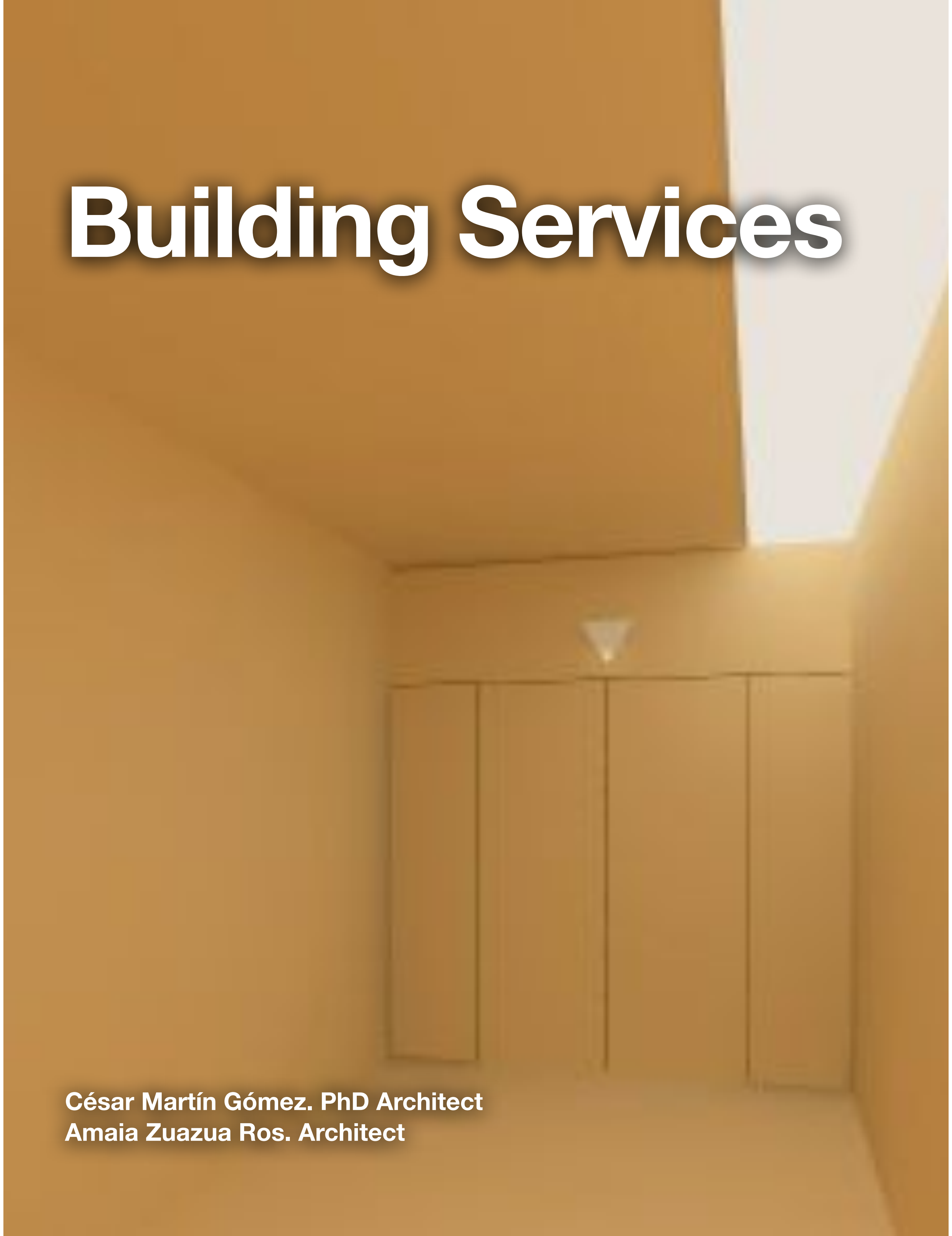
Building Services



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Chapter 1

General Overview

‘In most cases, a man with a machine is better than one without a machine’

Henry Ford (Free translation from the Spanish text by authors).

What are we referring to when we speak about installations in architecture? The installations range from the essentialsupplies of water and electricity, to the set of mechanisms, sensors and technological elements that allow man to enjoy a welfare impossible to have merely with the physical elements (structure, enclosure...) of traditionally understood architecture.

Without installations, most contemporary buildings do not satisfy the Vitruvian utilitas of the 21st century. A hospital or an office building, without installations, does not stop being an optimized structure and a construction that protects it from the inclemency of the weather, but it no longer carries out the functions for which it was built. Although in some buildings the budget devoted to installations can exceed 50% of the whole, there is no clear definition that explains the exact concept of installations in construction.

There are countless publications that explain in detail how to carry out a plumbing, drainage, air conditioning or electricity installation. If it is needed to calculate, design or choose the suitable material for an installation, it is possible to resort to them. What we deal with here is the relationship between architecture and installations –at the level of design, order and accessibility, fundamentally over the course of 20th century, at present and suggesting some of the possibilities that await in the near future, laying special emphasis on the capacity of the installations like generating elements of projects.

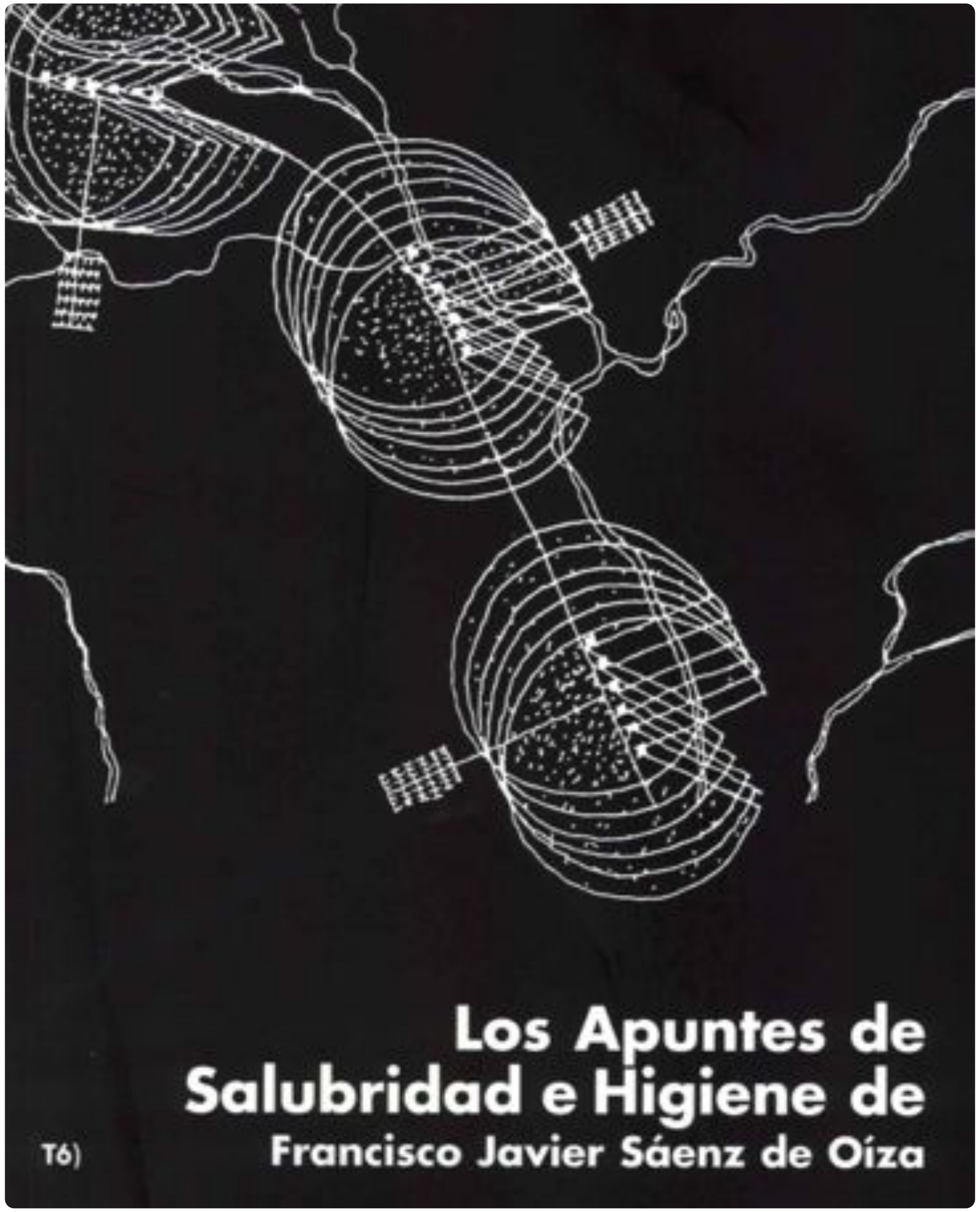
Although the welfare parameters have been evolving through history, in integration between installations and architecture there are some non-temporary intellectual values associated with the way in which the building is conceived. This assertion makes complete sense if we think that the requirements of an American kitchen in the 1940’s are similar in terms of requirement to those of a Spanish house at the beginnings of 21st century, or that concepts such as the welfare feeling inside a building, depending on temperature, humidity and air quality, are the same within each climate zone.

A very general classification of the different installations will be made, with the difficulties that this entails. For instance, the system of access control of a building can mean that from certain hours on elevators don’t have stops at certain floors, or it can be merged with the lightning system so that when stopping the cabin at a floor, the lobby lighting comes on. In what section would a system of this type have to be included? Control, security, home automation, vertical communication, lighting? This is a sample of the interactivity of different installations.

This interdisciplinary design of the installations with other elements of the architecture is evident in buildings such al Lloyd's by Richard Rogers, where the lighting, air movement, building services distribution, structure of floor-slabs and constructive section of the façade are designed jointly.

On the variability of the necessary data to carry out an installation, some of the pages of ***'Los Apuntes de Salubridad e Higiene'*** ('Notes on Healthiness and Hygiene') that Saénz de Oíza prepared for his students in the fifties are revealing. For example, he collected different references about the requirements of ventilation in premises depending on their use and occupation; but the differences between the different authorities were such, that finally he chose to include all the data. This situation continues to occur nowadays: New technologies

Gallery 1.1 Publications.



Reprint of the 'Los Apuntes de Salubridad e Higiene' ('Notes on Healthiness and Hygiene') of Sáenz de Oíza, Spanish architect and master of so many architects in all matters related to building services.

and the rules make the necessary data for an installation change much more quickly that those that affect the structures or to the enclosures of a building.

Nevertheless, this change should not be interpreted as a problem of the installations, but as an opportunity to carry out new approaches. In this sense, words by Norman Foster about the development of the communication installations are eloquent:

> To demonstrate this fantastic progress, we can check that a telecommunications satellite made of only a quarter of a ton of material exceeds nowadays the capacity and quality of overseas news transmission of 175.000 tons of copper cables. This means an increase of seven hundred thousand times the invested cost by pound in communications.
>
> (FOSTER, N. Sol Power, GG, Barcelona, 2002, p.8.
> Free translation from the Spanish text by authors).

Installations are reviewed in this article from the small scale of objects such as lamps and fans to the implications of energy in the town planning. Many are the architects who have designed some shown elements of the installations to integrate them in the buildings, but maybe not yet all of them are conscious of the possibilities offered by the creation of a new urban structure, the choice of a centralized or decentralized model of energy production, or how the accessibility and the maintenance are as important in a building as in the service installations of the city.

We have opted for an outline that enables the reader to cover the considerations about each type of installations in a unified way. But another possible outline would have been to group types of installations depending on the building that they serve: the requirements are not the same for a house, a hospital, an auditorium or an office, and within the typologies it is not the same if the office is situated in a Mediterranean, continental or tropical climate.

The technology to create new architectural solutions is available on the market; it simply has to be applied. Elements such as glass with electrical resistors for heating, or solar panels, do not have their origin in the technological development at the end of 20th century; they were developed decades ago. In fact, among other authors, Saénz de Oíza mentioned them in Spain in an article written for the National Magazine of Architecture in 1952 entitled ‘El vidrio y la arquitectura’ (‘Glass and architecture’), which involved the intellectual start of the integration of installations in buildings in Spain.

However, despite his fascination with these systems, Oíza was aware that time is the main difference between architecture and installations: they are systems with different useful lives. Firstly because architectural form is restricted by the stylistic trends of the moment in which it is built, and secondly because installations undergo faster development than architecture, owing to the fact that civil construction is not their only client. Electrical systems or hygrothermal conditioning advance at the rate that the demanding industrial pace requires, with the need to produce ever faster and cheaper, with greater energetic efficiency. Engineers must make an effort to constantly optimize machines and technologies, and later, sometimes years later, these advances are used in construction.

Therefore, it is necessary to know the benefits offered by installations, but also their requirements. It is not enough to know that the premises can be ventilated through a pipe that reach the roof and save the space of the pipe’s size. The duct requires a system of supports that also takes up space; if the pipe is linked to a fan, it can transmit noise, which is why the transmission of vibrations to the structure and closures must be avoided by means of shock absorber elements. But if in addition the pipe goes through different fire areas, we must plan either space for the fire-resistant insulation, or a firebreak door, which, on the one hand, as a mechanical element needs maintenance, and, on the other, accessibility.

