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Photo: NASA Goddard Photo and Video

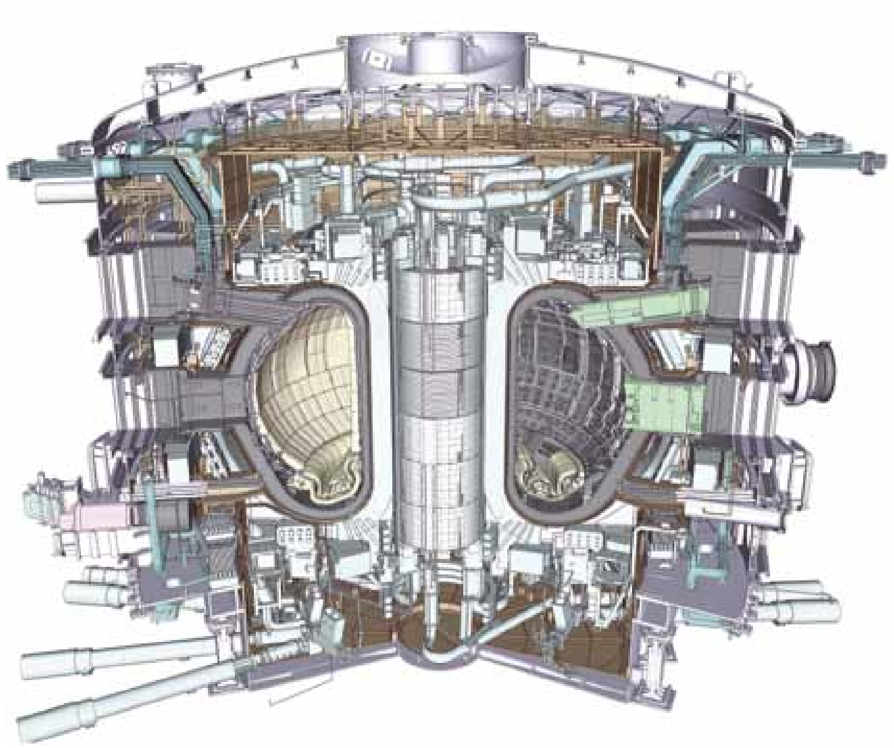
The ITER Project
At the core of the future of energy

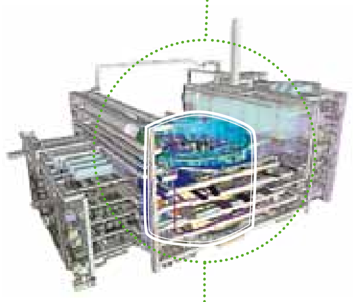
“We are collaborating in the design of an device, fundamental for this nuclear fusion experiment"

Fernando Rueda
Project Director

The aim of The ITER Project is to build a fusion reactor twice the size of the largest tokamak currently operating, with the goal of demonstrating the scientific and technical feasibility of fusion power.

It is a project being carried out between the European Union, China, India, Japan, South Korea, the Russian Federation and the USA. ITER will be constructed in Europe, at Cadarache in the south of France. The fusion reactor is expected to start operation in 2019.





Fusion reactors, deuterium - tritium

ITER, as a step towards DEMO

The ITER Project is essentially a large test-bed for new technologies which will form the basis of even more ambitious projects. If the experiment goes as expected, by 2050 DEMO, the first commercially exploitable fusion reactor will be commercially operational.

One of the key technologies be to tested in the ITER project is the so-called Tritium Breeder Blanket concept, which is one of the ITER missions and has been recognized as an essential milestone in the development of a future reactor. These devices have three three different functions: the extraction of heat from nuclear reaction; the regeneration of the tritium that acts as "fuel" for the reactor; and the protection of the key components of the reactor with respect to radiation.

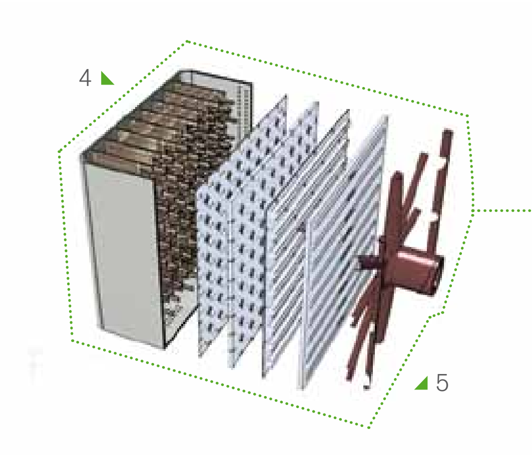
This device while apparently simple, consists of a an actively cooled hollow metal housing, within which material is regenerated enabling neutron multiplication and tritium generation.

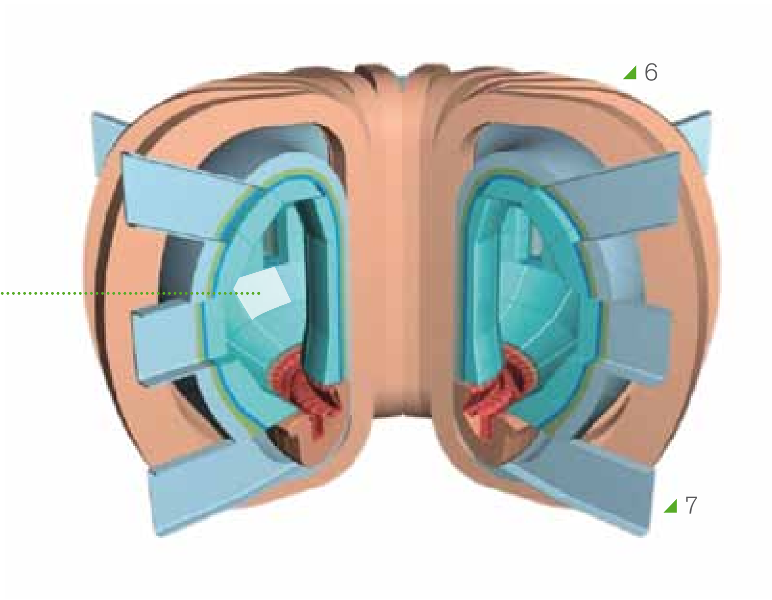
1/ The ITER Tokamak & Vacuum Vessel
2/ The Tokamak Complex
3/ The ITER Project site in Cadarache (France) with the Tokamak complex highlighted

Photo: © ITER Organisation

"The success of ITER depends on finding a design that ensures the self-sufficiency of the reactor in the production of tritium and extraction of heat from the core"

Fernando Rueda
Project director





Tritium Breeder Blanket.
Photo courtesy of Karlsruher Institut für Technologie (KIT) & Fusion for Energy (F4E)

- **4/** Inner side directly facing the plasma
- **5/** Connection to the Vacuum Vessel

Vacuum Vessel

- **6/** Toroidal field magnets
- **7/** Lower Ports

Generate tritium & extract heat

Tritium Breeder Blanket

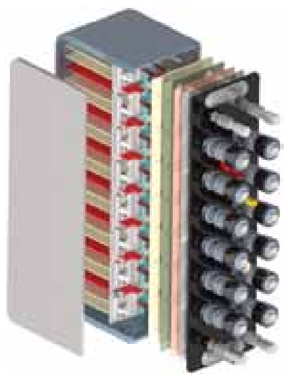
In future fusion reactors, the process will be to fuse two hydrogen isotopes, deuterium and tritium, to form a helium atom in an exothermic reaction, releasing energy which will then be used to produce electricity.

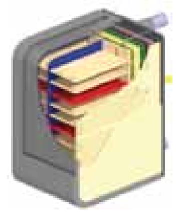
Tritium will therefore be the "fuel" and the reactor will need to continuously regenerate this isotope while extracting thermal energy from the heated plasma under conditions suitable for the production of electricity.

This function will be carried out by a device called a Tritium Breeder Blanket, a refrigerated "blanket" lining the inner chamber of the Vacuum Vessel and will be in direct contact with the plasma.

To understand the importance of the Tritium Breeder Blanket, suffice the say that the success of ITER will depend on finding a design that guarantees the self-sufficiency of the reactor in the production of tritium and the capacity to extract the heat generated.

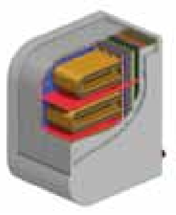
◢ **HCLL** Helium-Cooled Lithium-Lead



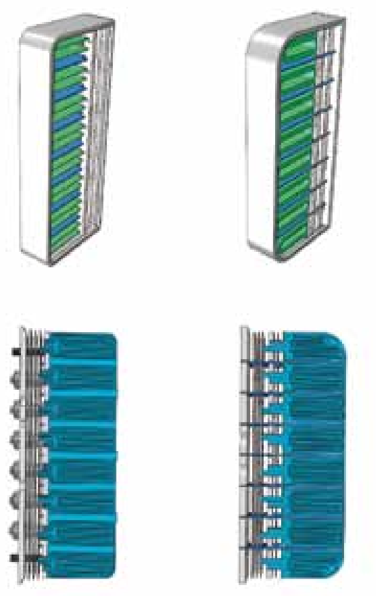


◿ **HCLL** sectioned view

◢ **HCPB** Helium-Cooled Pebble-Bed



◿ **HCPB** sectioned view



The two European designs for the Test Blanket Module (TBM), the HCLL and the HCPB will be tested simultaneously in the equatorial port #16 in ITER. Both will be inserted vertically into the "Port Plug Frame".

Two experimental devices
Test Blanket Modules

Over many years, up to six Tritium Breeding Blanket concepts have been developed. These devices have been designed in the form of metal modules (Test Blanket Modules, TBMs) and will be tested in the equatorial ports 2, 16 and 18 of ITER.

Europe is currently developing two test blanket modules to be tested in ITER. What both concepts have in common is their use of Eurofer steel structures, steel with low activation properties. Both designs also use the same cooling gas, helium at a pressure of 8MPa at temperatures ranging from between 300 to 500 ºC.

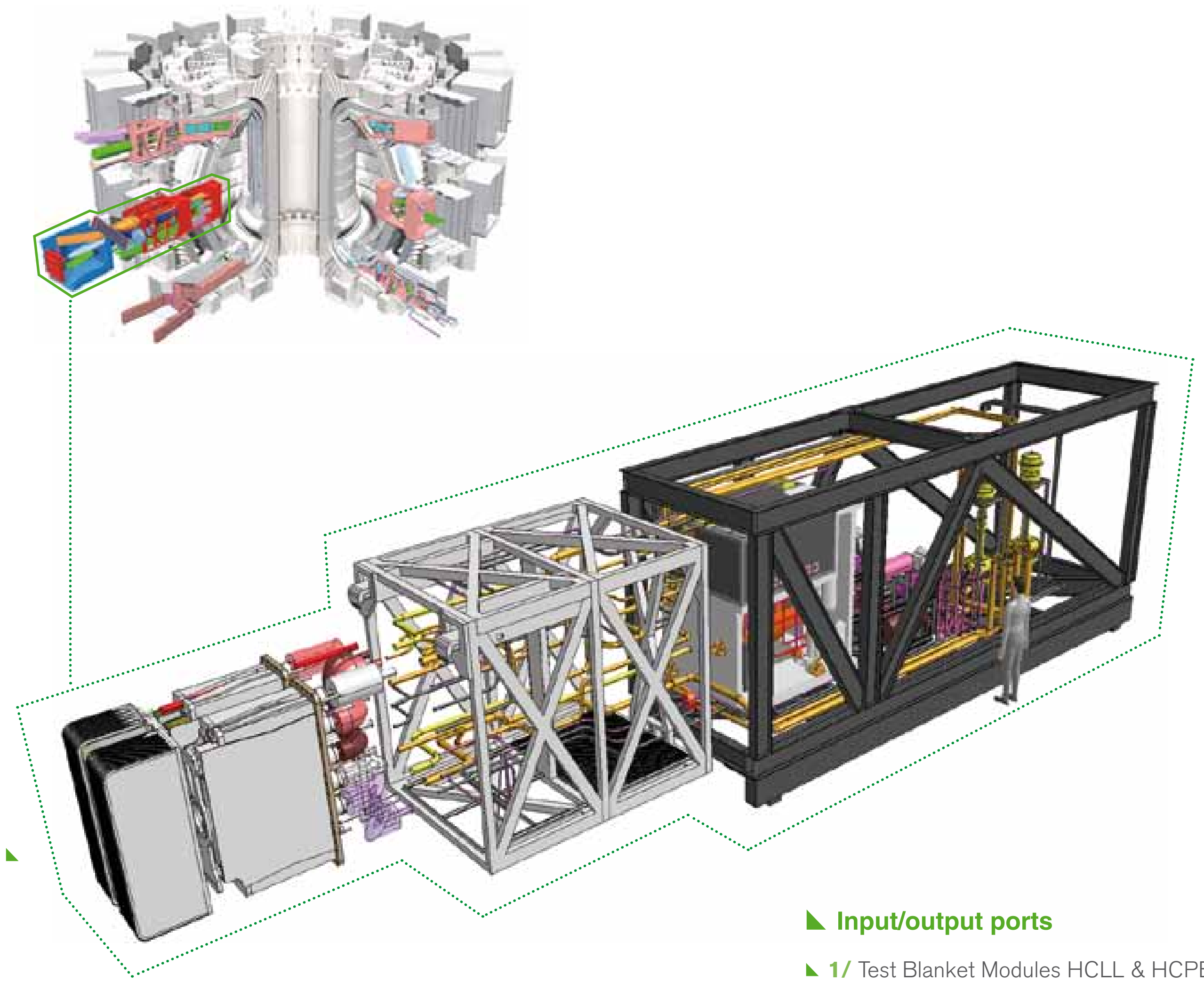
The difference between both designs is in the material used for the breeding of tritium and neutron multiplication.

1/ The concept of "Helium-Cooled Lithium Lead" (HCLL), uses a liquid lithium lead eutectic Pb-15.7Li (enriched in 6Li), and was originally developed by CEA (Commissariat à l'énergie atomique et aux énergies alternatives).

2/ The concept of "Helium-Cooled Pebble Bed" (HCPB) uses solid ceramic pebbles enriched with 6Li to breed tritium and beryllium particles for neutron multiplication, and was originally developed by KIT (Karlsruher Institut für Technologie).

A collecting system located at the rear of the Test Blanket Module (TBM) ensures the reception and distribution of helium to the various parts of the TBM, in a manner that optimizes the temperature of the device according to their function.

The tritium released from the breeder material contains impurities; therefore it is transported via a slowly circulating Helium purge stream or Pb-15.7Li flow through the external detritiation units where the tritium is recovered.



1 ◣

◣ **Input/output ports**

◣ **1/** Test Blanket Modules HCLL & HCPB

Assembling the Tokamak Building
Test Blanket Modules

The systems that make up the Test Blanket module are not just located in the reactor building but also in the other buildings on the ITER site.

The helium cooling system, for example is connected to the general heat rejection system.

The tritium extraction system is located in the port cell and the tritium building. The coolant purification system is located in the CVCS area.

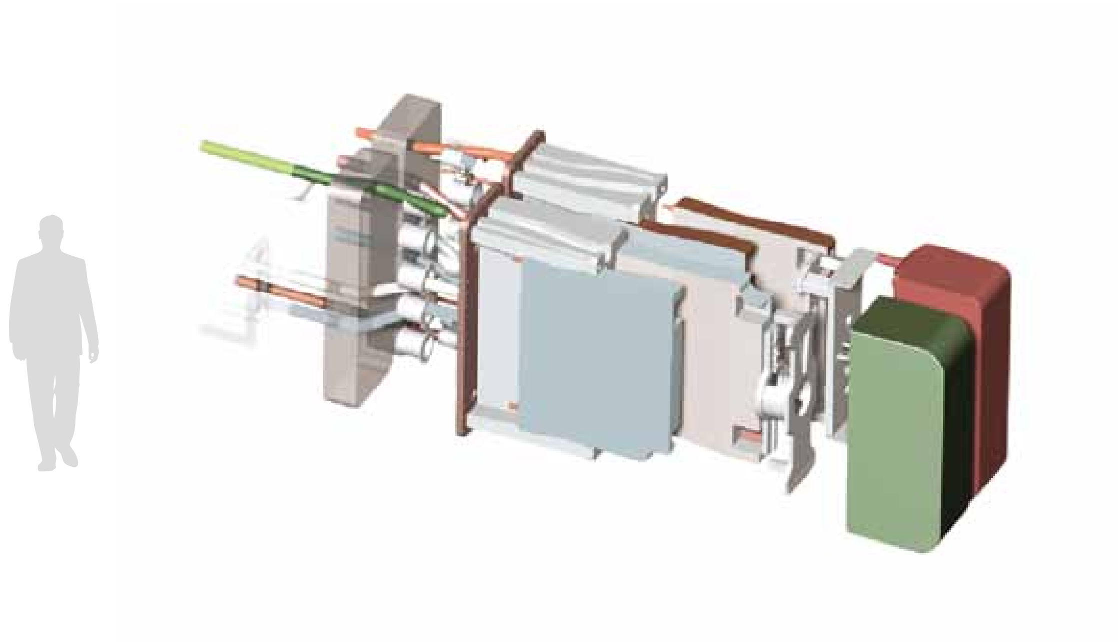
The main mechanical component of the test blanket module (TBM) is a steel box that houses the materials used both to regenerate tritium and multiply neutrons, as well as a series of heat extraction plates that come into direct contact with these materials.

A reinforcing grid in the interior provides the mechanical strength for the structure while segmenting it into cells that are used to house the reproduction and multiplying materials and the cooling plates.

These cells or boxes are assembled on the end of a steel beam of considerable length, meeting strict shielding requirements to house the diverse conducts from the Tokamak building to the vacuum chamber where the steel boxes are located, through the equatorial port in question.

