IDOM
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IDOM
ARCHITECTURE
BUILDING PHYSICS

BUILDING PHYSICS

ARCHITECTURE

IDOM

"As an aged professional I can say that contemplating a young person that is progressing in experience, going from unexperienced to expert in his trade, is one of the most interesting spectacles in life. Seats could be sold to see how some take the steps of transition, from youth to professional maturity."

"Como profesional ya viejo puedo decir que contemplar a una persona joven que está progresando en experiencia, pasando de inexperto a experto en su profesión, es uno de los espectáculos más interesantes que hay en la vida. Se podrían alquilar sillas para ver cómo algunos van dando los pasos de la transición, desde la juventud a la madurez profesional."

Rafael Escolá Gil
Founder and first president of IDOM

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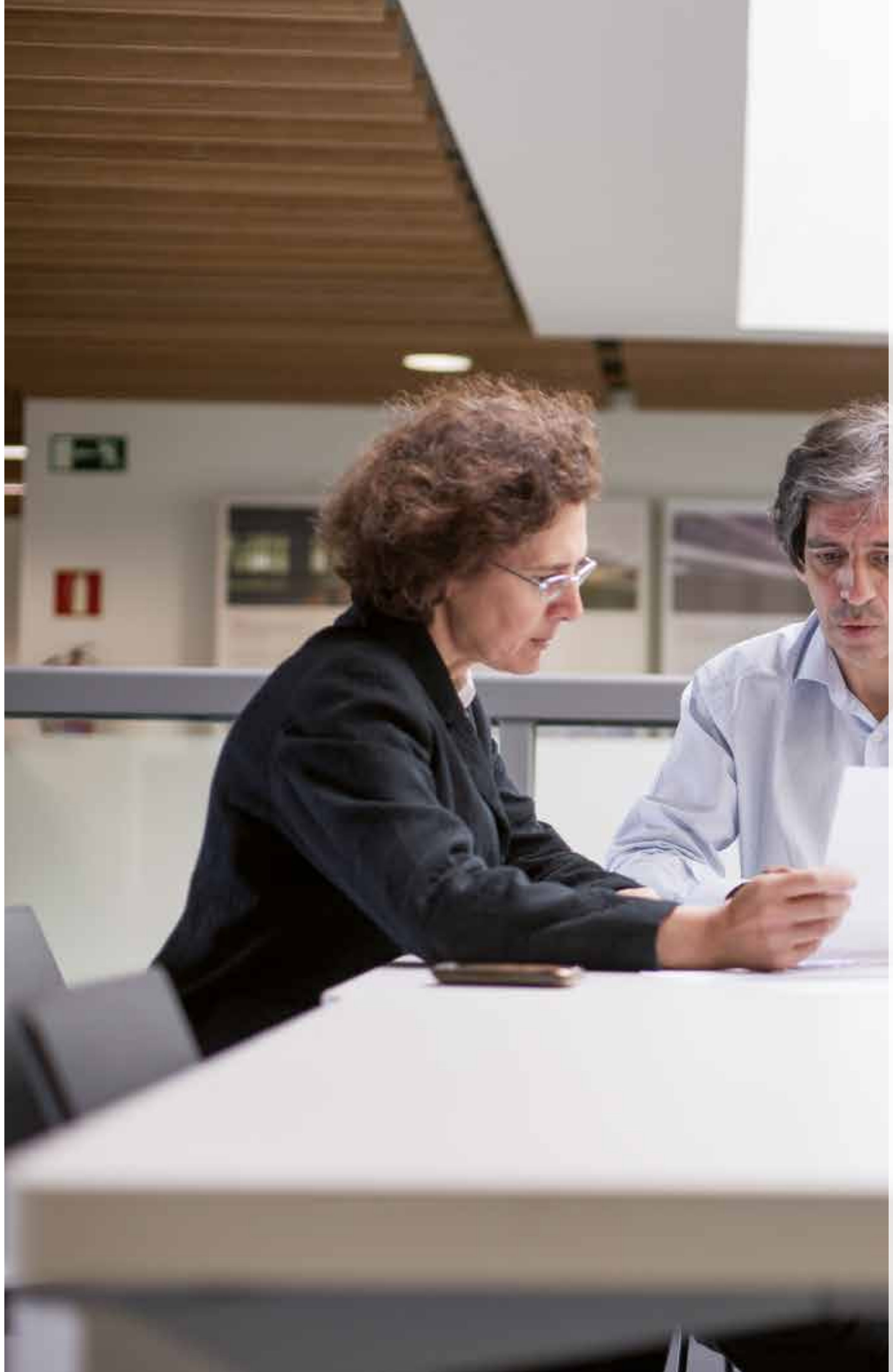
ABOUT **IDOM**



290 M€
income

64
years

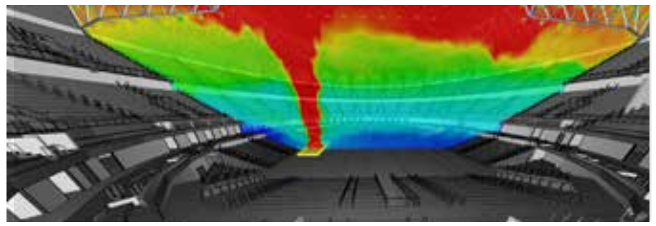
125
countries

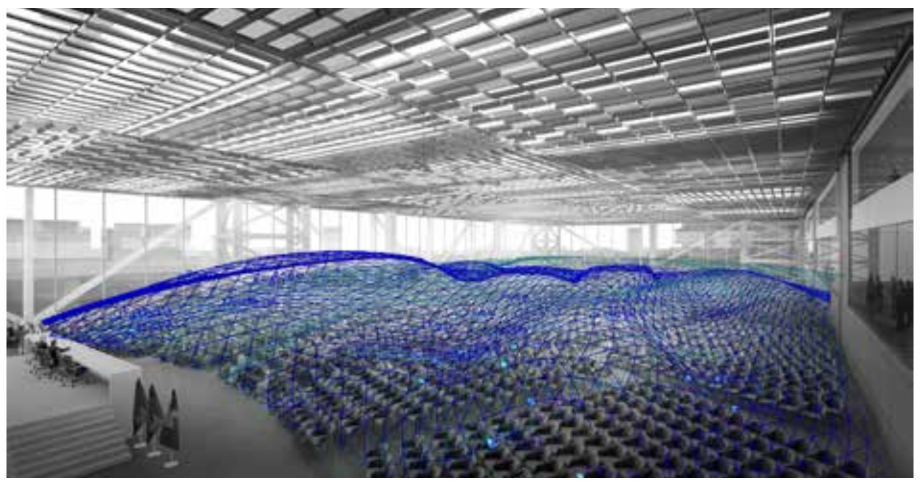
45
offices

893
partners

3,800
people

Consulting | Engineering | Architecture





BUILDING PHYSICS

In this publication, Building Physics, we wish to show the innovative approach we use to develop projects within IDOM. We are convinced that it helps to improve the quality of the architecture we produce and allows us to offer a quality service to our clients and the society we are devoted to. It is the result of a paradigm change caused by the intense transformations present in today's society. Building Physics are part of a methodology with great potential, yet to be explored and developed with a great future ahead.

Building Physics refers to the process which allows us to physically materialise ideas; it must be an inseparable and essential part of the architectural concept of a building, which is coherently interconnected with all the disciplines from the initial idea to its materialisation. This is in keeping with a way of conceiving projects where architecture and engineering are two sides of the same coin.

The term Building Physics is not limited to the traditional idea of building engineering. It goes beyond and involves the very different disciplines of; physics, chemistry, geology, biology, acoustics, lighting, biotechnology and other classical fields. Behind every one of these disciplines are the professionals that sustain them, creating a vast diversity of interests and trainings which include: architects, different types of engineers, physicists, chemists, biologists, geologists, lawyers, economists, etc.

At IDOM, we want architectural projects to incorporate the wisdom and experience of all its professionals from the beginning. Making the most of their different fields of knowledge will ensure the generation of a single character, which will generate a united, holistic result.

We have structured this publication around thirteen topics: Sustainable design, Zero consumption, MEP building services, Acoustics, Lighting, Fire, Water, Wind, Structure, Building envelopes, People flow, Information and Security technology, and Green design. These are only a starting point from which we can develop any number of new sub-specialities. For each topic we have focused on a representative project, the experiences are real, and contain significant references which cross very different technical fields. We trust that this book will transmit the professionalism, effort, commitment and passion invested by the IDOM professionals who are involved within such unique projects.

BUILDING **PHYSICS**

SPECIALITIES

Sustainable design
Universities of Alouine Diop and Gaston Berger

Zero consumption
New Red Electrica Campus

Building services (MEP)
Riyadh Metro

Acoustics
Lima Convention Centre

Lighting
Illumination of archaeological sites in Egypt

Fire
India International Convention & Expo Centre

Water
IDOM's Madrid Office

Wind
Marques de Riscal winery

Structure
San Mames football stadium

Building envelopes
CUF Descobertas Hospital

People flow
Istanbul metro

Information and security technology
Data processing centre in Cerdanyola del Valles

Green design
Da Gare park

METHODOLOGIES

BIM. Building Information Modelling
Energy efficiency. Optimum cost
Parametric design of building envelopes
Design-construction-operation management

SPECIALITIES

SUSTAINABLE DESIGN

IDOM's Bilbao office. Through a comprehensive renovation of an old bonded warehouse, IDOM's office in Bilbao was an important step towards the recu-peration of the industrial area of Zorrozaurre. The building was awarded a LEED Gold Certification for Sustainable Design.

IDOM's Madrid office. IDOM's office in Madrid completed the challenge of achieving exceptional results in terms of comfort and energy consumption within an office block. The building was awarded a LEED Gold Certification for Sustainable Design.

SUSTAINABLE DESIGN

"Man has always used the materials that nature directly put in his hands to build an environment fit to live in"

"El hombre siempre ha usado los materiales que la naturaleza le ponía directamente en sus manos para construirse un entorno habitable"

Alejandro de la Sota

Sustainable construction must be environmentally, socially and economically responsible. It must take into account the building's entire lifecycle, from: design, construction, use and demolition. Incorporating sustainability strategies within the early stages of the process enable the design of highly sustainable buildings through sensible, cost-effective interventions.

By approaching the different elements that define sustainable buildings, the project can achieve a highly efficient energy performance with an excellent environmental awareness. At the same time, environmental comfort and quality are also achieved on the inside. The design must protect the user from the harshness of outside conditions, at the same making him the beneficiary of a controlled interior environment through light, heat and views of the landscape.

The only possible approach to successfully reach the objectives of sustainability and energy efficiency is a holistic one. The project is conceived by a team of architects, engineers and other professionals trained in different disciplines, together they all approach the aspects that affect the project's sustainability. Therefore, the result is not a compilation of factors or a number of elements, but it is a global conception in which each element is affected by and intertwined with the rest. With the aim set on buildings with a triple goal of zero energy, water and waste, we focus our efforts on those stages and processes that have a greater impact on the use of environmental resources, achieving a sustainable design that minimises the cost of buildings throughout their lifecycle.

UNIVERSITIES OF ALIOUNE DIOP AND GASTON BERGER

Bambey and Saint Louis - Senegal

The Government of Senegal, financially assisted by the World Bank, developed an improvement plan for several universities in the country. IDOM were commissioned for the extension of the Alioune Diop University in Bambey and the Gaston Berger University in the city of Saint Louis.

The projects for these new buildings were developed on basis of a sustainable building methodology. Design decisions for energy saving, drinkable water, thermal comfort, choice of materials and the construction method itself, were the consequence of previous detailed studies based on the local environmental and socio-economic factors.

In Senegal the climate is harsh, with high temperatures and high humidity throughout the year. Thanks to bioclimatic design strategies tested during the design stages – by dynamic energy simulations – the buildings are capable of internally avoiding and dissipating the heat. The combination of solar protection strategies – optimized by detailed shade studies –, natural ventilation and high thermal inertia allows internal areas to passively maintain a temperature from 5ºC to 10ºC below that of the exterior, thereby significantly improving the comfort conditions within the classrooms.

The rainy season in Senegal lasts for four months, but for the rest of the year, there is a shortage of water. For this reason, the building has very low water consumption fittings and a waste-water recycling system to prioritize the demand for drinkable water.

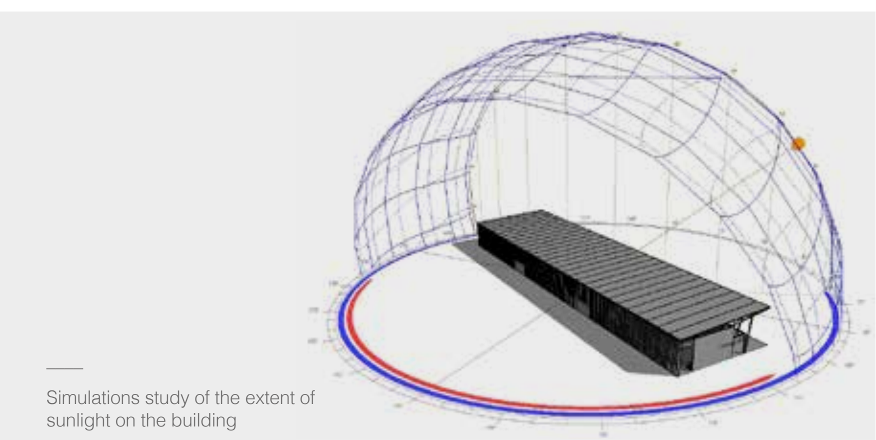
The construction of the building was carried out using local materials and workforce, applying local techniques for an efficient bioclimatic design.

LEAF Awards
First prize, Best Regenerative Impact category - 2018

BEAU, Spanish Biennale of Architecture and Town Planning
Award - 2018

WAN Awards, *category Sustainable Building*
Winner - 2018

Publication in Detail. March 1st 2019



Simulations study of the extent of sunlight on the building

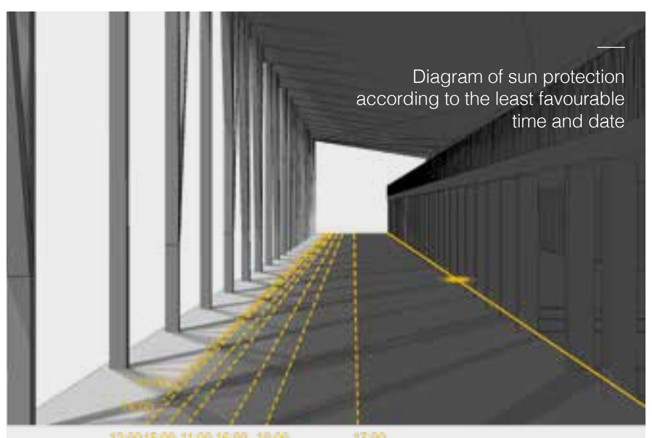


Diagram of sun protection according to the least favourable time and date

ZERO CONSUMPTION

Building for sheds, workshop and offices for the Odense tram in Denmark.
A nZEB (nearly Zero Energy Building) according to Danish legislation and building code.

Energy thermo-activation in a building **of the New Red Electrica Campus in Tres Cantos (Madrid)**

ZERO CONSUMPTION

"Every designer that neglects knowing his principles is exposed to great failures; and the thing is, there is so much to be learned at school that seldom is there any time left for thinking."

"Todo proyectista que descuide el conocimiento de sus principios está expuesto a graves fracasos; y el caso es que en las escuelas hay tanto que aprender que rara vez queda tiempo para pensar."

Eduardo Torroja

The terrain, air and sun, all present in the exterior environment, offer possibilities often denied or forgotten in building design. If we design to compensate primary energy consumptions with the production of renewable energy, we reach the idea of Zero energy Consumption.

In parallel, when we design seeking zero consumption by making the most of the surrounding resources, the quality of air and comfort are improved, and the required maintenance is reduced.

Where there is fresh air, it's always better if it is used. Sunlight is more desirable than artificial light and reducing the number of mechanical elements is nearly always a good idea. Selecting the best orientation is free and a good building envelope benefits the building throughout its whole life. The HVAC and lighting systems are not independent from the architecture, they are a part of the building system and cannot be designed as watertight boxes. Zero Consumption is only possible when the architecture and the engineering come together as one.

The recognition of the building envelope as a key element in the building-environment relation, is a challenge for the future. Living systems such as green façades or roofs are not aesthetic systems, they have great features offered by the vegetation, which human technology has not yet been able to replicate.

Thermal inertia and control over its behaviour is one of the areas with the greatest future in the field of energy. Structural thermo-activation and its combination with geothermal energy implies a true revolution in this field.

RED ELECTRICA'S NEW CAMPUS

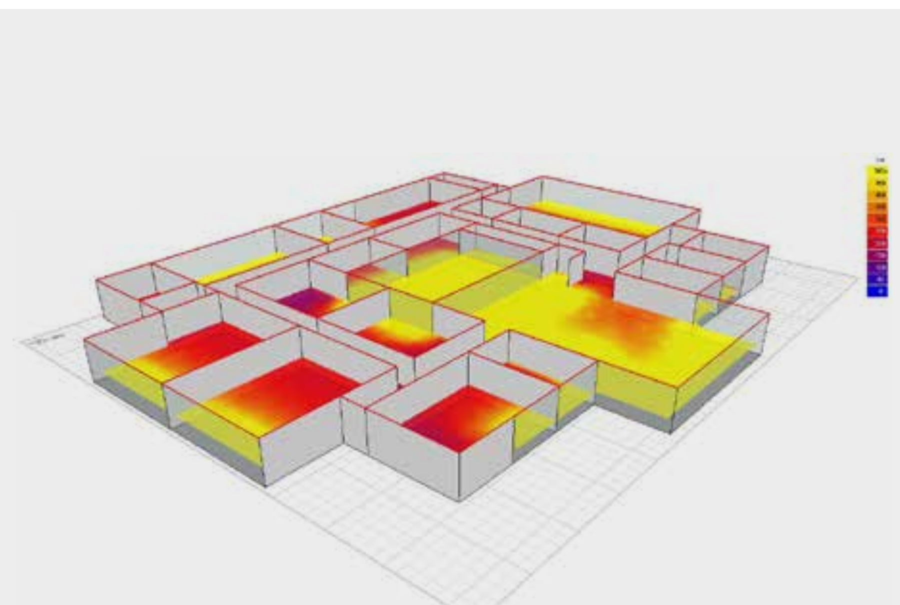
Tres Cantos/Madrid - Spain

Red Electrica de España (REE) commissioned IDOM with the comprehensive refurbishment of two buildings in the Technology Park of Tres Cantos, in Madrid. The intervention included the complete adaptation to the company's new training and technological requirements, modernizing the set of buildings through an intervention which would make it possible for them to meet both the functional and energy efficiency requirements.

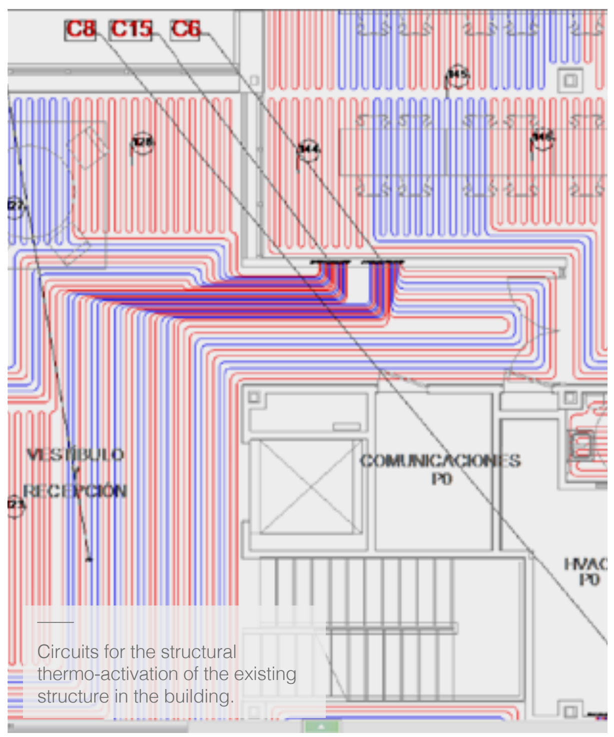
The buildings were renovated entirely for energy efficiency, including their roof insulation, floors, façades and solar protection. The intervention was highly technical. A GEOTABS solution was planned, which included the thermo-activation of the existing structure in combination with a geothermic system in the ground, acting as the single production system.

The existing structure was a common one-way slab. Thermal activation implied setting in motion an innovative project since there were no direct and complete solutions on the market. Tests were carried out with three different technologies (wet-mix gunite, dry-mix gunite and plaster), in situ samples were taken of them all. The thermal activation was combined with a 19-well geothermal exchanger, made with double-drilling-head boring techniques of 130 m deep, which feeds two geothermal heat pumps at 60 kW each.