What is intended in these lines is that the good design of installations, the areas required by the machinery room and the pathways –sometimes superhighways- of the different networks, need to be considered from the beginning of the project with just as much importance as the structure or how to construct the building.

These comments can lead to different questions. Will systems of purification of grey waters be introduced? Will the cordless urban networks replace the present data systems inside the buildings? What will happen when hydrogen storage is applied as an energy vector in houses? What is the future of thermoelectricity application in construction? How will the construction of bio- mass power stations to generate and distribute heat affect different buildings? Will the need to save energy in buildings and urbanism modify architecture as it is nowadays understood? Maybe nothing change or, maybe, the addition of small changes will generate new building typologies, and even affect the way of designing the city and of facing the different architectural scales in their relation with landscape.

> Or do you prefer to keep the rather limited –and, to tell the truth- rather fascist- idea of the natural as something totally new and the artificial as absolutely bad?
>
> (LASZLO, P. ¿Se puede beber el agua del grifo? Akal Editions, Madrid, 2005, p. 59. Free translation from the Spanish text by authors).

Building Services Design

'Contemporary constructive technique is absolutely unsuited to this world subject to constant change'

(PARICIO, I. Proyecto Casa Barcelona, Construmat Barcelona, 2001, p.17. Free translation from the Spanish text by authors).

The design of installations refers here to it being suitably setting up and to its easy subsequent maintenance and not only (obviously) to its aesthetic result.

The real open floor in many architectural projects does not lie only in the more or less complex change of partitions, but in the possibility of access to all services demanded by the users in any location. Therefore, the limit of the real flexibility is the limit of use of the whole installation services in any place of the building.

The design of different installations has traditionally constituted an excellent opportunity so that architects participate in the design of objects of different scale, from lamps to air conditioning ducts integrated in façade, with examples so outstanding as the concept of served and server spaces by Kahn, at the Salk Institute, a concept that in itself generates splendid buildings, fundamental to understanding the contemporary design of architecture and installations; or in the same way that Wright built the Larkin building in 1905, where *'the machinery of the different supply systems with its raceways, ventilation and heating conduits, just as the staircases, that also serve as emergency exit, are arranged in four parts in the plan, located in the four exterior corners of the building, leaving this way the whole interior surface to be used for jobs'* (BROOKS, B. Wright, Taschen, Köln, 2004, p.23. Free translation from the Spanish text by authors).

On the other hand, one can point out the interest of underground car parks and decks as the contemporary architectural elements that show the interdisciplinary nature of the different subjects that make up the construction, its internal order, a reflection of what happens inside the building. Thus, TV aerials, satellite dishes, mobile phones aerials, collective chimneys, individual chimneys, cooling towers, cooling units, air conditioners, the extractors of the car parking ventilation, the bathrooms and toilets extractors... shape and are part of the urban landscape and of the image of the city. Even when they will remain out of the global design in a building that would be nothing without them?

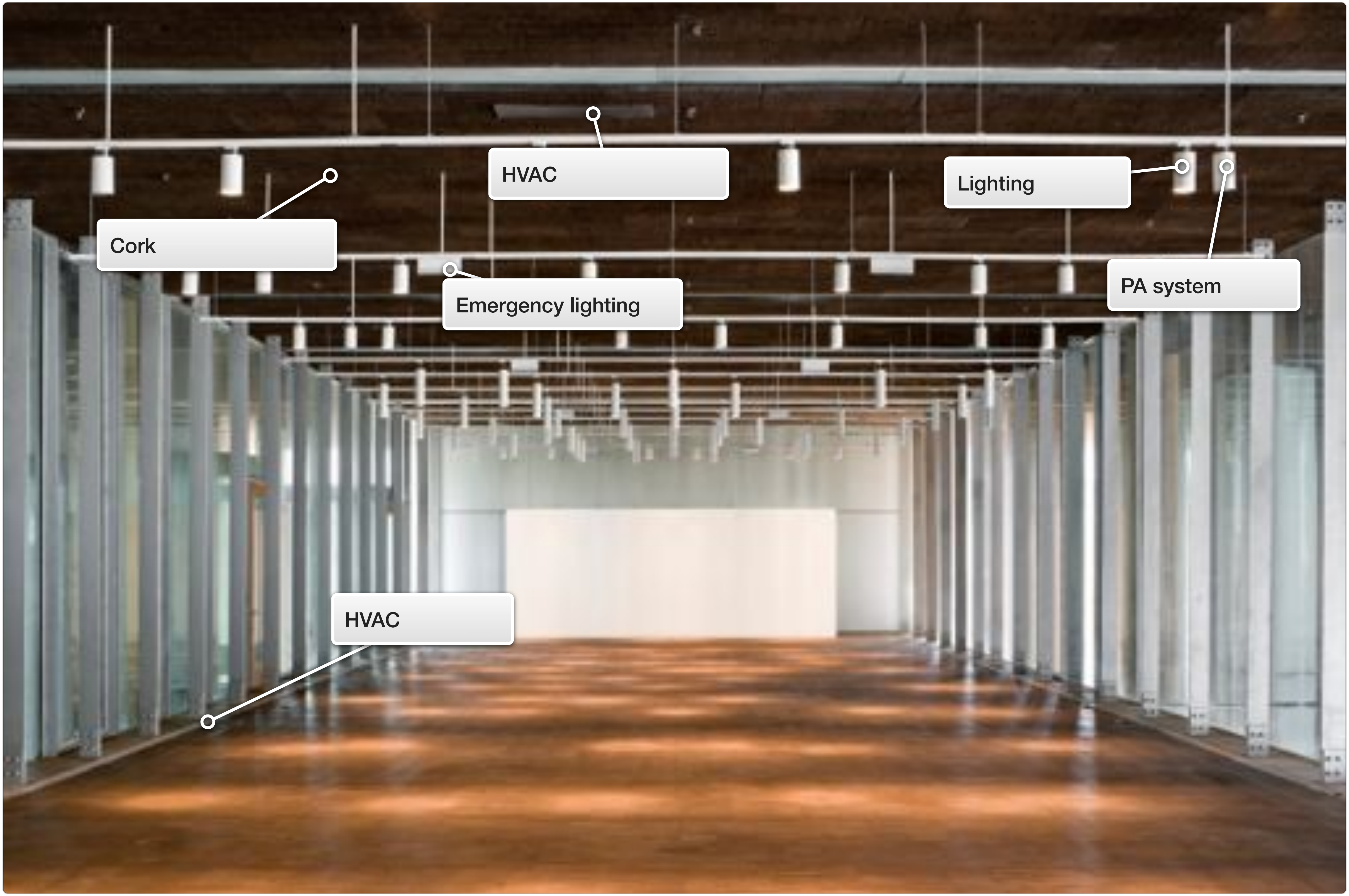
In certain typologies, such as high-rise buildings or those of great volume, the decision about the laying of installations, the way the main centralizations are raised and the choice of the system for fire evacuation, are the great shapers of the buildings. Thinking about these matters generate different typologies, for example the Hong Kong & Shanghai Bank by Foster has one centralization per floor; the Parisian Pompidou has two, and the Banco Bilbao by Oíza or the Chase Manhattan Bank have four, whereas the Richards building by Kahn has one centralization per tower.

We also have to think that each building typology needs a different outline of thinking. How is a high building air-conditioned? Why are skyscrapers not crowned with a big chimney? Why are these design techniques not used in other buildings? Once again a similarity with the automobile world can be established: in the same way that advances in Formula 1 cars come sooner or later to simpler vehicles, the ideas and advances in control and management of energy reserved for the most 'sophisticated' buildings will be introduced sooner or later in the housing.

The architects who have analyzed different naval and aeronautical references to apply them in architecture have been many, although in some cases it only formal operations were transferred to their project and not intellectual strictness. It is surprising that in a high-tonnage ship, where the available space is so tight, machines have what they need in their technical rooms to make maintenance easy (without it, the ship-machine does not work) and however in some projects of architecture, installations have to be adjusted to minimum areas, in plan and section, that are designed in this way without really knowing why.

The correct design of installations in architecture should be situated at a point of equilibrium and compromise between the virtues of these sophisticated machines

Interactive 1.1 Building Services Design.



(ships, aircraft…), the coordination between the occupancy of areas and the laying of networks of the different installations, and the rest of aesthetic, functional and economic parameters that constitute architecture. It makes no sense, therefore, to talk about hidden or visible installations: each architecture must have its corresponding design of installations. It is not about different realities that join together to form a building, but different visions of the same object.

In addition, we must remember that every machine breaks down and sooner or later it has to be replaced; the useful life of the installations is different from that of the buildings, which is why it is necessary to think about how the machines will be replaced without disruption inside the building and without bothering its inhabitants. The solution is easy: plan the necessary space for the machines, their maintenance and their replacement. Machines need space and the networks need accessibility, a valid statement both in buildings and at an urban level.

To end this section, some questions: When will we have at our disposal in kitchens elements so versatile in services as the dentist's chair with its electricity, water and plumbing intakes? Why are there no solutions similar to the equipment of a hairdresser's to evacuate the waters in residential plumbing? How long will the users take to demand the same comforts and facility of use and maintenance in their cars and in their homes? Why can the wiring of a car can be modified in minutes and a house needs maybe days and several different tradesmen to simply change the electrical outlets?

> Confusing the vanguard with high technology is a mistake. Rather the vanguard is to propose the appropriate and suitable reply to the historical moment.
>
> (STAGNO, B. CIBARQ04 Free translation from the Spanish text by authors).

Chapter 2

Fire Safety

‘One of the reasons of the huge success that this house had lies in the explicit demands of the client, Frederick C. Robie. He wanted a house protected against fires within closed areas in the shape of ‘block’ and within the usual ‘decorative’ elements, such as curtains and purchased carpets, etc. As an engineer, he also wanted a house that worked like a good machine’

(BROOKS, B. Wright, Taschen, Köln, 2004, p.31. Free translation from the Spanish text by authors).

Photography: M. Castells

As introduction quotation instructs, the prevention of fires in buildings is an obsessive concern for humankind, because the fire that heats is the fire that can destroy everything.

Not only do the rules of fire protection refer to the installations that must be placed to detect and smother a fire, but also to the fire resistance of the materials used, the layout of staircase and emergency exits, evacuation routes... they are rules of minimums that always be improved.

The measures of fire protection are divided into:

- **Passives.** They are measures directed to facilitate the evacuation of the building (the rules penalize dead ends) and ensure the containment of the fire inside an enclosure until the arrival of the extinction services (requirements of structural and constructive elements fire resistance). These measures also affect other installations. For example, an air pipe can be isolated against fire when it goes through different fire areas, with isolation and firebreak doors, but the first measure is to propose a design of pipes in such a way that these always stay in the same fire area.

- **Actives.** They cover the installations of detection (fire detectors, manual push buttons, door retainers, control stations...) and the different systems of alarm, signs and extinction (fire extinguisher, hydrant, pumping equipments, fire hydrant cabinets, sprinklers, extinction by gaseous agents or specific extinction for kitchens).

Of these measures, we will now mention a series of points with greater architectonic content, which can even go so far as to condition the final shape of the building.

- Zoning and fire stability in the formation of volumes and structural framework of the building. At this point, making the proper decisions as regards the materials used and the arrangement of the different fire areas can simplify other solutions of fire protection. For instance, although the rules allow the increase of the area of a sector by placing sprinklers, it works out easier to place fire-resistant sliding doors with retainers at strategic points in order to avoid an

Gallery 2.1 Fire safety images.

Urban pipe for firefighters' work.

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excessive complexity of the installations.

- Zoning depending on the building typology. The requirements of evacuation of an office building, an entertainment center or a hospital are not the same. In this last, the horizontal evacuation to other fire areas can be prioritized, and not vertical evacuation, for moving the convalescent patients quickly and safely, in which case, moreover, it is necessary to establish intermediates areas of evacuation that have specific installations (oxygen, vacuum, power points, etc.) in order to take care of the emergency patients until the extinction services come.

- Drainage. It is a installation that also must be considered when sectorizing a building, because drainage pipes constitute pathsways for fire (which risk can be minimized by placing FR rings), a normal circumstance for example in the zoning between a car park with dwellings above, or between damp premises in buildings with vertically superimposed areas.

- Staircase and evacuation routes. In buildings of a certain magnitude, it is crucial to design the building considering these elements from the first moment. Improving the evacuation of a building through a specially protected staircase with direct ventilation to the outside, or with ventilation by overpressure, can generate two buildings that, with the same schedule, are formally different, with the added factor that in the latter case demands constant maintenance of an installation that guarantees people’s safety, and this is not so in the former, although caring equally for their safety. As a sample of the relationship between different installations, we can state how, in a public building, improvement of fire evacuation by installing more outer doors increases access security in the building, which is compensated for by the introduction of additional anti-burglar measures (door contacts, cameras...).