Test Blanket Modules HCLL + HCPB

The principal stresses to which the TMBs will be subjected in ITER are mainly thermal due to the intense heat fluxes generated by the plasma and neutron deposition, and mechanical, due to the high pressure helium refrigerated system



Idom in the ITER project

Technical feasibility of the TBMs

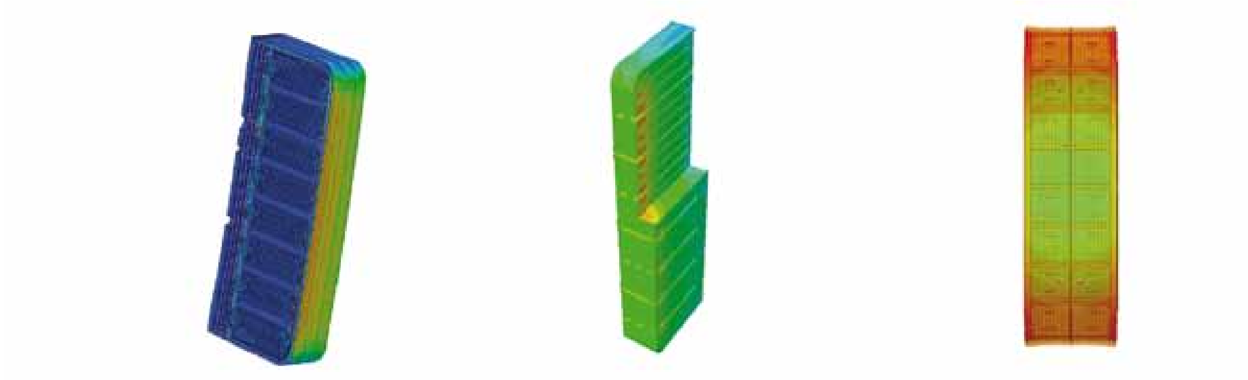
Idom is working in collaboration with Fusion for Energy (the European domestic agency within the ITER project), in the study of the technical feasibility of new TBM concepts in which ferritic-martensitic steel content (such as Eurofer) is reduced or eliminated. These recent studies have shown that the significant presence of ferromagnetic materials in the vacuum chamber, in quantity and location similar to that of the TBMs might hinder the fulfilment of certain objectives related to the control of plasma in ITER.

New design methodologies

The study of the technical feasibility of these new concepts goes far beyond the application of the conventional rules of design and calculations used in other industries, mature and backed up by decades of operating experience. The conclusions that must be used by scientists and engineers to support decision-making in research projects such as ITER, leading edge on a global level, are based on sophisticated analyses which determine the thermo-mechanical behaviour of the various component parts of the TBM under the main operating conditions and in the worst cases scenario of an accident. The main stresses that the TBMs will be submitted to within ITER will be of a thermal and mechanical nature. The thermal stresses arise from the intense heat fluxes on the inner face (directly exposed to the plasma) of the vacuum chamber and by the heat generated inside the TBM itself by neutron deposition. The mechanical stresses deriving mainly from the high pressure helium refrigerated system traverses the complex channels embedded in the steel box, stretching the length and breadth of the various plates that comprise the TBM. As such they must be manufactured by a sophisticated process of diffusion welding that is being tested by partial prototyping.

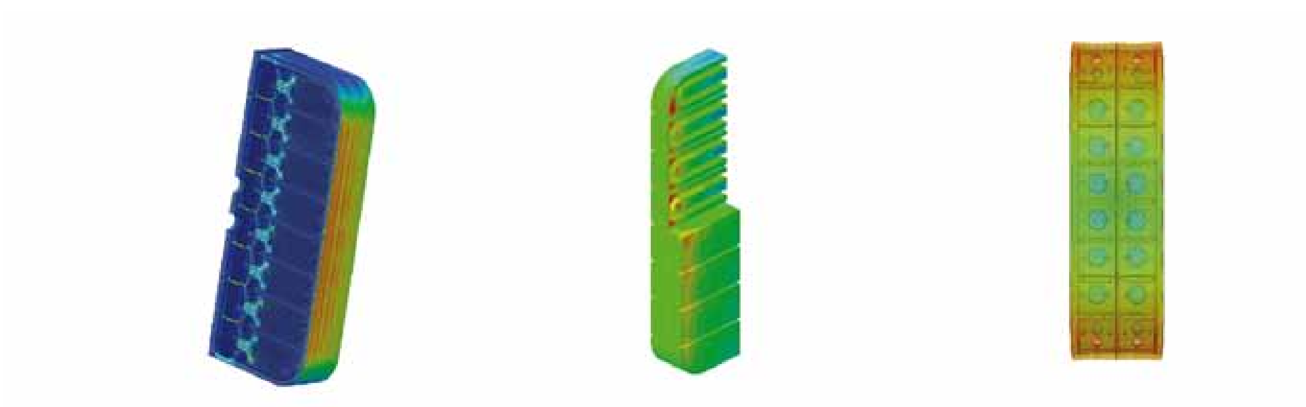
Thermal analysis

HCLL Helium-Cooled Lithium-Lead



Idom is studying the feasibility of the main components of the TBM, using advanced simulation tools

HCPB Helium-Cooled Pebble-Bed



Technical capacities

Idom is studying the feasibility of different design alternatives based on a global and coupled approach for all the major components of the TBM. This global approach relies on advanced simulation tools, some of which have been developed for the analysis of transient components, through the generation of ad-hoc calculations made by our engineers. This approach makes it possible to determine the overall performance of the TBM in relation to temperature and mechanical stresses at any instant within the operation cycle of ITER, including each of the numerous cooling channels. The possibility of the components developing failure modes such as plastic deformation, local instability (buckling) or fatigue is analysed and translated in terms of capacity to assess the feasibility of each of the proposed alternatives and as a consequence make decisions aimed at deciding on the final design which is technically feasible.

IDOM HEADQUARTERS IN BILBAO

Energy demand management

The management of energy demand and a reduction of CO_2 emissions is one of the main objectives set out by European Institutions for the coming decades.

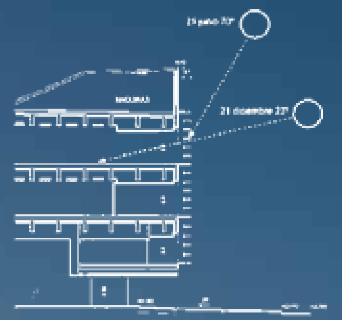
The building sector is being targeted by legislators, given that buildings are responsible for 40% of the total primary energy consumption in the European Union.

The Idom headquarters in Bilbao is at the forefront of a new approach to sustainable architecture. The building has earned the Class A energy performance certificate in accordance with the Spanish energy certification system (RD 47/2077), and is at the accreditation stage in the process of obtaining the LEED sustainable certification.

The following is an outline of some of the energy management strategies incorporated in this building project.

Solar protection

In addition to using high performance glass, the exterior has been clad with louvres whose design in relation to the solar elevation angle, allows light to enter in winter while providing shade in the summer.



Starting point

A Port Bonded Warehouse

At times, it is important to recognise the opportunity in a complicated situation. An existing building which for reasons of town planning regulations, must largely be conserved can normally be an obstacle for the development of a good design.

In the case of the Idom Corporate Headquarters in Bilbao, this complication was understood as an opportunity and it was decided to maintain not just the part of the building regulated by planning, but the building in its entirety. The decision to respect the structure of this imposing port warehouse was twofold: to significantly reduce CO_2 emissions during the construction phase (reduction in the use of cement and concrete structures), and to take advantage of the high inertia mass of the building by leaving the existing structure on view.

These energy saving strategies along with many others have been capitalized on in the design and choice of casing for the building, cooling systems and heat recovery equipment.

Solar protection

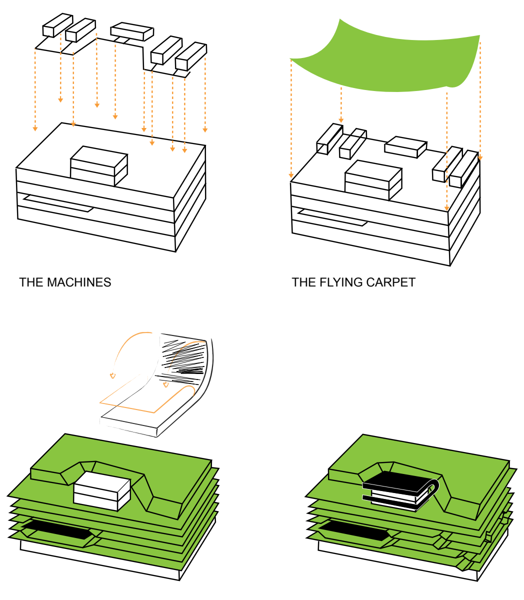
Façade design

When designing the façade of a building, it is necessary to consider the location and climatic conditions. The location of this building is subject to weather conditions which are for the most part cloudy.

Different glazing was chosen for each façade, achieving the best level of solar protection for the building, reducing solar heat gain from intense thermal radiation in the summer while still allowing a significant degree of penetration of visible radiation on cloudy days.

Roof design

Additionally the roof has been highly insulated using a combination of elements such as an area of artificial and natural grass with a dual deck “buffer” zone. This element has been used to house the machine rooms and separate the office floors from the roof which is sunny and in contact with the outdoors. It acts to mitigate heat reduction the energy demand in the building.



Luminosity and lighting

Form factor

The original building had a good form factor rating (Surface-area-to-volume ratio). This was a characteristic which was considered in the passive design strategy for the building, as a key to good overall thermal performance.

On that basis, a design taking full advantage of natural light was produced, resulting in significant savings in the energy used for lighting. In addition, high efficiency lighting, adjusting to the brightness levels of the natural radiation conditions was used throughout. The lighting installation is equipped with motion detectors to avoid unnecessary consumption.

Following the initial six month trial period, during which the lighting usage was monitored, measured and recorded, the actual lighting energy consumption is now less than 5 W/m^2 (based on the gross area of the building).

Demand Reduction

Heat recovery systems

Due to the high internal gains (people, equipment, etc.), air conditioning is one of the most important factors affecting energy consumption in an office building. To achieve a reduction in consumption, it is necessary to focus on two aspects: reducing the demand of the building and minimizing the use of mechanical devices associated with the air conditioning systems (fans, pumps, etc.).

In a complex building located in a mild climate, it is normal for zones to exist that require heating while others require cooling. Thanks to the heat recovery system, it is possible to transfer energy between areas which depending on the sunlight or level of activity have different demand requirements.

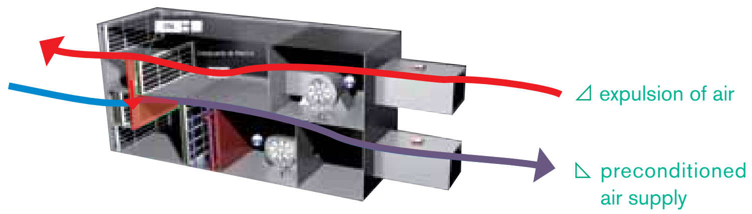
Transfer of energy

Some situations in which mixed demand is required (heat in one area and cold in another) were identified: for example, in the data processing centre, the south facing façades and some interior areas with a high concentration of people and computer equipment may require cooling, meanwhile the areas with façades facing north and east, the auditorium and other rooms with low usage might require heating.

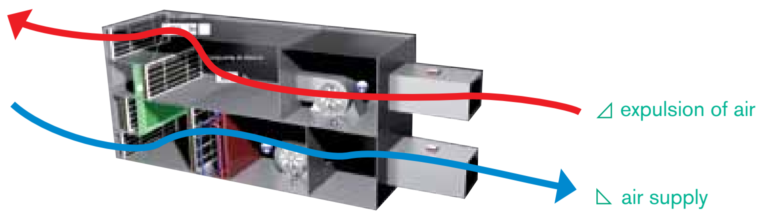
This transfer of energy between zones that demand heat and those that need cooling considerably reduces energy consumption.

The cooling of the data processing centre (DPC), for example, allows the recovery of a large amount of heat during the day, which is then used by the main air conditioning system to heat colder areas of the building. This system switches off automatically at night, and the job of cooling the DPC is taken over by a smaller cooling unit, meanwhile the main system remains in a state of reserve for emergency situations.

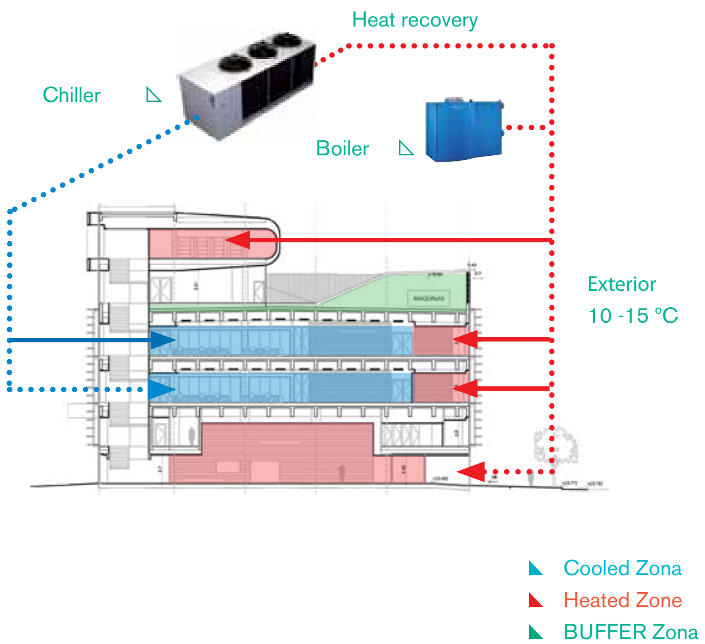
HVAC in heat recovery mode



HVAC in free cooling mode



Transfer of energy



The free cooling system takes advantage of the external thermic conditions in a mild climate, drawing in external air to cool spaces within the building.

Transfer of energy

During working hours, the data processing centre produces a great amount of heat which can be transferred to colder zones in the building. At night the transfer system switches off automatically.

Demand reduction

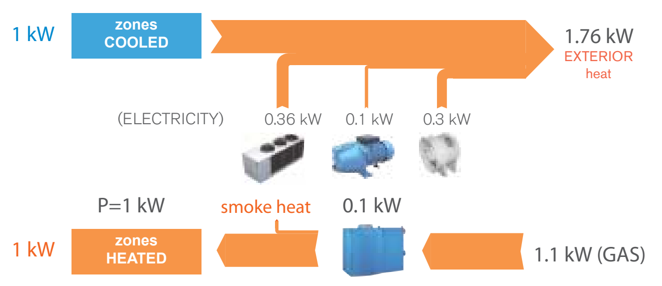
Minimizing the consumption of refrigeration equipment

VARIABLE FREQUENCY

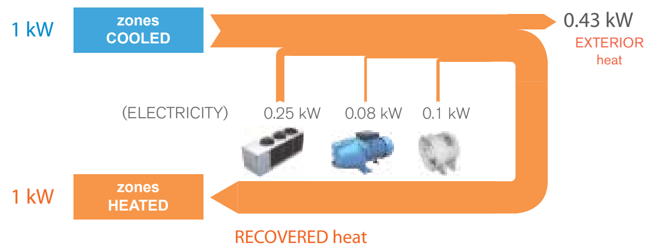
The thermal demand of the building is not constant throughout the day. A conventional system addresses this variability by increasing the amount of water and air in the system while the drive motor continues to operate at full speed. The drives installed to control the pump and fan motors regulate power usage based on demand, resulting in energy savings of between 35 to 50 % compared to constant speed devices.

A reduction in the energy consumption of the refrigeration equipment has been obtained by minimizing the unnecessary use of fans and systems, while using moderate heat levels in refrigerants and incorporating inverters for pumps and fans.

Normal circumstances: consumption 1.86 kW/kW



Situation idom: consumption 0.41 kW/kW

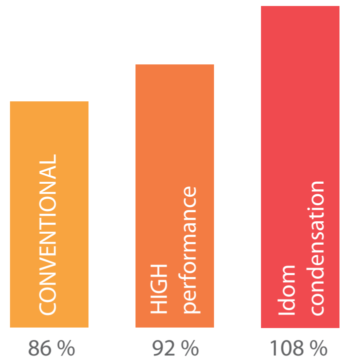


HIGH EFFICIENCY EQUIPMENT

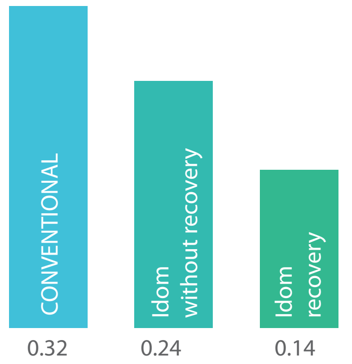
Another of the basic elements used to minimise consumption has been the installation of the high-efficiency equipment.

The main chiller has a high EER which is significantly improved even when the chiller is operating in heat recovery mode, resulting in extremely low seasonal consumption.

In relation to the production of heat; besides the recovery of heat obtained from the chiller, two condensing boilers have been installed. This type of boiler gives an output which is higher than 100% of the minimum inferior calorific value, as it also captures some of the energy from the condensation of gasses released in the chimney flue.



Bioler efficiency based on NCV



Chiller kW consumption e/kW (thermal)

Comparison of the performance of conventional equipment in relation to that used in the Idom building in Bilbao

“We want the office worker to have the feeling of working in a comfortable microclimate, as though they were working under a cluster of trees”

Javier Pérez Uríbarri
Architect

The chilled beams

In open areas, it was decided to leave the existing building structure on view, a type of harbour loft design. Between the structural beams of the building the chilled beams, seamlessly integrate the normally bulky air conditioning system.

A cold water pipe runs along the length of the inside of the chilled beam and cools the inner coils and the perforated metal casing of the beam itself. This creates a space where natural air convection occurs. When the hot air that rises comes into contact with the chilled beams it cools, becoming denser and descends. This system of diffusion by displacement dose not requires fans or mechanical parts, is completely silent and does not create troublesome draughts. All of which makes for a system which is highly comfortable.

This system offers a high level of performance and efficiency as the installation operates at temperatures between 15 and 18º C, very close to the set point, thereby greatly reducing energy consumption in cooling mode, normally required in internal working areas.