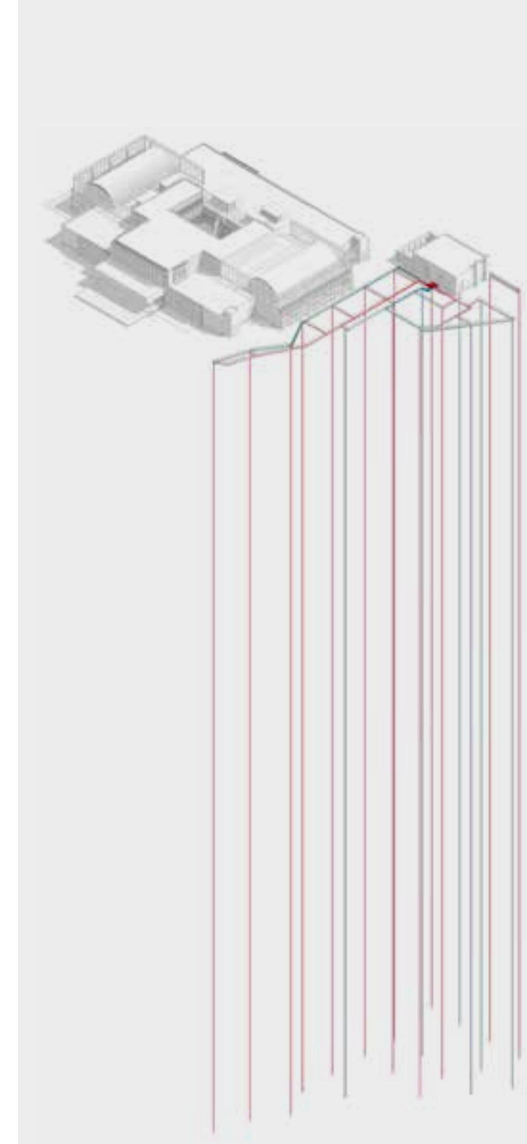
Finally, when the building started functioning it confirmed the exceptional results for both comfort and energy. The environmental impact of the refurbishment was minimal, in keeping with Red Electrica's standards and the energy efficiency requirements set by today's regulations.



The façade is designed for each orientation following the entrance of sunlight.



Circuits for the structural thermo-activation of the existing structure in the building.



Geothermal exchanger bores (GeoTABS system)

MEP BUILDING SERVICES

Beronia Rueda Winery. The building services (MEP) in the winery require a high specialization in wine production process to ensure its great quality is guaranteed.

Bilbao Exhibition Centre. The great volume and its diverse, complex usage, condition the design of MEP building services which are solved by giving flexibility and reliability to the systems.

MEP BUILDING SERVICES

"...functional architecture in my country didn't work. Taps wouldn't give water and drains would be clogged up. For ten years I explained the subject, talking about the sun, water, the importance of controlling the environment in order to create habitable forms. This was the first lesson. The year would come to an end and I would still be on lesson one."

"...la arquitectura utilitaria de mi país no funcionaba, los grifos no daban agua, los desagües se obturaban; durante diez años expliqué la asigna- tura, hablando del sol, del agua y la importancia del control del medio para la creación de la forma habitacional; esta era la lección primera. Terminaba el curso y yo seguía en la lección primera."

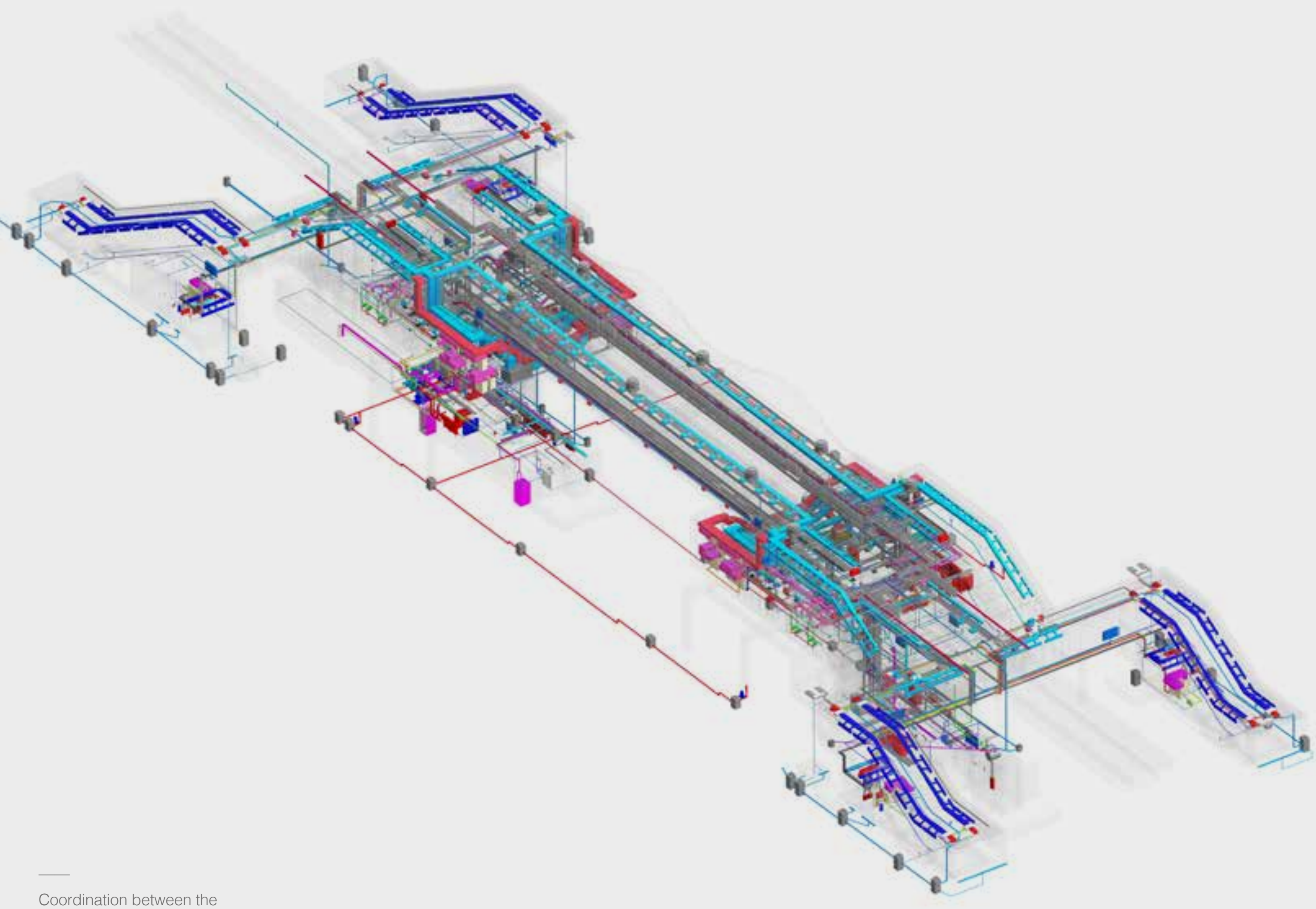
Francisco Javier Sáenz de Oiza

The services of a building serve inner thermal comfort by achieving the adequate temperature, humidity and air speed levels, without disregarding visual comfort. These are controlled by making illumination or acoustic comfort appropriate for each activity, avoiding exterior noise, particularly those produced by the building services themselves.

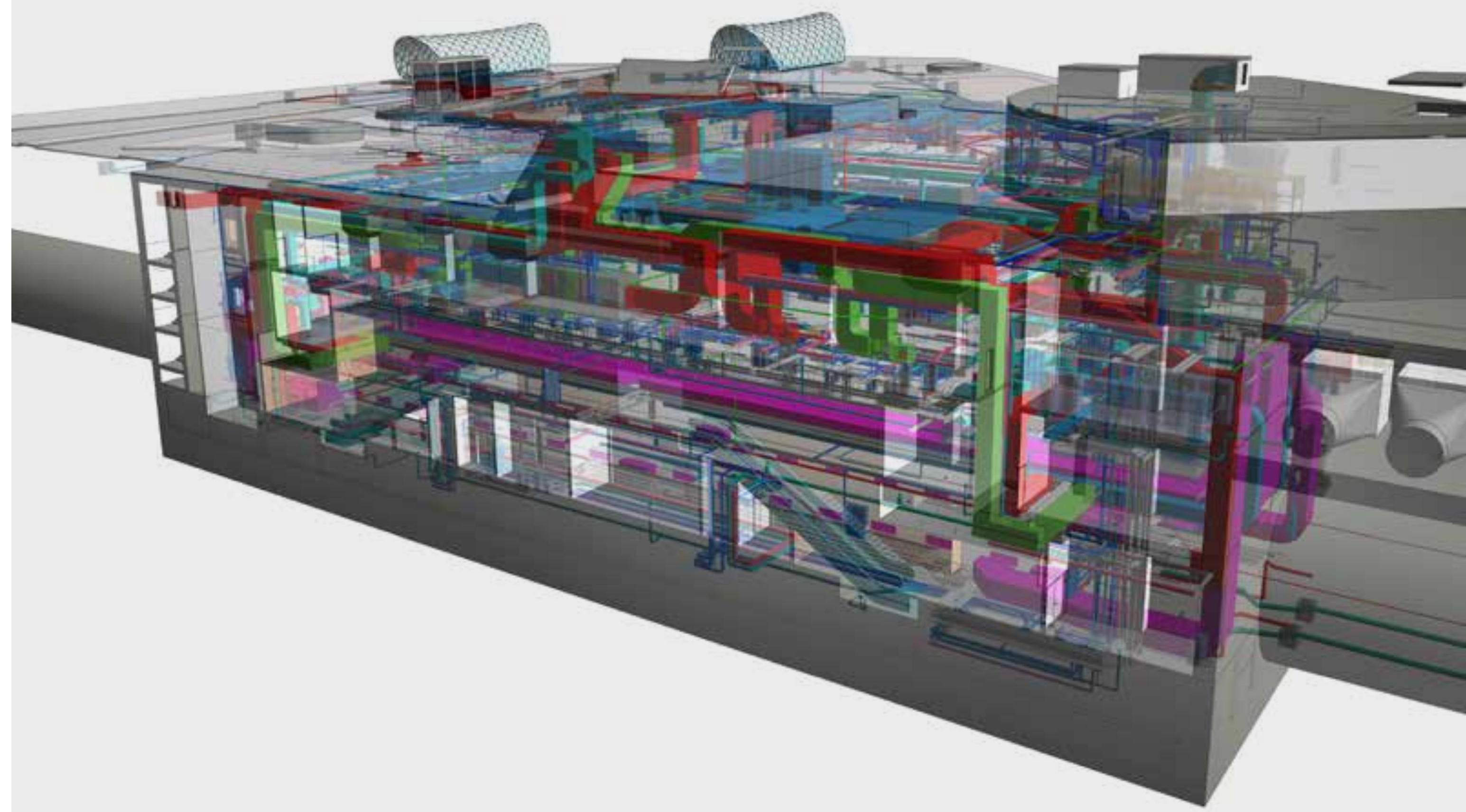
A standard building's systems cost between 30% and 60% of its budget and occupy over 50% of the project's paperwork. While the building is in use, they require 75% of all maintenance operations. All this turns the design of building services into something very relevant in any architectural project.

It is important to understand that building services are not independent from the building and cannot be added as elements, lacking connections with the rest of architectonic and structural components. They are an essential part of the global design. Such is the case, for example, of the thermo-structural activation; a HVAC system used by IDOM in several projects which uses the structure as a core element in the accumulation and distribution of thermal energy throughout the building.

The goal is to carry out each design by taking constructability into account, so that the building services are fitted in the natural order of construction, and can be coordinated with the remaining services, structure and other architectonic components. For this last task, we consider it essential to use BIM software so that the entire building can be modelled in 3D. This makes it possible to work virtually, achieving the coherence of all the building services like we do on site.



Coordination between the different building services, structure and architecture



Coordination between the different building services using BIM software

RIYADH METRO

Riyadh - Saudi Arabia

IDOM are responsible for the entire engineering works on line 3 of the Riyadh Metro, a project which includes the design of 20 passenger stations, 2 sheds and numerous depot facilities.

There are three different types of station:

- Aboveground stations located on viaducts
- Semi-subterranean stations under road junctions
- Underground stations in the central part of town, including an interchange station

One of the biggest problems we were faced with was the extreme temperatures of the city, this made it imperative to achieve a good cooling system for efficient operation and maintenance conditions.

The following systems were installed:

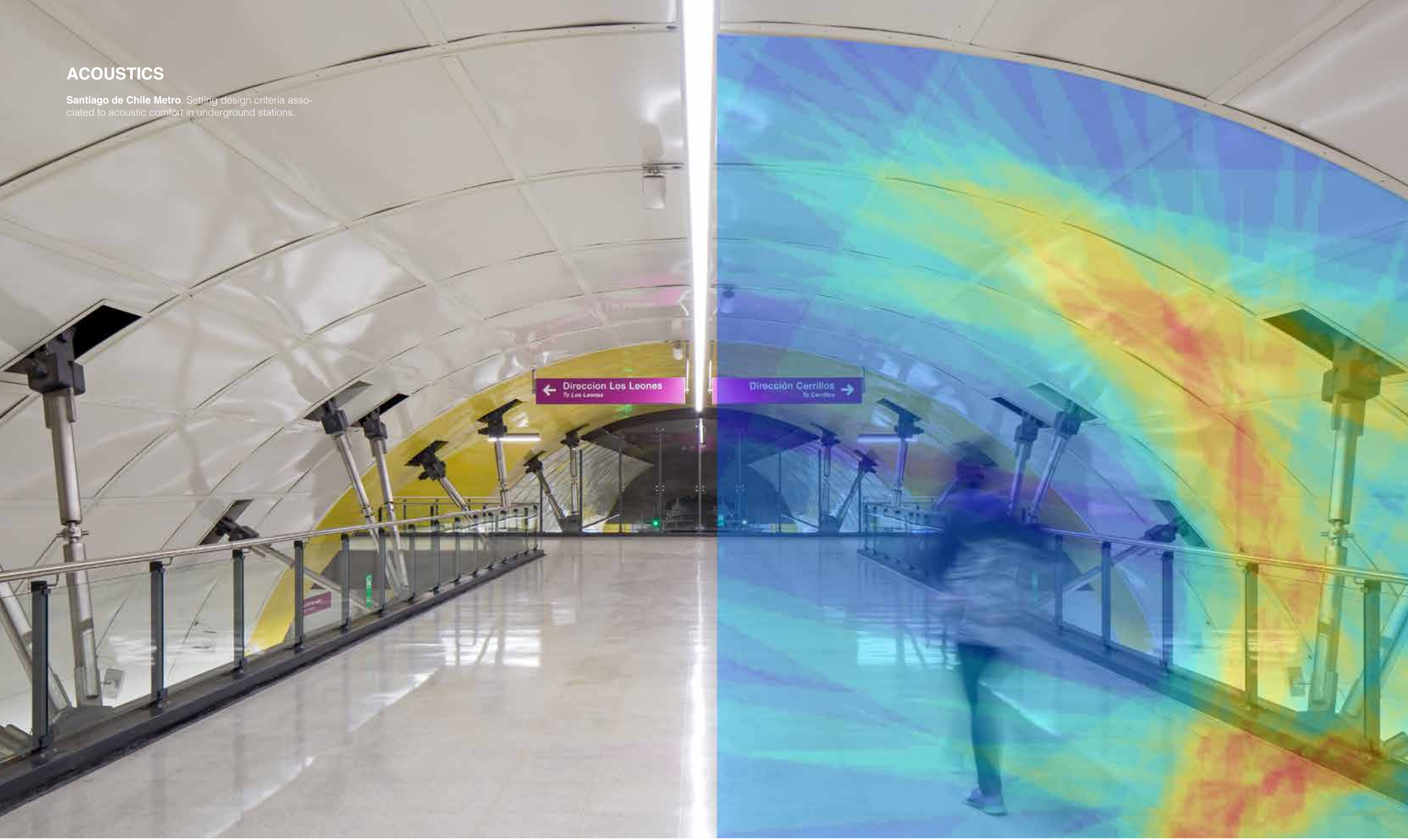
- HVAC systems
- Mechanical ventilation systems in all areas
- Fume extraction and immediate fire extinguishing systems through water and gas
- Required electrics to serve all these works

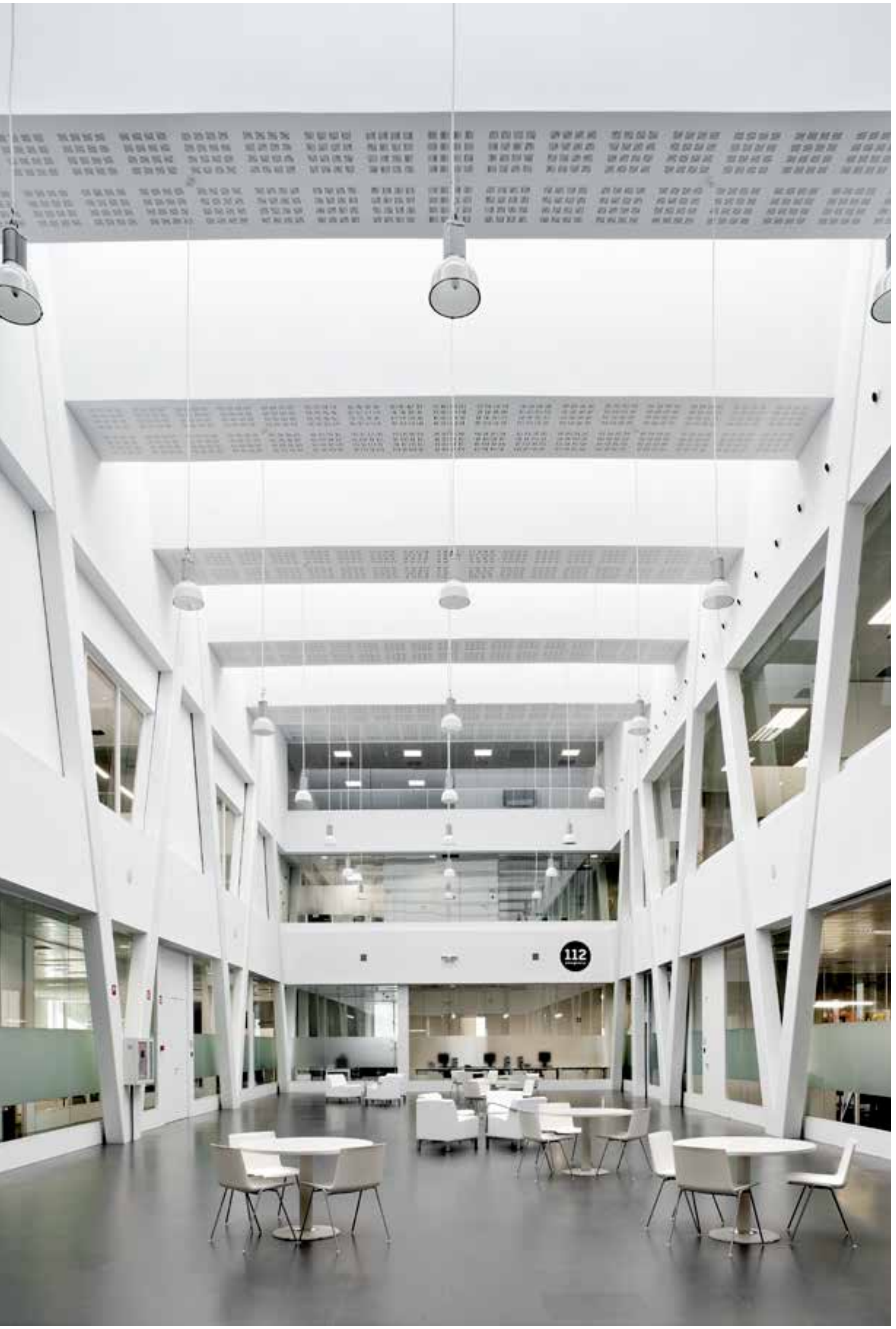
One of the greatest challenges was the design of the structures which had to coexist with the building services throughout the entire process. Co-ordination was achieved through the use of BIM software.

Using different software packages, we were able to integrate the variables that could affect the design and construction and meet the client's demands.

ACOUSTICS

Santiago de Chile Metro. Setting design criteria associated to acoustic comfort in underground stations.





112 Emergencies Reus Building.
Acoustic treatment of the atrium.

ACOUSTICS

"Why are Stradivarius violins so good and why are so many others made since then not in that category?"

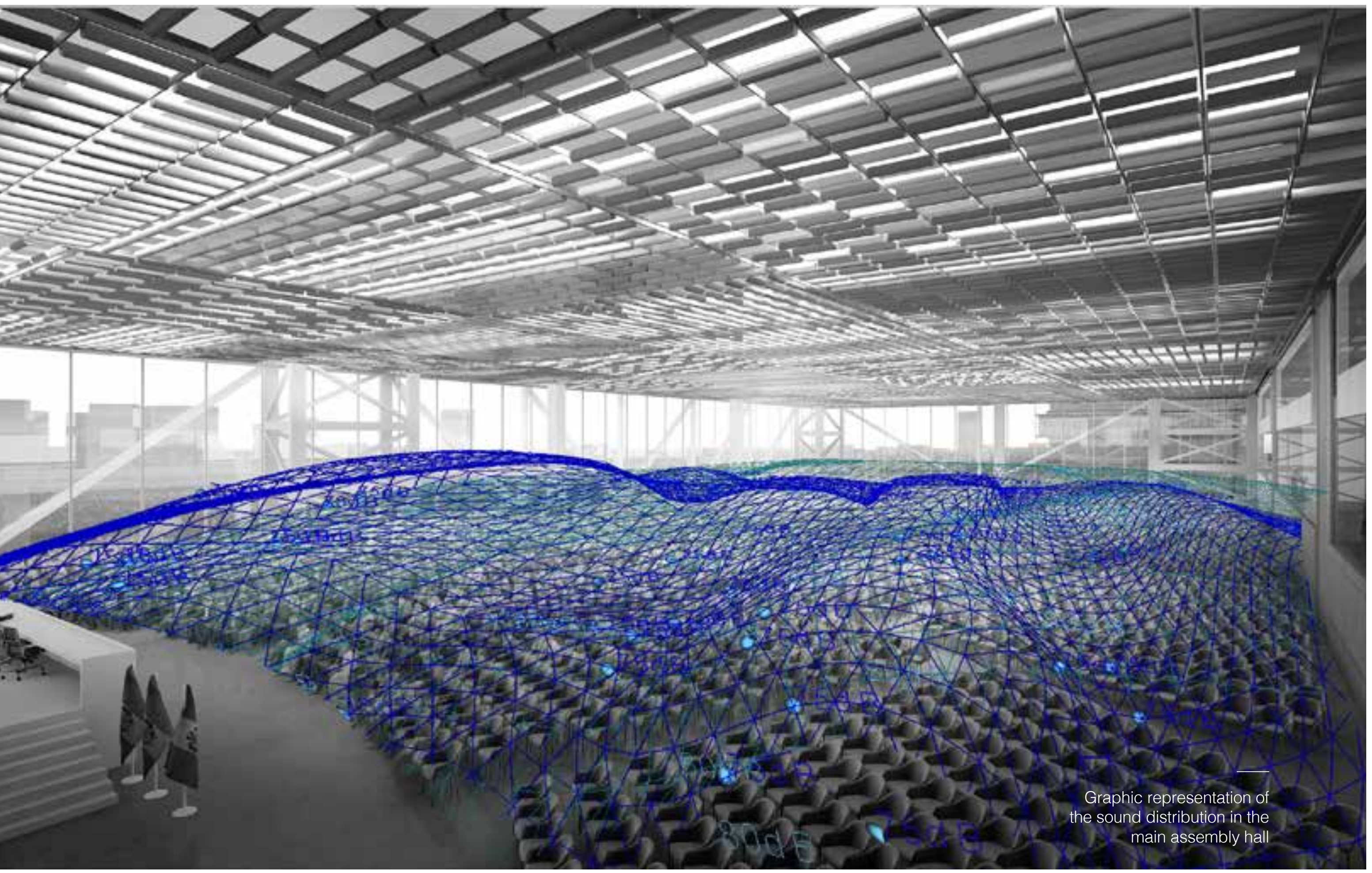
Leo Beraneck

One of the issues that influences the perception of architecture is its acoustics. Our brain continuously analyses the acoustic information from our surroundings, reacting to sound changes by increasing level of alertness to adapt as efficiently as possible to the change. That is why sometimes, without even realising, we find ourselves in places with acoustic pollution and only become aware of it when we leave that location.

