. There are virtually no limits to the distance to connect subscribers to an exchange. Formerly, cabling reach extended to only a few kilometers because the copper tended to degrade the quality of the voice signal. At present, there are less telephone posts because there are cabinets with connections to channeled cables that replace aerial cabling. Trunk cables reach these cabinets via underground channeling and are distributed to subscribers on the block from here. Nevertheless, in some places

telephone posts are still the best alternative, particularly in the interior.
There are over 3,000 kilometers of urban underground cabling installed inside steel pipes that carry copper and fiber optic trunk cables, and 16,000 kilometers of interurban cabling carrying exclusively fiber optic cables. There are over 30,000 kilometers of subscriber cables. If we include all the pairs, this adds up to over 5,000,000 kilometers of copper cables.
The development and explosion of telecommunications would not have been possible without fiber optic technology. When trunks were analog, each one could support around 1,800 simultaneous phone calls at the most. If the communication capacity between two cities had to be enlarged, a new trunk supporting an additional 1,800 calls had to be added. Currently, a standard fiber optic cable enables 120,000 simultaneous calls but, if needs be, this capacity can be multiplied times 40.
In Argentina, there are 750 telephone exchanges for 5,000,000 lines. The fiber optic trunks that carry the telecommunications from the center of the country are very important because they are part of an international ring that connects Buenos Aires and Miami and runs along the sea bed of the Atlantic and Pacific Oceans entering the Province of Buenos Aires through the seaside town of Las Toninas. This fiber optic trunk separates into two branches that run on land and converge at the frontier pass at Las Cuevas, from where it enters into Chile and then submerges once again in the ocean at Valparaíso. The trunk carries data, Internet, telephone and television signals. When we surf on the Internet and visit a foreign page, the chances are it will come in through this trunk.

Data processing at the Central Juncal exchange and its connection with the works at EFT

The works at Espacio Fundación Telefónica are connected to a computer that receives information on the telephone traffic variables at the Central Juncal exchange in real time. These variables include: the number of calls per hour, the most usual destination, the path followed by the call, the number of incoming calls from destinations other than Recoleta and Barrio, Norte which are serviced by the Central Juncal, and the number of outgoing calls, amongst many other variables. This information constantly feeds the works transforming the dynamics of telephone traffic into aesthetic variables.
The information is furnished by CSRTA. Julio Bunetta and Fabio García were in charge of preparing and feeding the information into the computer, which they did by sending it from the Central República telephone exchange through an internal network.

CSRTA

CSRTA is located in the Edificio República. Telefónica de Argentina's entire network is supervised from this building. This network comprises all the telephone exchanges throughout the country, the fiber optic transmission equipment and the broadband Internet transmission equipment. In the mid-1990s, the company adopted the strategic decision of centralizing the supervision and control of the network in a single location, and this is how CSRTA came into being. The work that is carried out at CSRTA was formerly performed in the different regions within the country which meant that there was no global vision of either the activities under way or the state of the network.
The setup at CSRTA comprises four semicircular rows of monitors arranged in front of a large central screen exhibiting a virtual map of Argentina with white and colored lines joining different points across the country's territory. The TN news channel is broadcast constantly in one of the corners of the screen. Bunetta explains:

A forecast curve of telephone traffic can be produced in the same way as it could be drawn in relation to any massive human activity. By observing the number of communications that flow along a specific trunk cable during the course of a day, one can determine what is the normal traffic volume. When that value rises or falls more than expected, the route is experiencing an exception or problem. When a line appears on the map of Argentina, it is a sign that that route is experiencing an exception; the color of the line describes its severity. The alarms that circulate through Telefónica's internal data network are triggered when a connection line in the network goes out of service or has an unexpected volume of traffic. The TN news program is always on because real-life situations frequently offer us an explanation of what is occurring with the telecommunications traffic.
Telephone networks have had a hierarchical structure from their early stages, from the very

> *conception of telecommunications triggered by the invention of the telephone towards the end of the 19th century. Since it is impossible to connect everyone with everybody else, the need to group both subscribers and exchanges soon became evident and led to the creation of exchanges grouping other exchanges, which are known by the name of "transit telephone exchanges." These are exchanges of a higher hierarchy that group the exchanges of certain areas and communicate with their peers in other areas or cities in the country. Likewise, in the case of communications with another country, the transit center will be an international transit telephone exchange.*
> *The information processed at CSRTA arrives through a Telefónica Intranet network connected to different systems that are linked to a main server that receives information and converts it into a standard format, regardless of the technology involved. All the exchanges are connected by X25 links, that are data lines, all of which report traffic information. All the data routed across the X25 network reaches the CSRTA systems, where a window opens every five minutes with traffic information. This is what occurs normally at all of Telefónica's 203 exchanges, and involves all the traffic of its own network in addition to the traffic exchange with other operators. All this information is viewed on the system every five minutes. The system finally sends the information to another machine in charge of processing all the traffic information.*