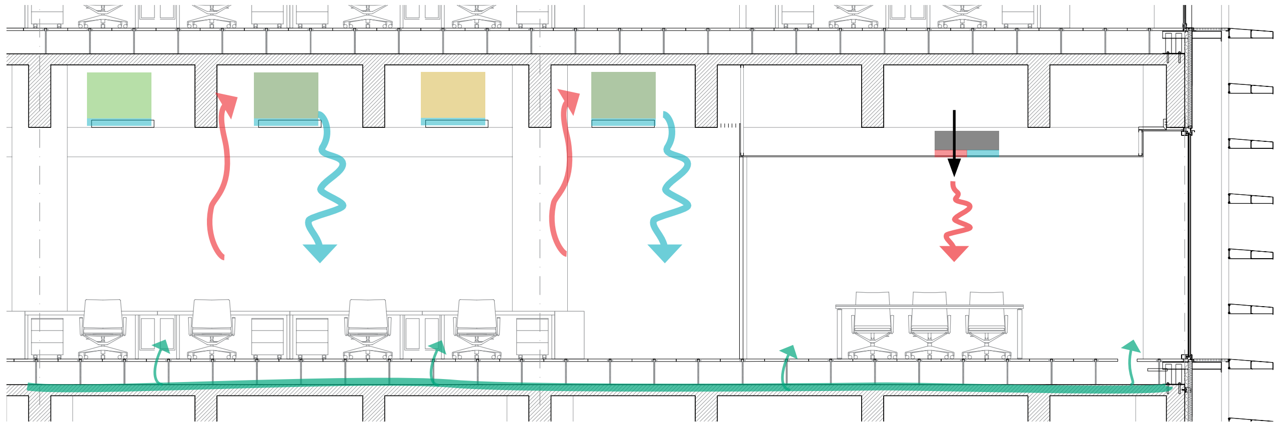
RENEWABLE ENERGIES

The building also uses renewable energy in the form of photovoltaic panels.

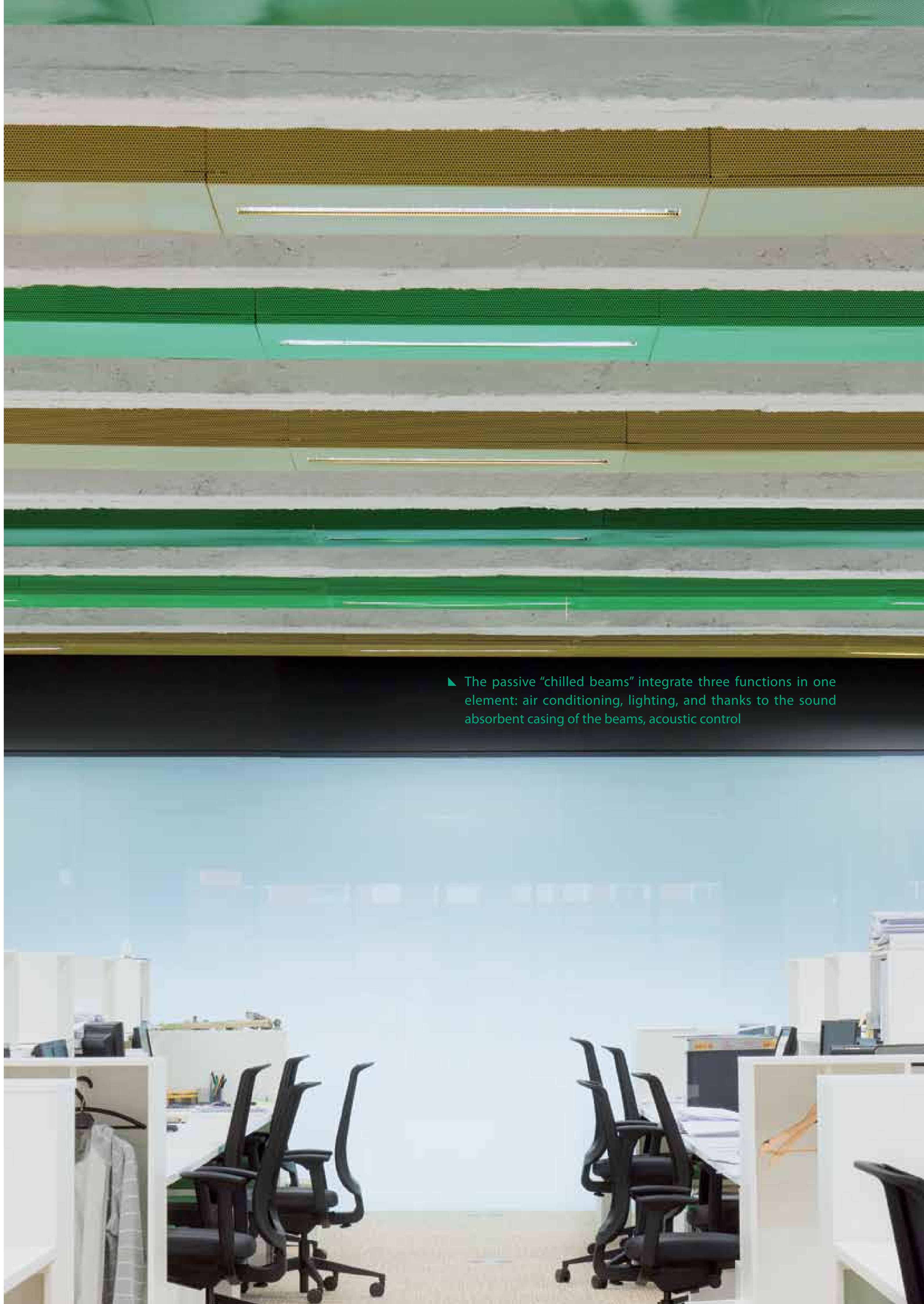
CLIMATE CHANGE

The building is a pioneer in Spain, incorporating criteria for adaptation to global warming. This criterion is based on an analysis of the risks of climate change carried out by Idom in collaboration with the University of Exeter during the design phase of the project.

- Forced convection
- Warm air
- Cool air
- Primary air



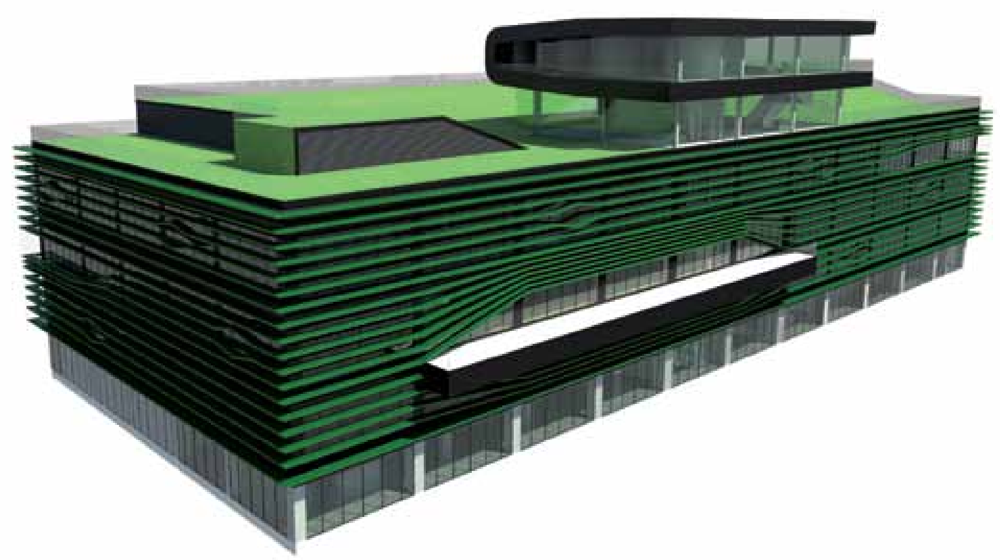
The central areas are serviced by passive chilled beams. In perimeter areas where thermal fluctuations are constant, we have opted for a system of inductors.



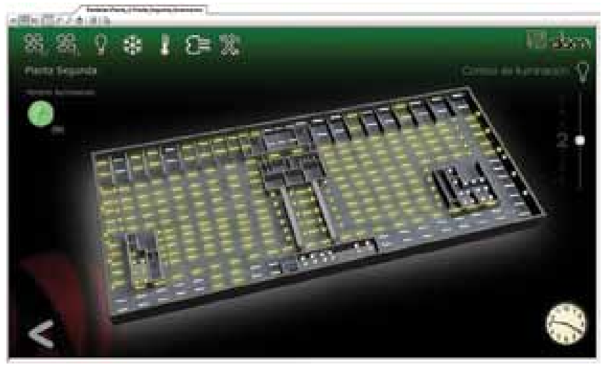
The passive "chilled beams" integrate three functions in one element: air conditioning, lighting, and thanks to the sound absorbent casing of the beams, acoustic control

BMS. Building Management System

Centralized technical management system



Lighting control



Air handling unit control

Terminal Unit control

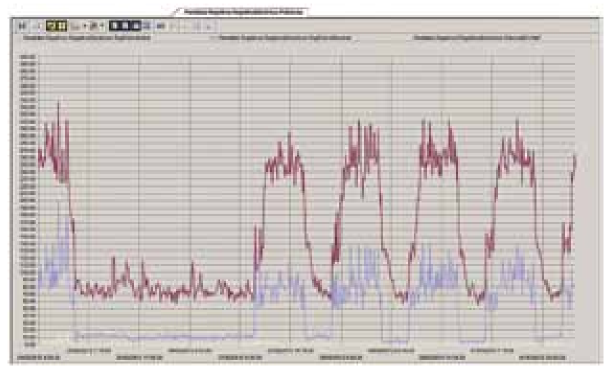
General Temperature control

Chiller control

Boiler Control

Consumption and emission control

Consumption monitoring



Monitoring and control

Real-time disaggregated system data

Energy Consumption Monitoring is the basis for energy management. In order to identify inefficiencies, control must occur in real time and by areas.

The management of this information conforms to the international energy management system standard ISO 50001, involving the organisation as a whole, which in most cases requires a change in consumer habits. The adoption of these standards means that the building should obtain energy efficiency ratings similar to those of other monitored buildings conforming to ISO 50001.

In line with this energy management standard, the monitoring of the building will include a breakdown of energy consumption by surface area, persons, and equipment. The results obtained will permit the detection of incorrect operation or use of the system (excessively high or low temperature, etc.). Monthly reports are produced including graphs presenting historical data on energy consumption and CO_2 emissions which can then be compared to reference levels.

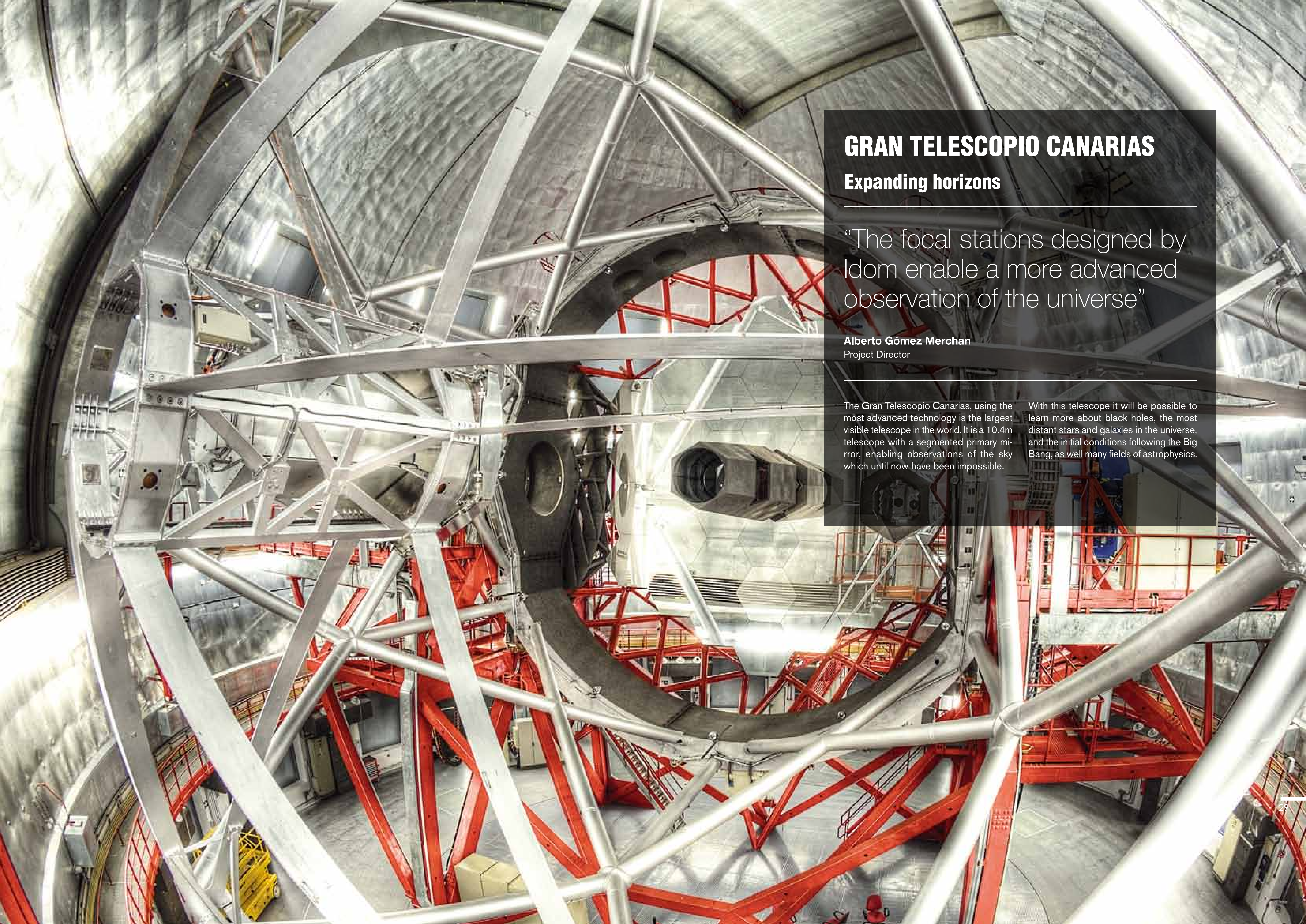
In the initial months of operation during the last quarter of 2011 and early 2012, the recorded consumption of HVAC (heating and cooling), lighting and production of sanitary hot water has been 16 W/m^2 during working hours, indicating an annual electricity consumption of 72 kWh/m^2 and annual gas consumption of 9 kWh/m^2, levels that position the building among the most energy efficient buildings in Spain.

Tendencies for the future

European Union Objectives

In 2010, the European Union issued a directive (2010/31/UE) setting out ambitious targets for energy savings and emission reduction through the promotion of efficient buildings, the energy management of these buildings through the use of ESCOs (Energy Saving Companies).

Idom is taking these objectives very seriously, and has set out to incorporate them in the design of their corporate headquarters in Bilbao and Madrid, capacitating Idom to offer its clients the experience gained in the reduction of CO_2e, environmental comfort, and all aspects included in the more general term of “sustainability”.



GRAN TELESCOPIO CANARIAS

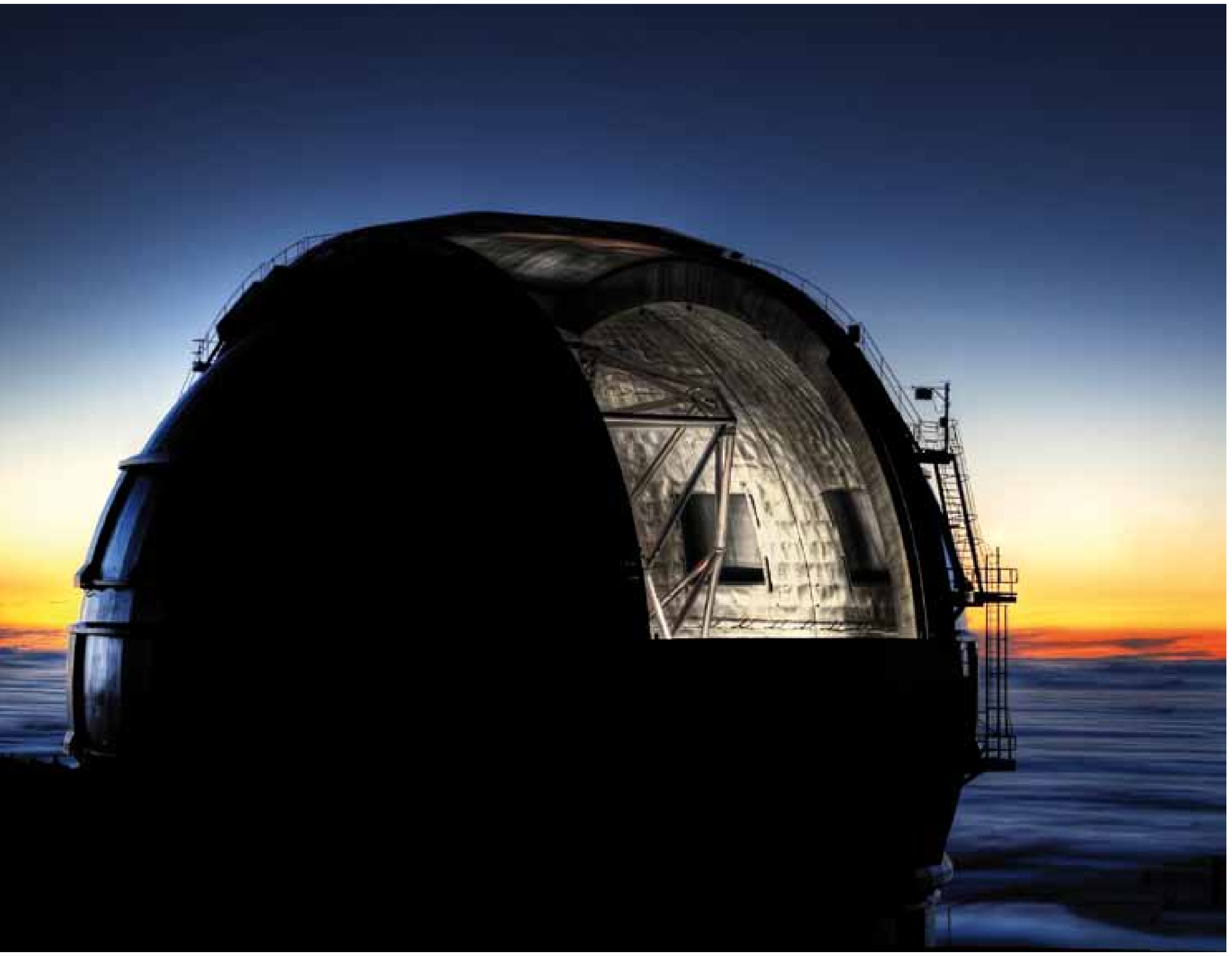
Expanding horizons

"The focal stations designed by Idom enable a more advanced observation of the universe"

Alberto Gómez Merchan
Project Director

The Gran Telescopio Canarias, using the most advanced technology is the largest visible telescope in the world. It is a 10.4m telescope with a segmented primary mirror, enabling observations of the sky which until now have been impossible.