Architectural projects within inhabited areas must master this type of perception since it is one of the most important ways of achieving optimum habitability and comfort conditions.

In all its designs, IDOM faces the challenge of carrying out an acoustic treatment based on the same principles and realities but in keeping with the architectonic concept, specifying and optimising both performance, materials and construction methods. This work philosophy is present from small hospital rooms to the demanding spaces destined for theatres, convention centres or concert halls. With the aid of the most reliable software and equipment (BASTIAN, EASE, SonArchitect, integrating sound level meters) we try to get the most credible theoretical and practical information that allows us to plot estimations of reverberation time curves or the most adequate soundproofing curves between enclosures.

In many cases, it is essential to apply auralization technologies to perceive how bespoke enclosures behave acoustically before they have been built. This allows for early detection of possible disturbances and raises awareness to the limits of design in its early stages.



Graphic representation of the sound distribution in the main assembly hall

LIMA CONVENTION CENTRE

Lima - Peru

The Lima Convention Centre or 27 de Enero Convention Centre, is located within the San Borja neighbourhood in Lima, Peru. Positioned within the city centre, the building is within the vicinity of the National Museum and the National Library, it is over 10,884 m2 and was inaugurated on October 1st 2015.

The complex has 18 rooms, four basements and four auditorium floors, and has a capacity for around 10 thousand people

The acoustic challenge in the LCC (Lima Convention Centre), was achieving high levels of soundproofing between the different convention halls, the majority of which can be changed thanks to mobile walls of sometimes over 11m tall. Owing to seism requirements the building was designed keeping the weight of elements such as slabs, roofs and façades to a minimum. This, along with the absence of conventional suspended ceilings in many rooms, complicated the acoustic comfort objectives.

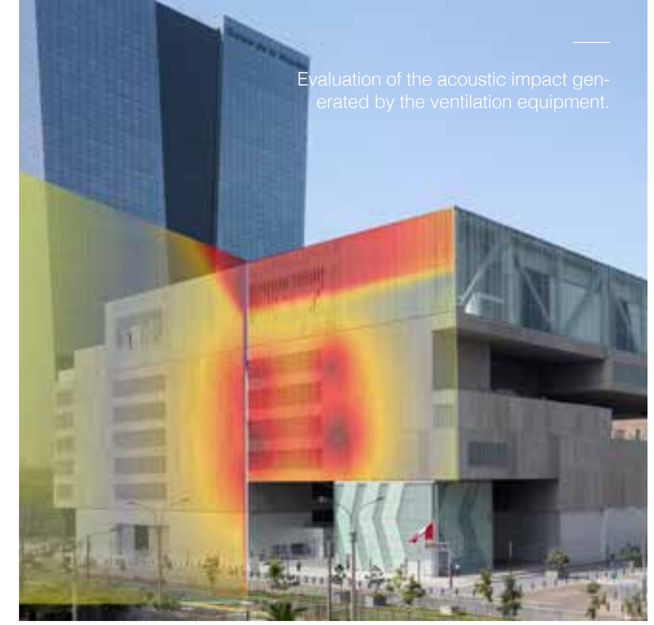
Additionally, sound absorption elements were also required in the meeting and crowd gathering areas. This was integrated into a design concept based on cemented perforated panels so that they would blend in with the façade and the immediate urban surroundings, establishing a material connection with the buildings that make up the Nation's Cultural Centre.

The great height of the convention halls called for the sound absorption systems to be integrated within the walls (fixed and mobile), as well as having free hanging unit systems (cylinders in this case). This grants great flexibility when dealing with fans, lighting and fume extraction equipment.

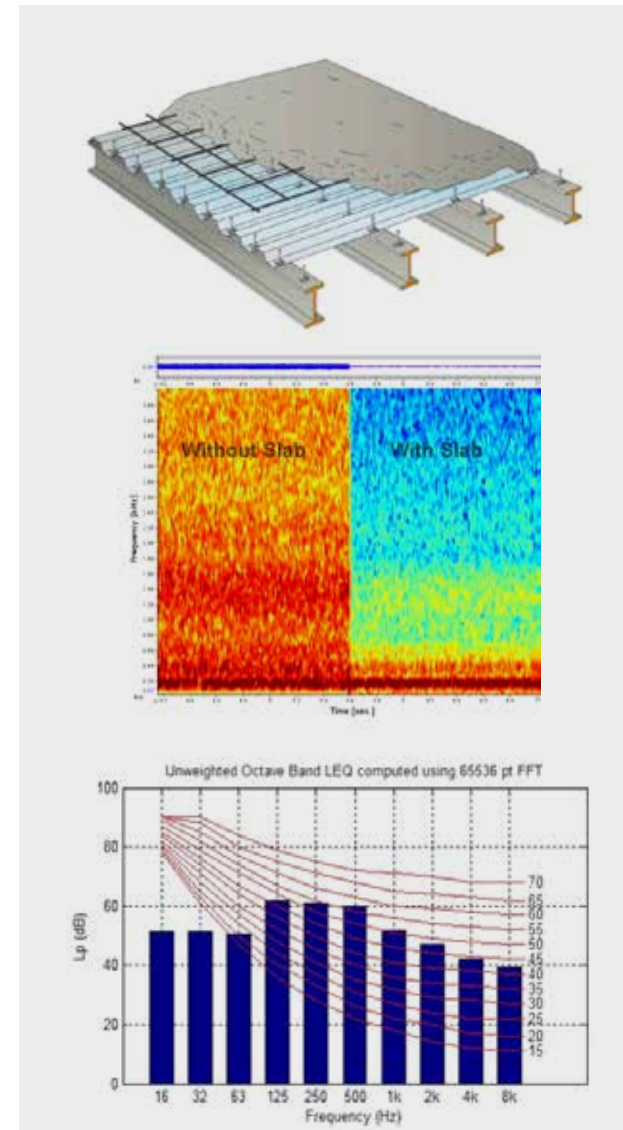
The result is acoustically comfortable spaces where noise pollution is minimised owing to the buildings design and material. Focus is then on the building itself, maximising the user experience.

International Architecture Awards
Award, Chicago Athenaeum - 2017

American Architecture Prize
Award, Landscape Architecture category - 2017



Evaluation of the acoustic impact generated by the ventilation equipment.



Acoustic characterization of the light composite slabs

LIGHTING DESIGN

Luxor Temple, Egypt.. Lighting Design is the ART of using light and shadow to reveal the SOUL of the Architecture and its true function. Creativity and technology converge in a common goal of giving a new perception of the space, but respecting and integrating with the architecture”

BTEK Building.
A theatricality of space, highlighted by the Daylighting Design.

LIGHTING DESIGN

"We are thanks to the hearth we light. Its light will always illuminate us"

"Somos gracias al hogar que encendemos. Su luz nos iluminará siempre"

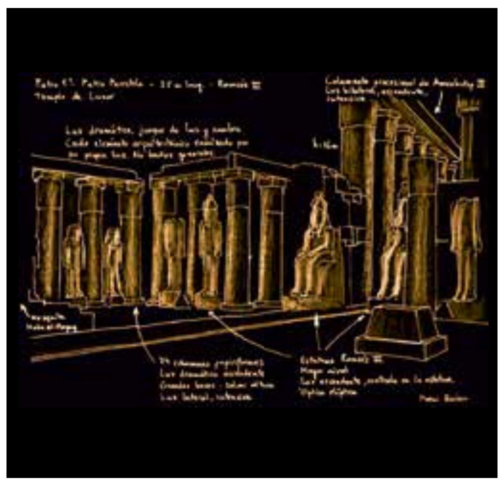
Pedro Azara

As Lighting Designers, we develop lighting projects in all fields of architecture: heritage, institutional, commercial, hotels & resorts, retail, transportation, restaurant; as well as landscape, civic, entertainment, scenic, 3D video mapping, decorative, and daylighting; having references all over the world.

We believe in Lighting Design as a form of art, and in light as its powerful tool, capable of shifting the onlooker's sensations and emotions through perception.

In our designs, creativity and technology converge in this common goal: using light to change the perception of space, highlighting the architecture, its meaning and its functionality. But always with the greatest sensitivity, respect and integration, and with an installation that during daylight is completely unnoticed.

To ensure the success of the lighting project, work doesn't end during the design stage of the project. It must go on during the entire process.



ILLUMINATION OF ARCHAEOLOGICAL SITES

Luxor, Cairo - Egypt

The government of Egypt set itself an ambitious program for the improvement and conservation of some of the most important archaeological sites of Ancient Egypt, from Gizah (the Three Great Pyramids) to Luxor (ancient Thebas, New Kingdom). The program included the monumental and landscape lighting projects of the archaeological sites to promote the night visits, as well as the security projects to prevent terrorist attacks. Some of these sites, which include Temples and Tombs of the greatest pharaohs of ancient Egypt, have been illuminated for the first time in history.

The main goal of the lighting projects for the Pharaoh´s temples was to come up with a respectful and sober lighting design that would highlight the three main aspects of pharaonic architecture and the sheer essence of such a unique civilization: its grandiosity, its spirituality, and the mystery that surrounds it. The design of the artistic illumination of the temples completely transforms the way the Temple is perceived, through lights and shadows that seek to move the visitor and improve his experience, giving a completely new vision of the temple at night.

The artistic illumination of the pharaonic tombs is that of an art exhibition: the walls are great canvases tens and hundreds of meters long and around 3.5 metres tall, carved and painted with magnificent hieroglyphs.

The lighting shows the original colours, without altering them, through high chromatic reproduction LED technology free of UVA and IR emissions. It achieves a continuous line effect with wallwashing light that covers its entire surface, from floor to ceiling, with great uniformity. They are controlled by a DMX (Digital MultipleX) protocol, with a three scene program that regulates its intensity depending on the time of day.

Duties carried out:

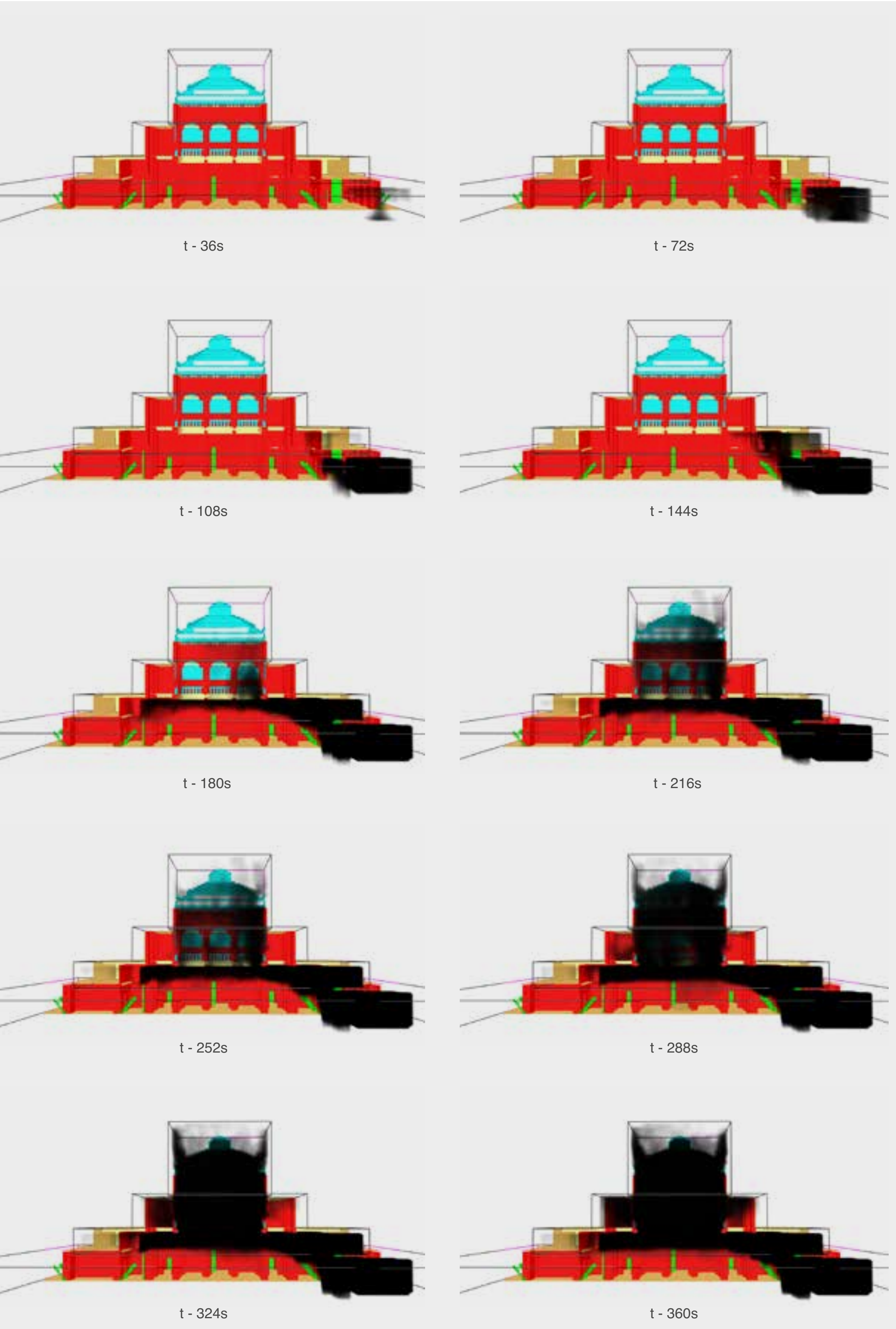
- Concept Design
- Schematic Design
- Design Development
- Purchase assistance
- Construction Project Management

Scope of the lighting masterplan:

- Luxor Temple (East Bank, Luxor; Egypt),
- Hatchepsut Temple (West Bank, Luxor; Egypt)
- Ramesseum Temple (West Bank, Luxor; Egypt)
- Medinet Habou Temple (West Bank, Luxor; Egypt)
- Tombs: Ramesses VII (KV1), Ramesses IV (KV2), Ramesses IX (KV6), Ramesses V & VI (KV9), Ramesses III (KV11), Sety I (KV17) (West Bank, Luxor; Egypt)
- Valley of the Kings (West Bank, Luxor; Egypt) – Landscape lighting
- Howard Carter´s House (West Bank, Luxor; Egypt) – Landscape lighting
- The three Pyramids: Cheops, Chephren, Mycerinus (Gizah, Cairo; Egypt).
- Gizah Plateau (Gizah, Cairo; Egypt) – Landscape lighting

FIRE

India International Convention & Expo Centre.
It was built following the most rigorous international practices in terms of fire safety.



BBVA, 10 Recoletos. Palace of the Marquis of Salamanca.
The evolution of smoke in a fire hypotheses simulation. It was proven that evacuation times were shorter than the time it took the fire to compromise the safety of the building.

FIRE

"Nothing is as dangerous in architecture as dealing with problems individually. If we divide life into separate problems, we divide the possibilities of creating good construction art."

Alvar Aalto

At least 71 people died and several hundreds were injured in the devastating fire at the Grenfell Tower in London. The difficulty of designing efficient fire safety systems in buildings, particularly those within high-rise, is an aspect of great repercussion for the safety of a building.

The goal of a fire safety strategy begins with the evaluation of the inherent risks of each activity which will be conducted within the building, this ensures the solutions which guarantee adequate levels of safety are in line with the design.

We use BIM work platforms which are adapted to calculation software to allow multidisciplinary disciples; architecture, structure and building services, to design simultaneously. This creates a design which is perfectly coordinated and aligned to the safety objective.

Calculation tools based on CFD can study the movement of smoke as well as other relevant parameters within the building such as; temperature, concentration of oxygen, visibility, toxicity etc, to help determine the feasibility of the evacuation routes. Together with smoke movement studies, assessments are carried out for the movement of people. This allows for the simultaneous evaluation of the evolution of the fire and the safety conditions within the evacuation routes. It adapts people's behaviour to the existing conditions to recreate a realistic simulation of the fire scenarios.

It is possible that conflictive areas can be identified during the early stages of design, which makes it possible to take the necessary safety measures.

INDIA INTERNATIONAL CONVENTION & EXPO CENTRE

Delhi - India

A complete analysis was carried out on the risk of fire within the building to guarantee evacuation conditions in any scenario. The four least favourable scenarios were identified, with the aid of virtual platforms they were analysed to assess the evolution of fire, smoke, and evacuation routes [see table 1].

SCENARIO 1: fire breaks out in the last row in the stands. The evacuation conditions for the building occupants were analysed, under both normal circumstances and with the intervention of firemen (temperature, toxicity, visibility). The simulation runs for 20 minutes which is the estimated time for fire department intervention. It was concluded that the tenable conditions were adequate even in the least favourable conditions where the roof was closed, and a reduced number of heat and smoke vents were opened.

SCENARIO 2: fire starts on the central level (pitch) during a concert or something similar with a high fire load. Like in the previous case, conditions were ideal for the evacuation of spectators.

SCENARIO 3: a passenger car goes up in flames at the Arena entrance. This scenario analyses the maximum temperatures reached by the exterior structure, local administration officials had serious doubts as to whether the exterior should have any kind of special protection against fire. After the assessment, it was concluded that the temperature did not go over 200 ºC. The structural design team took this value as a starting point for their structural calculations.

SCENARIO 4: a screen on the upper part of the exterior structure catches fire. Like in the previous case, the highest temperatures near the fire and did not go above 200 ºC.