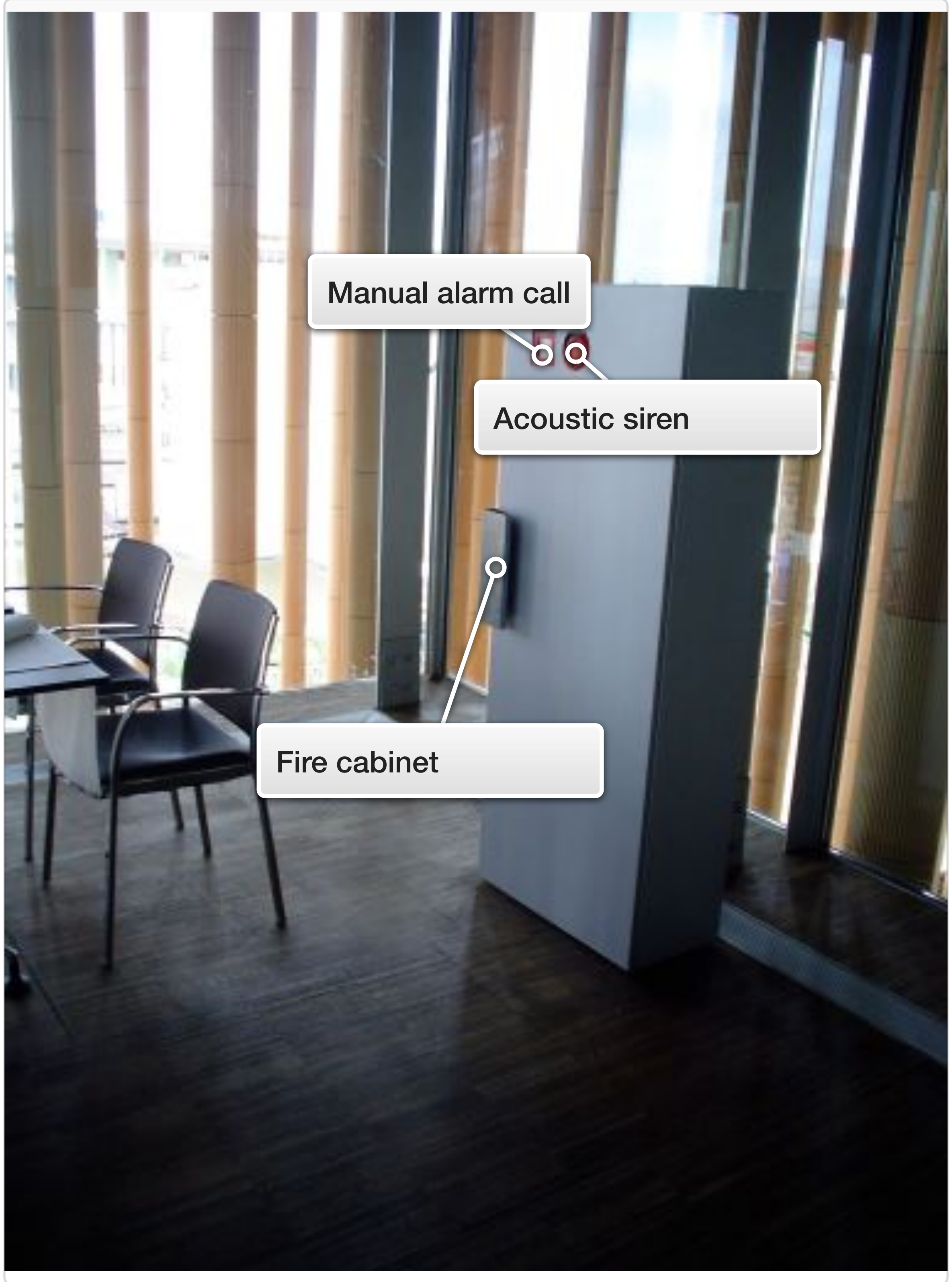
- Emergency lighting and signs. So that these elements (fundamental in case of evacuation) carry out their function, they must be visible; we must incorporate them into the design, but never hide them.

- Car park ventilation. It has two aims: to guarantee that carbon monoxide will not accumulate, as it is dangerous in the normal operations of the car park and, in case of fire, to evacuate the fumes.

- Large volume areas. In these cases the rules allow for special solutions if one particular volumetric configuration in the relation between the delimiter areas –walls and ceilings- and the built area is fulfilled. This option can be completed with the positioning of extractors at the top of the space that are opened in case of fire, although it is not always an advisable option, because depending on the load of interior fire, the extinction services may consider more suitable that they give the signal of command and action manually (not through the control system) and control thus if more or less air enters the fire area.

- Singular solutions. Respecting the rules in force, there are many possibilities adapted to the architectonic concept: exterior stores of water of fire that are used as swimming pools, constructive and town planning regulations to make the spread of fire difficult, outer staircases in facades to facilitate evacuation (think about the metallic staircases on the facades of American buildings)...

Interactive 2.1 Fire protection cabinet.



- In buildings open to the public, it is necessary to complete the traditional systems with other additional ones for people with some physical disabilities, visual (sequenced acoustic signals, walls with raised signs...) or aural (sequenced pilot beacons, magnetic curls...).

To prevent a fire affecting people or properties we must ensure that it does not happen, and in this sense those who also make the decisions about the suitability or not of certain solutions, together with the competent organisms with the corresponding rules, are the insurance companies, by proposing solutions that do not appear specifically in any rules, but without which the policy costs will increase considerably. They advise solutions that come from their experiences in similar buildings, in a complementary way to what is laid down in the specific rules.

Chapter 3

Water Management

‘The tap water, so simple in appearance, so common and obvious, is actually the final product of quite a rather complex process of purification and sterilization in several stages, that [...] is subject to numerous and frequent administrative controls. As most of the current social replies to our basic necessities (feeding, clothing, transport, etc.), fresh water has become a formula, an industrial and commercial product, even though we maintain the illusion that this is something simple’

(LASZLO, P. ¿Se puede beber el agua del grifo?, Ediciones Akal, Madrid, 2005. Free translation from the Spanish text by authors).

Plumbing and drainage installations are different but they are united by an obvious concept: what goes into the building has to go out and the ways for this must be settled.

For centuries effective systems of drainage have existed to evacuate the used waters and rainwater. Every day the faucets are turned on and the toilet is used naturally. They are apparently simple installations, they hardly need any auxiliary machine, and yet they are installations that after centuries of utilization, continue to be associated with a large number of pathologies in buildings, and make us feel there is little room for evolution. Nothing could be further from the truth. Think about what it means within the great ideals of Architecture –in capital letters- to move a faucet in order to free up floor space: building workers to break things, plumbers to place the pipe in its new position, building workers, plasterers and painters for the finishes (without mentioning the changes involved in moving the drainage too). The solutions associated to these installations need so much development that of five of the proposed ideas for the Casa Barcelona in Construmat 2001, three had the installations of plumbing and drainage as a development basis to try to contribute new solutions to construction (raised floors, modular kitchen and toilet-furniture).

The optimization of the benefits of plumbing and drainage installations, together with the introduction of prefabrication in the construction, generated solutions of prefabricated toilets that, in most of cases, were not introduced onto the market because they lacked the necessary requirements for their replication in other buildings. Later though, thanks to the spirit of these pioneer experiences, commercialized systems for the assembly of the plumbing and drainage systems have been developed, usually associated with dry assembled partitions.

The collection of rainwater is also part of the constructive process from the beginning, in such exemplary projects as the Crystal Palace by Paxton, the Spanish Pavilion at the Brussels Exhibition by Corrales and Molezún, Stansted airport by Foster... On other occasions, as happens in the roofs of great surface, the solutions of design of the rain drainage are determined by the necessity of giving a minimum slope to the drainage, but it is possible to resort to systems without slope based on

Gallery 3.1 Water management images.

Rain water drainpipe.

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the principle of the vacuum induced by gravity (they enable the use of reduced diameters in comparison with traditional systems and reduce the final number of drainpipes). How long will it take for these systems to be used in other types of buildings?

On the other hand, could the present system of sewage drainage be improved? Perhaps, what is missing is the public awareness of avoiding evacuation procedures that do not take into account that water is a valuable resource (with the use of a considerable amount of water regarding the matter in suspension), and that other solutions are available that cover from the realism of the improvement of the present systems of separation of grey waters, to taking up again other solutions like those proposed by Buckminster Fuller:

> Both the twenty-six- and fifty-foot Fly's Eye domes are semiautonomous, i.e., have no sewer, water-pipe, or electric-power-supply connections. The personal hygiene, clothes-and utensil-washing functions are accomplished with the high-pressure, compressed air and atomized water fog gun which requires only a pint of water per hour. The human excrement is deposited in the dry-packaging toilet. The human sits on fresh, plastic-film-covered, fore-and-aft seat halves.
>
> The excrement falls into the top-open plastic tube as it is formed by the two converging edges of the two plastic sheets, which are then electrosealed together from the originally separate two plastic film rolls, whose filmstrips first covered the two seat-sides. The hermetically sealed-off tubular section containing the excrement is then mechanically detached and conveyed away as litter to be neatly packed in a corrugated carton clearly marked for pickup and dispatch to the methane-gas-producing plant and the dry-power fertilizer manufacturer or to be processed into methane gas and fertilizer powder by accessory equipment of the dome home itself.
>
> (FULLER, B. El Camino Crítico, COAATM, Murcia, 2003, pp. 144-145. Free translation from the Spanish text by authors).

This approach of fecal drainage without water is not an isolated or illusory solution, as in the early Törten housing development in Dessau (1921-1928) by Walter Gropius, dry toilets that convert fecal faeces into manure for the gardens are proposed in the dwellings.

The ‘simple’ plumbing and drainage installations condition building design because of such a simple issues as the economic and constructive logic involved in the vertical stacking of the damp premises. One example on the matter: in the project of the Landfair apartments of the year 1937, Neutra ‘arranged the bathrooms of the upper floor over the kitchen, to save pipes and piping’. (LAMPRECHT, Barbara, Neutra, Taschen, Köln, 2004, p.41. Free translation from the Spanish text by authors).

Oíza carried out a similar approach in the housings of the directed village of Entrevías in 1956, where he arranged the housings toilets in order to share a single drainpipe. Although the constructive concept is obvious, the reality at that moment was other: the drain pipes were executed with fiber-cement pipes, but the junctions of the outlets of the toilets pipes to the main drain pipe had to be executed with special lead pieces as link pieces were non-existent for this type of joints, which is why it was cheaper to put the drain pipes in parallel (one for each home, although they occupied more space and more meters of pipe were needed) than carry out the solutions that Oíza suggested.

It would not be suitable to finish this section without remembering the importance that, in certain typologies, usually associated with the leisure (swimming pools, saunas, sports centers…), water acquires as the protagonist of the use for which the building has been conceived.

Looking to the future, it is necessary to deal with different matters like the following, as the development of these installations will come from the simple elements of daily use in the home:

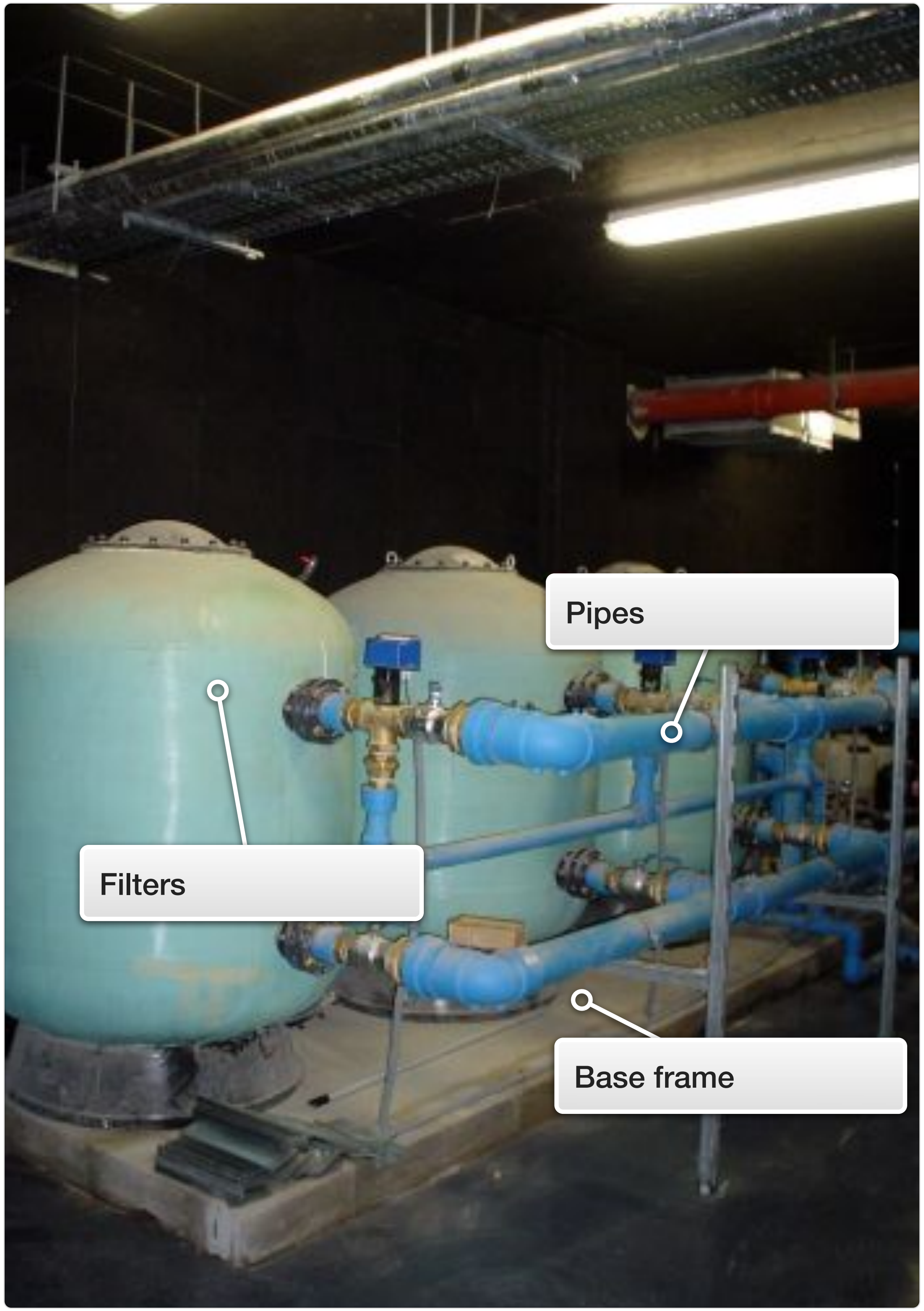
- The possibility of using bithermal electrical appliances has been proposed, this is, with a double water point for the connection (like washing machines and dishwashers) in all the buildings in which solar energy is used to produce hot sanitary water, so that these electrical appliances use the hot water of the solar production system, and electricity consumption is reduced up to a 85%.

- In the few last years there have been improvements in the different systems in which shower or washbasin water is recovered and, after filtering, re-used to fill the toilet cistern, which allows save up to a 40% in water consumption (although inevitably the apparatuses have to be adjoining).

- Urinals without flush valves or presence detector (placed **Interactive 3.1** Recycling of the water from a pond. in Germany and France fundamentally in the domestic market) that work with a battery or connected to a network, by the change in ph of the siphon when contains urine.

Regrettably, the revolution in these installations will not happen until, in a not very distant future, water be a more valued (and more expensive) element than at the present time, a moment when what will matter is not that a building saves, but it spends little. But until then, according to the rules, who is responsible to integrate A type washing machines , which can save more than 560,000 liters of water a year, in a promotion of 100 dwellings?

Interactive 3.1 Recycling of the water from a pond.



Our main protagonist finished her bath making the water disappear through the same outlet pores. The volume of used water was stored in the soft fabric of the walls where it was purified by biological procedures. The same volume was used as system of structural balance or security against fire.

(PÉREZ ARROYO, S. Vivienda y tecnología, Arquitectos 176, CSCAE, 2006, p.56. Free translation from the Spanish text by authors).

Chapter 4

Electricity and Data Network

It can be asserted surely that electricity has become the blood of contemporary society:

> "An architectural analysis of the classical Roman bath would be incomplete if it ignored the pipes, the water and the distant aqueducts that made its function possible. Nowadays, the predominant infrastructure is not the water, but electricity in all its extraordinary magnitude. This has become the new architectural order of the built environment [...]. Being without electric energy during a time reminds us how dependent on electricity we have become and how difficult it is imagine to how we could live without it".
>
> (CARROLL, B. T. Arquitectura y Energía, 2G no18, pp. 129-134. Free translation from the Spanish text by authors).

This section deals simultaneously with electricity lines and data networks even though they are different installations. This is because it is logical to plan them in an unified way since their origins (voice and data closets, electrical panels), their pathways (trays, tubes) and the final elements of the network, such as computers or television sets, are similar or they even fit physically into the same element. However, these similarities in the laying of lines do not mean they always have to be together. In fact, sometimes the requirements of services sensitive to electromagnetic interferences, such as the lines of scenic lighting in an auditorium or the supply lines of an operating room, force those networks to run parallel but separated by a short distance that minimizes the effects.

Nowadays, the system used in these installations does not always satisfy the users, if the location of the power points and switches does not suit them; changing the position of just one means calling on different tradesmen or having to spend hours of do-it-yourself work to achieve a not-always satisfactory result. Think about the existing differences between the use and maintenance of the electrical installations in a kitchen, perhaps the part of the house with greater technological load, and an automobile.

A partial solution to the problem would be to put up with installations in full view, without an interpretation in terms of design, with a common-sense and economic perspective such as that proposed by architects like

Gallery 4.1 Electricity and data network images.

High voltage line.

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Lacaton and Vassal, with the saving of costs (also during the useful life of building) as the basis in many of their projects.

In the case of the roofs of buildings, as well as the chimneys, the lighting conductors... , they support hundreds, thousands, of aerials of different types that take up space higgledy-piggledy , aerials that are seen from the streets and are not always an element we wish to see in the urban landscape.

We should also reflect on the technical and aesthetic introduction of photovoltaic cells with the approval of the Código Técnico de la Edificación (Building Technical Code), with references as different as the façade of the Pompeu Fabra library by M. Brullet, their incorporation as part of the waterproofing (Intemper) or the photovoltaic roof by Lapeña y Torres in the esplanade of Forum 2004.

On the other hand, the simple objective of the user of the future will be the freedom to live and work without ties, this is, without cables. Where cordless devices have really come into their own is in the data networks: wireless, Bluetooth... tools and methods that no longer impress anybody, that speak clearly about the simplification of use in installations, thanks to the complexity of the standards of communication and terminal devices. The present technological period invites us to think that the data networks are those that will bring the most surprises, with benefits that will improve in an exponential way in a near future. Two recent examples:

- Since 1946 when the first transatlantic telephone cable was laid, numerous means of communication have been created. Some electrical companies offer access to internet through the electrical network by means of PLC technology (Power Line Communications). In this way, through any power point, they can offer service of Internet and telephony -another example of the interaction between installations which were considered unrelated.

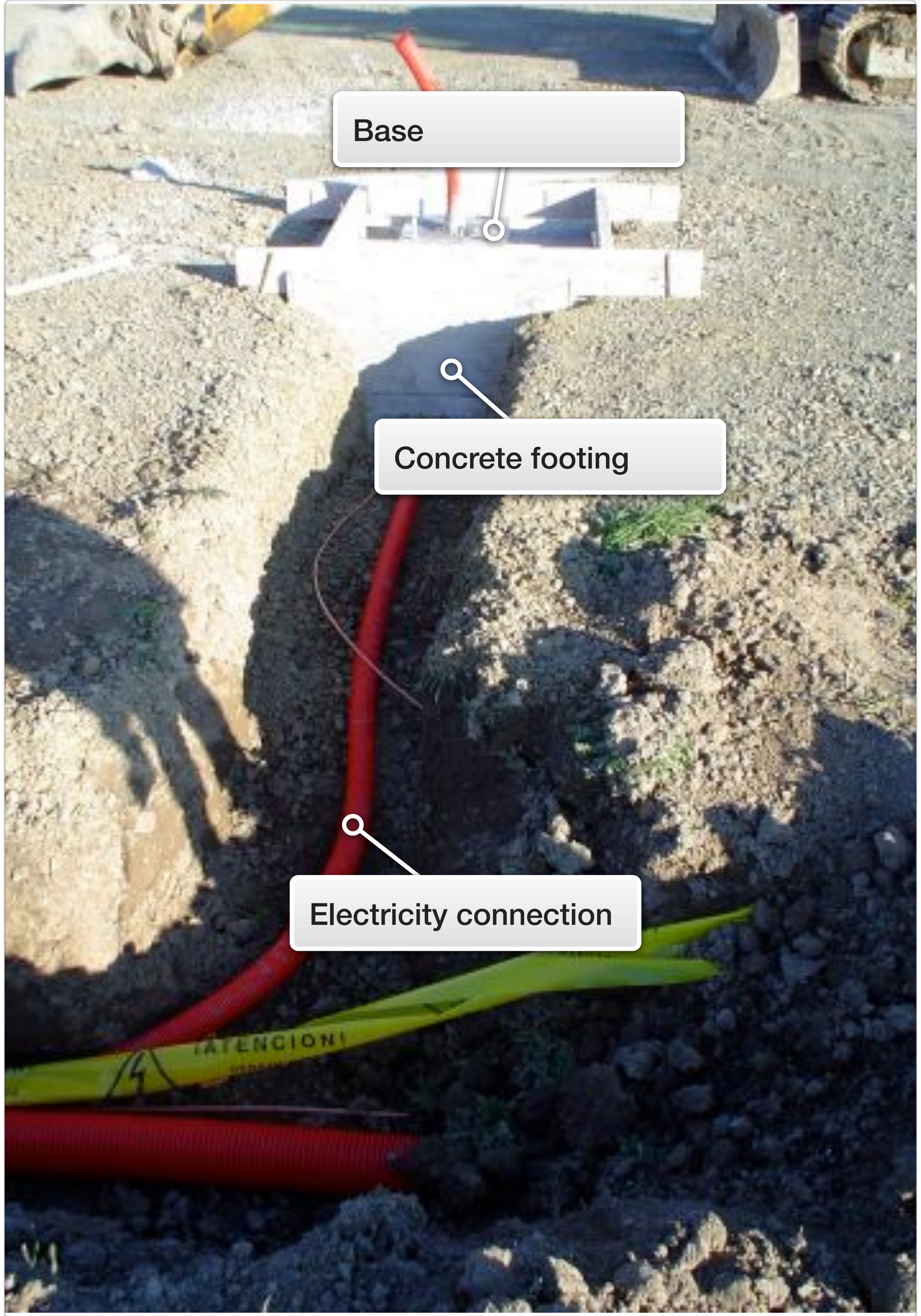
- In 1936, with the technology developed by John Logie Baird, the BBC broadcast the first TV transmission. In 2006, Terrestrial Digital Television has started a stage that promises to be spectacular thanks to the greater quality of the images and the interactive services that it offers.

This use and social dependence of the devices and mechanisms that technology offers, and those that we cannot dispense with in as much as they contribute to the leisure time of the Western society, may soon lead to demand for the installation of systems of uninterrupted supply in dwellings, with the same passion shown over the last few years for the 'necessity' of having a cooling system in each home.

This section dedicated to electricity would not be complete without a reference to lighting, both interior and exterior, merely functional or perhaps ornamental. This is one of the most attractive, important issues of present-day architecture and has the greater visual load. Due to its importance and the possibilities it offers, a further issue will be dedicated to more detailed research on the matter.

> By recognizing this common Architecture of Electricity in our everyday lives, the
> potential exists for the democratic and sustainable redesign of Electrical Civilisation.
>
> (CARROLL, B. T. Op. cit, p. 143. Free translation from the Spanish text by authors).

Interactive 4.1 Streetlight installation.



Chapter 5

Hygrothermal Conditioning

This section is called hygrothermal conditioning because the term air conditioning does not precisely define the final aim of these installations. Climatization is not the same as air-conditioning, heating, cooling or ventilation, nor can we identify conditioning with the placing of the installations. Passive measures must be complemented with other active ones; by reducing consumption peaks installations can be smaller and therefore take up less space.

Hygrothermal conditioning refers to temperature and humidity, because although sometimes it may be thought that changing the temperature may produce sensation of well-being, this is not so.

A radiator, suitably sized, can be enough to achieve a suitable average temperature, but it is badly located in relation to the windows and doors or to where the users are , they will not be comfortable. The next step is to increase that ‘occasional’ transfer of heat from the radiator through greater heating surfaces, which may be placed in the floor, the wall or the ceiling, and can act by yielding or absorbing heat. These are techniques that go from the under-floor heating of the traditional ‘glory-hole furnaces’ of popular architecture, to the use of this technique in numerous buildings by Mies, Wright or Neutra.

Up till now we have acted in the simplest way on the temperature, but we also have to act on the humidity. This can be done with more or less complex humidifiers, but also with the simple resort to putting a container with water near the radiator –as it is done in some homes- to favor its evaporation, and reach a humidity of between 40-60% where, depending on different parameters, the human well-being is situated.

As it is seen, pretentious technology is not necessary to satisfy minimum well-being. So, placing canopies on the sunny façades of a building provides suitable conditions to avoid the placing of an expensive cooling installation, or the use of water, either in a courtyard or in an urban space, acts simultaneously on the humidity and the temperature.