With this telescope it will be possible to learn more about black holes, the most distant stars and galaxies in the universe, and the initial conditions following the Big Bang, as well many fields of astrophysics.



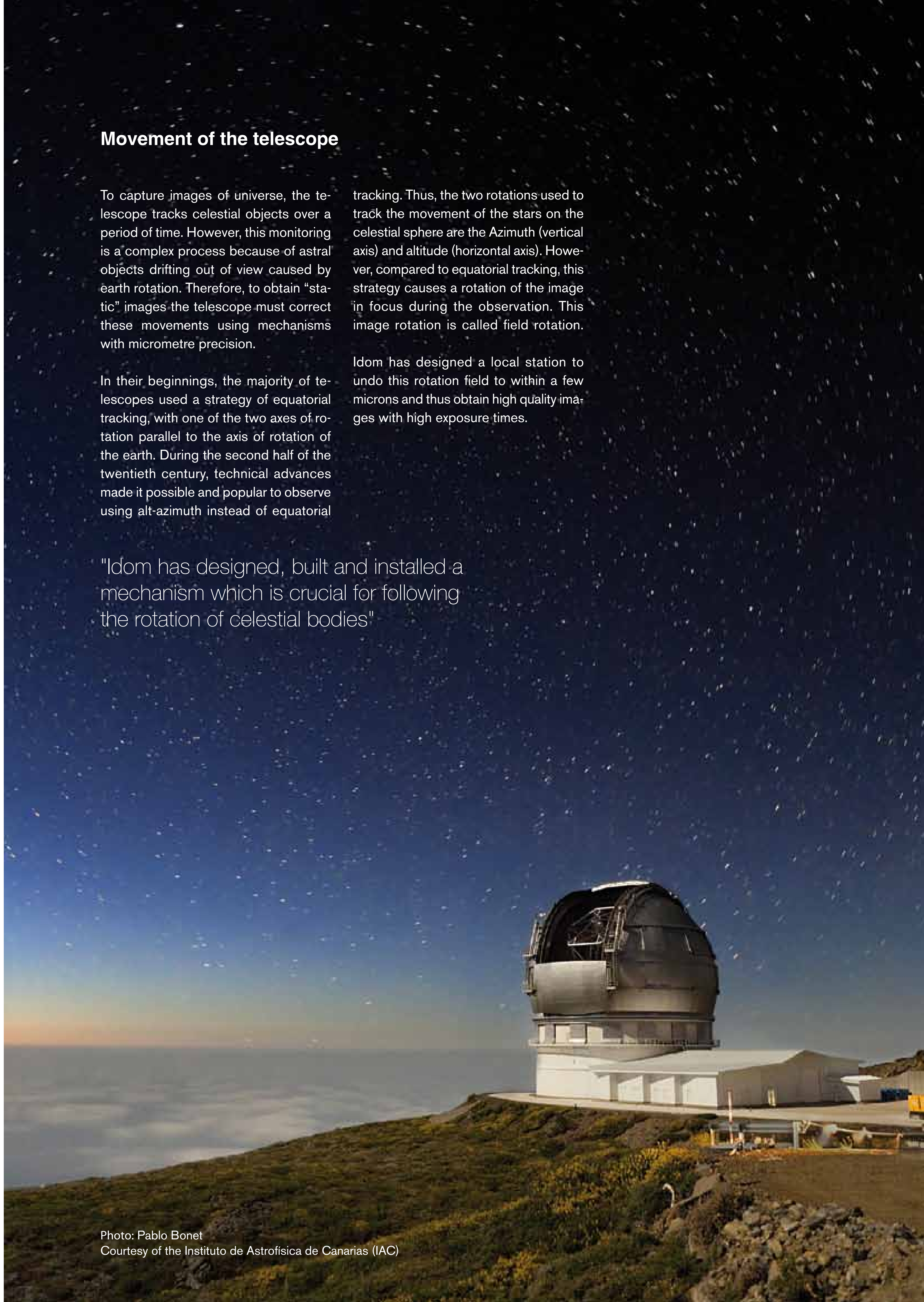
A tool with great potential

The telescope is situated at the Roque de Los Muchachos Observatory, (La Palma, The Canary Islands), a location that offers optimal conditions for observation because of the quality of the night sky and meteorological conditions.

This Project which has been considered a success since its launch in July 2007 is being led by the Institute of Astrophysics of the Canary Islands.

However, there is still plenty of scope for technological development in the project, mainly the incorporation of new instruments which will permit increasingly sophisticated observations.

Idom has designed, built and installed a mechanism that is considered crucial for the incorporation of new instruments. The following is a description of this process.



Movement of the telescope

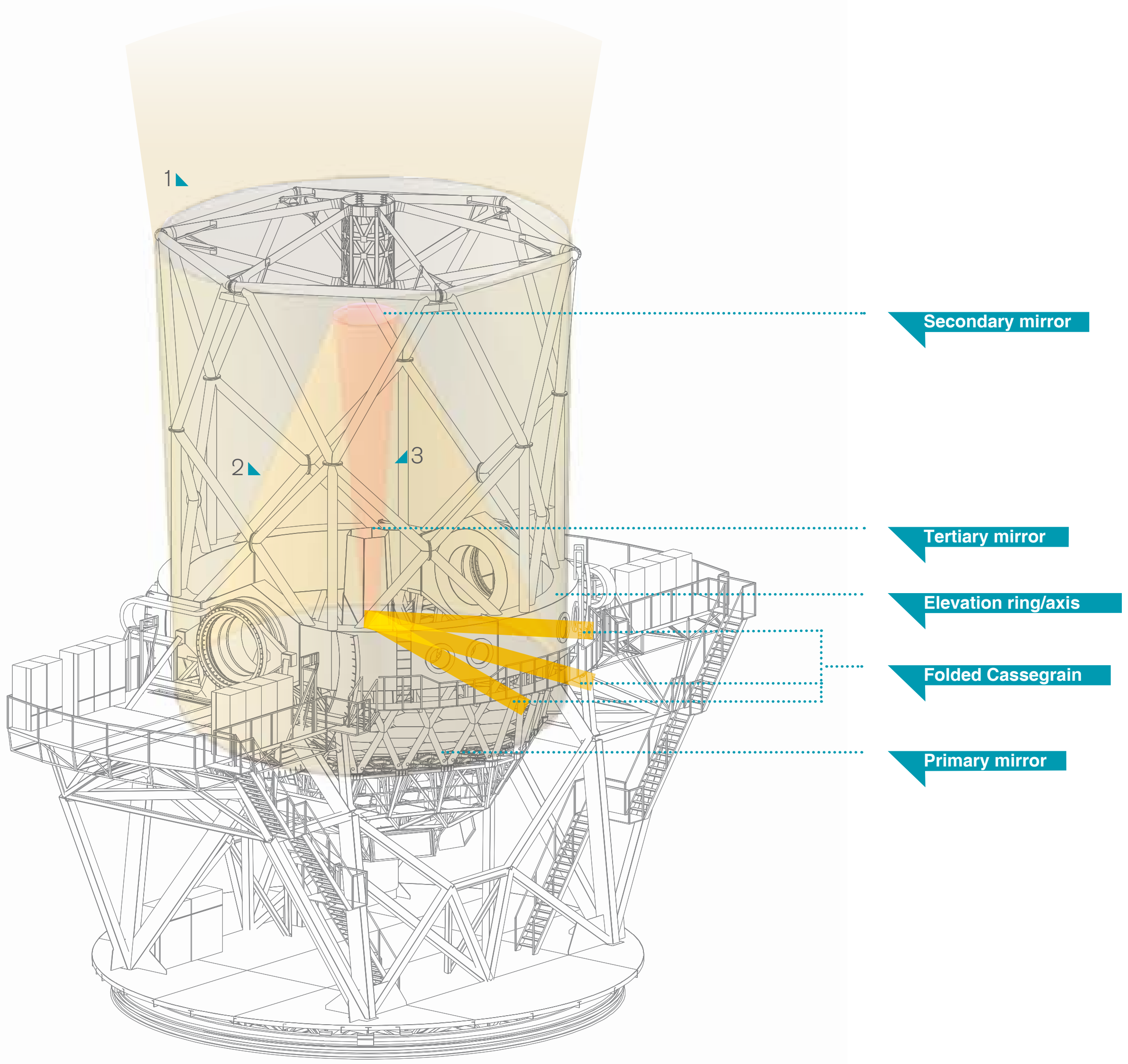
To capture images of universe, the telescope tracks celestial objects over a period of time. However, this monitoring is a complex process because of astral objects drifting out of view caused by earth rotation. Therefore, to obtain "static" images the telescope must correct these movements using mechanisms with micrometre precision.

In their beginnings, the majority of telescopes used a strategy of equatorial tracking, with one of the two axes of rotation parallel to the axis of rotation of the earth. During the second half of the twentieth century, technical advances made it possible and popular to observe using alt-azimuth instead of equatorial tracking. Thus, the two rotations used to track the movement of the stars on the celestial sphere are the Azimuth (vertical axis) and altitude (horizontal axis). However, compared to equatorial tracking, this strategy causes a rotation of the image in focus during the observation. This image rotation is called field rotation.

Idom has designed a local station to undo this rotation field to within a few microns and thus obtain high quality images with high exposure times.

"Idom has designed, built and installed a mechanism which is crucial for following the rotation of celestial bodies"

Photo: Pablo Bonet
Courtesy of the Instituto de Astrofisica de Canarias (IAC)



The path of light inside the telescope

The instruments designed by Idom deal with the correction of this movement, the rotation of celestial objects. These instruments are called "Field Rotators" and must be located at the point where the light of the telescope converges, the Cassegrain and folded Cassegrain foci.

The beam of light from the sky is reflected by the primary mirror to the secondary mirror and when necessary to a tertiary mirror. The points where the beam of light converges are called foci and are the specific locations where the instruments to be used for analysis will be installed. Basically these are "Cassegrain", "Folded Cassegrain", and "Nasmyth" foci, taking their names from their respective inventors.

Grantecan has been operating successfully with the instruments installed in the Nasmyth foci since the first light. However, early on, a process to increase its observation capacity was initiated making it necessary to develop the necessary devices to use the Cassegrain and Folded Cassegrain Foci.

1/ Light from the universe enters the telescope
2/ The light strikes the primary mirror is then reflected to the secondary mirror
3/ Once the light is reflected to the secondary mirror, a cone of light travels to the tertiary mirror and depending on its position, the beam of light is deflected is to the "Nasmyth", "Cassegrain" or "Folded Cassegrain" foci

The Cassegrain Foci

The French researcher Laurent Cassegrain improved on the Newton telescope by adding a hyperboloid mirror which focused the light beam on a focal point behind the primary mirror, therefore allowing the centre of mass of the telescope at the base.

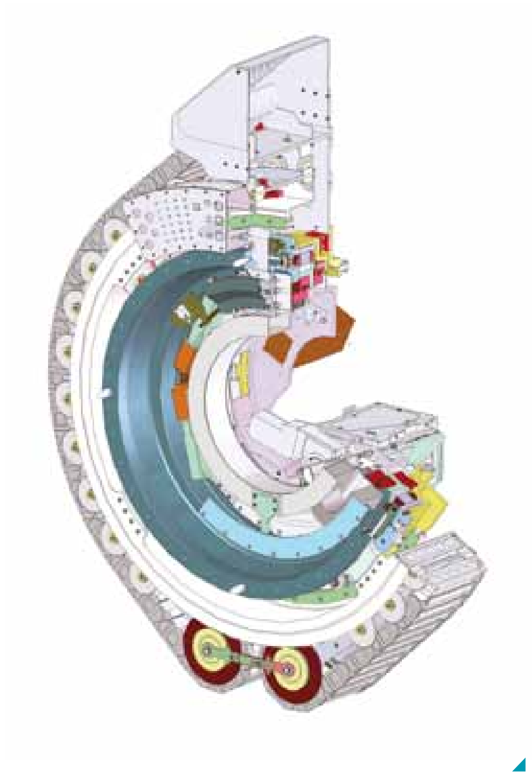
This is the basic configuration of the Grantecan telescope, however, using an advanced design incorporating segmented mirrors and active optics to correct gravitational deformation, and the use of new materials and new reception instruments.

It was decided to first develop the bent Cassegrain foci in order to install the first and second instruments such as Canary Cam, Megara and Miradas.

In 2010, Grantecan commissioned Idom to carry out the detailed design and supply the two Folded Cassegrain sets. In the same year, Idom carried out the design work including a review of the preliminary design and the critical design.

Photo: Pablo Bonet
Courtesy of the IAC

1



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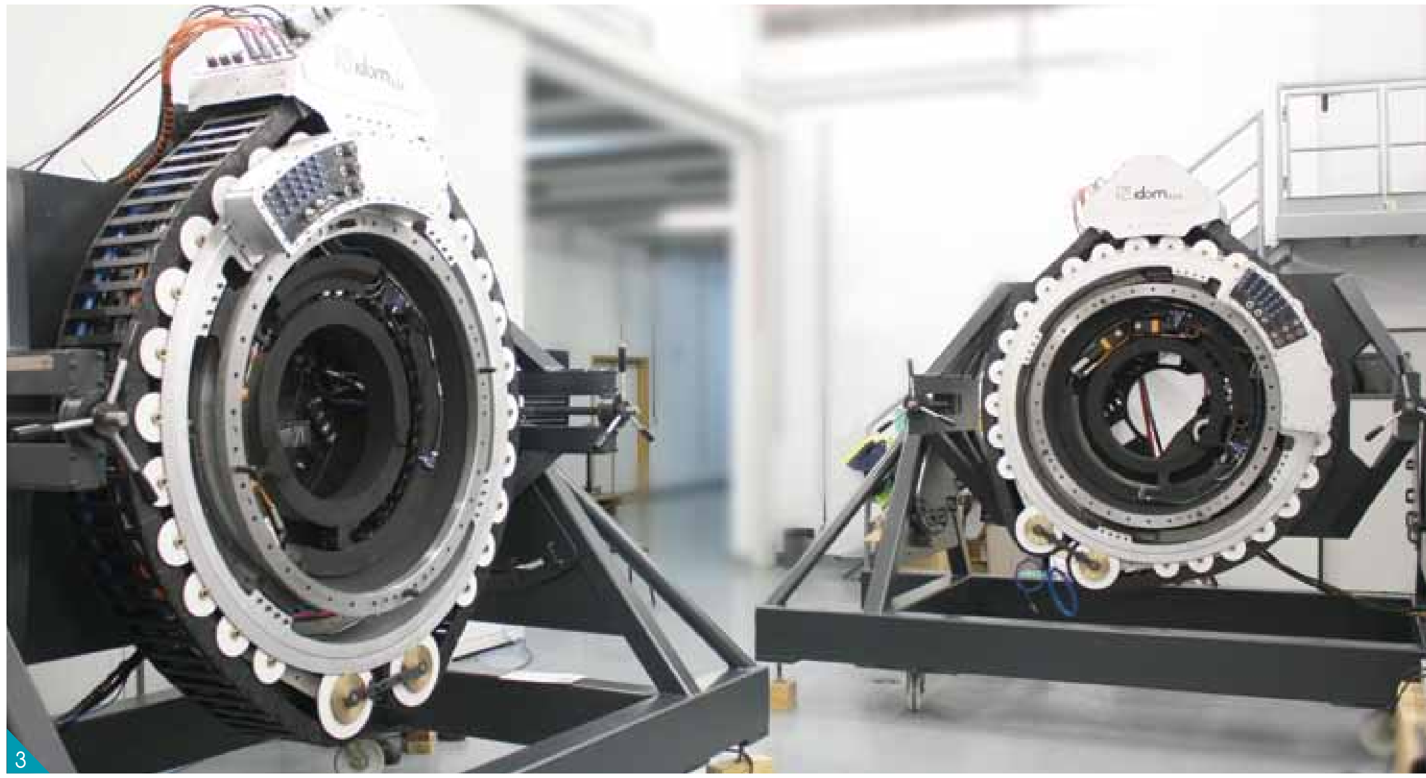


3

Design Requirements

The Folded Cassegrain sets (FC-Sets) that have been designed by Idom are opto-mechanical components which provide the folded Cassegrain foci with the capacity necessary to install and operate the planned observation instruments.

The units must satisfy three fundamental requirements:

1/ Undo the rotation of the field of the image, as mentioned before, due to the rotation of the earth and the tracking algorithm alt-azimuth mounts, the field of view (image) on the image rotates. The focus is designed to undo this rotation and obtain high quality images with high exposure times.

2/ Provide services (electricity supply, communications, helium, water, etc.) for the instruments taking into account that these rotate in front of the telescope.

3/ Provide the telescope with the necessary feedback information to track the celestial objects being studied.

The design of Idom

The design being proposed by Idom comprises of a Direct Drive Permanent Magnet Synchronous Motor with a precision bearing to guide and rotate the instrument.

In turn, supply-line guide chains designed by Idom provide the instrument with all necessary services. The innovative design is based on an adjustable intermediate structure of guide rollers incorporating supply lines while offering smooth and controlled movement. The design has resulted in a significant reduction in weight and complexity of the component, as the need for an auxiliary drive motor has been eliminated.

Features

The system operates at a maximum positioning speed of 2.5 rpm with a 2 arc second accuracy. The turning range of the cable rotator is 530º.

An additional system which offers acquisition and guiding capabilities is composed of a turntable design based on precision gears driven by servomotors with an anti-backlash configuration. A rotary stage and linear stage (both commercially available) allow the Acquisition and Guiding Optics to target and focus.