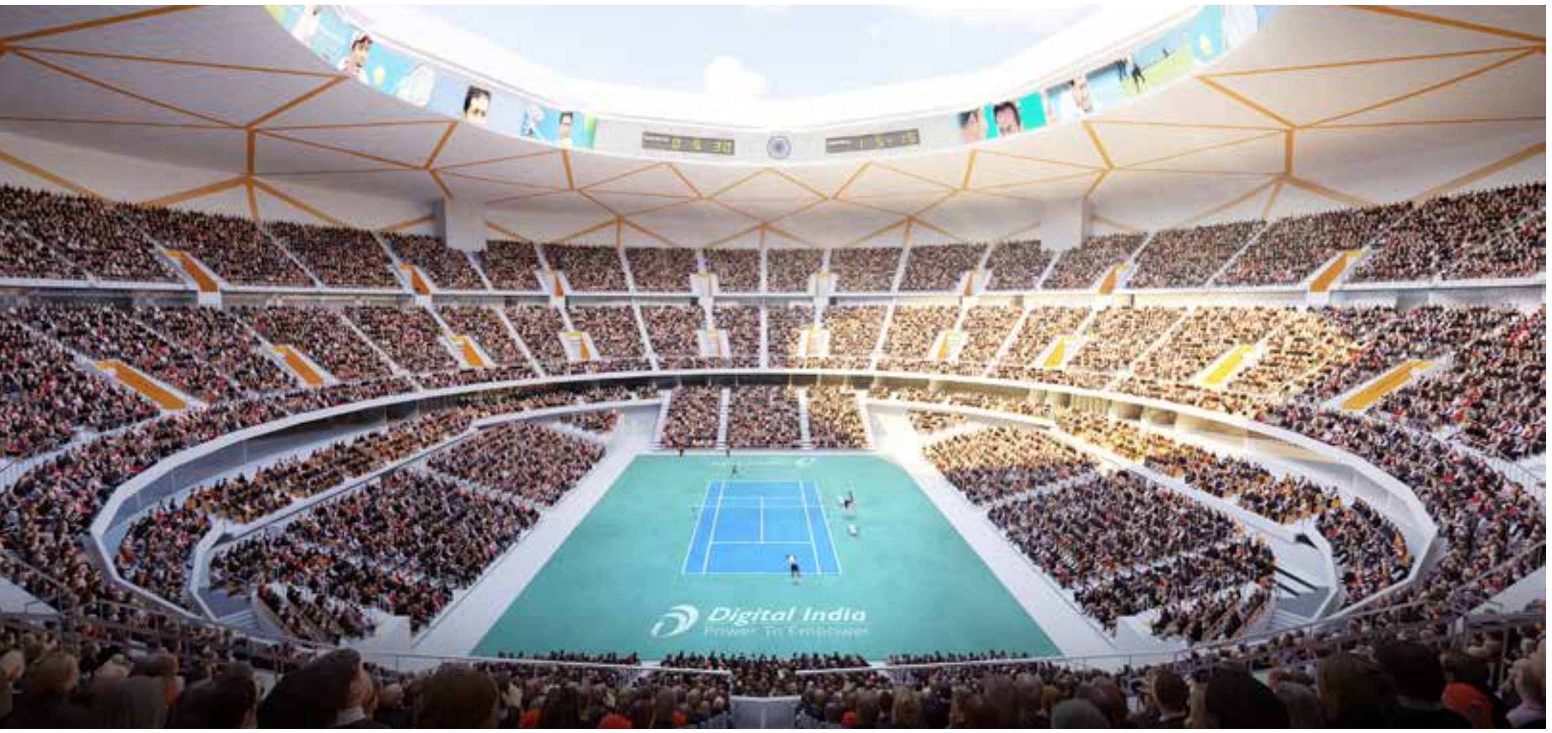


TABLE 1

SCENARIOS (Where the fire is located)	SCENARIO	PEAK FIRE POWER	AFFECTS
1. LAST ROW STANDS	Two seats within arena with litter underneath	3 MW	Evaluation of the roof structure and smoke management in the facility
2. CENTRAL LEVEL (PITCH)	Set-up stage (during a concert)	30 MW	Evaluation of the roof structure and smoke management in the facility
3. ARENA ENTRANCE AREA	Vehicle on fire	5 MW	Evaluation of the structure of the exterior elevation
4. ELECTRICAL FIRE (SCREEN) FAÇADE	Electrical wiring (4m long, 0.2 m thick)	0,3 MW	Evaluation of the structure of the exterior elevation

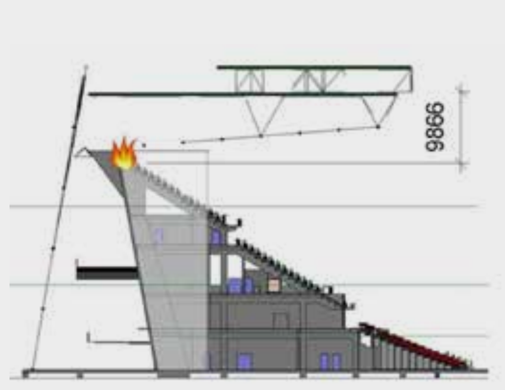
SCENARIO 1: fire in the last row of the stands.

SCENARIO 2: fire on the pitch during a concert or similar event

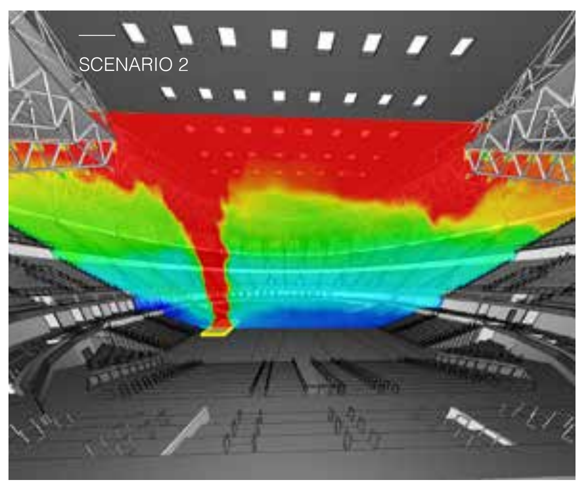
SCENARIO 3: passenger car on fire in the area of the entrance to the Arena

SCENARIO 4: façade wiring on fire

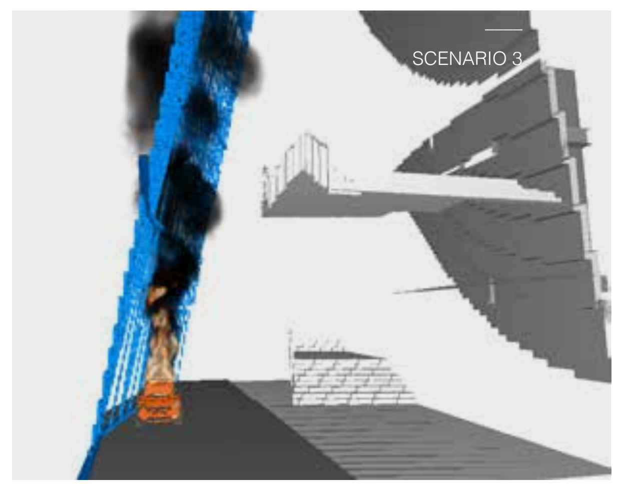
SCENARIO 1



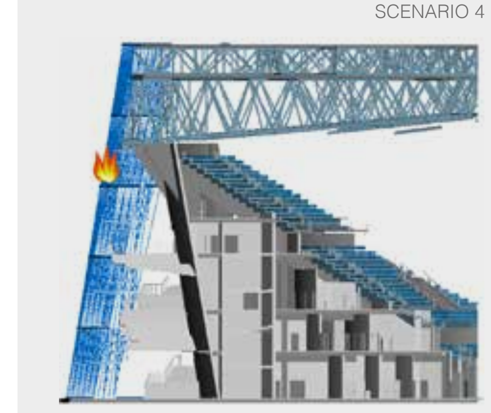
SCENARIO 2

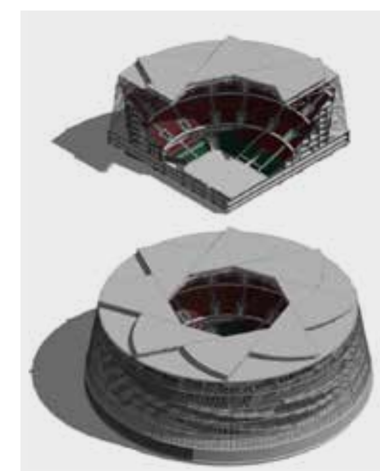


SCENARIO 3



SCENARIO 4





WATER

Master plan for the University of Gastronomic, Tourist and Environmental Sciences in Santa Maria del Mar, Lima (Peru). Water cycle and zero waste. Harnessing air humidity. Using the resource of water for generating energy, human consumption, agriculture and leisure activities. Water r is the projects central element.

Vizcaya School's swimming pool. Bilbao.
Water management

WATER

"Water is the great public space"

"El agua es el gran espacio público"

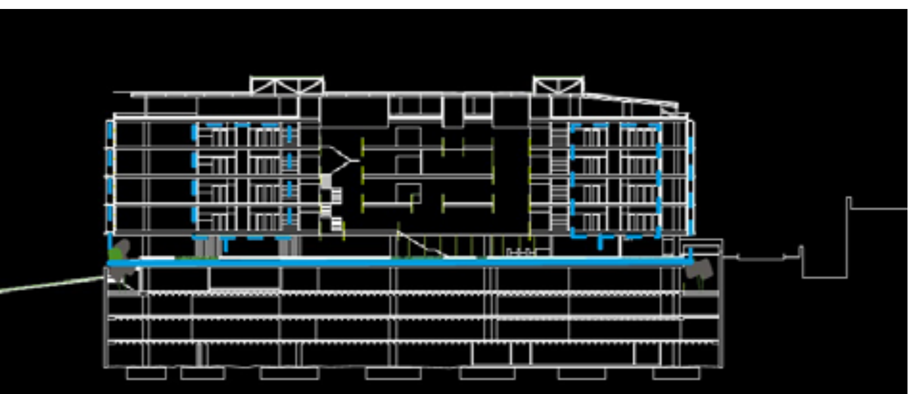
Jaume Plensa

Water is an essential and renewable natural resource, yet it is in short supply. From an environmental point of view, we must take water into consideration when thinking about sustainable buildings.

Water appears in architecture in many ways, both in interior and exterior spaces and offers human beings health and comfort. It contributes to the appropriate thermal conditions from the humid air that we breathe. Good architectural projects consider water as an essential part of their design because wherever humans decide to live, water is present.

At IDOM we evaluate water consumption and its possible reuse through its recovery, filtration and depuration. It is a sustainable building methodology in which energy and water consumption is based on a detailed study and understanding of the location's conditions.

We look for new and more efficient water management systems with the idea of reducing its consumption and maintenance costs, as well the energy expense. We work towards an acceptable environmental integration that guarantees the safety of the host environment.



Longitudinal section of the building's water circuit

Four reservoirs on the ground floor collect all the rainwater

IDOM MADRID OFFICE

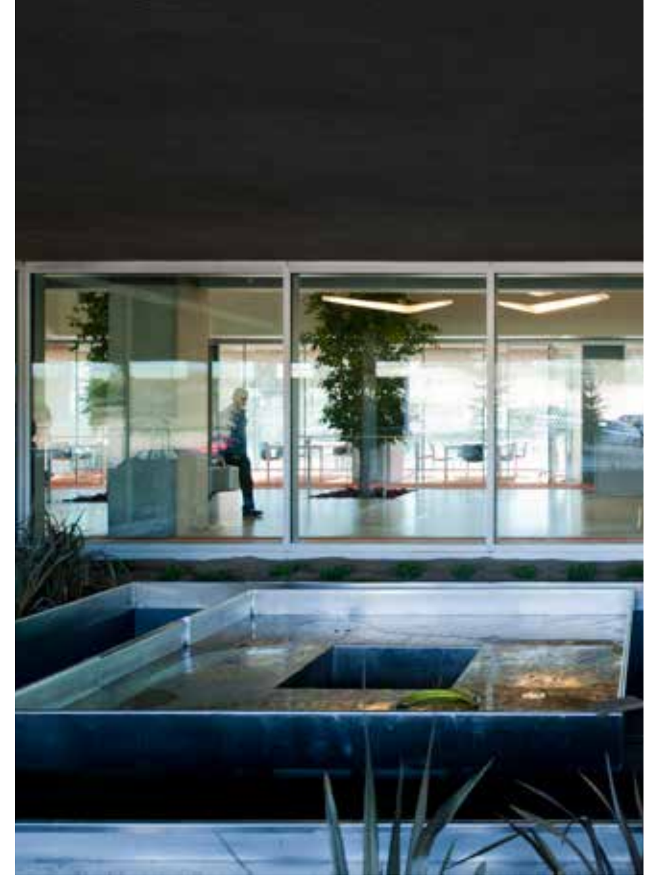
Madrid - Spain

IDOM's office in Madrid is an example of a sustainable building which is respectful to the environment while being comfortable and flexible in its use.

One of the most important elements in its respect for the environment is the use of water and how it is managed. An office block has significant water consumption in toilets, watering gardens and thermal purposes. To minimise this consumption, the building incorporates very efficient water saving systems in the toilets as well as other areas.

A rainwater collection system was designed to channel most of the water that falls on the building. The building's footprint is 2,400 m2 and rainfall in Madrid averages 435 mm/year, this translates into over 1 million litres of rainwater per year. 85% of that water is recovered and re-used. For this purpose, rainwater is channelled through exclusive downpipes to 4 reservoirs located on the ground floor near the gardens which surround the building. These reservoirs have a double sheet of water: the upper one, whose level does not change, and the lower one which is variable. Hence, as rainwater is used, the visible level of water remains constant. The water from these reservoirs is purified with a sand filtering system in combination with an ultraviolet filter that allows life in these reservoirs since excessive chlorination is not necessary.

The recovered, filtered and purified water is then used in toilets, the watering of plants and in the cooling tower that serves, among others, the thermo-active structure by cooling the structure's water during the night thanks to a strategy called "hydraulic freecooling".



WIND

Marques de Riscal hotel and winery.
Wind analysis through CFDs.

Iberdrola Tower. Analysis of wind loads on the tower's façade.

WIND

"Proportions are what makes the old Greek temples classic in their beauty. They are like huge blocks, from which the air has been literally hewn out between the columns."

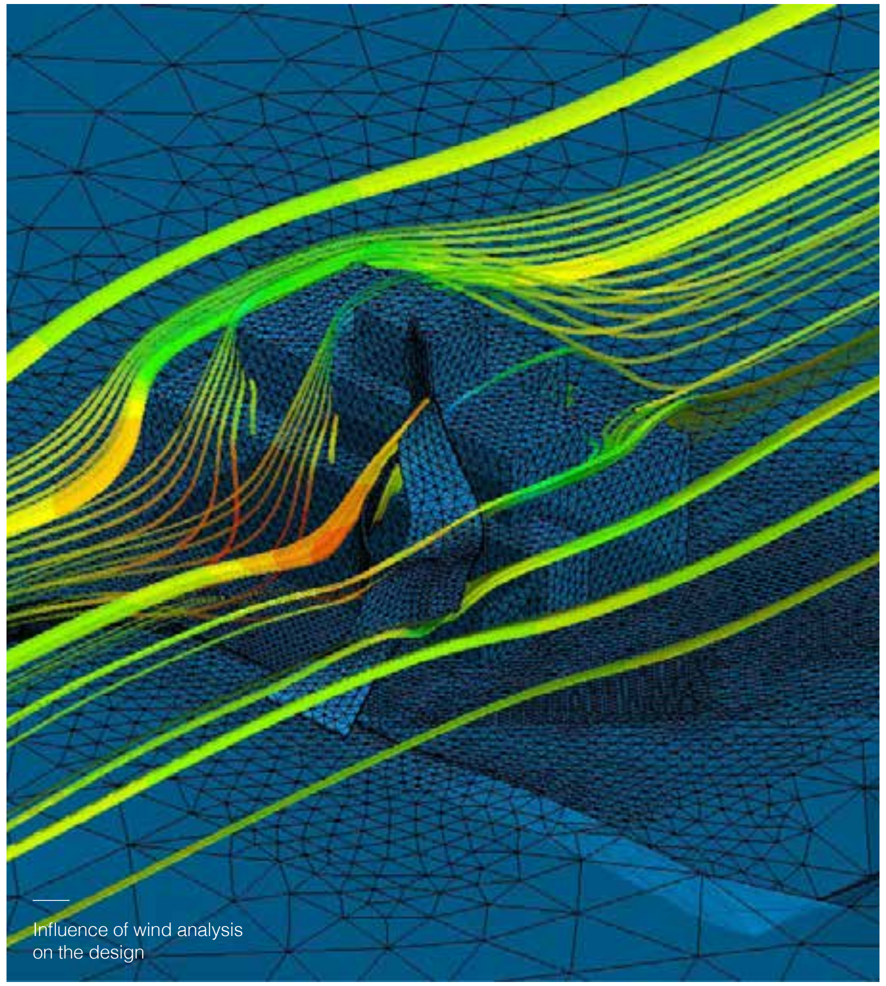
Arne Jacobssen

Wind affects the shape and structure of buildings, their façades, their inner ventilation and it is responsible for making the certain areas surrounding the building habitable and comfortable.

The effect of wind on singular structures like high-rise buildings, slender geometries or complex shapes sometimes constitutes one of the main factors to be considered in a project; particularly in those cases in which being exposed to wind can compromise the architectural solutions proposed in the conceptual design stage.

The various aspects that will likely need assessment in these kinds of projects are:

- Location assessment, where the nature of the load is characterised by determining the statistical distribution of the wind's speed and direction.
- Calculation of static wind loads on structures with a complex shape, through CFD (Computer Fluid Dynamics) numeric tools, validated over time with tests run in wind tunnels.
- Calculation of dynamic wind loads and the evaluation of aeroelasticity phenomena that can turn out to be critical in flexible structures. IDOM have long collaborated with the Department of Structural Dynamics and Aeroelasticity at EADS-CASA (an aeronautical construction company).
- Wind speed studies in the habitable areas around the building with the idea of determining how comfort is affected by wind speed itself and its appropriateness for the activities that are carried out in the area, such as walking, sitting on a bench or other activities.
- Likewise, how wind affects thermal comfort is also considered.



Influence of wind analysis
on the design

MARQUES DE RISCAL WINERY

Alava - Spain | *Architect - Frank Gehry*

Marques de Riscal, one of the most prestigious wineries in the Rioja Alavesa region, embarked to create the “City of Wine” in order to promote their product and present their history, culture and philosophy. The building houses a hotel designed by Frank Gehry, a wine-therapy spa and museum and an oenological research training centre, in addition to all the required infrastructure of the winery.

Analysis of wind loads
on the building

IDOM embarking on this project with Frank Gehry to provide architectural and engineering services, followed the success of the previous collaboration on Guggenheim Museum.

Gehry's design, innovative and avant-garde, stems from a fluid organic form which he combines with set volumes, creating a new architectural language.

The free form conceived by Frank Gehry for the Marques de Riscal winery set a challenge in determination of wind impact on the building; both in terms of the supporting structure and design and fixing of the curved stainless steel and colourful titanium canopies. Although the height of the building was not significant (25m), the highly complex curved geometry presented a challenge as it couldn't be approached with standard methods.

Different tests and verifications were carried out, this included testing a scale model of the project in a wind tunnel in Canada. The test was later verified with a CFD simulation programme, which presented a very similar result.

STRUCTURE

The Philharmonie de Paris. The unique geometry of the Paris Philharmonic is solved with a combination of different structural systems that blend reinforced concrete with spatially complex steel frames. Rigorous detailing was required at every joint.

San Mames football stadium. IDOM

STRUCTURE

"A structural unit -the result of a creative process, a unity of technology and art, research and imagination - goes beyond the sheer domain of logic and enters into the secret frontiers of inspiration."

El nacimiento de un conjunto estructural, resultado de un proceso creador, fusión de técnica con arte, ingenio con estudio, imaginación con sensibilidad, escapa del puro dominio de la lógica para entrar en las secretas fronteras de la inspiración"

Eduardo Torroja

Within the disciplines included in Building Physics, the structure is the primary support of the building. Thus, it must be able to safely bear gravitational, seismic, wind and climate-related loads as well as all those other situations it may come across during its construction or throughout the building's lifespan.

But the essential function of resistance is not the only requirement structures have. Stability, stiffness, durability, economy, constructability, robustness, reliability, sustainability…are other concepts that drive their design and that, sometimes, determine the structure's definition more than resistance does.

These requirements can be derived from the structure itself, from its use, client's needs, peculiarities of the architectural design or even other requisites stemming from other Building Physics disciplines.

For a correct definition of a building's structure it is therefore essential to know all the disciplines and appropriately interact with them, allotting more or less importance to each need in each case, eventually reaching a holistic design in which all of them are combined. This approach to designing a building is intrinsic to IDOM's multi-disciplinarity.

SAN MAMES FOOTBALL STADIUM

Bilbao - Spain

The extension of the roof added between 13 m and 23 m to the original projection, turning the extended roof into a 60 m canopy over the long stands and 75 m over the short ones. The size of the extended projection and the structural type of the extension were carefully considered to offer as much sheltering surface as possible whilst compatible with the capacity of the existing roof structure and porticos. And so, the original 20,000 m2 roof was extended a further 4,700 m2, with an increase in weight of just 680 tons against the original 4,700 tons.

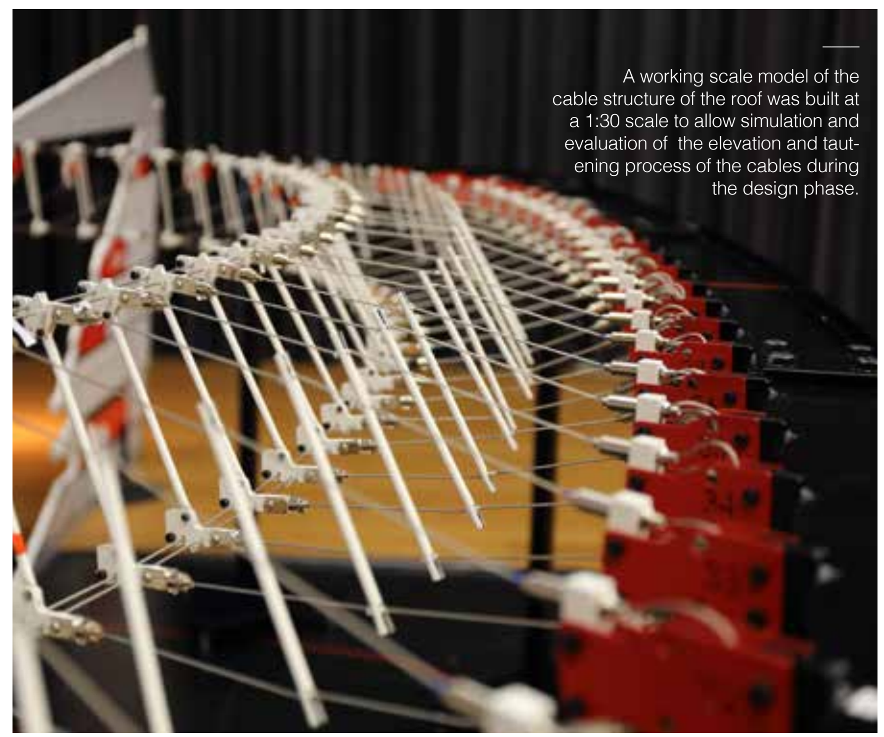
The structure of the extension is based on a convex system of radial cables with a double inner traction ring and an outer compression ring (bicycle wheel configuration). Such structure rests on the ends of the variable thickness corbels or the original roof which required a careful design and optimization process.