But it is also necessary to act on a third parameter: the air quality of the occupied zone (a particularly important aspect in the hospital architecture). The air must not be foul, reason why we must speak about the replacement of the air inside by 'new' air, that is, ventilation. In accordance with the rules, the definition of an occupied zone refers to the area designed for the human occupation and is defined by the vertical and horizontal planes of the zones where the occupants reside and where the demands of the interior environment must be satisfied. The efficacy of the ventilation depends on the layout and quality of the added air, as well as the type and the location of air pollution in the space.

In accordance with these approaches, when beginning a project, if a technician is wondering "How much room is needed to put the air conditioning?", maybe he should consider if the first question should not be, "Is air conditioning really needed?. The best conditioning installation is the one that does not exist. For example, in tropical climates (with problems of high temperatures and high humidity), an effective solution with which satisfactory well-being is reached, by allowing the generation of numerous cross-draughts in the building. The first option matches the air- conditioning with the climate, taking advantage of the local meteorological characteristics (like the wind), and only after considering these options, if it is necessary to further adjust the conditions of temperature and humidity, should the active systems of installations be placed.

While in buildings which are air-conditioned by automatic means the sensors activate the devices that control the interior climate, in these 'simple' buildings it is the inhabitants who control the ventilation systems manually. This is architectures that requires the users' participation. So, Behling points out how giving options to the users of the buildings ("you shall be able to connect the air conditioning or to open the window instead of connecting the air conditioning") contributes to making them happier, just as other scientific articles assure.

Even these parameters of design can be the origin of projects as interesting as the Commerzbank by Foster in Frankfurt, the result of a simple initial concept developed together with the engineer Klaus Daniels: do not have any office without sunlight and without natural ventilation. Thus, in spite of being a high-rise building, patio gardens that make cross-draughts easier were installed. It was found that the people in the building use the ventilation of the windows 90% of the year, and only in the hottest days

Gallery 5.1 Hygrothermal conditioning images.

Air-ground heat exchanger.

1 de 16

of summer do they connect the air conditioning.

While in Germany, for example, all employees are entitled to have a window from which see outside and the wish of having natural ventilation exists, in the United States it is preferred to have constant light during all day; you can go into an office and find there is no window, and there is fluorescent light and air conditioning, with premises at a temperature of 21ºC, whether it be spring, summer, fall or winter. In this sense, scientific studies have proved that this criterion in healthy because the organism do not feel comfortable in situations of constant humidity and temperature. In addition, the American model will always have high operational costs and low costs of investment. However, in Europe, costs of operation are relatively low, but in comparison, it has high costs of investment. The American model will continue having high energy consumption, with large CO2 emissions, whereas the European model will not.

Nowadays the installation of hygrothermal conditioning is in great demand in our search for the wellbeing that the present society yearns for. The historical parallelisms in the conditioning installations of the automobile industry and housing are significant in this sense: although in the 1930's air-conditioned cars existed, it was not until a few years ago that air conditioning became common even in the smallest vehicles; in the same way, although at the beginning of the century you could install a conditioning system in any building, it was not until nowadays that the users considered having placing 'air conditioning' (more correctly, 'cooling') in their homes as another element for wellbeing.

From the point of view of its evolution, hygrothermal conditioning covers a very interesting set of systems, machines and equipment, a history in which we can count by the hundreds the milestones that have gone into shaping this technique (In 1930 who could have imagined the importance of the cooling gas Freon?).

The history of these installations is sometimes associated with wasted energy, as in the Palm House in the Botanic Gardens in Kew, London, projected in 1844, with a heating system composed of twelve boilers that fed a network of underground pipes with hot water, and could guarantee an interior temperature of 27ºC in winter - a climate machine with a high energy consumption. (BEHLING, S. Sol Power, GG, Barcelona, 2002, p.139.).

In 1851, the first commercial machine in the world used for cooling and air conditioning appeared, and, in 1906, in the attraction 'Coasting Through Switzerland' at Dreamland, the cooling system was part of the show.

In 1929, the air-conditioning of the Rockefeller Music Hall, including the Radio City Music Hall, allowed for use by six million people a year, with some rooms where thirty thousand people came and went each day.

In 1930, Le Corbusier proposed his 'respiration exacte' in the Centrosoyuz in Moscow, with some constructive solutions that would ensure an inside temperature of +18ºC when outside it was -40ºC, but he had to wait for the construction of the Cité de Refuge to apply, for first time, the system of the exact breathing in hermetic buildings.

During the second half of the twentieth century technological advances were multiplied with the integration of the conditioning systems in building, and from these babbling beginnings it has gone on to conditioned spaces like the Houston Astrodome (with an electric power that exceeds 18,000 kVA) or to now have at our disposal affordable systems of cold-generation by absorption, linked to solar receivers, even for use in private dwellings.

ELEMENTS

It is not possible to make a classification of each one of the conditioning systems that a project designer can imagine, since these installations are usually tailored for each building, and different systems may be used simultaneously. Classifications vary depending on the chosen source, in this case we opt for that proposed in the DTIE 9.01, in which the primary tieº is separated from the secondary one, the primary tie being the production and distribution of cooling and heating, and the secondary tie the use of the caloric fluid to heat and cool the air.

Primary tie, heat and cold producers:

- Boilers.
- Cooling by compression cycle.
- Cooling by absorption cycle.

- Heat pumps (included land/water and land/air).
- Solar receivers.
- Heat recovery. There are different systems, although the best known is that of free cooling by air (commonly known as free-cooling), that lies in replacing with outer air, simply filtered, the return air that is impelled to an air-conditioned premises. This may be uses as long as the enthalpy of the outside air does not exceed that of the necessary impulsion air.
- Cogeneration. This is the application in which the waste heat of the generation of electricity is used. If the produced heat is used, at least in part, to produce cold, the installation is named trigeneration. In any case we must not forget that the economical profitability of these systems should not be taken as energy efficiency.

Although the description of the systems is more complete if the primary tie is mentioned and, possibly the means of transport, it is the secondary tie which is most used to classify them, even it is usual in the technical publications to classify by attending only to the secondary tie, with the following options:

- Air-water systems: fan coils, inductors.
- All water systems: fan coils without ventilation, heating and cooling by heating panels.-Systems of distribution that use the refrigerating gas as heat-carrying fluid.
- All air systems: batteries in series and in parallel, variable volume of air, autonomous with variable flow, variable flow with overheating, variable flow with recirculation.

They are all air systems, which by their volume and special features require a more detailed commentary. Although it is a more and more demanded installation, we are not always conscious that if we want air-conditioning with air only, the systems will take up more space than air conditioning with water; this greater volume is materialized in the use of different specific components:

- AHUs (Air Handling Unit, usually known as air conditioner). They are the machines that move and treat the air to manage to adapt their characteristics to the specific needs of a room.

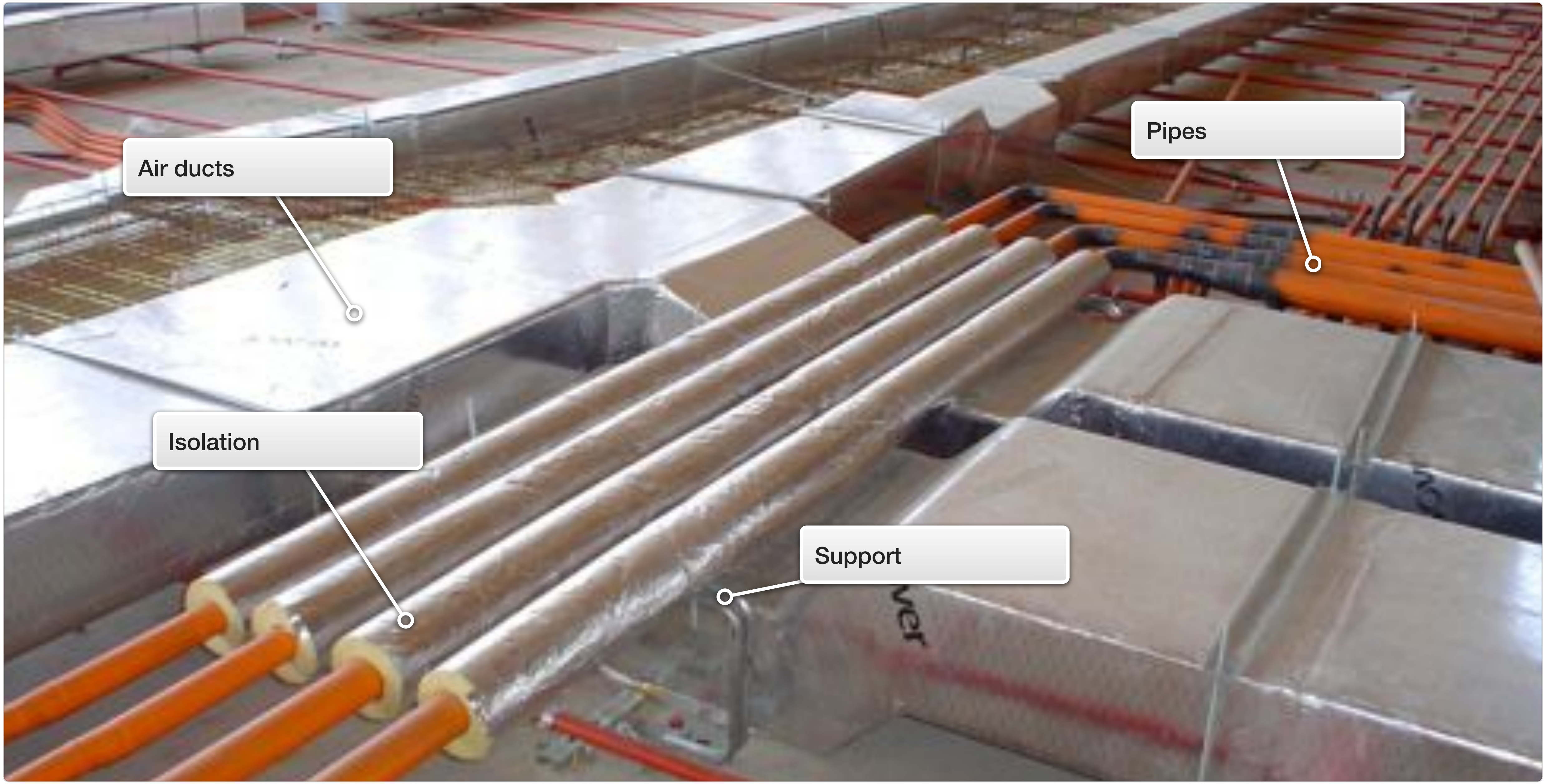
-Ducts. Responsible for moving the treated air from the AHUs to the air-conditioned premises. They mean considerable volume easements (both to impel and to return the air), and sometimes they have a dead weigh in the formal composition (Lloyd's Building, Pompidou Center) just as in the constructive and structural design of the buildings (Sainsbury Center by Foster, Yale Gallery by Kahn, and generally in the design of dropped ceilings or raised floors).