As regards the volume of traffic and its visualization, Julio Bunetta and Fabio García make the following remarks:

> *In view of the large volume of information we handle (millions of data per day), and to prevent this volume from overwhelming whoever has to deal with it, we have resorted to visual translation devices. We try to translate everything into an operator-friendly language. In the past, when we wanted to establish a connection with a telephone exchange, we had to do so through a PC using commands that were often in English* [...] *hard commands between man and machine that required operators specialized in computer programming. We had the same problem with the alarms, so we were forced to create a new specialization, an operator focused not so much on interacting with the exchange to program it, but rather an expert in alarms* [...] *We needed to create a language that was both comprehensible and standard. If the exchange had to say "it hurts," it had to do so in a comprehensible language, regardless of its manufacturer. It was only when the information was translated into a simple, understandable language that the technical aspects cane into play and the operator started to interact. All this involved a great deal of work; to a certain extent, this question of studying the differences between the equipments and attempting to unify them by means of a graphically acceptable system amounted to an art.*

Connection with the works at EFT

Based on this structure, the engineers at Telefónica designed a method for obtaining data in real time from the flow of communications at the Central Juncal exchange and converting them into the input required by the works at EFT.

Fabio García gave us an introduction to some of the characteristics of the telecommunications traffic at the Juncal exchange, as a first approach to the variables at the exchange which were to be the starting point of the research into the aesthetic parameters:

> *The Central Juncal exchange may have intense traffic with the CTZs and CTNs that are area exchanges. The CTZs (urban transit exchanges) are exchanges located within the same area (downtown) that have intense traffic at midday. Moreover, in the downtown area, there are many routes between the Telefónica exchanges (for example: the República, Juncal and Rivadavia exchanges) and the exchanges of other companies. Traffic information is available every five minutes. Route occupancy percentages can be checked. These percentages vary since a local exchange in the downtown area does not have the same level of activity as an exchange located further away. While midday is probably the peak hour at the Juncal exchange, other exchanges may have different peak hours.*

The system developed by CSRTA takes the information of the traffic going exclusively into and out of the Central Juncal exchange every five minutes, and sends files in text format with all the

information to a PC located at the Juncal/EFT premises. The chart included below summarizes the connection between CSRTA and the works at Espacio Fundación Telefónica achieved through the files. These files are read by a program in a server which then distributes the information required for the operation of each work through a network that interconnects them.

Translation processes

Technological progress and the advent of digital technology in particular made it necessary to translate into visual patterns phenomena that were observable in the past. In the field of telecommunications, it was necessary to develop a language designed to "speak" with the exchanges, because processes became unintelligible. In order to prevent engineers from becoming overwhelmed by the volume of information they have to deal with, visual translation systems were developed that made the information comprehensible for an operator with the required training rather than a computer programming specialist, since engineers cannot be expected to be decoding codes constantly.

The *Telefonías* project performs a similar operation, since it works like a "translator" by making comprehensible and by "translating" into sense experiences highly complex technological processes that would otherwise remain unreachable and intangible. In this sense, understanding and making comprehensible is tantamount to translating. The task undertaken by the *Telefonías* project consisted in restoring materiality through color, texture, density, sound and rhythm to phenomena and processes that have become invisible and intangible over time, investing them once again with sensoriality and sense.

Notes

[1] Aira, César, "La utilidad del arte," in *Ramona*, 15, Buenos Aires, August 2001.
[2] The Central Juncal telephone exchange was inaugurated in 1920. For further information on this topic see: García Romero, Graciela, *La central Juncal. Historia de la telefonía en la Argentina*, Buenos Aires, Fundación Telefónica, 2005.
[3] Espacio Fundación Telefónica opened its doors in 2003.
[4] Manovich, Lev, "The Anti-Sublime Ideal in Data Art," Berlin, 2002, available online at: www.manovich.net/DOCS/data_art.doc
[5] Some examples in the context of electronic art are "1:1," by Lisa Jevbrat: http://jevbratt.com/projects.html, "Heartbeat of the City," by Andrea Polli: http://turbulence.org/Works/heat/, "Ear to Ground," by Mark Hansen and Ben Rubin: http://www.lucent.com/press/0300/000323.bla.html, "Making Visible the Invisible," by George Legrady: http://www.georgelegrady.com/, and "The Source," performed at Greworld, London Stock Exchange.
[6] Herrera, Alejandra, *La revolución tecnológica y la telefonía argentina: de la Unión Telefónica a la Telefónica de Argentina.* Buenos Aires, Legasa, 1989.
[7] Ibid.
[8] All the quotes were taken from an interview conducted with Javier Amato and Walter Acosta.