World Stadium Congress Awards.
Stadium of the Year, Qatar - 2015

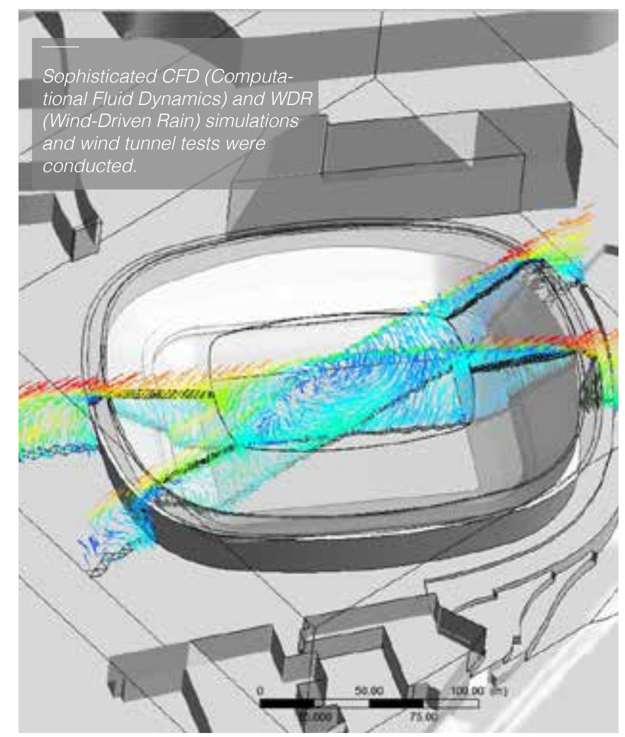
WAF World Architecture Festival
First prize, Singapore - 2015

ACHE
First prize, façades and roofs category -2015

Structural Awards
First prize, Long Span Structures, UK- 2017



A working scale model of the cable structure of the roof was built at a 1:30 scale to allow simulation and evaluation of the elevation and tautening process of the cables during the design phase.



Sophisticated CFD (Computational Fluid Dynamics) and WDR (Wind-Driven Rain) simulations and wind tunnel tests were conducted.

BUILDING **ENVELOPES**

Ultra-high voltage laboratory in Munguia, Biscay.
The mirror-like stainless steel building envelope forms a great Faraday cage, required for the precision of the measurements taken within. It offers an innovative image while reflecting the landscape.

Historical archive of the Basque Country. Biscay

BUILDING **ENVELOPES**

"Contemporary architecture substitutes the notion of façade for that of skin: exterior layer mediator between the building and its surroundings."

"La arquitectura contemporánea sustituye la idea de fachada por la de piel: capa exterior mediadora entre el edificio y su entorno".

Manuel Gausa

The building envelope is the limit, the frontier. It defines the building; it identifies it. The technical characteristics of façade systems require careful coordination from the very first stages of a project.

They must be approached holistically and with an awareness that it defines the public facing image of the building. An awareness is also needed of the performance of energy, light and acoustics within the building as these are directly linked to the decisions that affect the façade system design and the materials used.

IDOM has developed many types of structural façade designs. In some cases, complex geometries have been used along with highly complex structural solutions. Using our own parametric design method for building envelopes allows us to rationalise aspects like solar protection, energy transfer, the entrance of light, required structure and cost so that the final envelope design is truly optimised for each project.

CUF DESCOBERTAS HOSPITAL

Lisbon - Portugal

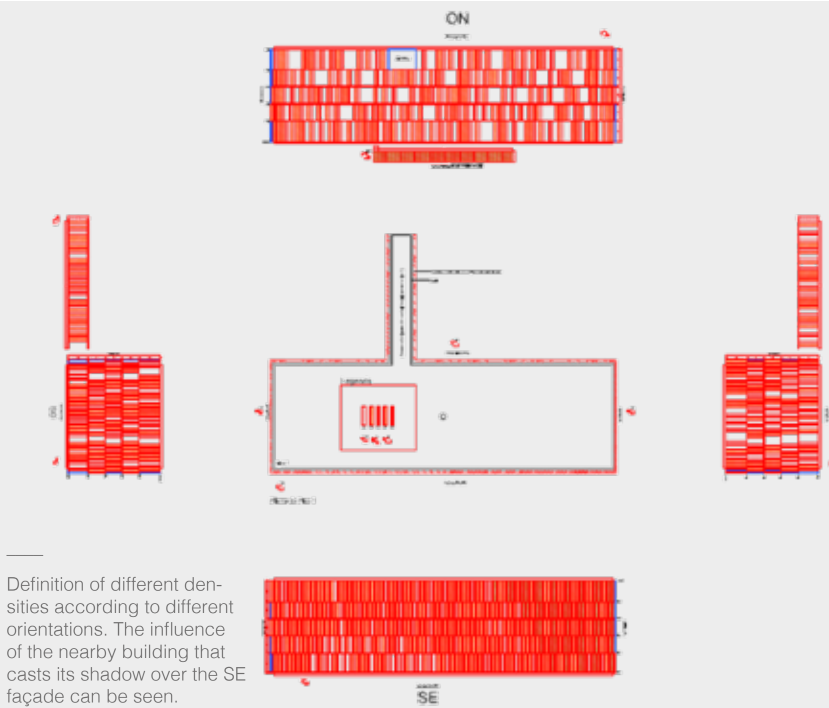
This new facility, located in the Das Naçoes Park in Lisbon, was required to be able to extend the CUF Descobertas Hospital, which has been in operation since 2001.

The project features a functional programme which highly efficient construction and energy use. It houses the outpatient's clinic and architecturally presents itself as a healthcare unit which is open to the public and the city.

Sadly, comfort levels in hospitals are not always optimal. The hospital's envelope was designed with consideration of the function of the building as well as the needs of patients within this building typology to maximise patient comfort.

Special attention was paid to energy efficiency throughout the whole project. The building envelope plays a key role by filtering the light so that the right amount of solar energy is let through and diffused to different areas within the hospital. Several simulations were run to optimise the design of a micro-perforated double skin. This allowed a limitation of direct radiation but guaranteed natural light. Sun-related glare was prevented, good visibility from the inside was allowed and a strong architectural image was created.

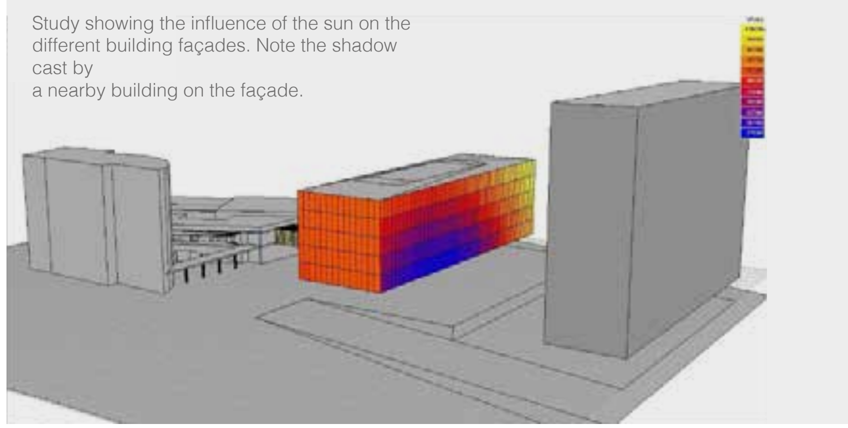
Once the project was finished, the client's expectations were met since the building's energy performance improved while respecting the restrictions imposed by the conditions of use.

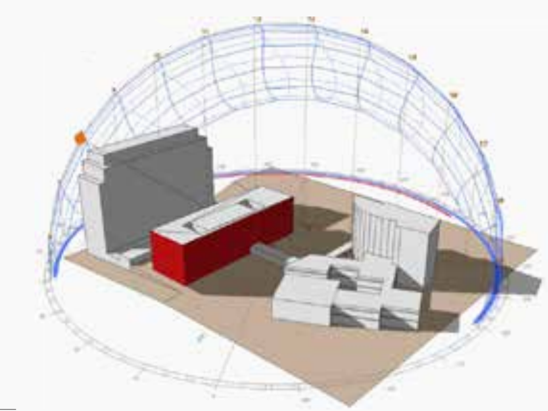


Definition of different densities according to different orientations. The influence of the nearby building that casts its shadow over the SE façade can be seen.

With three different perforation degrees, 5 sets can be obtained, which are then chosen for each façade

Study showing the influence of the sun on the different building façades. Note the shadow cast by
a nearby building on the façade.

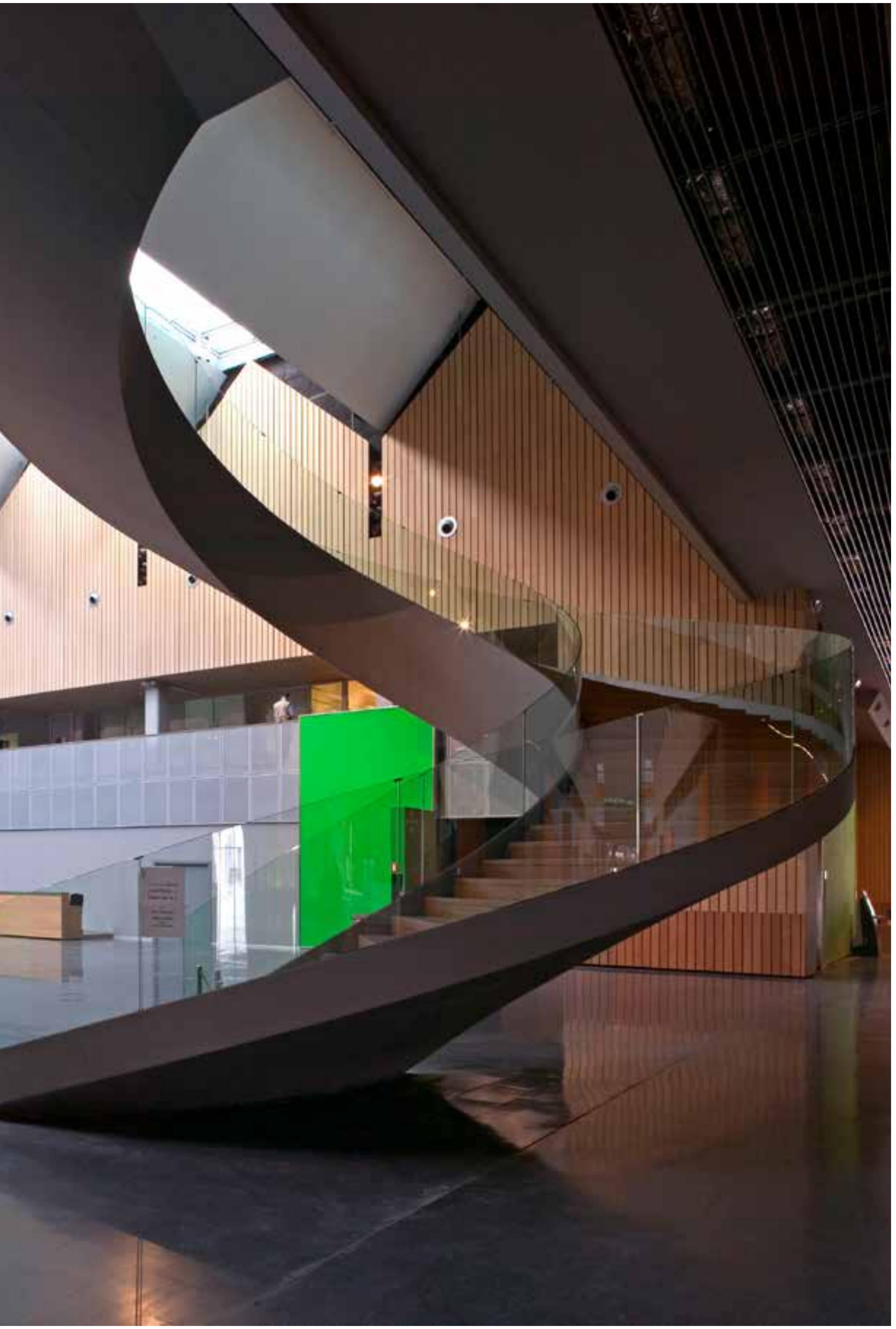




Sun path throughout the year

PEOPLE FLOW

"Joaquin Sorolla" AVE station.
Study of the flow of passengers



Bilbao Exhibition Center.
Analysis of the flow of people.

PEOPLE FLOW

"The architectural design of the future will be based on the imitation of nature because it is the most rational, durable and economic of all methods"

"El diseño arquitectónico del futuro se basará en la imitación de la naturaleza, porque es la forma más racional, duradera y económica de todos los métodos"

Antonio Gaudí

One of the basic aspects of architecture is to define the size of public spaces, including those in which the number of people moving through is very high.

Projects dealing with transport hubs (whether rail, roads or airports) as well as those involving museums, hospitals, shopping centres, public administrative buildings, temples etc. require a detailed study of the movement and stay of people. IDOM relies on specific software, like Legion Spaceworks, to measure and monitor these aspects.

The results are firstly used to measure out spaces and to analyse the effect of placing obstacles within. This makes it possible to analyse possible disturbances generated by barriers in the event of refurbishment work or other maintenance operations, and design solutions to deal with these accordingly.

These studies are also applied to the dimensioning of public transport infrastructure and to the flow analyses of vehicles (whether private, freight or public.) They are also used to inform the dimensioning of roads, parking areas, loading bays, taxi rank queues and bus stops.

ISTANBUL METRO

Istanbul - Turkey

Istanbul, with a population of over 14 million, attracted over 11 million tourists in 2014. The city has had a Metro System since 1989. At present, three lines are being built on the Asian side of the city and four on the European one.

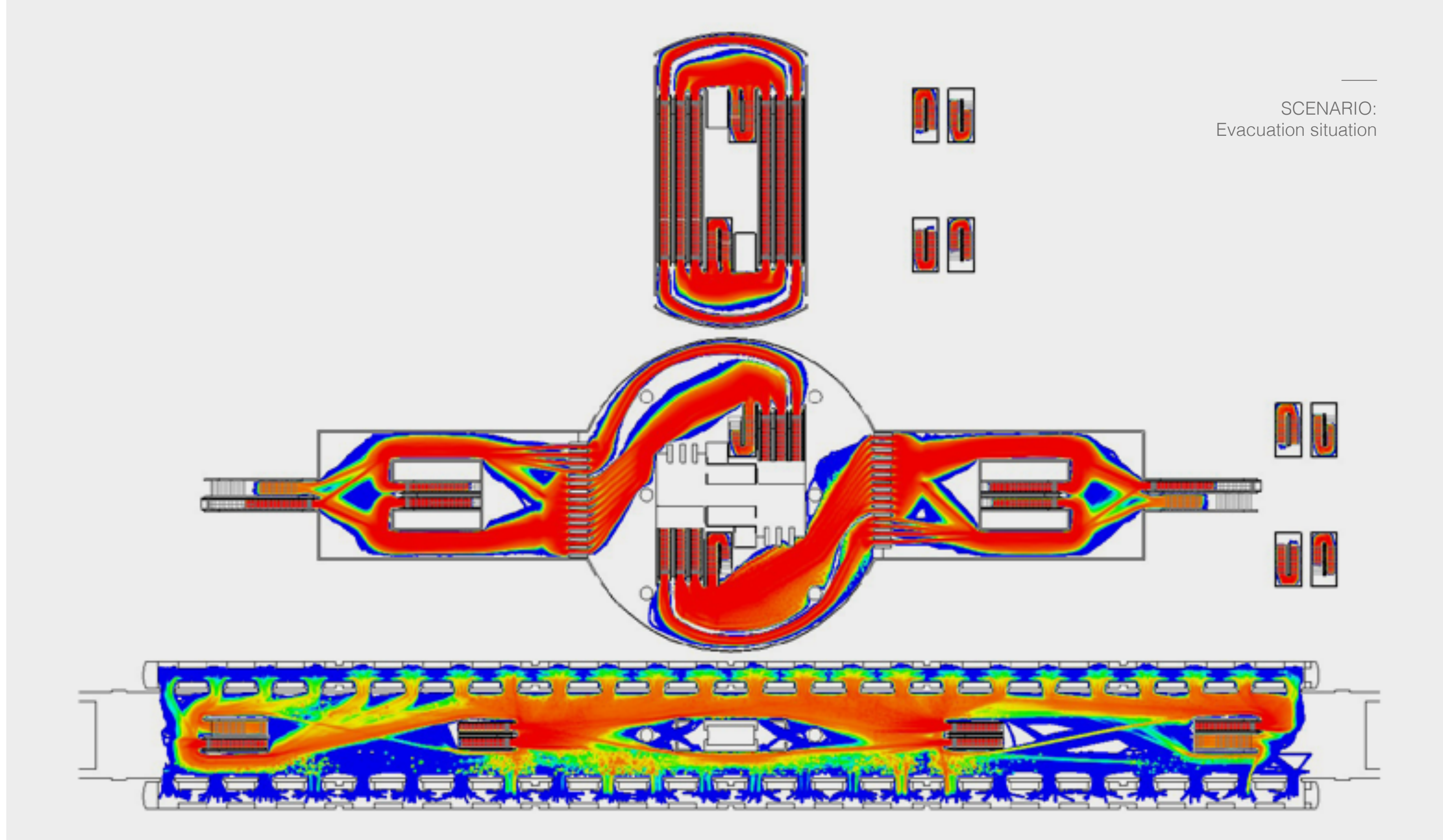
IDOM is in charge of designing one of the new lines which will have a total of 15 stations. The scope of the job includes the preparation of an alternatives study, transport and layout study, geotechnical research, feasibility study, architectural and structural projects, electromechanical project and the tender documents.

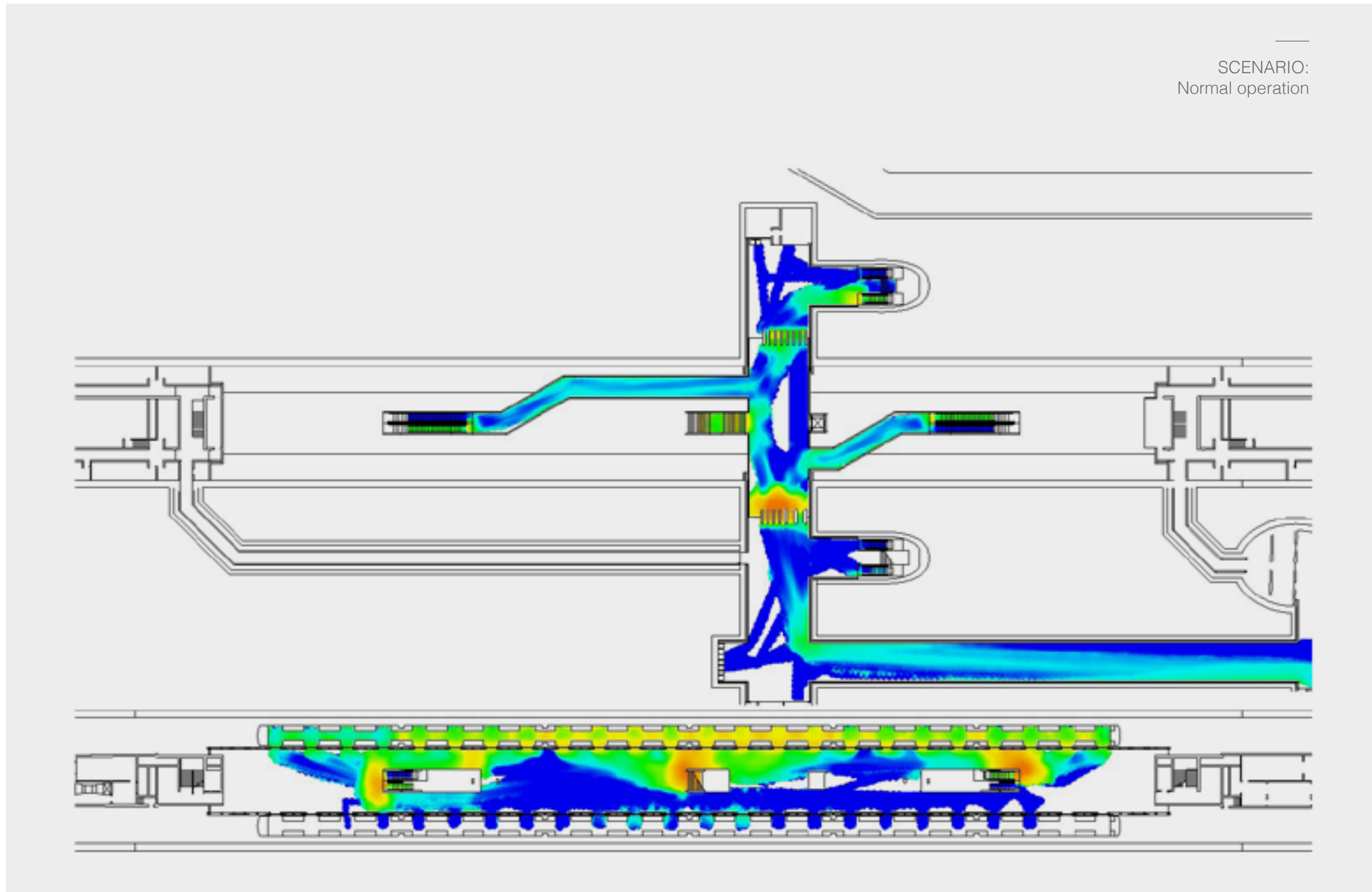
The station buildings have been grouped into different design categories: completely underground stations with different construction methods (cave, double tube or central well) and having different access configurations (of which there are four interchange stations.)

The stations' design has been validated by factoring in the estimated future demand at rush hour during two scenarios:

- Normal operation
- Evacuation situation

IDOM has also analysed the distribution of the future demand in the entrances of the new stations. This study is focused on the analysis of the lift capacity, the escalators and the stairs of each entrance. This required an analysis of the access times as well as the interaction of the flow of passengers with the exterior during the peak morning of the target year.