This system takes a maximum of 10 seconds to position itself, with a positioning accuracy of 16 microns and an all-night stability of 70 microns.

Construction & assembly

Once the design was approved in November 2010, the process for the procurement of commercial components was launched along with the manufacture of the components that make up the telescope. In June 2011, the assembly was completed and preliminary tests were carried out. The final assembly was subsequently completed in October 2011, with the factory acceptance tests were approved in November 2011.

In December 2011, the two units were delivered at the facilities of the Gran Telescopio Canarias at the observatory of Roque de los Muchachos on the island of La Palma. During December 2011 and January 2012 the acceptance tests were carried out on-site and were approved in February 2012.

1/ Folded Cassegrain Foci
2/ Section of the Folded Cassegrain Focus
3/ Delivery of the rotators at the Grantecan facilities

INNOVATION IN THE CONTROL SYSTEM FOR FUTURE COMBINED CYCLE PLANTS

Fieldbuses for General Electric Standard Plant

Over recent years, General Electric (GE) has been designing equipment (GE 9FB gas turbine, 109D-14 steam turbine and W28 generator) that will set a new standard for combined cycle power plants which are both efficient and flexible, achieving performance levels over 61% higher than the base load.

The turbines have been designed to work in an integrated manner with other renewable sources (solar, wind, etc.), that is, flexible in their operation, adapting the variability of these complementary sources.

The complexity of this system prompted General Electric to look for an engineering company to develop a standard plant design which is optimal, yet flexible (a 510 MW single-shaft platform), guaranteeing the correct integration of their equipment. The company selected for this task was Idom.

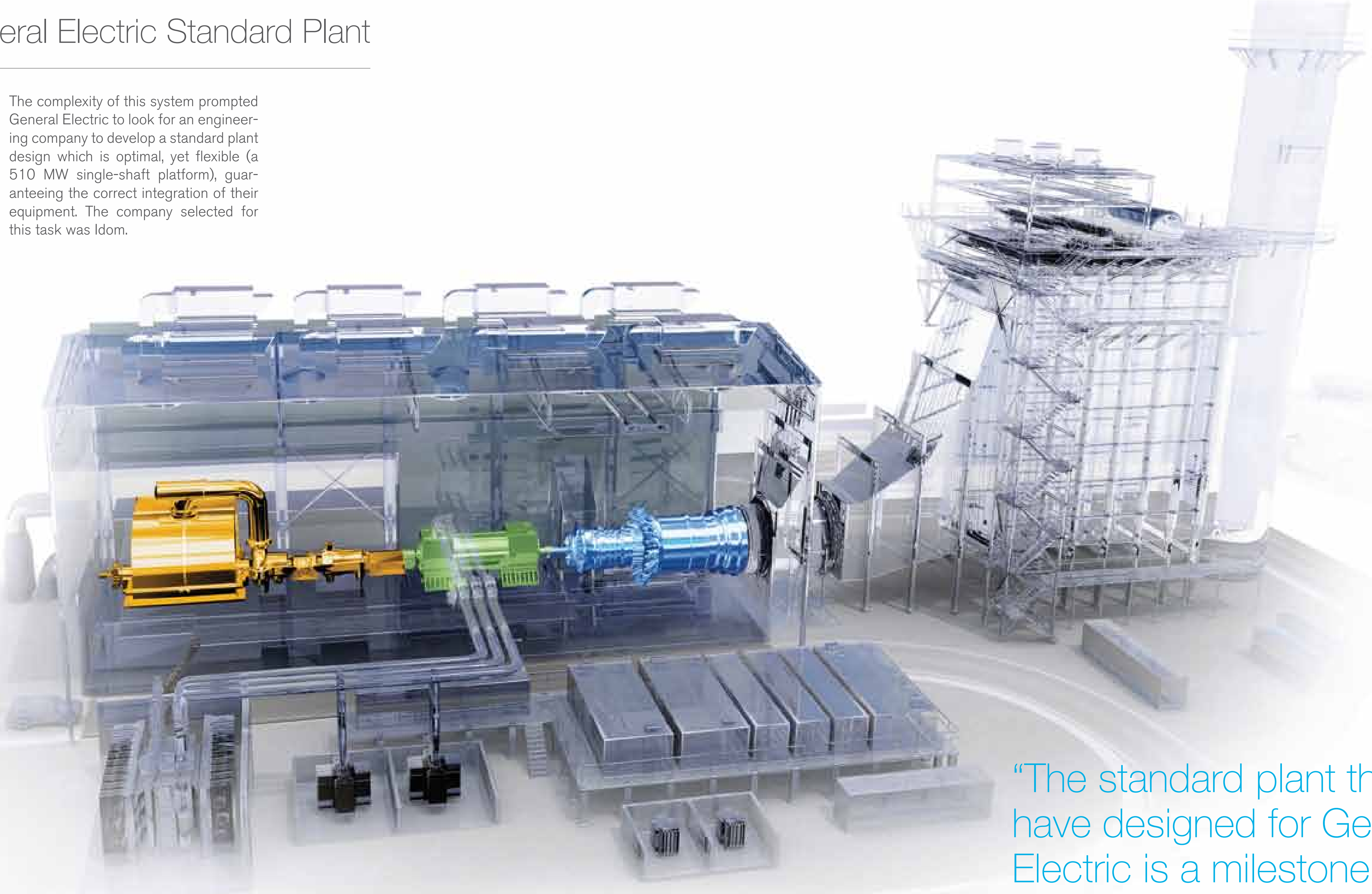


Image courtesy of General Electric

“The standard plant that we have designed for General Electric is a milestone in the construction of Combined Cycle Power Plants”

Imanol Urquiaga
Project Director

A response to market needs

Flexibility & efficiency

The new generation plant, FlexEfficiency™ 50 meets the needs of the customer; a rapid response to power demand, with a 50 MW per minute ramp rate and capacity to reach the baseload in just 30 minutes with 60% efficiency down to 87% of load, and up to 61% efficiency at baseload with guaranteed emissions from 40% load.

The plant will mean annual fuel savings of 6.4 million cubic meters of natural gas (equivalent to the consumption of about 4,000 households) with respect to a power plant of similar output (510 MW), using current technology, and a reduction in emissions of more than 8.7 tons of NOx, and 12,700 tons of CO_2 (equivalent to the CO_2 emissions of some 6,400 cars).

As mentioned, the system can work in an integrated manner with other renewable sources (solar, wind, etc.), and provide reliable energy production to the network smoothing out the peaks and valleys that occur with renewable energy production. Therefore, the baseload efficiency of an integrated solar combined cycle plant would be 70%.

Plant design & product development

Multifunctional & innovative design

To ensure the integration of the equipment developed by GE with the standard FlexEfficiency™ 50 plant, it was necessary to produce an optimal, constructible design for the combined cycle power plant.

The design produced by Idom has considered possible configurations based on different cooling methods (cooling towers, air cooled condensers or open circuit), and has been carried out simultaneously with the final development of the new GE equipment.

This simultaneity has permitted the exchange of data, therefore improving the integration and maintenance of the plant equipment. As a result, the GE equipment has evolved.

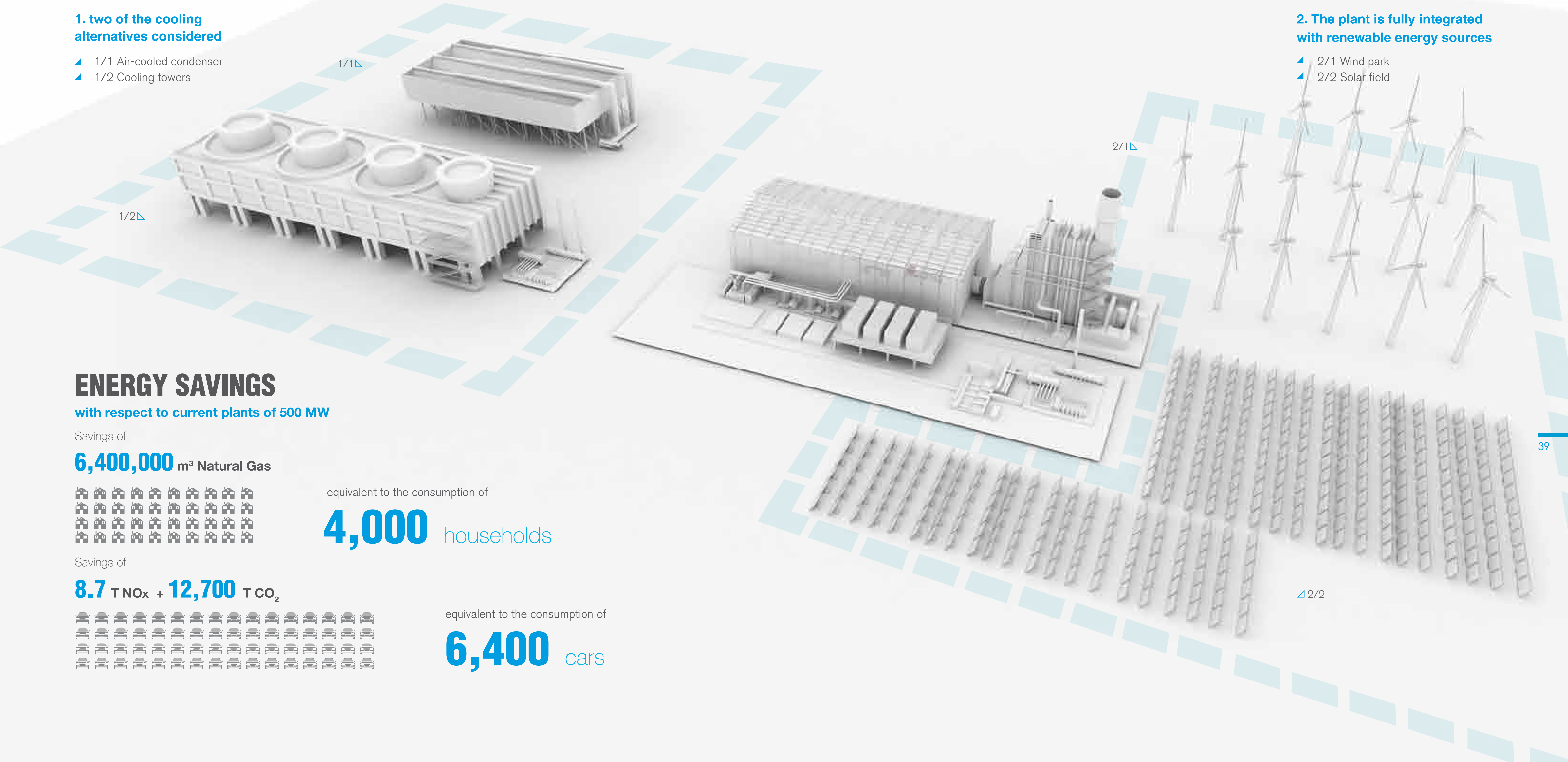
While this chapter does not detail all the improvements made, the many options considered or the analysis carried out to ensure that this innovative plant truly meets expectations; it is important to note that all disciplines (process, mechanical, civil, electrical and instrumentation and control) have contributed innovations, optimizing the plant design to permit the incorporation of the latest technology.

1. two of the cooling alternatives considered

- 1/1 Air-cooled condenser
- 1/2 Cooling towers

2. The plant is fully integrated with renewable energy sources

- 2/1 Wind park
- 2/2 Solar field



ENERGY SAVINGS

with respect to current plants of 500 MW

Savings of

6,400,000 m^3 **Natural Gas**

equivalent to the consumption of

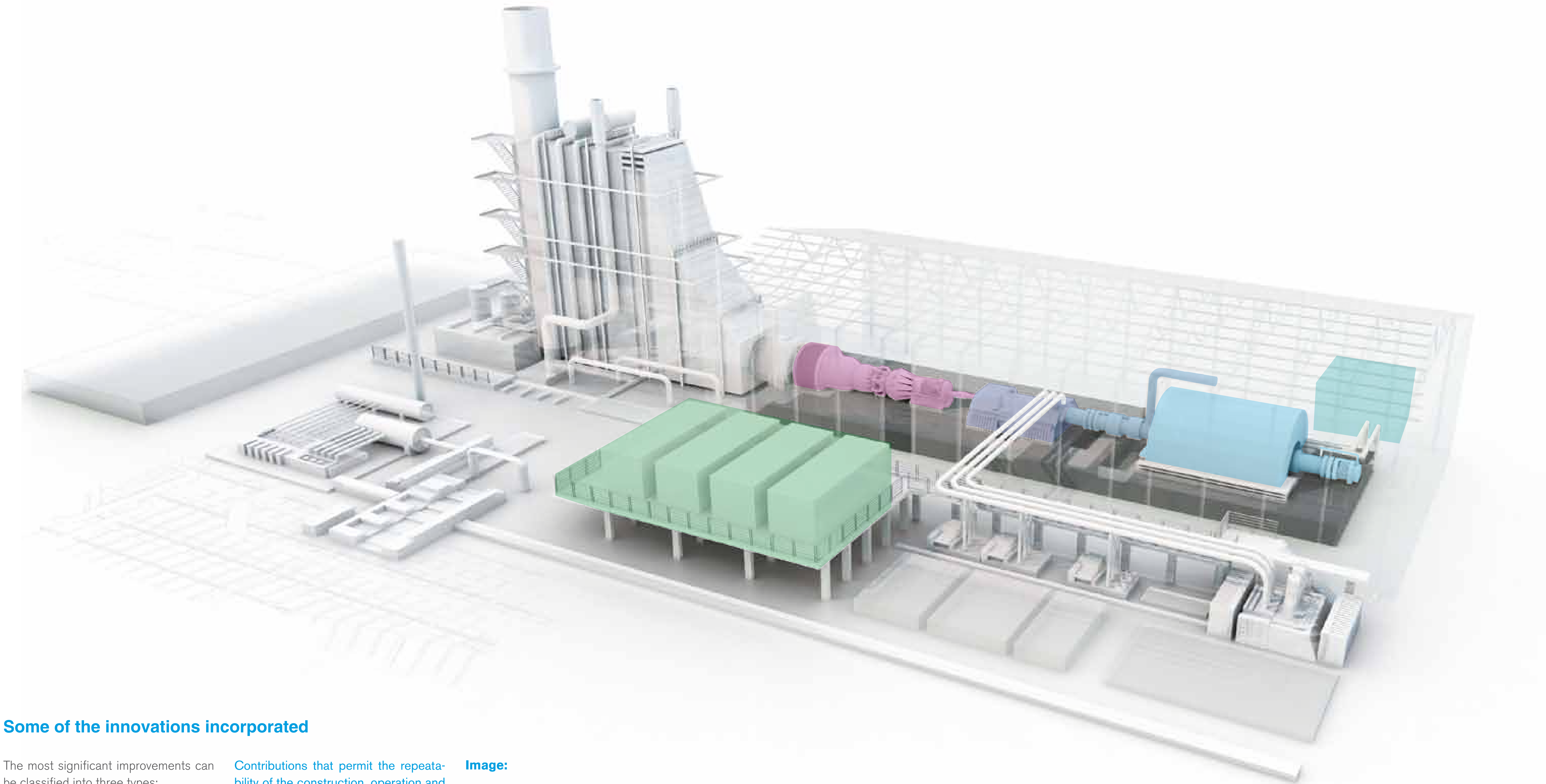
4,000 households

Savings of

8.7 T NOx + **12,700** T CO_2

equivalent to the consumption of

6,400 cars



Some of the innovations incorporated

The most significant improvements can be classified into three types:

The contributions made by Idom that have influenced the development of GE equipment.

The design of the plant has sought the optimal integration and maintenance of the equipment. As a result, some modifications to the design of the steam turbine connections have been necessary, to ensure integration with the condenser, the foundations and the main steam steam piping, or of the housing of the gas turbine, to ensure a proper maintenance with crane installed in the Turbine building.

Contributions that permit the repeatability of the construction, operation and maintenance design.

The alternatives proposed included two design alternatives that consider seismic activity, moderate and high, looking to achieve minimal design changes in each case. The moderate seismic activity design covers 70% of the cases in Spain, France, Ireland the UK and Germany, while high seismic activity alternative covers 100% of the aforementioned countries and Turkey.

Image:

- Gas turbine
- Generator
- Steam turbine
- Condenser
- Electric & control room

A detailed study has been carried out on the piping layout in the proximity of the powertrain as well as a sensitivity analysis of the foundations, in order to achieve a model and design criteria as realistic as possible. This resulted in the need to rethink the foundations. Areas were redistributed, dismountable sections were defined, and the specific steps for laying the foundations were defined in order to accommodate piping and provide accessibility for proper registration and maintenance.

To avoid interference during the construction phase, priority was given to the priority was given to the underground electrical cableways and so main buried duct runs were designed in order to reach the equipment was designed. This system allows the running of not just electrical wiring, but also control cabling below the main foundations.

The application of advance technologies

The plant has been equipped with an analogic Electrical Control System (ECS) similar to that used in large power distribution networks using IEC 61850 protocol, which allows control and monitoring of the electrical system and the programming of intelligent protection, along with the greatest possible integration with the electrical networks working with the same protocol. At the same time, GE is developing their own products to meet this protocol (including Mark VI), to allow for greater future integration.

Another of the most significant innovations was the implementation of fFoundation Fieldbus and Profibus DP protocols in the process control of the plant. This theme is covered in more detail in the following pages.