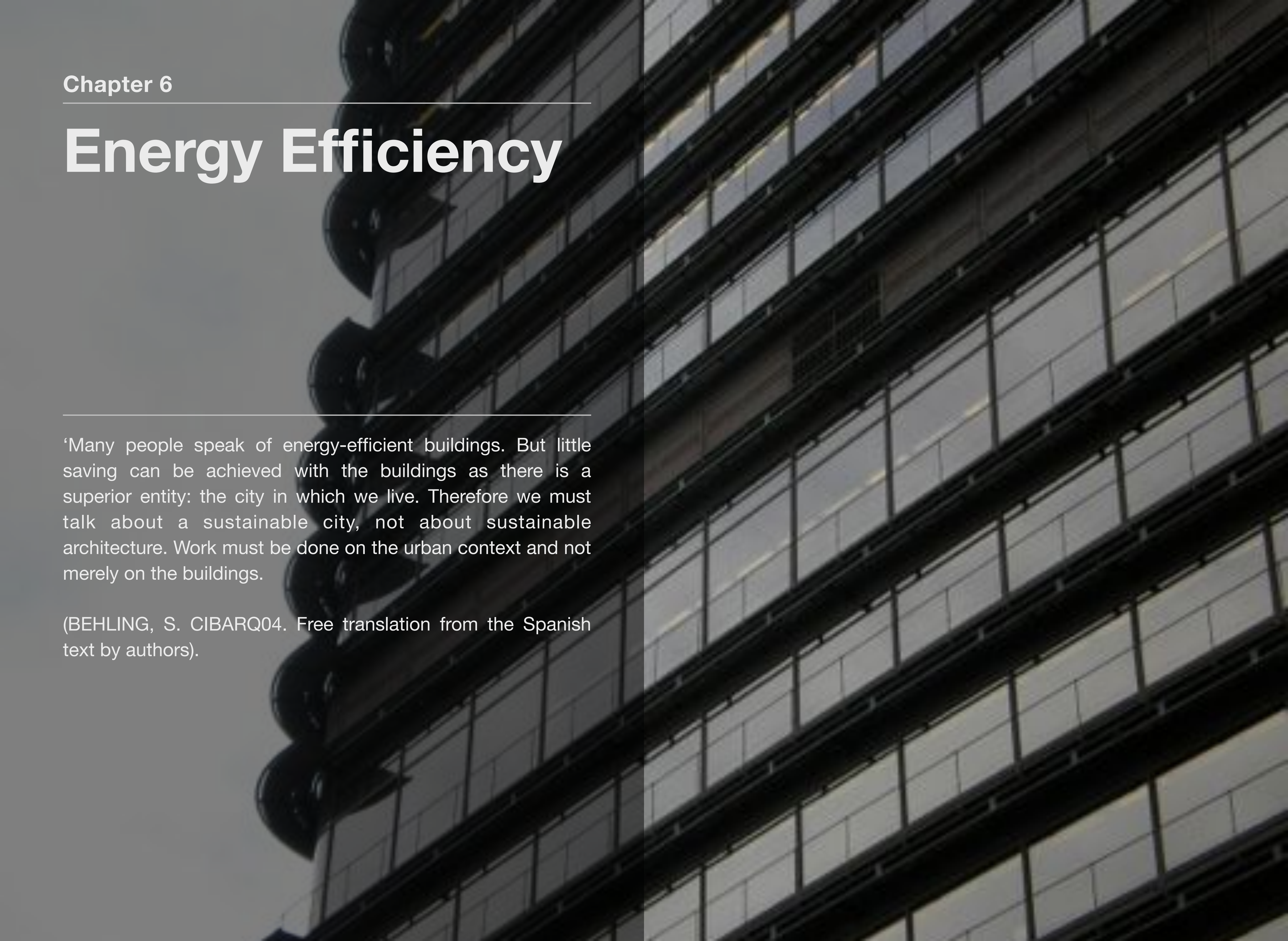
- Diffusion. Once the treated air arrives at the premises, it has to carry out a suitable sweep of the premises without disturbing the users and without leaving areas untreated; for that reason, the location of the diffusers like the return grilles that assure the proper movement of the air is so important. The possibilities are many depending on the volume of flow to be impelled (so that the air currents will not be annoying and be adapted to the calculation design of the diffuser), the height at which they are placed (on the floor, on the ceiling or the wall), the distance of sweep (from long-range nozzles to rotational step diffusers), the location of the people or the use of the premises (the required diffusion in an operating room, an office or an airport is not the same).

Given that the demands of heating or cooling in the premises are not constant either in the course of a day or of a year, whenever an installation of hygrothermal conditioning is carried out, you must propose a parallel system of regulation and control of the temperature and the humidity, that adapts the operation of the air-conditioning systems to the requested needs. For that reason the control systems need sensors to measure the conditions of the premises which they serve (the probes); these will give a better response if they are placed next to the point that you want to control, the place where there are people, and therefore, they are seen. The further they are placed from that optimum situation, the lower is the response quality of the system.

At this point, we must keep in mind that the air-conditioning systems are the main energy consumers in buildings, but there is no point in using the most efficient installation on the market if the closures, the orientation or the passive design of the building are inappropriate.

Interactive 5.1 HVAC installation in relation with other building services.





Chapter 6

Energy Efficiency

‘Many people speak of energy-efficient buildings. But little saving can be achieved with the buildings as there is a superior entity: the city in which we live. Therefore we must talk about a sustainable city, not about sustainable architecture. Work must be done on the urban context and not merely on the buildings.

(BEHLING, S. CIBARQ04. Free translation from the Spanish text by authors).

Energy efficiency can be taken to mean the set of actions aimed to enable the users of an installation to enjoy its services, with the minimum energy expenditure (and as far as possible the energy will come from renewable sources). Therefore we are not talking about forms or type of installations, but the attitudes facing a project, as in the project of the BB headquarters, where Oíza and his engineers devised an electric building, a battery building "with low basal metabolism, that need a minimum amount of calories (or B.T.U.'s) for the preservation of indispensable comfort, like an economic live organism". (VELLÉS, J. Banco de Bilbao Sáenz de Oíza, Departamento de Proyectos - ETSAM, Madrid, 2000, p. 16. Free translation from the Spanish text by authors).

However, the concern about the relation of energy consumption between a building and a city is relatively recent. An example of this: the thermal islands in cities. A great number of buildings have incorporated heat pump systems to air-condition in summer. A heat pump moves the inner heat of the premises to the outside, but it must do this at a temperature higher than that of the street, which is why the addition of thousands of heat pumps generates a small rise in temperature. At night heat dissipation of the buildings inside is a little lower since during the day a somewhat higher temperature has been reached. The next day the transfer of heat from thousands of machines will occur at a slightly higher temperature a bit higher, and so on... a vicious circle of rise in temperature that the inhabitants of the big cities know perfectly well. In fact, this has been one of the great problems in the last few summers in Spain, with the saturation of power lines because of the massive consumption of these machines, which has caused serious power cuts in some areas.

The importance of defining these issues must be realized when designing a building, because although one wrong action may be of little importance, this is not so for the sum of thousands of wrong actions. So much so that the energy consumption of the buildings in United States represents 50% of that of the whole country; in the European Union it stands at 35% and in Latin America 27%.

Analysis of the relationship between energy, buildings and urban actions can be carried through examples so different as the natural ventilation of the 1867 Vittorio

Gallery 6.1 Energy efficiency images.

Wind turbines in Navarra.

Emmanuele II Galleries in Milan, the projects of urban heating in United States years later or the creation of power stations by geothermic vapor in Italy at the beginnings of 20th century, until we come to the studies on different prototypes of “solar houses” that were developed in the MIT from 1939; the house for Herbert Jacobs (The Solar Hemicycle) by Wright in 1944, or the Autonomous House projected by Foster Associates, R. Buckminster Fuller and his wife in 1982, a light and extremely efficient structure:

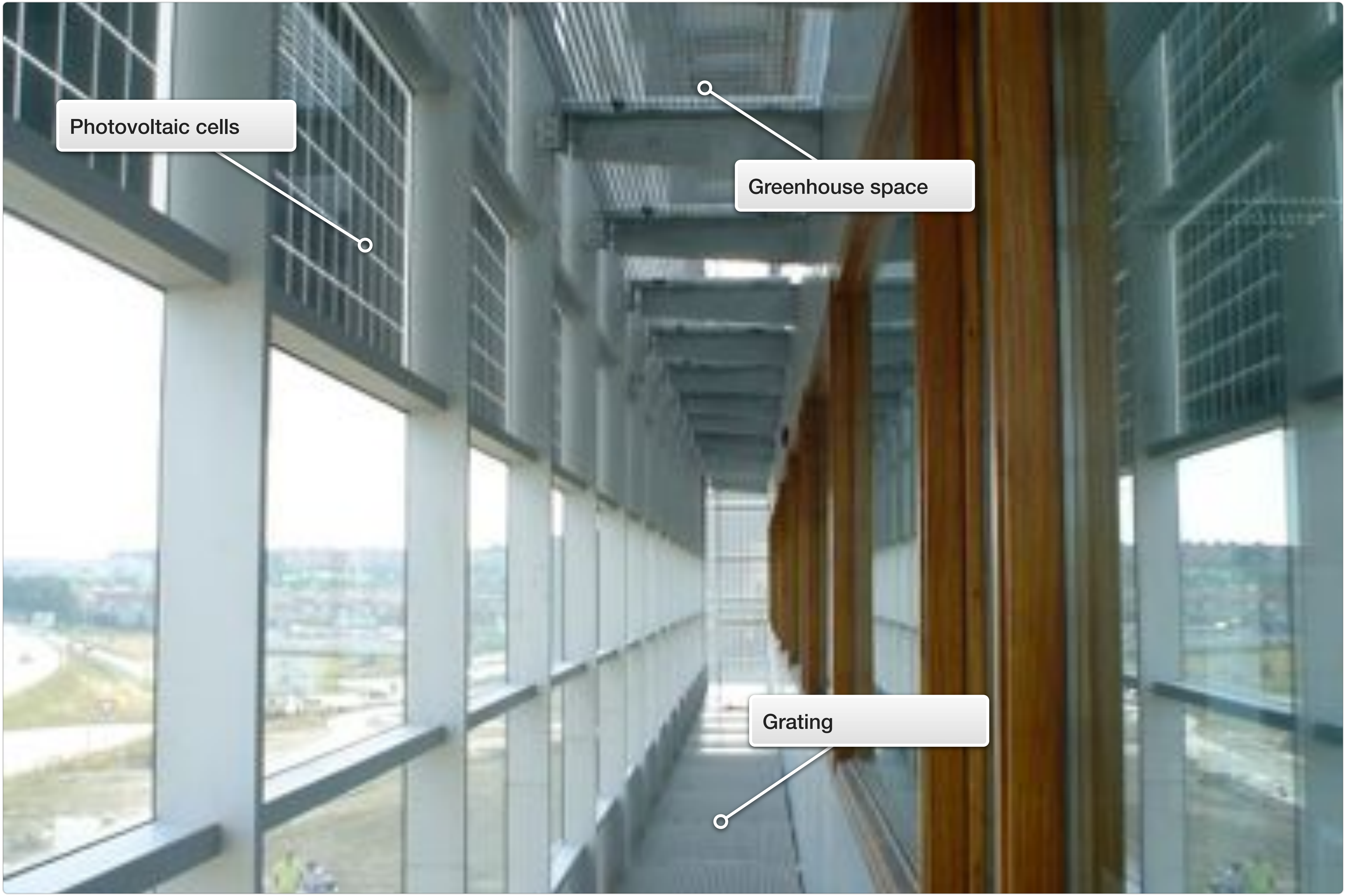
> The lower dome and the exterior one should float over a sliding hydraulic surface, sealed and with little friction. As exterior covering a structure used in aerodromes was planned, capable of moving independently around a similar inner dome to supply different homes. Both domes were covered with glass and aluminum panels in equal parts, so that at night the house could get completely dark and follow the sun’s course during the day, like an eye and its eyelid, with an intermediate room to facilitate the air movement.
>
> (BEHLING, S. Op. cit, p.226. Free translation from the Spanish text by authors).

A possible materialization of this project would be the building of the Great London Authority by Foster Associates, a sample of energetically efficient design.

This is where the Lord Mayor of London lives and works, which is why the architects team wanted to build a symbolic building, which is why they did not want to design something integrated into the environment, but rather a building of a great symbolism. The thermal and solar impact on different glasses were simulated, the generation of a ‘self-shadowing” form was analyzed, so a sphere was taken as starting volume, as it is the most compact form in terms of thermal loss, and it was turned, broken and rotated in such a way that in the southern zone shadows were generated by the upper floors, and in the northern façade there was totally transparent glass, as obviously the upper zone receives the greatest solar impact.

Renzo Piano also opted for a very interesting solution in energetic terms for the Cultural Centre Jean-Marie Tjibau in New Caledonia, where the wind behavior (bearings, speeds) was analyzed, which together with a free interpretation of the local architecture, resulting in an

Interactive 6.1 Office building double skin facade.



architectonic project of low consumption and low maintenance.

These approaches to energy represent an intellectual attitude, not a new idea promulgated by ‘bioclimatic’ precepts. So, continuous innovation, one of the special features of installations applied to buildings, is even a more outstanding –in energetic terms- when applied to a city. The decision of installing independent heat production per home, building or group of buildings (district heating), with bio-mass boilers, with the (apparently) futuristic tests that are been carried out with hydrogen cells or with rubbish incineration (like the systems used in Paris, Vienna and Lisbon), even the possibility of air-conditioning several buildings as centralized productions (district cooling) directly affect the urban landscape.