INFORMATION AND **SECURITY** TECHNOLOGIES

112 Emergencies Reus Building. Communication networks, data and security centres.

New Docalia office and RSI data processing centre. Development of advanced technological solutions.

INFORMATION AND **SECURITY** TECHNOLOGIES

“Where technology reaches its true content,
it transcends into architecture”

L. Mies van der Rohe

IDOM offers a multidisciplinary and integrated vision of IT, communication and security systems. We use the latest technologies to bring together all the systems, creating an innovative, flexible and accessible product.

Systems based entirely on IP technology have been developed to carry these tasks out, enhancing their reliability and effectively and rapidly detecting possible bugs.

As for security, the strategy evaluates risks, defines the technology and the systems, the operation procedures and the people’s needs, always counting on the latest developments available on the market.

This physical and network security is backed up by the design of a data processing centre (DPC) where all the equipment associated to the systems will be kept.

DATA PROCESSING CENTRE IN CERDANYOLA DEL VALLES

Cerdanyola - Spain

The programme of the CPD1 includes over 6,000 m2 of processors distributed in 18 IT rooms, as well as car parking areas, contingency offices, coupling facilities, testing rooms, providers and workshops, which total 25,000 m2.

The typology demands maximum technological functionality, prioritising flexibility, scalability and energy efficiency. Computer rooms are located across three floors. Technical floors are located on the roof and basement for HVAC and electricity services respectively.

The unique location of the Technology Park, set within the context of nature, calls for an intervention that is minimises its environmental impact by keeping the volume of the excavation and its footprint to a minimum.

Both formally and functionally, the main challenge was to fit a rectangle (measuring 100x43 meters) that will hold six IT rooms (measuring 12x29m) per floor into a triangular plot. The office block was the only building with a degree of programmatic flexibility. This became elevated above the ground floor to create a garden-space that becomes the main access to the building. This solved the main avenue issues by creating a layout perpendicular to the technical area.

Technically, the global design of the facilities achieved a TIER III security level and an energy efficiency PUE ratio below 1.8. The electrical engineering plan was designed for a total power of 16 MW and a TIER IV security level (Uptime Institute). Getting the DPC into operation will be done in two stages (with an initial IT power of 2.5 MW.) As for the physical layout and the topology of the room, the DPC follows a cool corridor-hot corridor structure. The high-density racks have in-row liquid cooling systems.

Balancing these two criteria – maximum functionality and minimum environmental impact – is the biggest challenge for the project. Applying sustainable design criteria and good practices have made it possible for the project to be LEED certified.

GREEN DESIGN

Jesus Galindez Slope estate.
Example of urban regeneration and dealing with the green slope.

Urban riverbanks of the Ebro River.
Example of an urban park on the riverbanks of the Ebro River.

GREEN DESIGN

"Greek theatre is magnificent, both in its dimensions and its effects, the same fine seriousness as in the temple. The answer is the open space with the sky above with the seats confluent towards the stage, the plain and the sea."

Erik Gunnar Asplund

The Landscape and Urban Design team covers all scales of urbanism and construction, from territory and sustainable habitats to the design of urban furniture. This includes new cities and large-scale complexes, urban integration of infrastructures, parks and public spaces and building green roofs and façades.

We carry out projects based on a bioclimatic architecture approach to maximise energy savings. We use trees to absorb CO_2 emissions and to effectively manage water resources and rainwater.

Energy or waste management, the integration and development of Smart Cities or sound design (soundscaping) are other aspects included in the design that can be used to achieve the projects initial objectives.

The goal of the landscapers, town planners and architects at IDOM is to contribute to the creation of value in the design of buildings, public spaces and new cities. They design strategies that generate more habitable, sustainable and attractive spaces.

We cover all stages. From the vision of the definition of strategies, the development of the design, the site supervision and the implementation of the different project stage.

Our focus is set on carrying out quality projects, within feasible time constraints, that provide value to our clients and that improve the environment and the quality of life of its users.

DA GARE PARK

Passo Fundo - Brazil

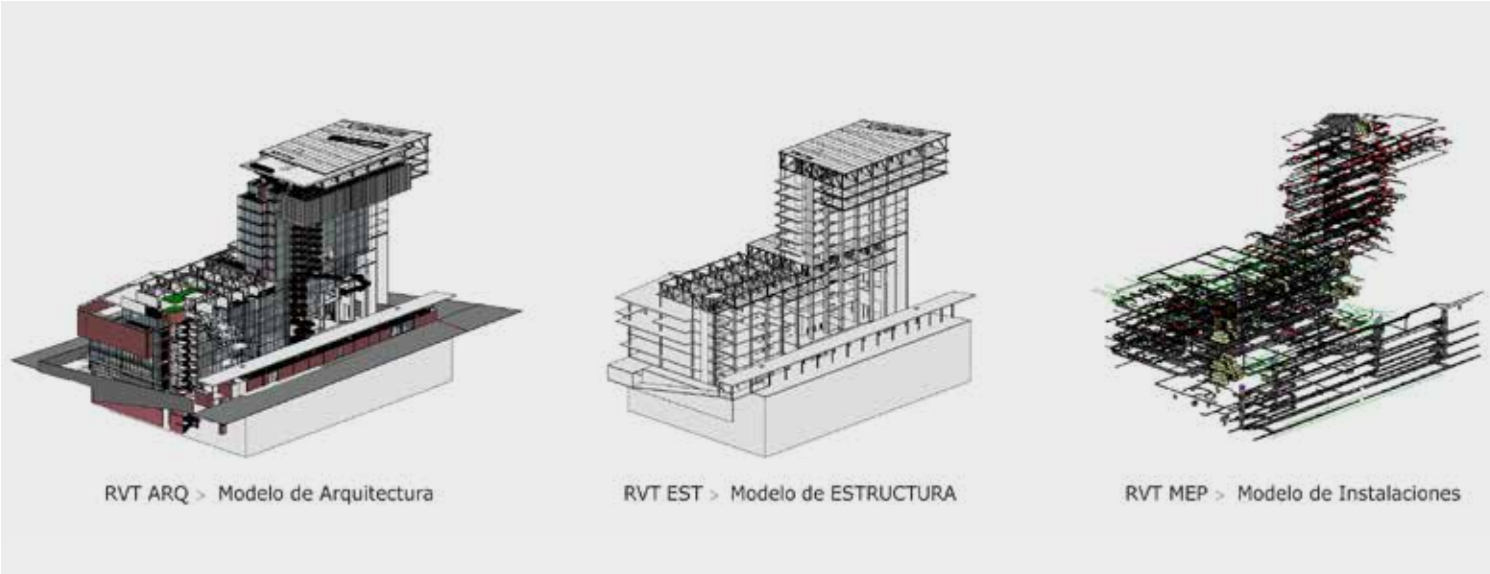
The design of the Parque da Gare is rooted in the revival of an old park next to an old railway station in the historical centre of Passo Fundo, in Brazil.

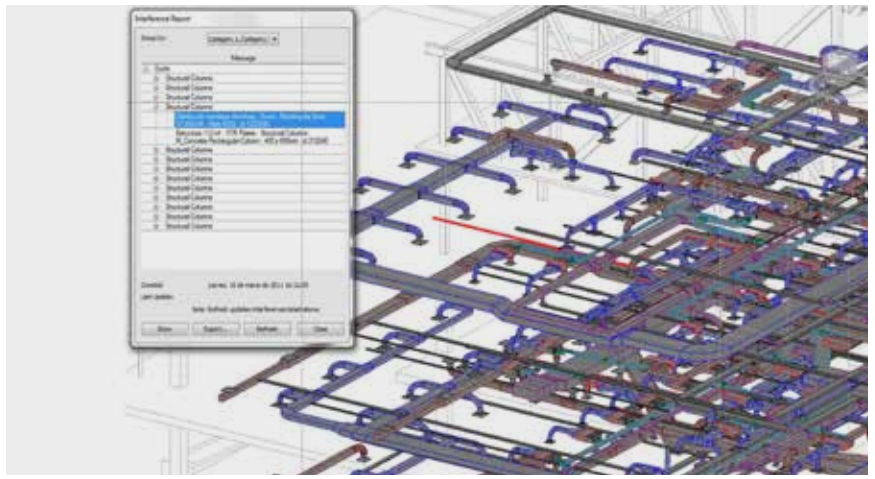
The project covers an area of almost 10 Ha and includes new infrastructures such as a farmer's market, a restaurant with an information desk, a multipurpose library area beside the lake and a toilet and maintenance area. IDOM carried out the landscape design, architecture, urbanisation and the infrastructure associated with the project.

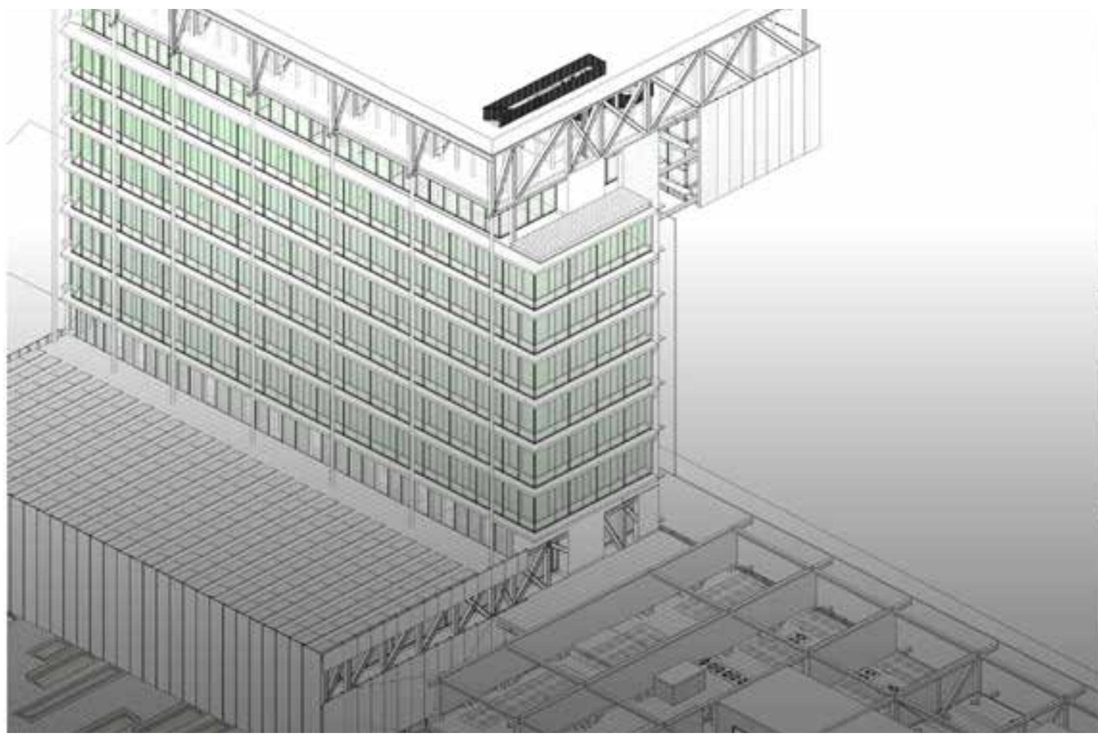
The intervention included a comprehensive urban and landscape revitalisation. The design preserved some historic and natural features while giving the park a new character. This was reflected in the urban integration of the design: making a difference between the inside and out of the park. On the outside, local stone was used, enabling continuity with the adjacent streets and the public areas of Passo Fundo. On the inside, a palette of concrete and timber were used to differentiate communal areas from contemplation areas.

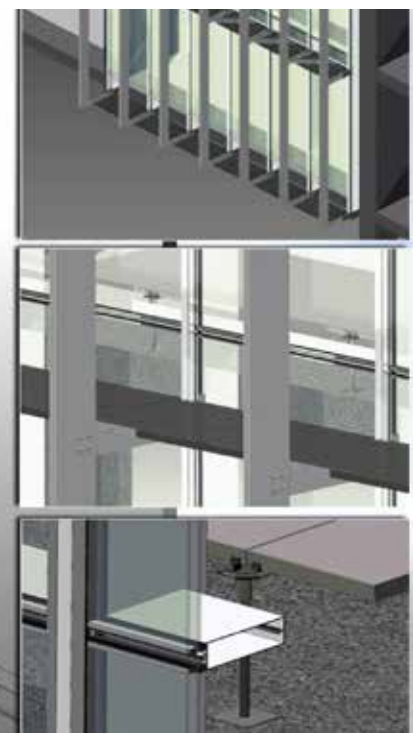
While keeping the large number of existing trees, new indigenous trees were planted to create forested areas that were set apart from clear zones. In other places, short-tree groves were created to minimise shade and enhance the oxygenation of the adjacent body of water. Colourful tree groups were planted to create a chromatic distribution that would contrast with the predominantly green hues of the forest.

METHODOLOGIES









BIM. BUILDING INFORMATION MODELLING

BIM, meaning Building Information Modelling, is understood in Spain as the modelling of construction information. It is a work methodology covering the design, construction, management and maintenance of buildings throughout their lifespan and can be applied to all project stages.

We could summarise BIM as generating a thorough data base, structured in a universal language that has a geometrical output (3D model) containing all the necessary information for the asset's validation, communication, construction, exploitation and maintenance.

At a design and construction level it is the ability to virtually build and test all the process before making the first move. On a management and exploitation level, it is the data base that allows us to register and check activity and its history. This enables us to make the best decisions to maximise the building's lifespan at the smallest cost possible, keeping it in the best condition possible.

At IDOM we understand BIM not only as a virtual 3D model but as a work methodology that intends to speed up design and construction processes while improving the quality of the built product and reducing the global cost of the endeavour.

The working possibilities of this methodology have several "dimensions", named 3D, 4D, etc.

3D: The geometric model itself

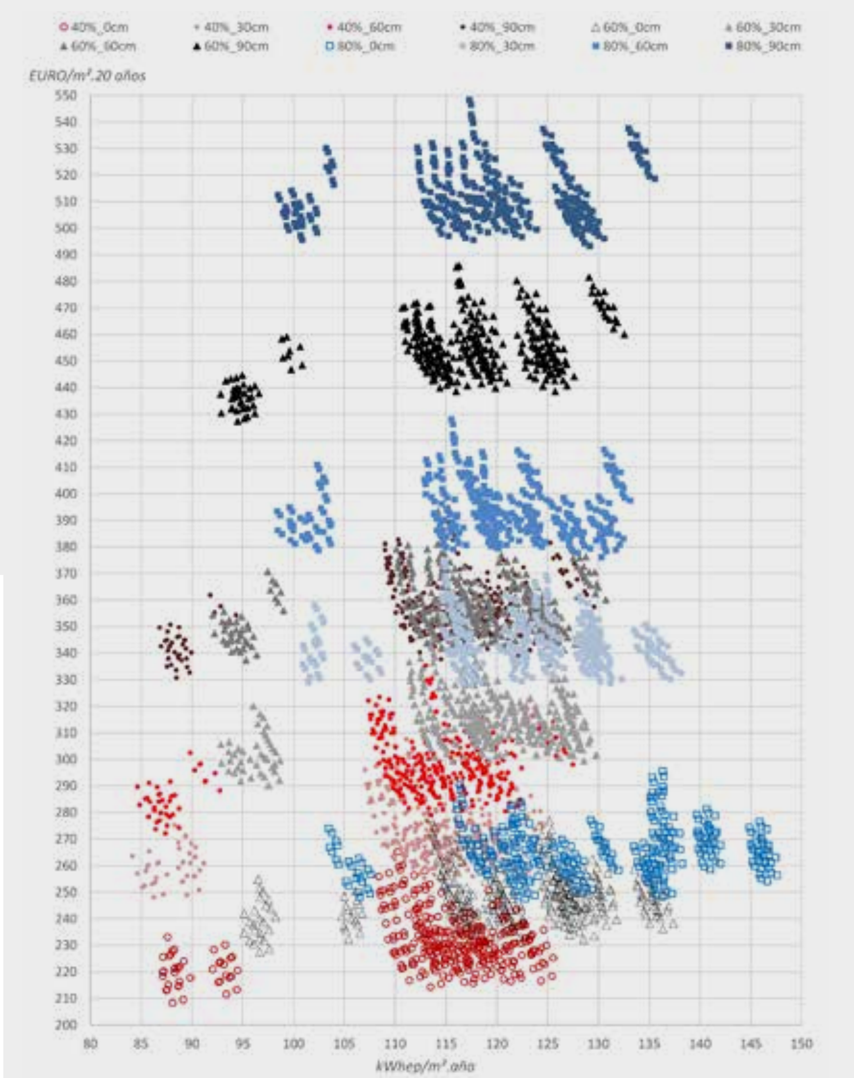
4D: Introduces the dimension of time. Each element in the model can contain information about the time it will be built, bought, undergo maintenance, etc.

5D: Introduces the dimension of cost. Each element has an attached cost, making it possible to work on the building's cost estimate from the model. It can also be used to track a cash flow.

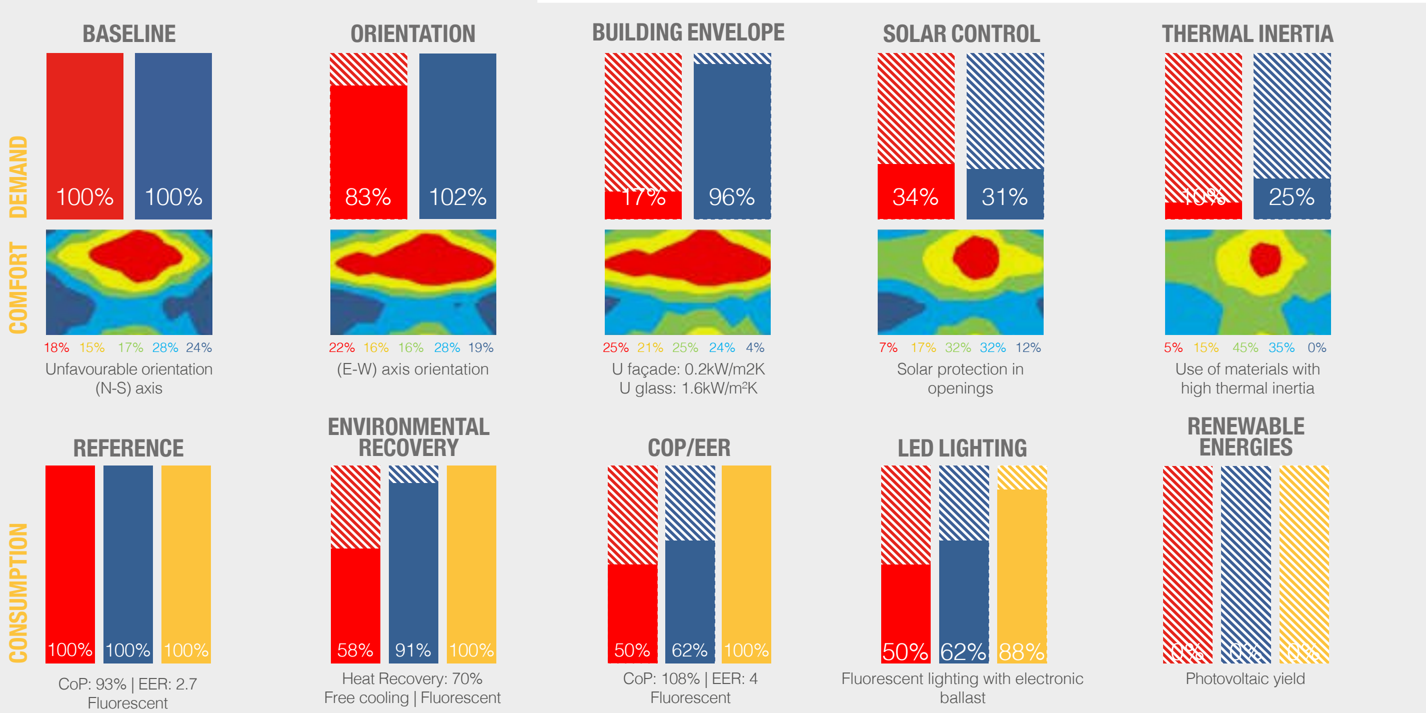
6D: As an important feature of the BIM methodology that introduces all the properties the building it represents would have. Therefore, by using the appropriate software, we can simulate its behaviour. This dimension of the building's "performance" is closely related to the appearance of Building Physics since the majority of elements considered (building envelopes, thermal, light, acoustic performances, etc.) are closely linked to the geometric model.

7D: The dimension that transcends the processes of design and construction and is therefore related with the building's operation. BIM tools have great potential when it comes to facilitating and optimising future maintenance, whether it be corrective, preventive or predictive. Safety is another field in which BIM technology can be immediately applied, as well as any other logistic or operational aspect throughout the building's life.

This exercise is done with matrix methodologies, as can be seen in the graph, analysing consumption and lifespan when specific variables are modified. For example, these can include: glazing percentage, the size of solar protection slats, infiltrations, insulation, U-factor of the glass and G-values. The lowest points on the graph represent those that have the lowest total cost, and therefore optimum-cost combination, after twenty years (investment costs plus operation costs derived from the consumption of energy).



Simplified analysis of the energy savings from heating (red), cooling (blue) and lighting (yellow) and the percentage of comfort hours (compared to a reference building). The most important aspects are varied, with the idea of achieving the greatest energy efficiency and level of comfort possible. The upper and lower lines represent the savings associated with passive and active measures respectively (compared to a reference building). By utilising the appropriate renewable energy, we can achieve zero consumption.