"The control system is essential to increase the reliability of the plant"

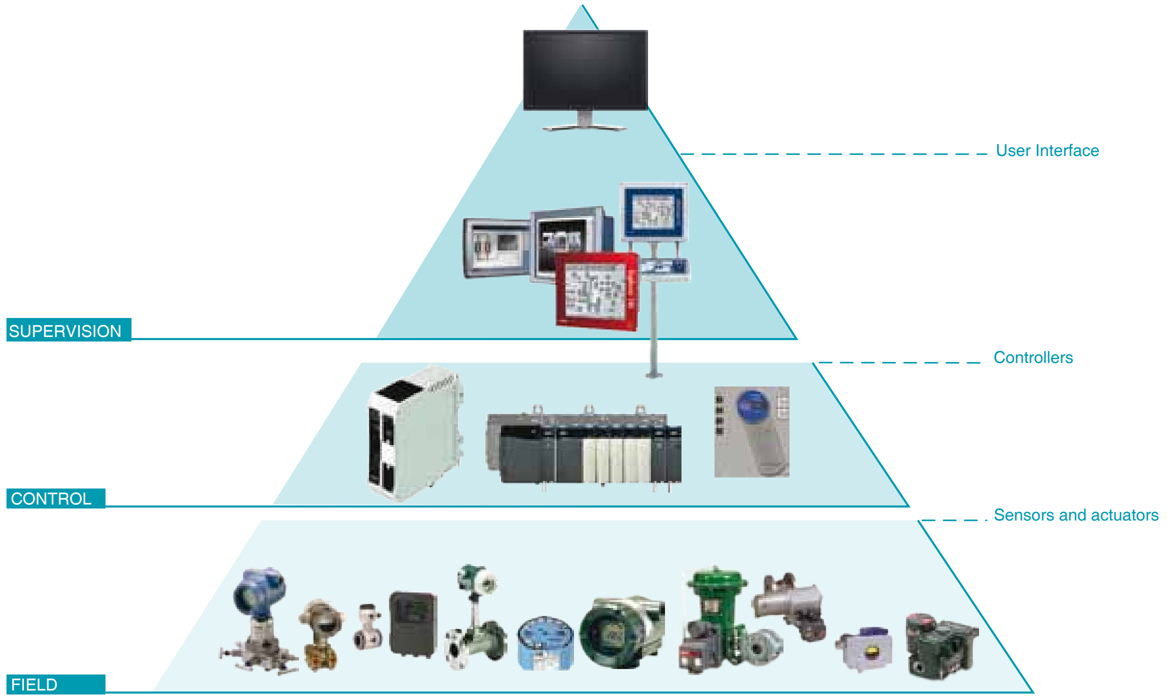
Ibon Laucirica
Industrial Engineer

A combined cycle plant is designed around essential components (Steam turbine, gas turbine, generator and boiler). The installation is completed with extensive piping and a great number of auxiliary mechanical equipment (pumps, compressors, etc.).

The installation requires additional control elements (temperature, pressure, level and flow transmitters, actuators, drives, valves, etc). The coordination, monitoring and control of all the aforementioned devices are peformed in a centralised system.

Automatic control is one of the fields where Idom has incorporated the main innovation in the design of the standard plant.

Pictured here: Ibon Laucirica, Marta Azcona & Imanol Urquiaga



Supervision, Control, Field

The three action levels in a control system

The Control System is composed of three elementary levels.

Field level: This basic level consists of components or devices that are directly in contact with the manufacturing process, both for the collecting of information (sensors, transmitters) and the modification of the process (actuators, control valves).

Control level: This is the level where strategies for regulation, control and protection of the processes are carried out, in effect the "brain" of the plant. It comprises of equipment designed specifically to carry out these tasks.

Supervision level: This top level consists of the elements directly in contact with man. At this level all the system information is collected and the process is controlled. It includes Human-Machine Interfaces (HMI) such as operating stations, screens, control panels, etc.

Traditional & future. System "point to point" & System "Fieldbus"

Systems used to connect field components with control components

The more widespread traditional system for connecting sensors and transmitters distributed in the plant (field level) to the control system has used just a pair of cables, transmitting an analogue signal containing information of the process provided by the field component (valve, sensor, etc.). The communication protocol associated with this technology, called "point to point" is a 4-20 mA current loop.

Currently several digital technologies have been developed which allow the interconnection of field components without having to connect them individually to a central control node. This results in a considerable saving and simplification in the installation of cabling, while in addition, permitting a greater flow of information from the peripheral devices.

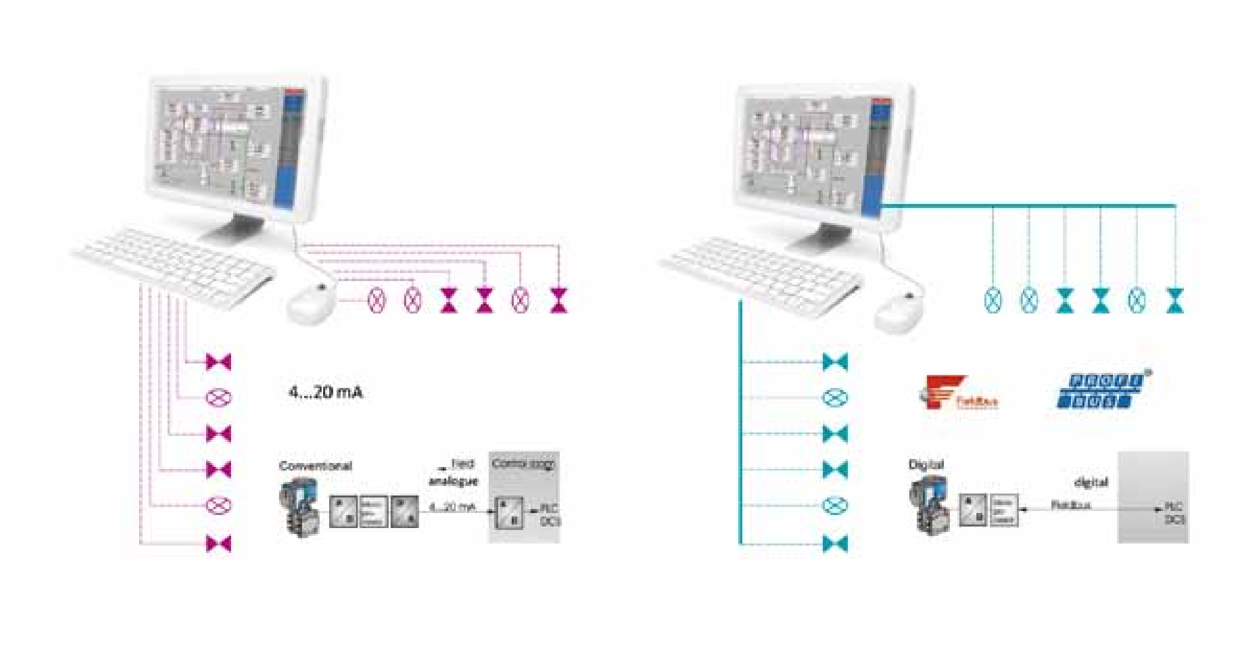
These technologies are called "fieldbuses" because all the information from each field component connected to this bus, is sent in digital packages which can be ordered linearly, one after another, with all of them using a single communication infrastructure (a pair of cables) to the control system.

Foundation Fieldbus is one of the more widespread fieldbus technologies and is set to become the new worldwide standard. It requires the use of specific field components therefore, the equipment and control software used must meet the "Foundation Fieldbus" certification.

◢ Schematic comparison of signal transmission between both technologies

◿ Point to point

◿ Fieldbuses



Advantages of the fieldbus system in the control of the General Electrical standard plant

In the design of the standard plant, Idom is implementing two fieldbus technologies (Foundation Fieldbus and Profibus DP).

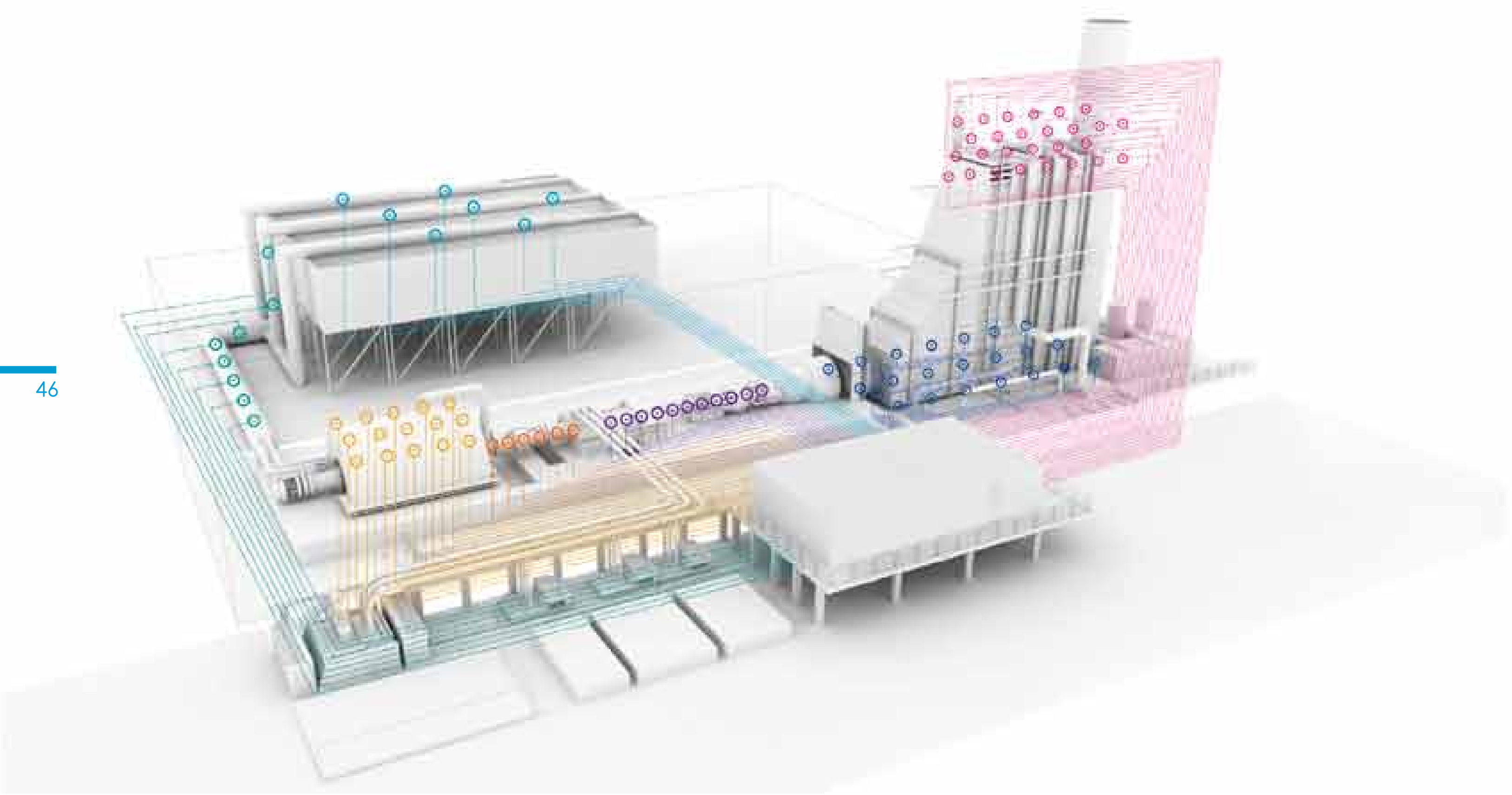
These fieldbus technologies will be the main but not the only technology used, because they cannot comply with all the requirements of cost and functionality of coexistence with the traditional wiring in a plant of these characteristics.

The use of fieldbus introduces a new concept of project design, new requirements and new tools, with the ultimate goal of increasing the availability and reliability of the entire plant.

Some of the advantages provided by this technology are:

- Reduction in the amount of of input/output interface hardware and cabling
- Reduction in construction time and commissioning of the plant
- Improvement of the reliability and availability of the plant
- Offers hot start-stop capabilities (plug & play) for repair work and maintenance during operation
- Provides asset management tools for the plant (maintenance)
- Enables proactive maintenance

The fieldbus technology introduces clear improvements over traditional "point to point"



Foundation Fieldbus

Technology used at field level

The introduction of a new technology at field level requires the adaptation of the system as a whole. So the first step has been to adapt the control system to the requirements of the Foundation Fieldbus system.

GE has had to adapt their plant control system, Mark™ Vle, developed for the standard 4-20 mA, a task which is now completed, recieving the Foundation Fieldbus certification on May 24, 2011.

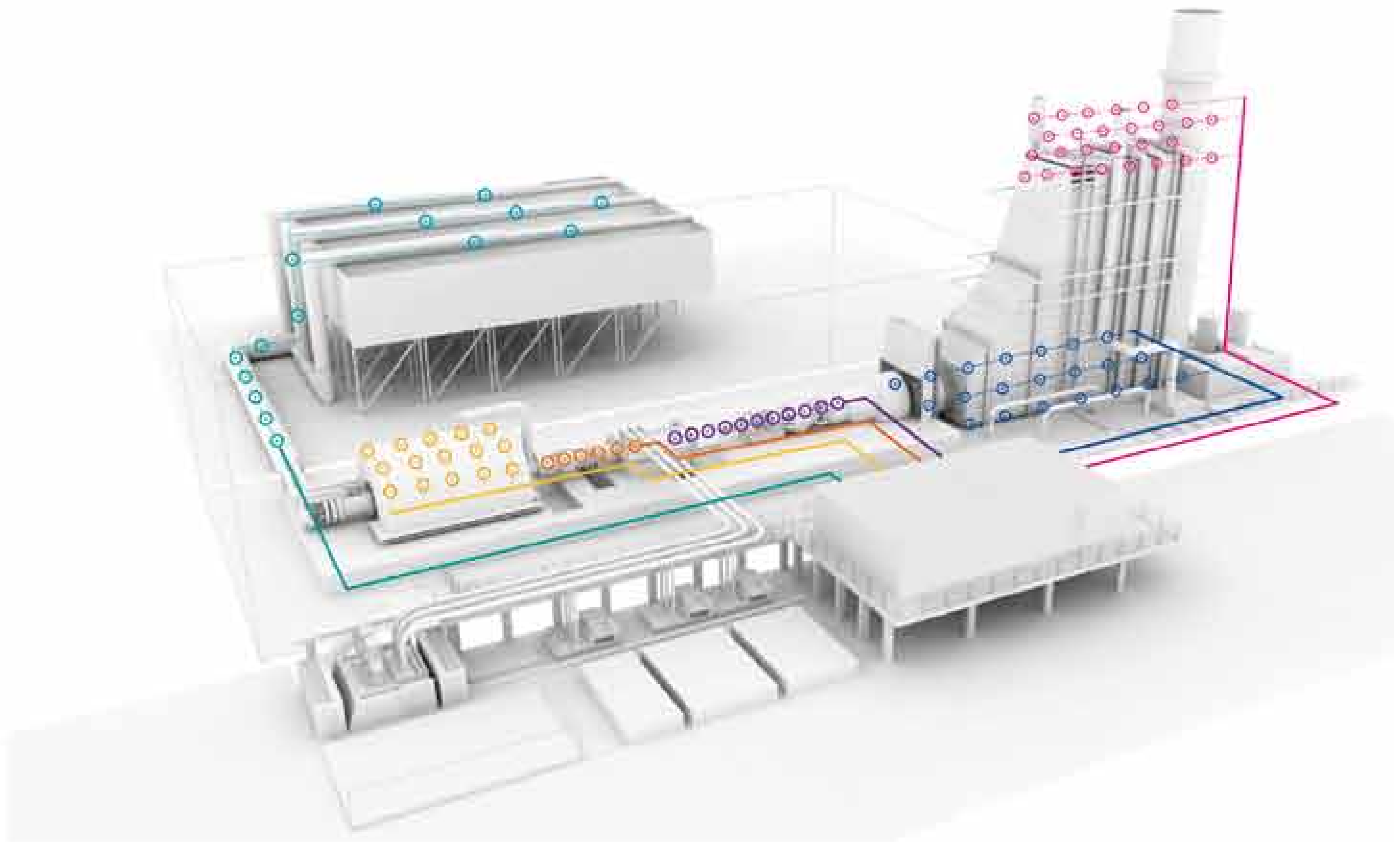
The plant is controlled from a centralised system, connecting all process transmitters (pressure, temperature, flow, level, etc.) and automatic valves (pneumatic and electric actuator) through a digital communication system, bidirectional and multipoint.

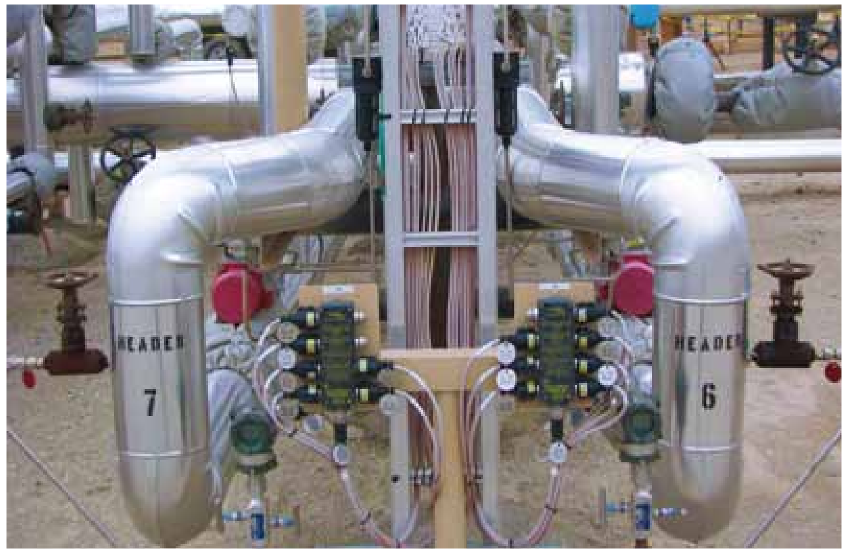
During the development, the criteria for the general design have been set out, as well as the instruments to meet the requirements of the project, the variables of the function blocks to define the tasks to be executed by each instrument and the selection of the diagnostics used for predictive maintenance; all this while maintaining close collaboration between Idom and GE.

Idom has also being studying the optimization of the system; defining the distribution, location and topology of all the Foundation Fieldbus segments connected to the control system. In the definition of these segments, the criteria and limitations of the protocol with respect to the maximum number of installed devices in the same segment or the maximum cable length per segment have been followed.