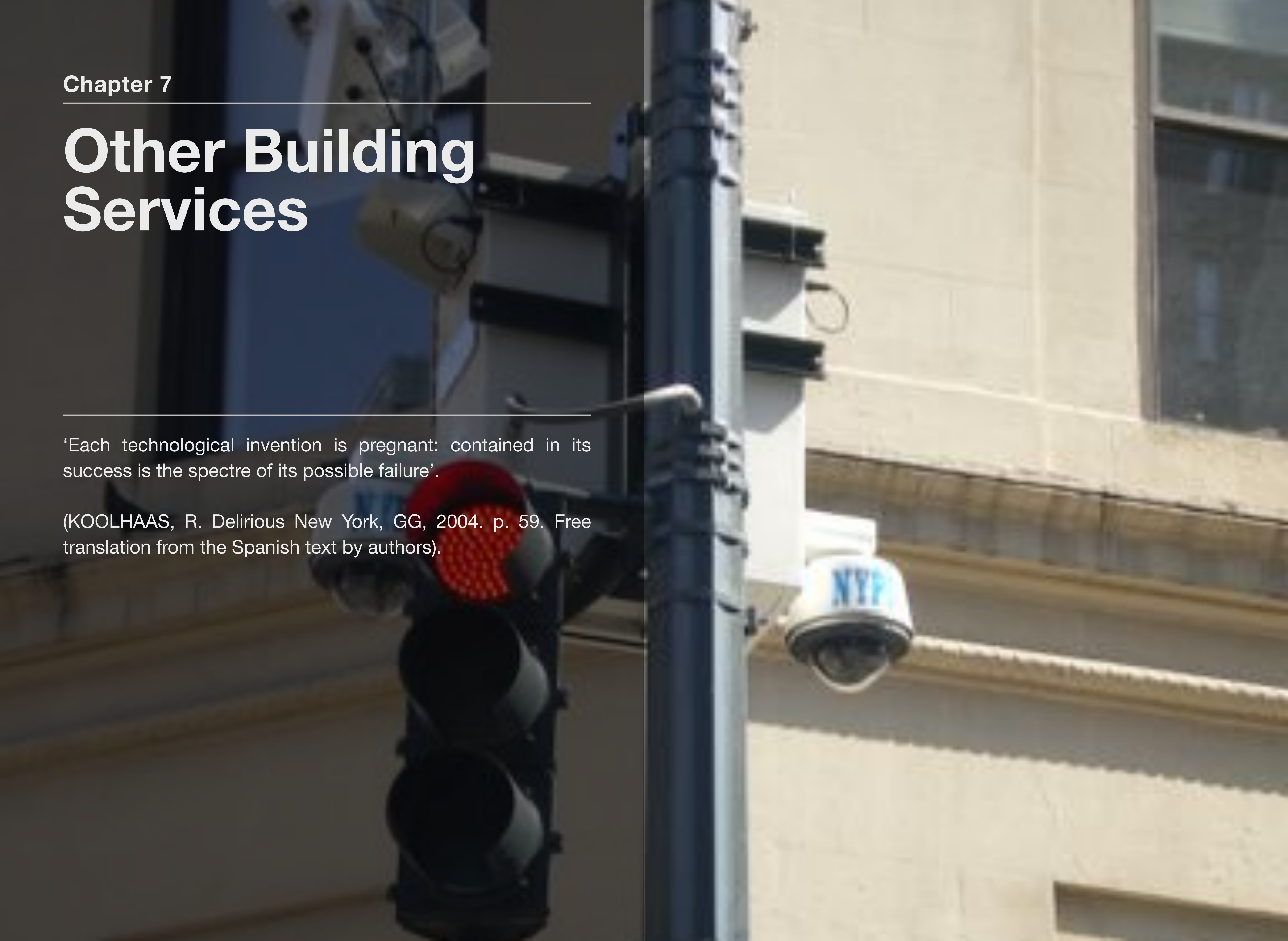
This thinking on a different scale about the use of the energy allows us to be optimistic about city energy development, even more so if it joined up with the possibilities that buildings produce more energy than they consume (for example integrating wind power, which no longer is utopian). Thus, if the necessity for energy transport with non-centralized productions is reduced or cancelled, the room in the buildings used by people might remain be similar, but there would be a radical change in architecture at the urban level.

Chapter 7

Other Building Services

'Each technological invention is pregnant: contained in its success is the spectre of its possible failure'.

(KOOLHAAS, R. Delirious New York, GG, 2004. p. 59. Free translation from the Spanish text by authors).



So far conventional installations have been mentioned, taken as conventional an installation which in one way or another is present in most building typologies.

But there are other installations which are needed for certain buildings to work, since they either complement the services of other installations or provide a specific service to the buildings. Just one example: if in an extensive course of piping we want to know the precise point in which a leak of liquid has taken place, the market offers escape detector cables that inform about the precise point where it occurred. Would this system be classified as plumbing? Air-conditioning? Or maybe it could be within the field of controls or domotics?

Next, let us take a quick tour of some of these installations.

VERTICAL COMMUNICATIONS

The invention of the passenger elevator by Elisha Graves Otis took place at the New York World Exhibition in 1853, when, standing on a platform four floors high, he ordered the rope that held him to be cut. However the platform did not drop to the floor, but remained steady due to the security mechanism he had invented. Doffing his hat to the crowd, he said, “All safe, gentlemen, all safe”.

This machine revolutionized the history of architecture by allowing the vertical conquest of space, a success later completed with greater comfort with the invention of the mobile staircase when Otis installed the first escalator for public use in the Paris Exhibition of 1900. For certain distances and number of journeys, the use of escalators can be more efficient than that of elevators (bear in mind the flow of people moving in a department store).

As in other installations, there have been many milestones contributing to the development of this technology, like the tables volantes, the installation of the first elevator in a ship in 1906 or the systems of two-deck elevators in one shaft marketed since 2003 (although

Gallery 7.1 Other building services images.

Interactive information screen.

during the 30's patents for that idea were registered). Even in this type of installations the great masters have created their particular utopias, such as the elevators proposed by Wright in the Mile High project in 1956:

> Elevators of five cabins impelled with atomic energy are like vertical 'trains' that run over foremasts, as a rack train. Given that the building rises from the base in five terraces, elevators correspond with the levels of each terrace. Although the building is getting narrower with the height, the shaft not, and you can see how they go up from the outside of the building, just as the corridors that connect the levels of the different floors.
>
> (BROOKS, B, Wright, Taschen, 2004, p.82. Free translation from the Spanish text by authors).

There are installations that offer different points of view from western architectural norms, as for example the oriental tradition of Feng Shui, in which it is believed that the staircases and elevators are the 'bloodstream' of a business, so the better the service, the more profit the business makes.

SECURITY

Although they share criterions for laying with the electricity or data network, they are installations that generate specific conflicts with some constructive elements, as occurs with built-in sockets or electrical locks in doors.

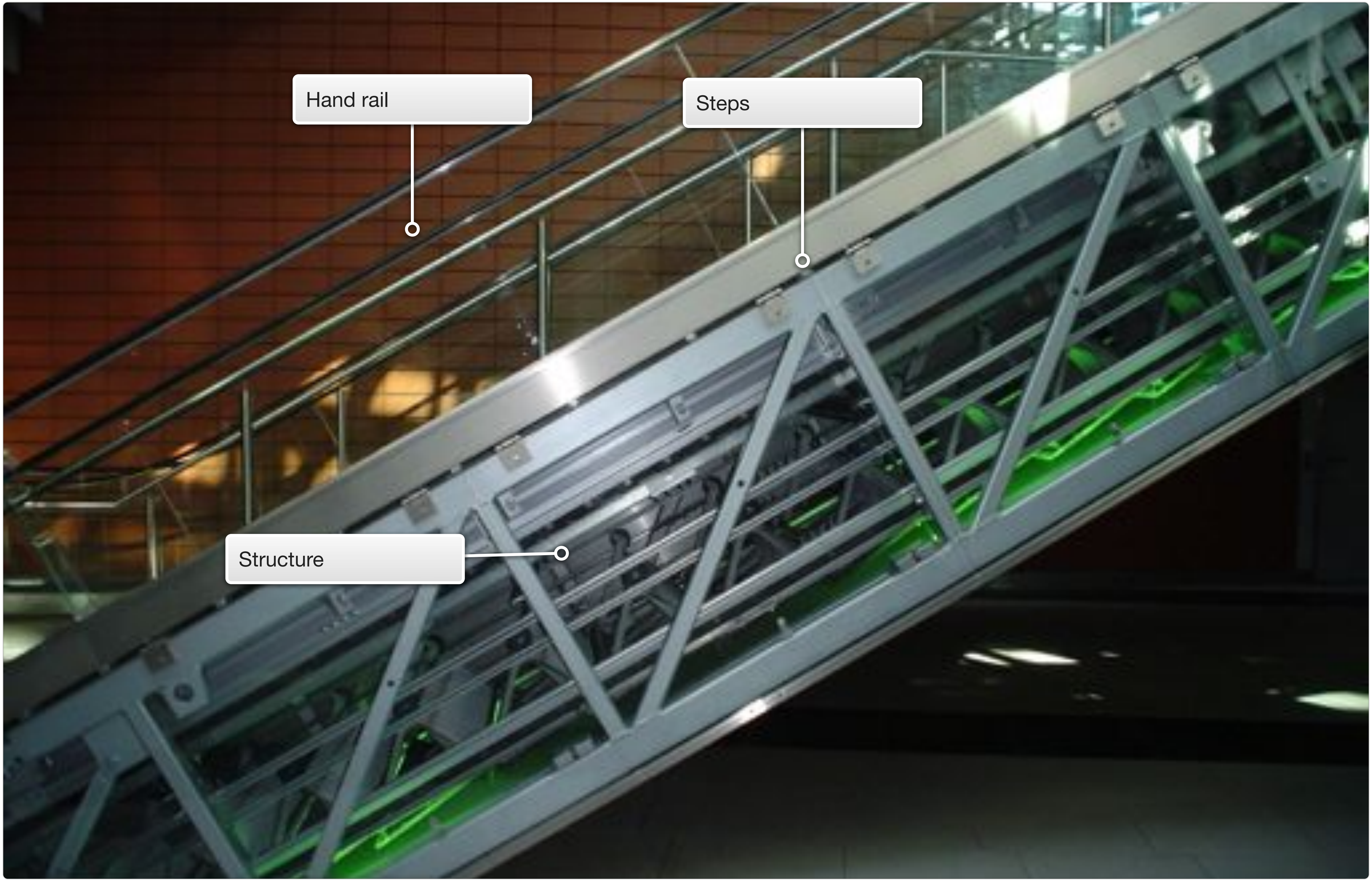
Sometimes, it is advisable that the terminal elements of these installations (cameras, detectors, alarms) be visible; then in this way they carry out an important dissuasive task.

PUBLIC-ADDRESS SYSTEM

It must not be considered merely as an element to transmit messages or music. Architecture can attend to different aspects, not only the usual ones of texture and sight, but also hearing, which fundamentally occur in constructions that will be short-lived, and can come up with such ingenious solutions as the hidden loudspeakers of Álvaro Siza.

OBJECTS MOVEMENT

Interactive 7.1 Dresden Airport escalator



In the early 20th century the American architect Irving Gill thought that for a house to be hygienic, it had to have a small rubbish incinerator and a built-in vacuum-cleaning system.

Under the umbrella of the atypical definition of this section installations that move different objects from a place to another are gathered, installations like a centralized vacuum-cleaner in homes, the pneumatic waste collection in cities or pneumatic capsule pipelines. These latter are used, for example, in hospitals to move samples between the laboratory and the rooms where the patients are, or, in a hypermarket, to transfer money between the cash desks and the control post.

In any case these installations work simply, but take up space and have important requirements owing to the wide turning radius of their piping.

SPECIFIC INSTALLATIONS

For hospitals, laboratories, industrial processes... They are installations made expressly for a specific client and purpose, so are usually high cost.

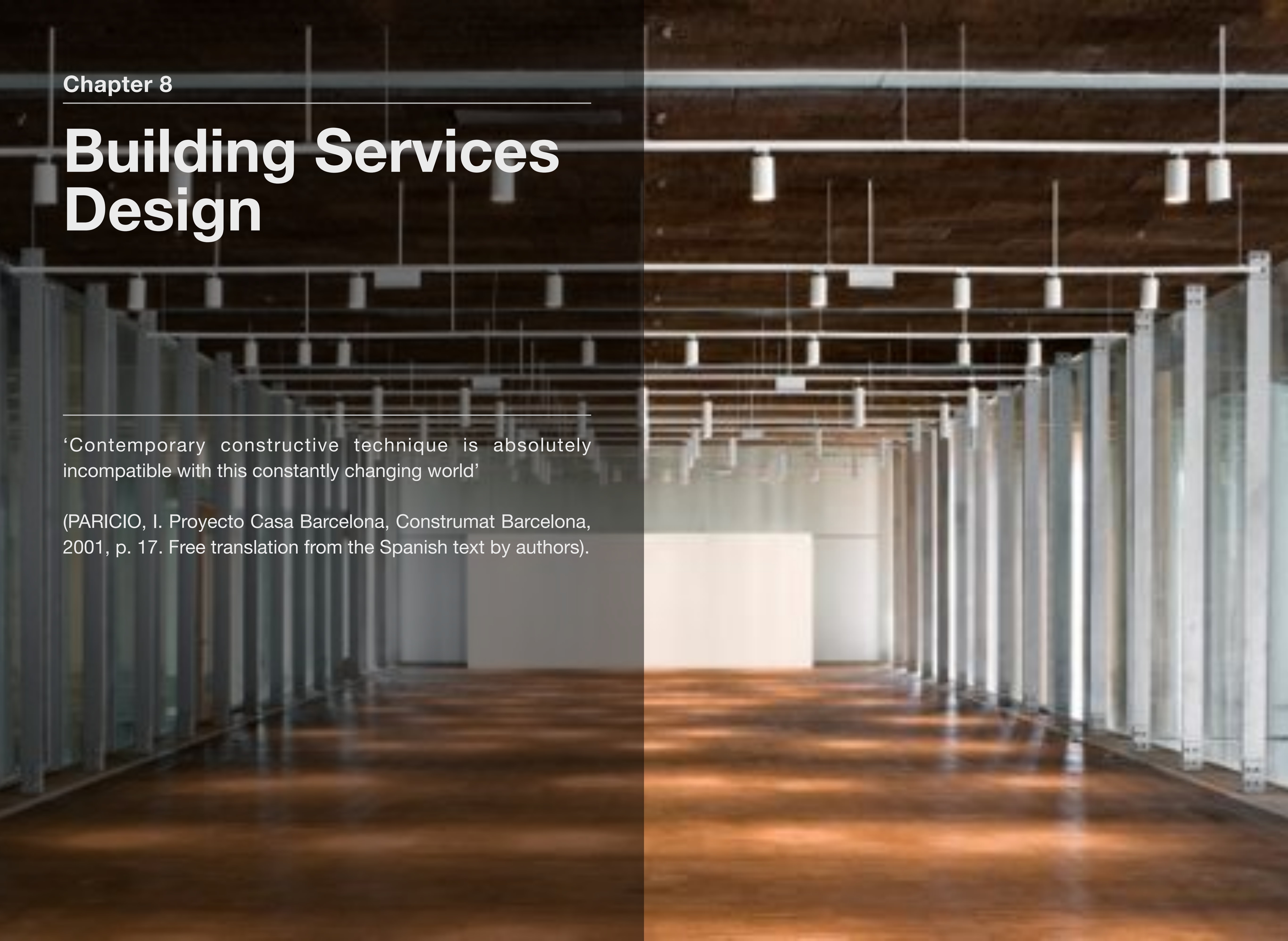
For example: the support towers to look after the patients in a ICU or the hospital bed headboard, both elements of small size but which have to incorporate different installations: power points, natural lighting and patient observation switches, data connections, earths, medicinal gases (oxygen, void...) and systems for calling the nurses.