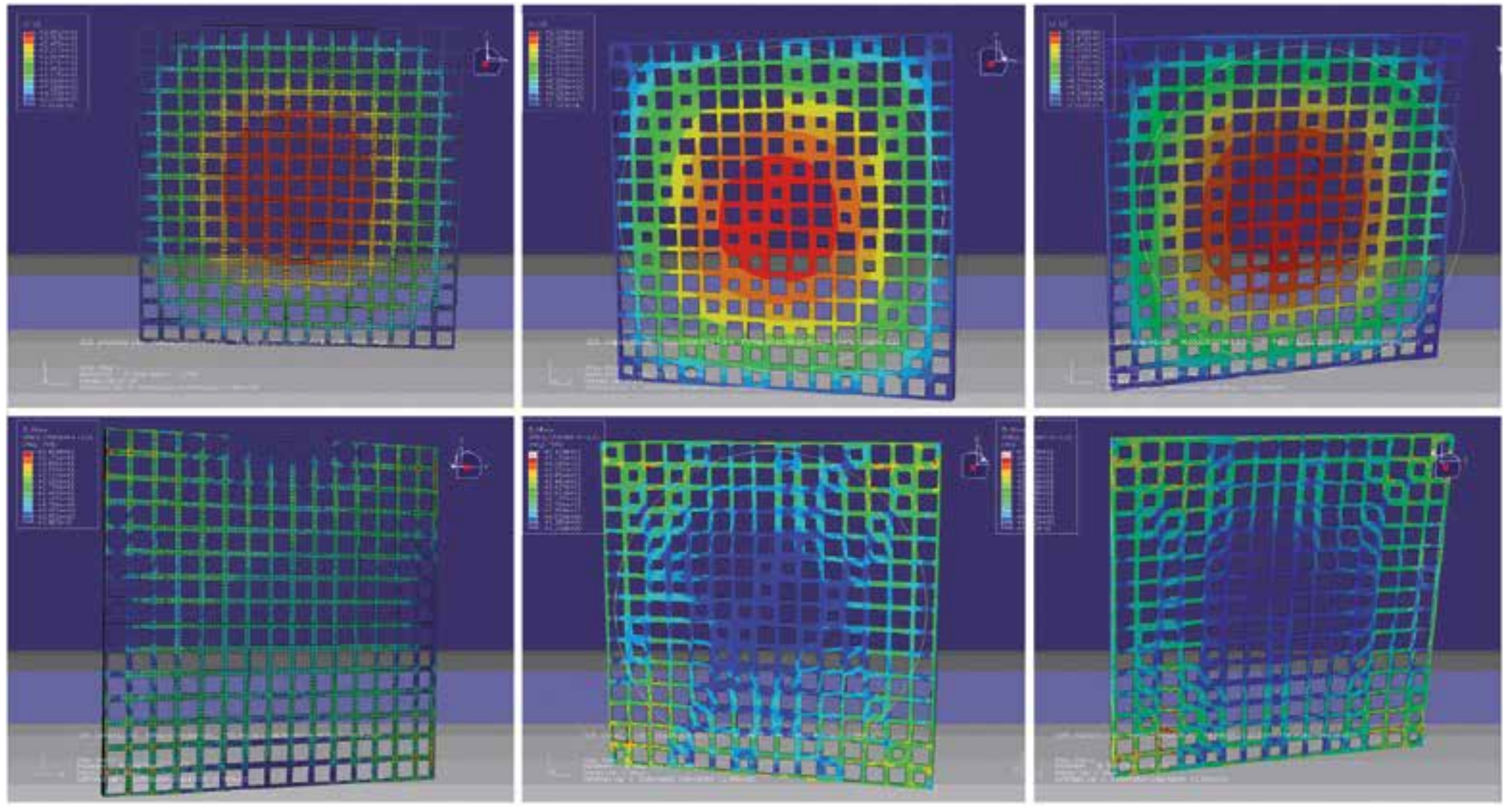
ENERGY EFFICIENCY. **OPTIMUM COST**

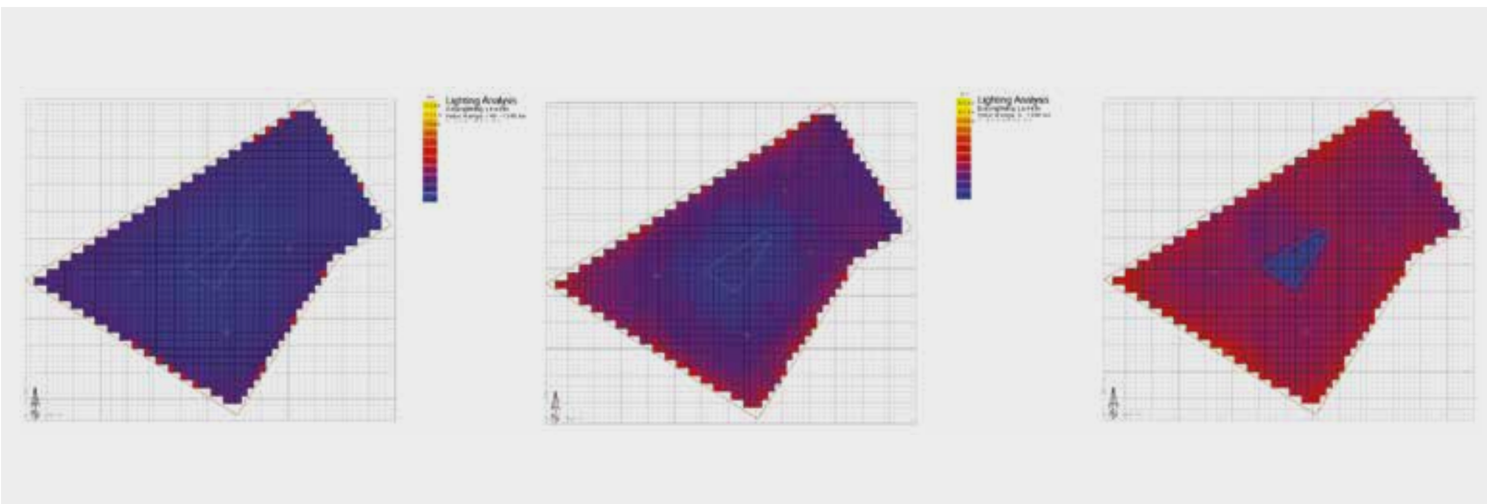
Design-related decisions such as orientation, the building envelope or the MEP system, amongst others, have a direct consequence on the energy consumption and cost of buildings. According to typology, climate, occupation or use, there is an optimum-cost design for each building. The optimum-cost design has the lowest total cost throughout the building's life.

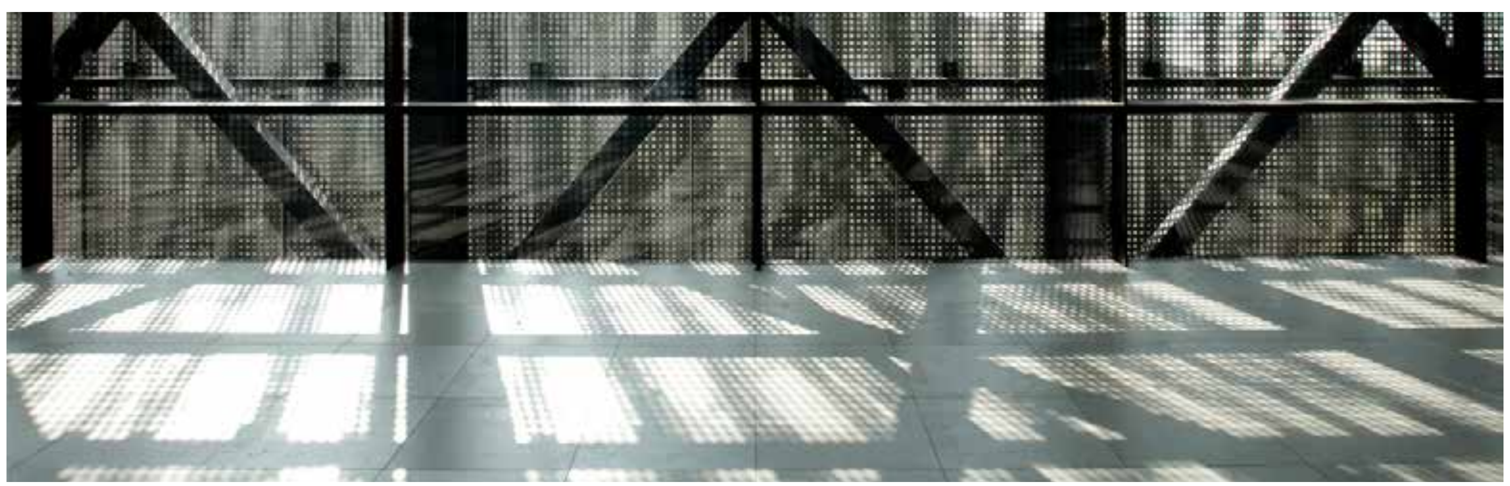
Generally, when designing a building, the minimisation of the investment costs and development of a low-consumption (but comfortable building) is desirable. For this, it is essential to have a methodology that allows choosing the optimum characteristics of certain elements in the building at the design stage. This ensures that the overall cost over the life cycle of the building is minimised.

The multi-parametric method, which analyses many variables and defines the best design solution (considering the building's entire lifespan) optimises and helps define the design with the lowest lifetime cost. We analyse both the cost of investment and the cost of operation, simultaneously comparing used energy and maintenance costs in a matrix. Analysing the cost of investment and the cost of energy consumption allows for the identification of the optimum-cost design solution for each case.

According to Directive 2010/31/EU, buildings must be nearly Zero Energy Buildings (nZEB) as of the year 2020. It also states that they must be optimum-cost. This work methodology allows us to meet these requirements.







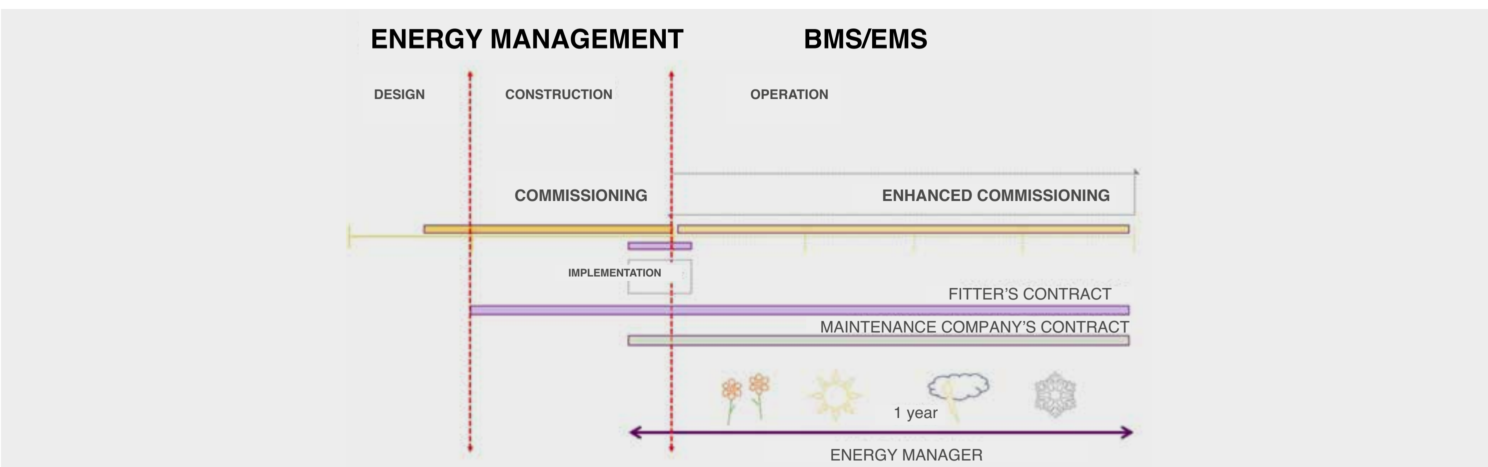
PARAMETRIC DESIGN OF BUILDING **ENVELOPES**

The buildings we design today must have an exceptional energy performance. The building envelope, apart from being the main image of the building, is of utmost importance. Ensuring good design is essential in this component as it is the point at which nearly all physical phenomena converge: energy, wind, light, water and acoustics. The great number of conditioning factors required for the development of the building envelope demands that we work with a non-traditional methodology. Our own methodology allows us to develop suitable envelope designs and is carried out using designs based on mathematical algorithms.

The following is an example of the parametric generation of a building envelope. It is made up from a double perforated metal skin which is separated from the building by an air cavity of variable thickness. IDOM has used it in several projects and it has become a unique building envelope design methodology.

Façade generation process. Stages:

- Production information: the construction system is defined, normally for 2 or 3 initial project variables.
- Digital prototype: a 3D design of all the components of the façade system.
- CFD (Computational Fluid Dynamics): development of a computational model to evaluate behaviour against wind and heat loss from the cavity.
- Light simulation: development of a model to assess the levels of light in the proposal required within the production information.
- Genetic algorithm: creation of an algorithm that generates different perforation patterns and optimises other variables like distance between skins or type of façade material.
- Calculations and partial results of different iterations are obtained until reaching the final solution.
- Physical prototype: normally developed in collaboration with the façade manufacturer.



DESIGN - CONSTRUCTION - OPERATION MANAGEMENT

The high performance of near zero-energy buildings calls for all of the building's aspects to be dealt with in a comprehensive manner. What used to be separate stages – design, construction, operation and maintenance – are now blended into a single phase in which there is no continuity solution.

A building designed and built very efficiently may turn out to be inefficient in operation. This can be a result of a faulty functioning of the BMS system, changes in the occupied building use during design or the optimisation margin of the building's energy management scheme (trigger values, algorithms and equipment start-up).

Design – construction – operation – maintenance continuous energy management aims to solve this problem, giving the planned efficiency back to the building (or even improving it.)

The proposal involves foreseeing, from the initial contracts, the continuity during the entire process:

- An independent contractor, an energy efficiency manager, in involved from the design stage and continues through to construction and operation
- The *commissioning stage (Enhanced commissioning) is undertaken for at least a year after the building goes into operation.*
- During the first year of operation, the installer must be linked to the building (under contract) and coordinate the adjustment operations and vigilance with the maintenance company.
- Lastly, the maintenance company must be hired and appear before the implementation operations at the end of the construction stage.

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HVAC
Javier Mendieta, Jorge Berezo, Rafael Pérez, Borja de Carlos, Rogelio Díaz

LIGHTING
Alvaro Gutierrez

WATER
Luis González

ELECTRICITY
Alvaro Gutiérrez-Cabello, Javier Aróstegui, Javier Surja, Pedro Sánchez, Rafael Pérez

FIRE
Luis González

SPECIALISTS
Iñaki Zabala, Víctor Oguiza, Imanol Eizmendi, Fernándo Jiménez, Erlantz Basauri, Víctor Zorriqueta

CLERKS
Blanca Ugarte, Sonia López, Rosa Mª Martínez

SITE SUPERVISION
Iñaki Garai, César Azcárate, Juan Coll, Daniel Gutiérrez, Javier Ruiz de Prada, Alberto Asla, Amaia Lastra, Mikel Mendicote, Jesús Barrenetxea, Jon Jona Larrauri

SITE MANAGEMENT
Vicente Boraita

PHOTOGRAPHY
César San Millán

DATA PROCESSING CENTRE IN CERDANYOLA DEL VALLES

HEAD ARCHITECT
José Antonio Fernández

PROJECT MANAGEMENT
Enrique Bolón

ARCHITECTS
Magdalena Ostornol, Fernando Rial, Elida Mosquera, Manuel Lópes

STRUCTURES
Gustavo Melón, Nuno Souza, Iván Florencia

BUILDING SERVICES
Oriol Passola, Marc Fandós

SITE SUPERVISION
José Antonio Fernández, Magdalena Ostornol, Jonathan García, Oriol Passola, Marc Fandos

SITE MANAGEMENT
Enrique Bolón, Gabriel Kososwski, Xavier Talló

PHOTOGRAPHY
Edouard Decam, Shutterstock.com

112 EMERGENCIES REUS BUILDING

HEAD ARCHITECT
Marco Suárez

PROJECT MANAGEMENT
Alfredo Fernández

ARCHITECTS
Élida Mosquera, Alex Borrás (Bec), Claudia Carrasco, Mireia Adnetller, Sorana Radulescu, Roberto Molinos

COSTS
Carlos Garín, Jordi Salido

STRUCTURES
Joel Montoy, M. del Mar Sahún, Roger Señís, Ana Andrade, Leonardo Domínguez

HVAC
Pablo Jorge Vispo

ENERGY EFFICIENCY AND SUSTAINABILITY
María Cortés

LIGHTING
Mercedes González

WATER
Miguel Castro , Pablo Jorge Vispo

ELECTRICITY
Alex Boada

TELECOMMUNICATIONS
Alfredo Fernández, Vicente Montoya

MASTERPLANNING
Javier Losada

SITE SUPERVISION
Marco Suárez, Carlos Garín, Jonathan García

SITE MANAGEMENT
Víctor Amado Valido

PHOTOGRAPHY
Adriá Goula

BBK SARRIKO CENTRE

HEAD ARCHITECT
Javier Aja

PROJECT AND SITE MANAGEMENT
Patxi Sánchez

ARCHITECTS
Helena M. Rios, Beatriz Pagoaga

STRUCTURES
Cristina Hernando

BUILDING SERVICES
Álvaro Gutiérrez-Cabello, Íñigo Aguirre, Mikel Fernández, Beatriz Lorenzo, Mª Eugenia Gauna, Mikel Fernández

ENERGY EFFICIENCY AND SUSTAINABILITY
Blas Beristain, Amaia Lastra

SPECIALISTS
José R. Rodríguez, Arrate López, Itziar Ramírez

CLERKS
Sonia López-Gómez

SITE SUPERVISION
Javier Aja, Javier Ruiz, Ziortza Bardeci

COMPUTER GRAPHICS
Roberto Fernández de Gamboa, Alfonso Álvarez

PHOTOGRAPHY
Aitor Ortiz

BUILDING 2 FOR THE CAMPUS DES MÉTIERS ET DE L'ARTISANAT

HEAD ARCHITECTS
Iñaki Garai, Inés López

ASSOCIATE ARCHITECTS
ATELIER 9.81

ARCHITECTS
Ricardo Moutinho, Gohar Manrique

STRUCTURES
PROJEX INGÉNIERIE

BUILDING SERVICES
PROJEX INGÉNIERIE

ENERGY EFFICIENCY AND SUSTAINABILITY
DIAGOBAT

KITCHEN CONSULTANT
CREACEPT

ACOUSTICS
LASA Acoustique

COSTS
MEIC

CLERKS
Clarisse Guiraud, Ariadna Morer

COMPUTER GRAPHICS
Roberto Fernández de Gamboa, Alfonso Álvarez, Gohar Manrique

MARQUÉS DE RISCAL HOTEL AND WINERY

HEAD ARCHITECTS
Frank Ghery, Edwin Chan, Andy Liu

PROJECT ARCHITECTS
César Caicoya, Fernando Pérez, José Sáenz de Argandoña

STRUCTURES
Javier Gómez, Miles Shephard, Karl Blettle, Miguel Ángel Frías, Eduardo Sáinz, Juan Ignacio Lesarri, Shyamala Duraisingam

BUILDING SERVICES
Patxi Sánchez, María Azpiroz
Jon Landaburu, Alberto Ribacoba, Amaya Lastra

WIND
Iñigo Eletxigerra

LANDSCAPE DESIGN
Luis González

SPECIALISTS
Iñaki Fuertes, Juncal Aldamizechevarría, Belén Usechi, Julio Piedra, Javier Dávila

SITE SUPERVISION
César Caicoya, Fernando Pérez, Pilar Mateo, Eva Madariaga

CONSTRUCTION SUPERVISION
Virginia Canales

PHOTOGRAPHY
Aitor Ortiz, Peizais, Shutterstock.com

104 COUNCIL HOUSING UNITS IN BORINBIZKARRA

HEAD ARCHITECTS
Iñaki Garai, Inés López

ARCHITECTS
Ricardo Moutinho, Beatriz Pagoaga

COSTS
Juan Dávila

STRUCTURES
Egoitz Olmo, Jon Calvo

ENERGY EFFICIENCY AND SUSTAINABILITY
Blas Beristain

SITE SUPERVISION
Iñaki Garai, Inés López, Sara Barreda, Juan Dávila

GRAPHIC DESIGN
Natalia González, Inés Uribarren

COMPUTER GRAPHICS
Roberto Fernández de Gamboa, Alfonso Álvarez

PHOTOGRAPHY
Aitor Ortiz, Pedro Pejenaute

49 DWELLINGS AND NURSERY IN BERMONDSEY

HEAD ARCHITECTS
Fernando Pérez, Viral Bhavsar

ARCHITECTS
Alejandra García, Caio Luis Mattei, Cristina Romero, Kenny Chong, M. Azhar, Nerea Pérez

COSTS
Viral Bhavsar

STRUCTURES
WHITECHAPEL T.C

HVAC
FOREMAN ROBERTS

LANDSCAPE DESIGN
Fernando Pérez

SPECIALISTS
Claire Roff, Irene Ron, Shan Rixon

SITE SUPERVISION
Fernando Pérez, Viral Bhavsar

PHOTOGRAPHY
Fernando Pérez

58 COUNCIL HOUSING UNITS TORRESOLO

ARCHITECTS
Iñaki Garai, Inés López, Ricardo Moutinho

COSTS
Agurtzane Insa

STRUCTURES
INAK

BUILDING SERVICES
Diego Zarranz

ENERGY EFFICIENCY AND SUSTAINABILITY
Blas Beristain

TELECOMMUNICATIONS
Mikel Fernández

SITE SUPERVISION
Iñaki Garai, Inés López, Iker Alkiaga

COMPUTER GRAPHICS
Roberto Fernández de Gamboa , Alfonso Álvarez

PHOTOGRAPHY
Aitor Ortiz

AMARANTE HOSPITAL

HEAD ARCHITECT
David Coutinho

ARCHITECTS
Inês Coelho, Francisca Bastos, Marcelo Dantas, Francisco Eloy, Jorge Paquete