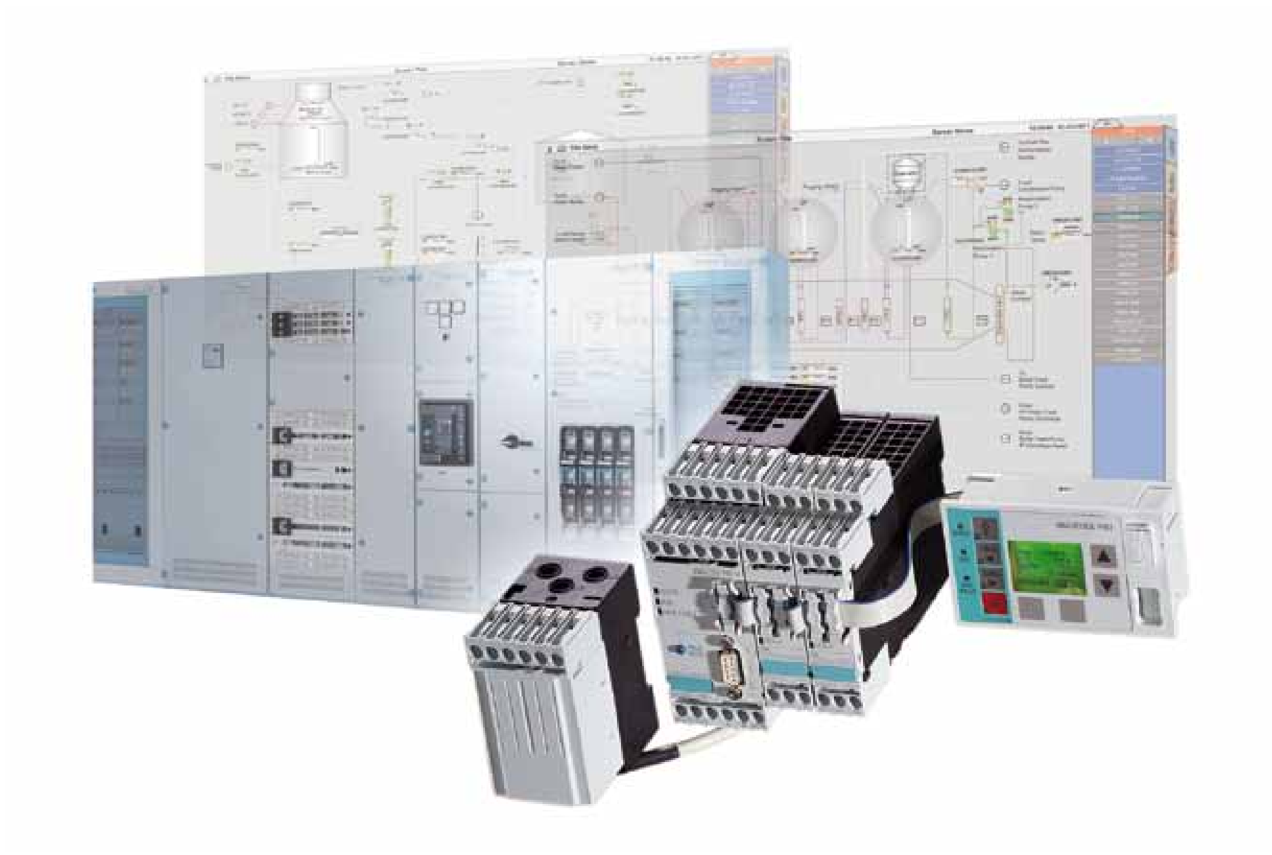
The time constraints resulting from the particularities of this technology have also been considered. These constraints must be considered in the implementation of certain control loops that have execution time requirements. Each type of control loop must be executed in a given time (160 ms. 320 ms. 640 ms. etc.), therefore the segments must incorporate transmitters and valves compatible.

Shown here: the wiring system required for the "point to point" and "field bus" systems





Foundation Fieldbus
field elements



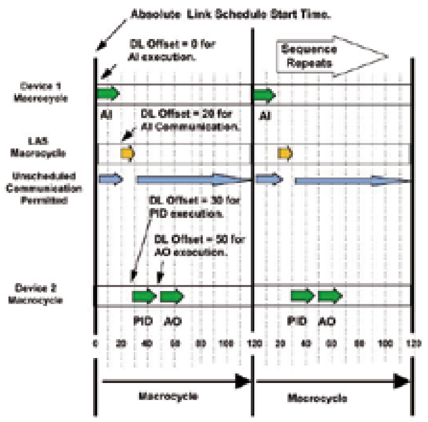
Profibus elements

Execution times of the control functions

The software presents in the electronics of Foundation Fieldbus devices uses an architecture of "blocks", that is, software packages to perform different functions. Each device uses certain function blocks to interact with the process. The times required for each function block depend on the particular function block and the corresponding transmitter model. From a list of devices previously approved by GE, the execution times have been adjusted as required.

The parameter for each segment in relation to the execution time has been the macrocycle time, defined as the time taken by a Foundation Fieldbus segment to execute its schedule of actions.

All the components necessary to carry out the complete installation including cable, terminators and connectors have been defined. The design of the power supply and hardware elements forming part of Mark™ VIe have been defined by GE.



Profibus DP

Technology used at control level

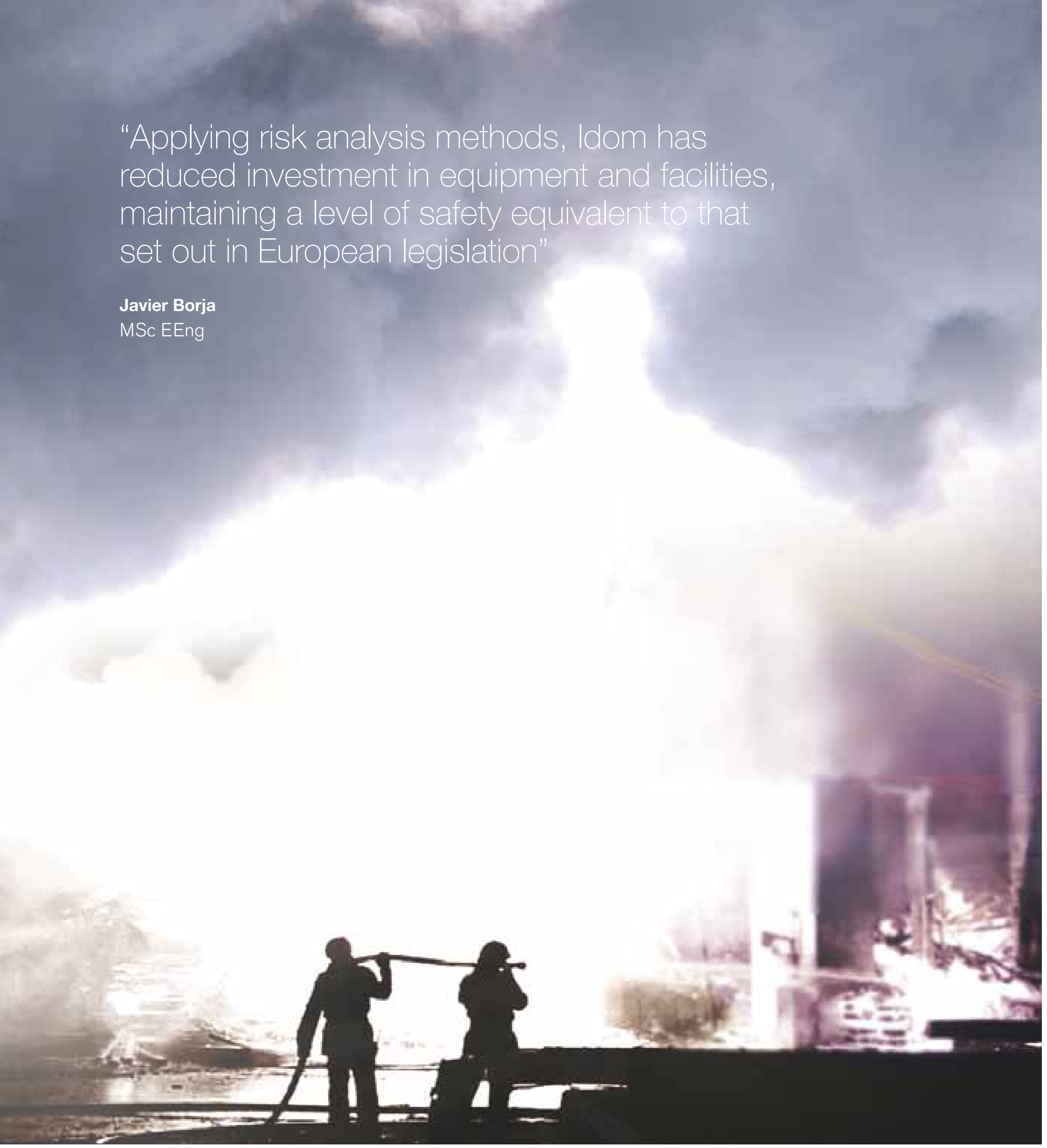
In this standard plant, a second bus technology, Profibus DP has been implemented, in order to overcome some of the limitations of the cabling currently being used for exchanging signals between the main control system and peripheral equipment (electrical cabinets, local control panels or Motor Control Centers MCC). This is an open digital communication system with a wide range of applications; the transmission technology used is RS-485.

Profibus DP has been used as the dominant field bus communication protocol in combination with the IEC61850 protocol over an Ethernet network, for exchanging signals between the control system and the electrical system.

A challenge to be overcome during implementation has been that of the newness of the technology, not all electrical devices on the market have Profibus ports. Therefore, converters for traditional signals - digital and analogue - to Profibus DP had to be used.

Idom has not only designed and optimized the distribution, location, and topology of all the Profibus DP segments connected to the control system, but also all the necessary elements to perform the complete installation including cabling, terminators and connection elements.

For the design of the segments, the criteria and limitations set out by Profibus International have been used in terms of the maximum number of devices in the same segment or the maximum cable length per segment. Calculations of cycle times for each segment have also been performed.



“Applying risk analysis methods, Idom has reduced investment in equipment and facilities, maintaining a level of safety equivalent to that set out in European legislation”

Javier Borja
MSc EEng

SAFETY IN ROAD TUNNELS

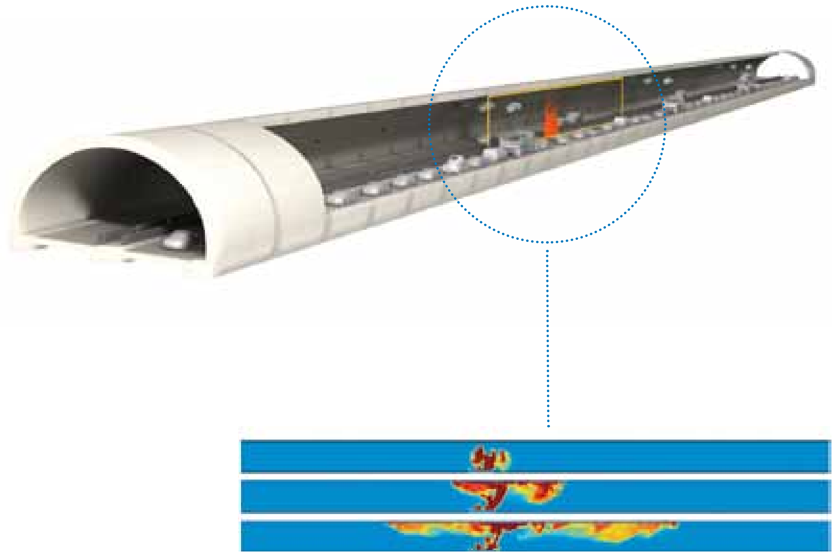
The accidents in Mont Blanc (March 24, 1999) and San Gotardo (October 24, 2001) marked a change in the perception of tunnel safety not just from the point of view of the professionals involved, but the users themselves.

The publication in April 2004 of the European Directive in minimum safety requirements for tunnels was the first attempt to achieve a higher standardized level of protection for all users of European tunnels.

European regulation

When the previously mentioned accidents occurred, the construction of the Somport international tunnel was underway. Although European standards did not exist then, those responsible for the technical aspects of Somport, including Idom, rethought all the security systems, introducing solutions which would then be contemplated in subsequent legislation. For this reason, the professionals of Idom from many specialist areas soon became leaders in development in this sector, a position that has been maintained ever since.

The knowledge gained in the Somport Tunnel was soon applied in the Juan Carlos I tunnel in Vielha (2002 Project) with the incorporation of an innovative water sprinkler system for fire extinction. This tunnel was given the top rating of five stars in the European security report, EuroTAP 2009.



Behavioural analysis of fire-induced heat and smoke

Access tunnels 4 & 5 (Alto del Monrepós, Huesca, Spain) on the A-23 dual carriageway

Photo: José Domingo Arcusa

Savings on investment

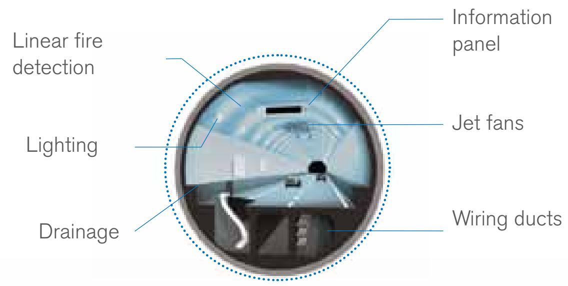
Design alternatives

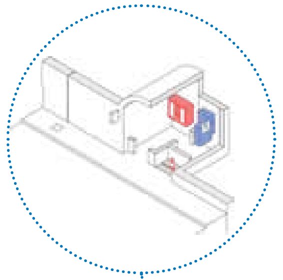
The implementation of all the security measures outlined in the European directive has meant high investment costs. A fact that Idom has become ever more aware of in the many projects carried out in relation to the refurbishment of several tunnels such as those in Huesca, Lleida, Leon, Bielsa and Vielha-Alfonso XIII, among others.

As a result, Idom began to examine how to reduce costs while maintaining the level of safety. European regulation allows for a margin of innovation, provided that it can be demonstrated that the measures and equipment proposed for a given project meet the level of safety stipulated. Idom has taken advantage of this margin for innovation to further develop risk analysis methodology and assess alternatives to the standard equipment being installed.

Risk analysis is a tool that has been used in the industrial environment for decades in the decision making process. However, its use in the area of security in tunnels is highly innovative, as its application permits the identification of the inherent risks in each infrastructure, assess and reduce the risks, and select the best option for the choice of equipment from both a technical and economic perspective. The methodology and

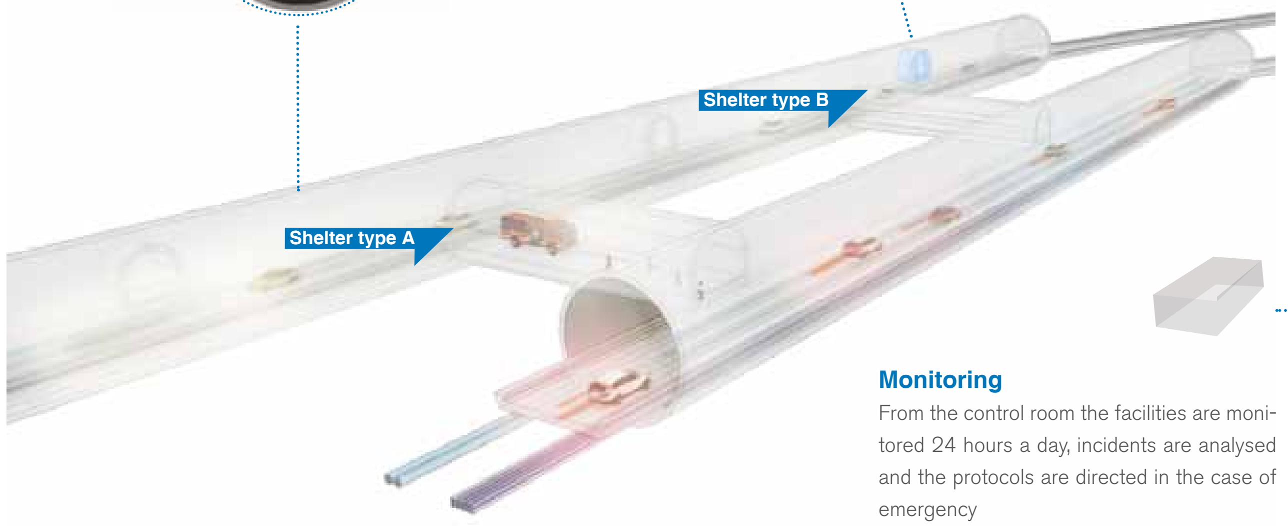
Tunnel type section





Emergency station

- Light signalling
- Emergency station
- Hydrant
- CO & opacity detector



Monitoring

From the control room the facilities are monitored 24 hours a day, incidents are analysed and the protocols are directed in the case of emergency

Photos: Control building, Monrepós

Connection between tunnels

Gallery type A_ This wider tunnel section permits the passage of both pedestrians and fire vehicles and stationary pedestrians and fire vehicles

Gallery type B_ This smaller tunnel section permits stationary pedestrians and the passage of emergency vehicles

approach used in the analysis is diverse and depends to a great extent on the risks studied in each case; risk assessment can be carried out from a quantitative, qualitative or systemic approach or based on scenarios using tools such as decision trees, etc.

As an example, Idom has changed the distance between emergency exits, defined the ventilation systems or studied the transit of dangerous goods vehicles in various tunnels, using simulation analysis for tunnel evacuation, user behaviour and the evolution of smoke in the case of fire. Along with computer models, real situations of smoke behaviour have been tested and monitored and the performance of emergency services has been evaluated.

Savings on the investment

Operation alternatives

However, a reduction in the investment is only one aspect to consider as there are steps that lead to major savings in running costs. For example, lighting systems are an important expense for public authorities.

In this area alone, Idom has been a leader in the study of alternative solutions such as LED lighting which apart from offering lower power consumption, can be continually adjusted or even switched off in absence of traffic. The use of fixed thermo-graphic cameras in the tunnel can help emergency services in certain cases, or the detection of hot spots of heavy vehicles are just some of the applications that are being investigated.