Chapter 8

Building Services Design

‘Contemporary constructive technique is absolutely incompatible with this constantly changing world’

(PARICIO, I. Proyecto Casa Barcelona, Construmat Barcelona, 2001, p. 17. Free translation from the Spanish text by authors).



Gallery 8.1 Building services design.

Radiator.

Chapter 9

A Possible Future

‘One cannot invest too much in hypothesis with the present information. Actually only the general order of the project and the generosity in the forecast of spaces are durable values’

(FUMADÓ, J. L, PARICIO, I. El tendido de las instalaciones, Bisagra, Barcelona, 1999, p.25. Free translation from the Spanish text by authors).

In 1873 oxygen was separated from hydrogen in water; in 1874 Jules Verne prophesied the use of hydrogen as the 'coal of the future' and in 1969 the fuel cell was part of the Apollo XI. With advances like these the future possibilities of installations in buildings and in the city depend merely on the imagination of the project design technicians.

With the developments of the present technology we can state that in a near future installations will be designed in a very different way for how it is done nowadays, since the natural tendency of complex systems is to tend to the essential, and, at the same time, towards an improvement of services. Thus it is logical think that many solutions in use at the moment, will be obsolete in a in a not very distant future.

Next, we propose a new relationship between architecture and installations, between served and server ones: Will electrical connections disappear and will each device, light fitting or electrical appliance have its own fuel cell? Will the house of the future be reduced to an empty space where the thermal control comes from the floor, light from electroluminescence by means of liquid crystals, and sounds and images rise from the wall just as Philippe Starck proposes?

It is obvious that the fear of fire and insecurity will condition the design of closures and structures although surely not in the way in which now they are proposed, owing to the appearance of new building typologies and the optimization of the existing materials and of those science will create.

In the future we will continue to need water for human consumption, which does not represent in any way a condition for the formalization of the architecture, but will the plumbing of these waters be needed? With the approaches by Buckminster Fuller mentioned earlier, not necessarily. There will be waste to evacuate, but not as it is done now since the values of recycling waste will increase considerably. Although the option of recycling the waste from the buildings to the recycling centers with garbage trucks is suitable nowadays, a better option would be minimize or eliminate that transport, which, after all, also implies energy consumption. This leads to the idea that the best option is to recycle waste at the point of production, thus suitable means to that end will

Gallery 9.1 A possible future images.

Temperature sensor in an external prototype.

appear in dwellings, together with piping for its evacuation and direct recycling. This development would entail the laying of piping of a certain diameter, with wide radius of curvature to make the movement of waste easier.

The use of the voice and data networks in Spain in 2001 meant that the person who had to change the location of their connection point, had to move the whole system (CPU, monitor, keyboard, mouse, printer...). But just a few years later, there is an enormous variety of possibilities to receive and send cordless information. This is an example of a network that has disappeared. If we want to change a house or an office layout, this installation which until quite recently was necessary, continues to exist, but not in terms of construction.

All the appliances that we use daily need electricity: lights, different electrical appliances, computers... But think about the size and durability of the first mobiles and the designs that the industry offers nowadays. If to this functional and design evolution we add the application of new technologies such as hydrogen mini-batteries, does anyone dare to say that it would not be possible for each everyday device to leave the factory directly with a battery inside with a durability of years? The electrical appliances (television, toaster, printer...) will be delivered and placed, a button will be pressed and it will work all its useful live without the hindrance of any cable (distant utopia? twenty years?). This is another installation that may disappear, one condition less in architectural construction. The result: a space without power points, simpler, without apparent limitations but with a greater technical complexity, that covers not only the buildings, since as far as the buildings reduce their electricity consumption (appliances come 'fed' for years), urban energy landscape also changes. The requirements of primary energy consumption to feed the batteries will be in the power stations which may be associated with wind farms, with photovoltaic cells, with tidal energy farms or wave power. Some manufacturers even propose the hydrogen battery for its application in the production of hot water and domestic heating, in a project called "decentralized cogeneration boilers" in which gas electrolysis produces the electricity and heat used to supply hot water and warmth to a house.

Air-conditioning in this section about a possible future refers to small spaces such as offices or houses, since the big air-conditioned volumes occupied by people will continue to need the contributions of impelled air (that is, built volume) to satisfy the needs of quality. In the related spaces two questions are considered:

- Increase of the heat recovery systems. It will be obligatory by law: it is not logical that a society concerned about recycling and energy should use all t h e normative means within its reach to avoid the wasting of produced heat which can be used somewhere else or for another purpose and not allow it to be released into the atmosphere. These solutions affect architecture in as far as systems of exchange, recovery or accumulation of energy require volume for their introduction, and condition the constructive solutions and the choice of the air-conditioning systems.
- In the future there will also be more requirements on the parameters of air-quality in buildings. Optimum quality is obtained from natural ventilation, for which the best thing is to introduce exterior air with the heat

recovery mentioned before, avoiding obligations of the ventilation systems in the rest of the building (in that sense the technology of active carbon filters for the kitchens that do not require to taking the ducts to the roof is fully developed).

With these solutions the peaks of consumption of heating and air-conditioning have decreased, but all times of year have not been resolved. The remaining energy surcharge is solved with a small apparatus (Electrical with hydrogen battery? Thermoelectricity – Peltier effect?) that does what is necessary to transfer the heat between the environment and the occupied space. But where this machine is located? Installations have been removed from the dwelled space, getting closer to the concept of a true free floor, which is why it is unlikely that the clients of the future will propose the location of hygrothermal conditioning systems in the middle of these spaces, so that only the façades remain.

There, in those walls of a certain thickness, is where the conditioning systems will be placed together with the systems of solar control.

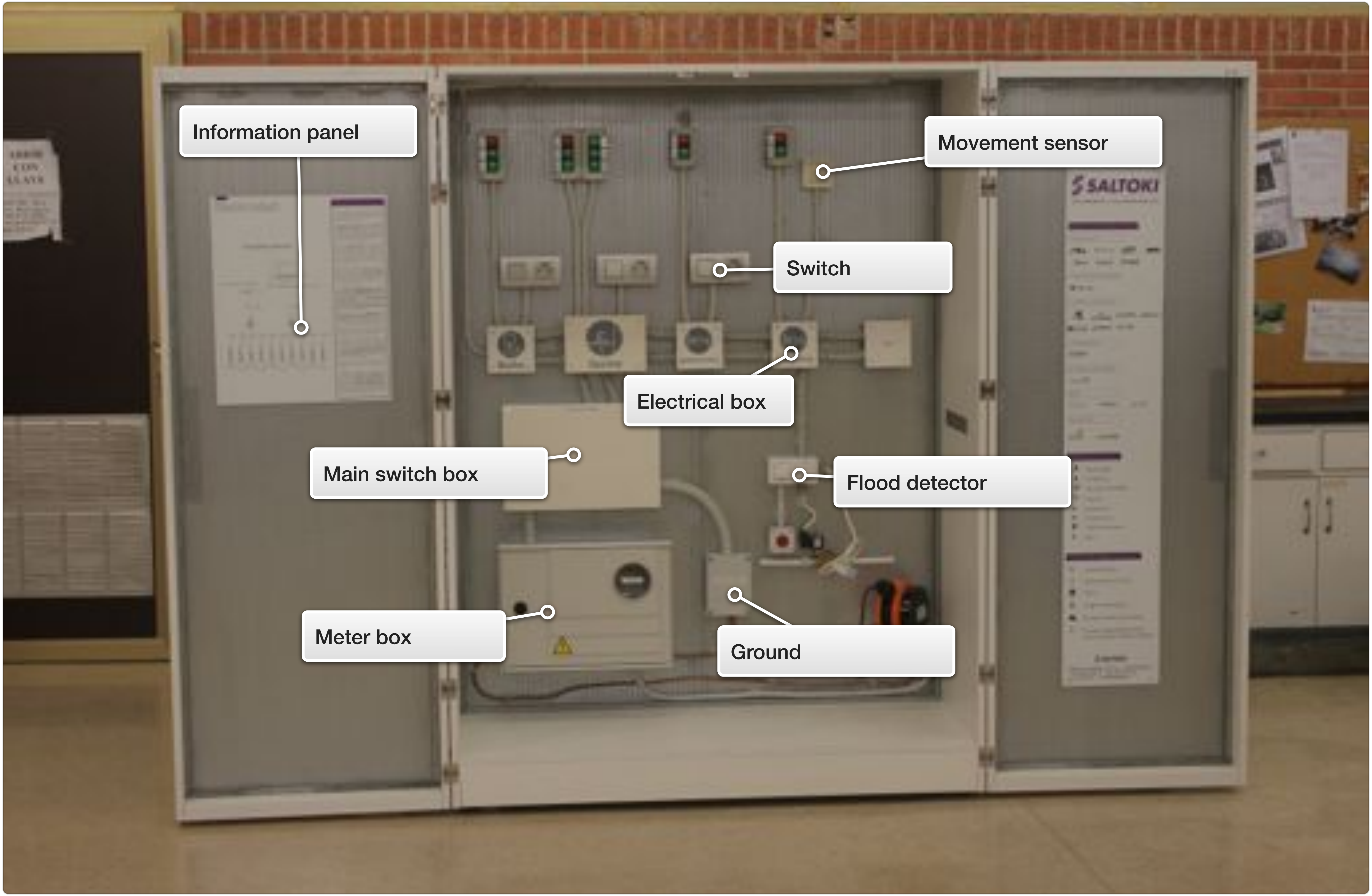
We can observe how, after all these guesses (without over-stretching the ‘machine of the imagination’), the occupation of the installations will decrease considerably. The result: free floors with more complex devices and more sophisticated façades.

In any case it will also be desirable, as a complementary measure, that the buildings produce their own energy thus avoiding the laying of the power supplies from the generator power stations: it will not be needed since each building will produce its own energy. These hypotheses are not the imaginings of a far-distant future, they are been proposed nowadays, although we will not see them as usual for a few more decades.

Two projects by G. Batlle on the matter:

- New York Yankees Stadium for 150,000 seats. A building in which numerous systems of energy production of renewable sources are incorporated: solar receivers that supply 100% of the hot water in winter; the rain water is collected (10 minutes of torrential rain provides the non-potable water that is needed in a year), and in the top part of the stadium

Interactive 9.1 Simplified scheme of a house electrical installation.



34 axial fans are proposed (with a diameter of 10 meters) that contribute to the electrical sell-by date of the complex.

- Proposal for the World Trade Center. A project with more 650 meters high, in which wind turbines have been proposed at the top of the building (with a noise level of 55 dBA) that produce enough electricity as to achieve an amortization of between 10 and 15%.

I hope I have conveyed the message that this section is no more than a theoretical exercise with which to open our eyes towards the possibilities of installations in architecture. The future can be different, and if it is somewhat like what is suggested here, architecture will have returned to its origins, though wrapped in a greater complexity: it would be a refuge, an empty space in which one can do activities without any other limitation that the exterior closures and the structure that maintains the whole structure.

There is nothing that cannot be re-thought, and installations are an excuse to carry out new approaches that will allow us to wake early 21st-century architecture from its torpor.

> It wasn't cold inside the well-heated car, but there was something frigid about a snow-covered world, even through glass, that annoyed him.
>
> He said, reflectively, "Some day when we get around to it we ought to weather-condition Terminus. It could be done."
>
> (ASIMOV, I. Fundación, Debolsillo, 2003, p.131. Free translation from the Spanish text by authors).

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