COSTS
David Coutinho

STRUCTURES
Silvia Castillo, João Almeida, Rita Fernández

HVAC
Álvaro Santos, André Mendes, José Sereno

WATER
Antonio Gaspar, Joel Vinagre, Ana Mendoça

ELECTRICITY
Fernando Loureir, José Quintas, Inês Cardoso, Luis Barra

TELECOMMUNICATIONS
Fernando Loureiro, José Quintas, Inês Cardoso, Luis Barra

FIRE
Belén Herrero

ACOUSTICS
CERTIPROJECTO

LANDSCAPE DESIGN
GLOBAL

PHOTOGRAPHY
FERNANDO GUERRA

UNIVERSITY OF NAVARRE CLINIC

HEAD ARCHITECTS
Jesús Mª Susperregui, Jorge Martínez, Pablo Elorz

PROJECT MANAGEMENT
Jorge Martínez

ARCHITECTS
Borja Gómez, Beatriz San Salvador

COSTS
Carmen Camarmo

STRUCTURES
Carlos Castañón, Jorge de Prado

BUILDING SERVICES
PROMEC

CLERKS
Banesa Marrero

SITE SUPERVISION
Jesús Mª Susperregui, Jorge Martínez, Pablo Elorz

COMPUTER GRAPHICS
POLIEDRO

CUF DESCOBERTAS HOSPITAL

HEAD ARCHITECT
Rui Maia

ARCHITECTS
Jorge Matías,João Santos, Javier Díaz, Laura Valcárcel, Magdalena Ostornol, María del Pino, Pablo Viña

COSTS
Carmen Camarno

STRUCTURES
Carlos Castañón, Pedro Viegas, David García, Romina González

HYDRAULIC FITTINGS
António Cardoso Gaspar, Susana Maduro

FIRE SAFETY
Belén Herrero

HVAC
Ramón Gutiérrez, José Sereno, Isaac Lorenzo, Javier Sánchez, Antonio Mendoza

ENERGY EFFICIENCY AND SUSTAINABILITY
Ramón Gutiérrez, Javier Martín

ENERGY LABELLING
Ana Rita Henriques

ELECTRIC FITTINGS
Luís Barra, Joao Parreira

TECHNICAL MANAGEMENT
Luís Barra

VOICE AND DATA / TELECOMMUNICATIONS
Asís Hernando, Inés Horta

SPECIAL FITTINGS (MEDICINAL GASES, PNEUMATIC)
Julio César García, Carmén Vieira

LIGHTING
Noemi Barbero

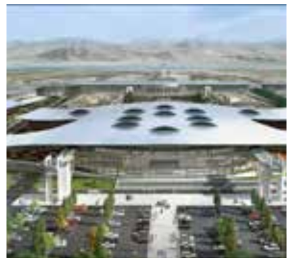
ACOUSTICS
Mario Torices, Odete Domingues

CLERKS
Vanesa Marrero, Isabel Cantero

CONSTRUCTION STAGE TECHNICAL INPUT
António Cardoso, Carmén Vieira, António Jorge Matias, Belén Herrero, Pedro Viegas, Luís Barra, Inês Cardoso, José Sereno

COMPUTER GRAPHICS
Manuel Leira

PHOTOGRAPHY
FG+SG



ARTURO MERINO BENÍTEZ AIRPORT, SANTIAGO DE CHILE

ARCHITECTURE
ADP INGÉNIERIE

STRUCTURES
SETEC
BUILDING SERVICES ENGINEERING
IDOM

COMMISSION DIRECTOR
Luis Gutierrez de Rozas

PROJECT TECHNICAL DIRECTOR
Jesus Sejas

IDOM CHILE DIRECTOR
Andrés Mackenna

HVAC
Jesús Sejas, Isaac Lorenzo, Alberto Fajardo, Yaiza Rodríguez, Beatriz de la Fuente

ELECTRICITY
Carlos Trujillano, Eugenio Domínguez, Carlos del Amo, Pablo Domínguez, Diego Manzano

DRINKING WATER AND SEWAGE
Ulises Rubio, Iván Quintana, Marta Bravo

FIRE SAFETY
Héctor Mayordomo, Marta Fernández, Daniel Arroyo

WEAK CURRENTS
Santiago Guillén, Antonio Carrillo, Fernando Tomás, Bruno Martínez, Asis Hernando, Carlos Ayala

BIM / MEP
Joseba González Mato, Eduardo Navarro, Pilar Sande, Óscar Martín, Alexey Lysogor, Carlos Toribio, Rosaina Ferreira

EXTERNAL WORKS
IDOM
Javier Lorente, Íñigo Ibeas, Alejandro Serrano

ARCHITECTURE, AUXILIARY BUILDINGS
IDOM
Manuel Andrades, Xabier Graas, Patricio Salinas, José Carlos Vial

CROSSBORDER TIJUANA AIRPORT

HEAD ARCHITECT
Manuel Andrades

PROJECT MANAGEMENT
Francisco Pi, Javier Losada, Manuel Andrades

ARCHITECTS
Pablo Viña, Jorge Rodríguez, Mauricio Gómez, Mauricio Durán, Oscar Ferreira

COSTS
Amílcar Soriano

STRUCTURES
Gorka Viguri, Eneko Saldise, Miguel Ángel Valverde, Alejandro Bernabeu, Jorge de Prado

HVAC
Beatriz Cárdenas

LIGHTING
Patricio Moniet, José Antonio Buendía

WATER
Carlos González

ELECTRICITY
Miguel Blanco

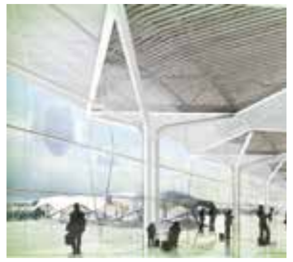
TELECOMMUNICATIONS
Teresa López Contreras, Beatriz Rodríguez, Patricio Moniet

SPECIALISTS
Carlos Esparza, Carlos René Ortega, Efraín González, Jesús Rodríguez, José Luis Muñoz Quezada, Jesús Alarcón, Juan Torres, Carlos Elizalde

SITE SUPERVISION
Oscar Ferreira, Alejandro Valdés, Carlos Esparza, Carlos René Ortega

COMPUTER GRAPHICS
Pablo Viña

PHOTOGRAPHY
Pradip J. Phanse



NATAL AIRPORT

HEAD ARCHITECTS
Pedro Paes, Marco Suárez, Alvar Cortada

ARCHITECTS
Juliana Ting, Carlos de la Barrera, Sara Panadero

COSTS
Luis Sagredo, Javier Sandalinas, Beatriz Rodríguez

STRUCTURES
Paulí Goñi

ENGINEERING
Pablo Jorge, Alexis Agustí, Oriol Passola, Marc Fandos, Albert Recassens

AERONAUTICS
Javier Losada, Federico Mestre, Héctor Martínez

COMPUTER GRAPHICS
Ismael Vega, Andréia Faley

CAR PARK AT HEATHROW AIRPORT

IN COLLABORATION WITH
GRIMSHAW Architects (Architectural Concept Design Advisors)

HEAD ARCHITECT
Viral Bhavsar

ARCHITECTS
Alberto Sabater, Álvaro López

STRUCTURES
Gorka Uria

BUILDING SERVICES
Álvaro Gutiérrez-Cabello

TRAFFIC EXPERTS
Raul Coleto, Falko Matthews

TRAFFIC MODELLING
Gary Zegarra

CLERKS
Irene Ron

PHOTOGRAPHY
Heathrow Image Library

JOAQUÍN SOROLLA AVE STATION

HEAD ARCHITECT
Elvira Puchades

PROJECT MANAGEMENT
Jorge Bernabeu, Elvira Puchades

ARCHITECTS
Eugénio Teixeira, Vera Leitao, Monica Villate, Rafael Papi

COSTS
Francisco Francés Pardo

STRUCTURES
Jorge Bernabeu, Fran Gómez, Eduardo Fernández

HVAC
Manolo Ferrandis

ENERGY EFFICIENCY AND SUSTAINABILITY
Pablo Miró, Manuel Peris

LIGHTING
Manuel Caro

WATER
Manuel Peris

ELECTRICITY
Manuel Caro

TELECOMMUNICATIONS
Sandra Trejo

PUBLIC WORKS
Maribel Botella, Daniel Mejía

FIRE
Sergio Calpe

SITE SUPERVISION
Elvira Puchades, Eva Quevedo, Guillermo Durban

SITE MANAGEMENT
Antonio Martín

GRAPHIC DESIGN
Macarena Cárdenas

PHOTOGRAPHY
Alfonso Calza

NEW SAN CRISTOBAL INTERMODAL STATION IN LA CORUÑA

HEAD ARCHITECTS
Gonzalo Tello, Jesús Llamazares, César Portela

PROJECT MANAGEMENT
Beatriz Olalla

ARCHITECTS
Beatriz Olalla, Borja Aróstegui

COSTS
Miguel de Diego

STRUCTURES
Jorge Bernabeu

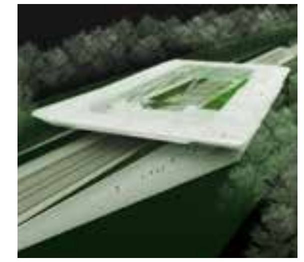
ENERGY EFFICIENCY AND SUSTAINABILITY
Antonio Villanueva

ELECTRICITY
Carlos Trujillano

ACOUSTICS
Mario Torices

CLERKS
Banesa Marrero

COMPUTER GRAPHICS
POLIEDRO



HIGH SPEED RAILWAY STATION POLAND

HEAD ARCHITECTS
José Antonio Fernández, Magdalena Ostornol

PROJECT MANAGEMENT
José Antonio Fernández, Magdalena Ostornol, Marcin Warda

ARCHITECTS
Carlos de la Barrera, Beata Szkotak

COSTS
Mirek Blajda, Carlos Garín

STRUCTURES
Joel Montoy

HVAC
Alex Barberá

ENERGY EFFICIENCY AND SUSTAINABILITY
María Cortés

LIGHTING
Mercedes González

TELECOMMUNICATIONS
Alfredo Fernández

FIRE
Alexis Agustí

CLERKS
Carol Moñiz

COMPUTER GRAPHICS
Ismael Vega, Andreia Faley

RIYADH METRO

(IDOM's scope included the design of many more elements such as viaducts, tunnels, layouts, landscape, park&rides, etc. The following list does not include the people invested in those duties but rather only includes those who took part in the design of sheds and stations)

PROJECT DIRECTOR Ramón Ramírez, Juan Carlos de Miguel

TECHNICAL DIRECTORS Pablo de la Puente, Iban Mirones, Fernando Pérez

PROJECT MANAGEMENT Joao Leitao, Miguel Ángel Utrilla, Fernando Martínez, Ángel Vázquez, Juan Carlos Gómez, Javier Pérez, Iñaki Garai

DOCUMENT MANAGEMENT Javier Jiménez, Laura Vall, Mohammad Shabbir

ENERGY EFFICIENCY AND SUSTAINABILITY Blas Beristain, Jesús Lázaro

CLERKS Carmen de Castro

COMPUTER GRAPHICS Roberto Fernández de Gamboa, Alfonso Álvarez, Jon Alegría

SHEDS

DIRECTOR ENGINEER Iban Mirones

HEAD ARCHITECT Jesús Armendáriz

ARCHITECTS Joan Espinás, Jonathan García, Mirari Larrañaga, Itziar Bañares, Leyre De Lecea, Helena Sa Marqués, Kenneth Bonifaz

SHEDS URBANIZATION Mireia Capmany, Amalia Botia

STRUCTURES COORDINATION Javier Goldaracena

STRUCTURES Natalia Sagasti, Miguel Ángel Valverde, Iván Ponce, Amaia Sánchez, Ana Atxurra

BUILDING SERVICES COORDINATION Juan Luis Geijo, Iñigo Aguirre

HVAC Camino López, Unai Ugalde

LIGHTING Mikel Fernández, Itziar Blanco

WATER Borja Martínez, Julen Vecilla

ELECTRICITY Mª Eugenia Gauna, Itziar Blanco

TELECOMMUNICATIONS Joaquín Fernández de Arcaya, Juan Carlos Herrero

SPECIALISTS Francisco Pérez, Daniel Gómez, Javier Negro, Ángel Novas, Gorka Aguillo, Carlos Olmedillas, Pablo Jesús Crespo

STATIONS

DIRECTOR ARCHITECT Fernando Pérez

HEAD ARCHITECTS Javier Aja, Javier Vergara, Manel Sánchez, Jabier Fernández

ARCHITECTS Nicolás Espinosa, Matteo Cassano, Damián Ayala, Ane Ferreras, Sara Oneto, Cristina Jódar, Gabriela del Toro, Patxi Matute, Hugo Prades, Patricia Quilez, Jon Ander Azpiazu, Ignacio Angulo, Álvaro Ascoz, César Jiménez, María López, Óscar Brazo, Asier Loroño, Iker Gandarias, Andrés Tabera, Lorena Sierra, Marina Ajubita, Naiara Bravo, Natalia Clúa, Ander Fernández, Juan Neira, Jaime Mancebo, Mikel Fernández, Ohiana Urgoitia, Olatz Elosegui, Ana Reparaz, Pilar Mateo, Beatriz Pérez, Victor Manuel Hinojosa

ARCHITECTURE STUDENTS Jonathan San Román, Raúl Penabad, Mikel Zabaleta, Maider Pérez, Nora Erdozain

FAÇADE SPECIALIST José Ignacio Lucio

SPECIFICATIONS Javier Ruiz de Prada, Joseba Andoni Aguirre, Sergio Llamosas, Ana Isabel Robles, Agurtzane Insa, Gabriel Bustillo, Gontzal Martínez, Arrate Bereciartua, Nérida Velasco, Sandra Santamaría, Marta Camarero, Ziortza Bardeci

STRUCTURES Francisco Javier Gómez, María del Mar Mayo, Antonio Martín, Carlos Alberto Campo, Javier Ayala, Iñigo Vallejo, Javier Durán, Javier Gómez, Leonardo Labastida, Gonzalo Zarrabeitia, Driss Mahamedi, Gonzalo Solana, Gonzalo García, Peio Uriarte, José Antonio Martínez, Borja Bergara, Natalia Sagasti, José Antonio Díez, Jorge Tierno, Juan Villanueva, Jaime Pino

GEOLOGY Josu Etxebarria, Fidel Rodríguez

BUILDING SERVICES COORDINATION Arturo Cabo , Patxi Sánchez, Jon Zubiaurre

HVAC Iñigo Aguirre, Leire Fernández, Oier Lejarraga, Naiara Moreno, Gorka Torres, Unai Ugalde, César Arnaiz

LIGHTING Javier Fernández, Miguel García, Juan Rivera

WATER Cristina de Miguel, Borja Martínez, Alberto González, Eñaut Leunda, Begoña de los Mozos, Francisco Javier Ortiz

ELECTRICITY Joseba Arregui, Itziar Blanco, Adolfo Casado, Javier Fernández, Miguel García, Juan Rivera, Francisco Javier Ortiz, Alberto González

TELECOMMUNICATIONS Joaquín Fernández de Arcaya, Verónica Menoyo, Ignacio Alcázar, Miriam Mato

FIRE Javier Peñafiel, Mikel Bilbao, Lara Escobio, Raquel Varela, Jesús María Díez

COMBINED SERVICE DRAWINGS Diego Zarranz, Julio García

ACOUSTICS Juan Ignacio Pérez

DESIGN BIM Andoni Aguirre, Silvia Aviñó, Andoni Castillo, Anna Fernández, Marta Giménez, Ana Moreno, Eduardo J. Rodríguez, Álvaro Van Horenbeke

SPECIALISTS Iñaki Zabala, José Ramón Rodríguez, Fernando Fernández, Cristina Peña

Urban Transport

SANTIAGO DE CHILE METRO

METRO DE SANTIAGO S.A.

ACCOUNT DIRECTOR
Rodrigo Raniman

HEAD OF ARCHITECTURE
Leyla Mursi

HEAD ARCHITECT
Claudia Chávez

HEAD OF STRUCTURES
Gabriel Valenzuela

HEAD OF SYSTEMS
Christopher Espinoza

IDOM

HEAD ARCHITECTS
Gonzalo Tello, Manuel Andrades, Patricio Browne (Mobil)

HEAD OF BUILDING SERVICES
Carlos Trujillano

COLLABORATING ARCHITECTS
Patricio Poblete, José Luis Álvarez, María José Martínez (Mobil), Félix Salinas, Sylvain Eymard (Mobil), Covadonga Vilanova, Pilar García, (Mobil), Diego Sánchez, Pablo Moreira (Mobil), Xavier Grass, Patricio Arraigada, Natasa Stanacev, Patricio Salinas, Belén Labiano, Luis Abengózar

PROJECT MANAGEMENT
Javier Puerto, Samuel Horche, Carlos Castañón

COSTS
Iván Portela, Miguel de Diego, Esther Arranz, Pablo Morales

DOCUMENT CONTROL
María Carril, María Miranda, Ivan Quintana,

QUALITY
María Romero, Mª Victoria Blázquez

STRUCTURES
Gino Rivera, Andrés Larrain (ALVING), Jorge de Prado, Romina González, David García, Rodrigo Langarita, Hernán Barrios, Manuel de la Cal, Alejandro Bernabeu, Felipe Correa, Patricia Solar, Juan Taborga, Enrique Aravena (Alving), Felipe Alarcón (Alving), Marco Bernal

FIRE SAFETY
Héctor Mayordomo

HVAC
Jesús Sejas, Jaled Salman

LIGHTING
Marcela Acuña, Noemí Barbero

WATER
Héctor Mayordomo, Raúl Miranda (PSI), Hugo Varas (PSI)

ELECTRICITY
Carlos Trujillano, Boris Ancape (PSI), Guillermo Hume (PSI) Patricio Vargas (PSI)

GRAPHIC DESIGN
Sergio Ramírez

DRAUGHTSMANSHIP
Óscar Martín, Alexey Lysogor, Alejandra del Pino

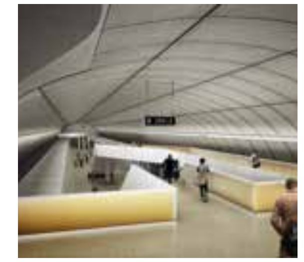
SPECIALISTS
Javier Delgado, Carlos Mendoza, Rubén Cid, Jesús Cid, Álvaro Sáez, Óscar Martín, Alexey Lysogor, Alejandra del Pino, MODELICAL

CLERKS
Verónica Trujillo, Claudia Escobar, Diana Zarricueta, Ana Belén García

SITE SUPERVISION
Patricio Poblete, Gino Rivera

CONSTRUCTION SUPERVISION
Nino Marzolo, Marco Bernal, Patricio Salinas, Patricia Solar, Carolina Figueroa, Jorge Vásques, Paola Inostroza, Ximena Araneda, Patricio Arraigada, Hernán Barrios, Nino Marzolo, Héctor Minder.

PHOTOGRAPHY
Nicolás Saieh



ISTANBUL METRO

HEAD ARCHITECT
Guillermo R. Di Gregorio

ARCHITECTS
Borja Aróstegui, Luis Valverde, Pablo Viña, Juan Pommarez, Juan Estévez, Alejandra Sánchez, Mark Graham, Francisco Javier Aramendía

REAL ESTATE
Marc Potard

COSTS
Carmen Camarmo

STATION STRUCTURES
Raquel Navarro

GEOLOGY
Francisco Peral, Fabiola Fernández

HVAC
Jordi Coves, Alberto Cuadrado, Asier Anacabe

LIGHTING
Noemi Barbero

ELECTRICITY
Asier Anacabe

TELECOMMUNICATIONS
Joaquin Fernández, Rafael Ibeas

FIRE
Javier Borja

TRACTION
Jordi Coves

PASSENGER TRAFFIC STUDIES
Alexandre Augusto Santos

GRAPHIC DESIGN
Pablo Viña

SHEDS, WORKSHOP AND OFFICES BUILDING FOR THE ODENSE TRAM SYSTEM

HEAD ARCHITECT
Jesús Ángel Armendáriz

ARCHITECTS
Sara Oneto, Alvaro Aguirre

STRUCTURES
Gorka Viguri, Gonzalo Zarrabeitia

ENGINEER IN CHARGE OF MEP
Arturo Cabo

HVAC
Unai Ugalde

ENERGY EFFICIENCY AND SUSTAINABILITY
Blas Beristain

WATER
Alberto Ribacoba

ELECTRICITY
Miguel García

FIRE
Arturo Cabo, Mikel Bilbao, Javier Peñafiel

COMPRESSED AIR
Arturo Cabo

CLERKS
Maite de Vega

COMPUTER GRAPHICS
Roberto Fdez. de Gamboa, Alfonso Álvarez, Jon Alegría

NEW SAN MAMES STADIUM

HEAD ARCHITECT
César Azcárate

CUSTOMER LIAISON
Alberto Tijero

PROJECT DIRECTOR
Oscar Malo

PROJECT MANAGEMENT
Alexander Zeuss, Gontzal Martínez

ASSOCIATE ARCHITECT
Diego Rodríguez

ARCHITECTS
Ricardo Moutinho, Luis Ausín, Leyre de Lecea, Marc Rips, Nuno Lobo, Santiago Alonso, Rafael Papí, Zuriñe Nofuentes, Beatriz San Salvador

COSTS
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