1

“The level of experience that Idom has in this field has resulted in the firm being asked to participate in the revision of the current Spanish regulation on tunnel safety, and in several working groups of the World Road Association (PIARC)”

Ramón López Laborda
ICCP - MEng Civil Engineering

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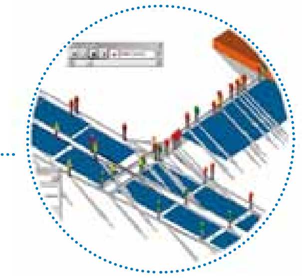
Evacuation analysis

Simulation of pedestrian dynamics using the Exodus software.



Sequence of action in the case of fire:

1/ Outbreak of fire. Vehicles trapped upstream of starting point

2/ Following detection, the emergency plan is put into action. The entrance is closed and the extractors expel the smoke

3/ Users leave their vehicles and make their way to the shelters, where they will receive instructions on how to complete the evacuation safely

A different vision

On occasions, the design criteria are developed from a somewhat theoretical perspective and must be tempered by experience and practice. In Idom, this experience has been obtained carrying out the responsibilities of “safety officer” in many tunnel projects (the tunnels of Aritzeta & Aginaztegi and the A8 tunnel), as set out in the requirements of the European directive on minimum safety requirements for tunnels. The experience gained in this role also means that Idom has a complete vision of any project and can offer a different viewpoint.

Practical applications

This body of experience is now being implemented in the coordination of projects and works of the eight tunnels of the A-23 motorway in the Pyrenean section (Huesca- Sabiñánigo), including the 3,000 meter tunnel of Caldearenas, an integrated project being carried out by Idom.

At this time, Idom is responsible for all of these tunnels, designed by different project designers and executed by different contractors (different equipment, systems, etc.), ensuring that the same level of quality in terms of safety can be centrally managed in a single control centre.

TRAIN GEOGRAPHICAL POSITIONING SYSTEM-RENFE

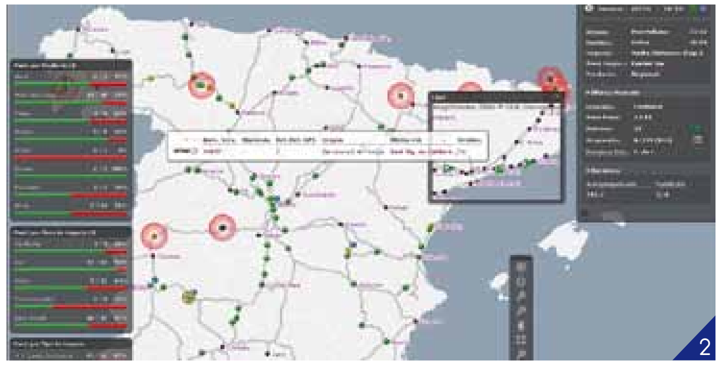
"In railway management, the visual location of trains speeds decision making"

José Espada

Manager of the Operations Centre, Renfe

Renfe the state-owned passenger and freight rail transport operator commissioned Idom to develop a geography information system gathering the necessary data to permit an analysis of some of the variables related to passenger transport.

The system developed by Idom displays on-screen data including train position information, station arrival and departure punctuality, the situation of the rolling stock and incidents occurring in the service.



1/ Digitization of rail network
2/ Monitoring of the Service: Positioning
3/ Punctuality rates
4/ Location of incidents per section
5/ Location of incidents per station

Digitization of the network

In the development of this work, the entire rail network has been digitally mapped to include all high-speed, inter-city, regional and short distance networks, and all stations on each line. The information gathered has been combined using a basic general mapping tool.

This tool is a web-based application developed using the .NET framework, programmed using ASP.NET and jQuery JavaScript Library. The technology ADO.NET has been used to access data. For the visual graphics, the mapping web servers MapInfo® MapXtreme® and the Google Maps API have been used.

Monitoring of the service

Besides providing a geographical visual display of the stations and the network, the system offers four different thematic maps.

The first of these maps displays the geographical position or location of the trains currently in service.

The position of each train is indicated by an arrow which also indicates the direction in which the train is travelling. The arrow is colour coded, indicating any running delays (minutes) of the trains.

Using mouse pointing techniques, once a train is selected on the screen, a graph on the right of the screen offers information about the capacity level of the train, occupancy level and the equipment and personnel resources allocated to the service.

Additional information is displayed in the graphics on the left of the screen indicating the number of delayed trains by product and by business areas. The punctuality of the mid distance and long distance trains is also displayed.

Punctuality

Another of the maps displays the timeliness of train arrival and departure from the station in graphic form.

At each station, a circle is displayed. The upper half of the circle represents the percentage of trains arriving punctually at the station, and the lower half represents the punctuality of departures.

Once a station is selected, further information is displayed about the trains that have passed through the station. This window displays historical data on timeliness over a determined period of time or by the stations selected by the user.

Status and position of each train

The third thematic map permits the user to know the situation of the rolling stock, and displays both the status of the trains (circulating, assigned, available, or broken down) as well as the position (on the track, in the depot or in station).

It is possible to filter the information to display the type of engine being used on the service and the material being hauled.

In relation to the engines in the depots or in the station, it is possible to obtain extended information in the form of a series of graphics that display the distribution of the equipment.

Positioning of incidents

Finally, the incidents occurring in the service can be plotted. Every event is assigned to the station of departure or the corresponding section. A graph is produced, colour coding the stations according to the number of incidents that have affected them.

It is possible to filter the information in relation to a general classification of incidents (technical, comfort, customer service) and for specific types (track, material, etc.) as well as a filter according to date, stations, product and business areas.

Once a station or section of the line is selected, the user can obtain information about the incidents that have occurred at the station, including the services affected, the number of delay minutes, the customers affected, description, consequences and management of the incident, causing services and services affected.

Image courtesy of Renfe
Photography: Patier

Viewing Google Maps

A tool that allows the key information to be viewed using Google maps has been developed.

This format offers the user the possibility of a more streamlined navigation option offering the user the option of using the different viewing modes offered by Google Maps (street, Satellite, terrain, etc.).

Application for Mobile Device Users

Users of devices such as tablets can access the application through a dynamic display, adapted to touch screen operation.

The display is based on Google Maps using "Multi-touch" software designed for screens to recognise multiple contact points.

ARCHITECTURE & PROGRAMMING

A cultural transformation

"We are breaking the old paradigms. In Idom we propose to transform the architectural object by changing the processes we use”

Tono Fernández Usón
Architect

Half a century ago, the pencil was a good tool to use for Project development. The reduced number of actors and specialisations involved in a project meant that just a simple drawing could communicate ideas to a small team of specialists gathered around a table.

Today, the value chain is far more complex. As the number of actors involved and level documentation has increased, so has the demand for environmental and economic sustainability, and the level of interest in efficiency focused on a reduction in consumption, concerns about material lifecycle, changes in regulation, etc. We now need to manage a huge amount of data and once analysed, we must come to precise conclusions.

In this new scenario, individual creation would not appear to be capable of integrating the complexity of projects and teams adequately without the quality of the process and the results suffering. The old paradigm, which focused exclusively on architecture using cultural parameters orientated to the development of a "plastic" shape, does not seem to provide the best foundation for technology and art to understand each other.

In recent years, Idom has used an approach in more than 30 projects which strived to improve the processes of thought, communication and production, developing the necccessary tools and custom software to respond to these new demands.

The conclusion, after years of work on the linkages between programming and architecture, is that Idom is on the path built with the foundations for enormous potential to transform the creative process, the final product and service for our customers and society.

Image: Ismael Vega Trillo

The evolution of the old paradigm

Changing the tool

The evolution of computing platforms and the inclusion of programmers in the working team means a new approach bringing us closer to reality.

Programming allows us to combine precise data gathered from the various disciplines involved and generate behavioural models that allow us address problems from perspectives which until now were previously unknown.

On one hand, the use of computational techniques such as generative algorithms, and in particular genetic algorithms, is producing results that we could not have imagined twenty years ago, armed as we were with a good pencil, a calculator and a good memory, or even a decade ago with computer aided design programs (CAD).

On the other hand, the evolution of computing applied to geometry allows us to generated parametric models (BIM) capable of integrating all the actors and data in a common environment, changing both the quality of the final product, the structure of the teams, and the way they communicate.

The design of a Project, involves an ever increasing quantity of data, accurate and in numeric form. Numbers and creativity, concepts which culturally have been understood to be opposites, now shake hands.

The application of algorithms in the process is allowing us to banish these prejudices and discover the magic of numbers. The models derived from the different iterations, if interpreted correctly can generate ideas and inspire new ways for development in architecture.

Generative model

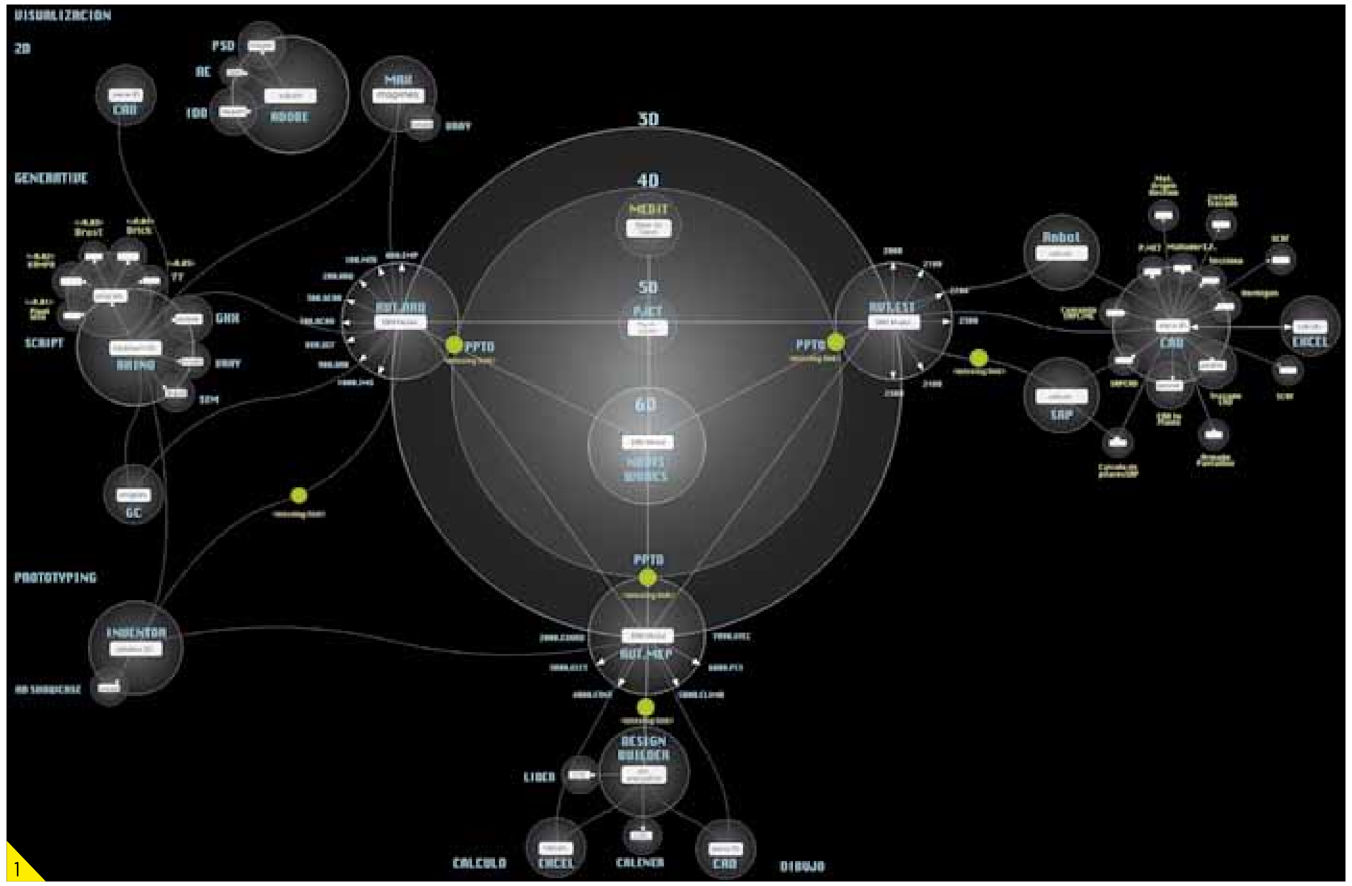
Rules define the geometry

A generative model is built around population, simple geometric components which relate to each other following rules of aggregation and elimination. The resulting model from the data introduced explores the related fields and generates shapes. The objective is, in most cases, the rejection or optimization of solutions.

Following the creation of a component and considering its subsequent interactions according to predetermined abstract rules, a "settlement" is generated, and behaves intelligently, in the sense that it has capacity to adapt itself and mutate if new rules are applied similar to a colony of ants, a swarm of bees, or a flock of birds.

A simple example of its application would be the introduction in the model of climatic variables to determine the distribution of the openings in the architectural envelope structure. The introduction of more complex variables to the model, such as the use of intelligent materials allows us to carry out simulations, analyse and determine the behavioural pattern that these mechanisms in the envelope should have to optimize energy performance and consumption.

In the development of this work, commercial software has been used and custom software has been programmed in response to specific problems or each working structure.

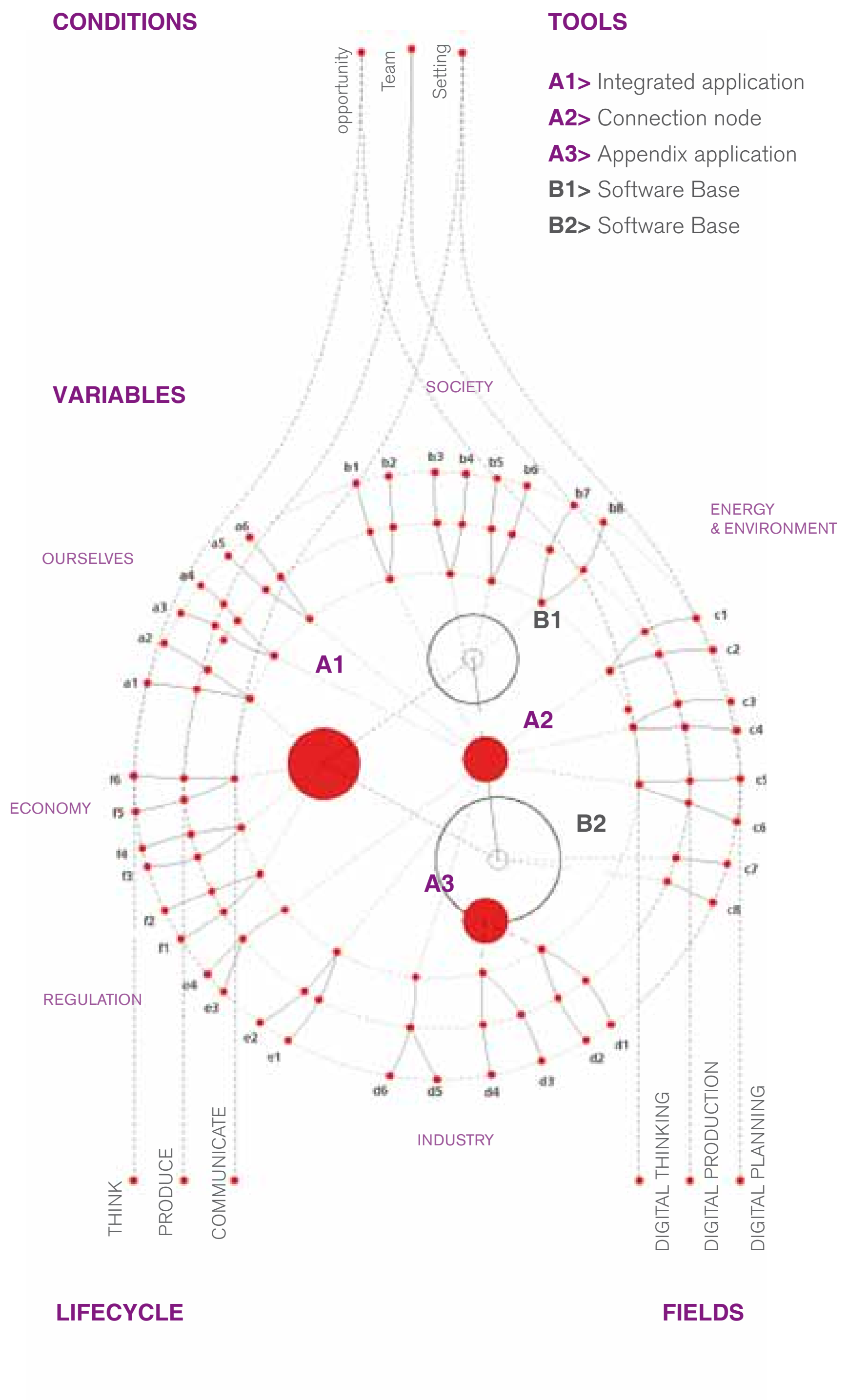


Parametric models

Links, geometry and automation

A parametric model is based on the relationship between variables. The alteration of a rule or constraint modifies a component of the model itself and has implications for the entire model. The modification is therefore automatic.

As a simple example: in a building information modeling (BIM), a window opening has to be positioned in the midpoint of a determined wall. Modification to the geometry of the wall will alter the absolute position of the window, although in relative terms it continues to be positioned at the midpoint of the wall.



If, for example, a second restriction is added to determine that the other windows are aligned in height with the first, all the windows of the model will be affected by the modification of the wall.

Unlike traditional modelling programs, in which relationships and results emerge from a previously defined geometry, a parametric model begins with relationships and is only then transformed into the final geometry. In a parametric model, data precedes the form.

In Idom, parametric models are linked to the use of BIM technology. This platform offers a series of interlinked software packages that cover almost all disciplines. However, in practice, there many gaps in the software on offer, and so which Idom has been working and programming to complete its "customised workflow".

Types of programming-

Modifying the work processes

Both inside and out the generative and parametric models, Idom is developing programs that respond to three basic types:

◣Complementary and Connectors:

Applied programs using a commercial platform that complement specific software (complementary) or connect two software packages (connectors), simplifying work processes.

◣Process Optimizers:

New stand-alone programs applied to previously defined work processes.

◣Disruptive Programs:

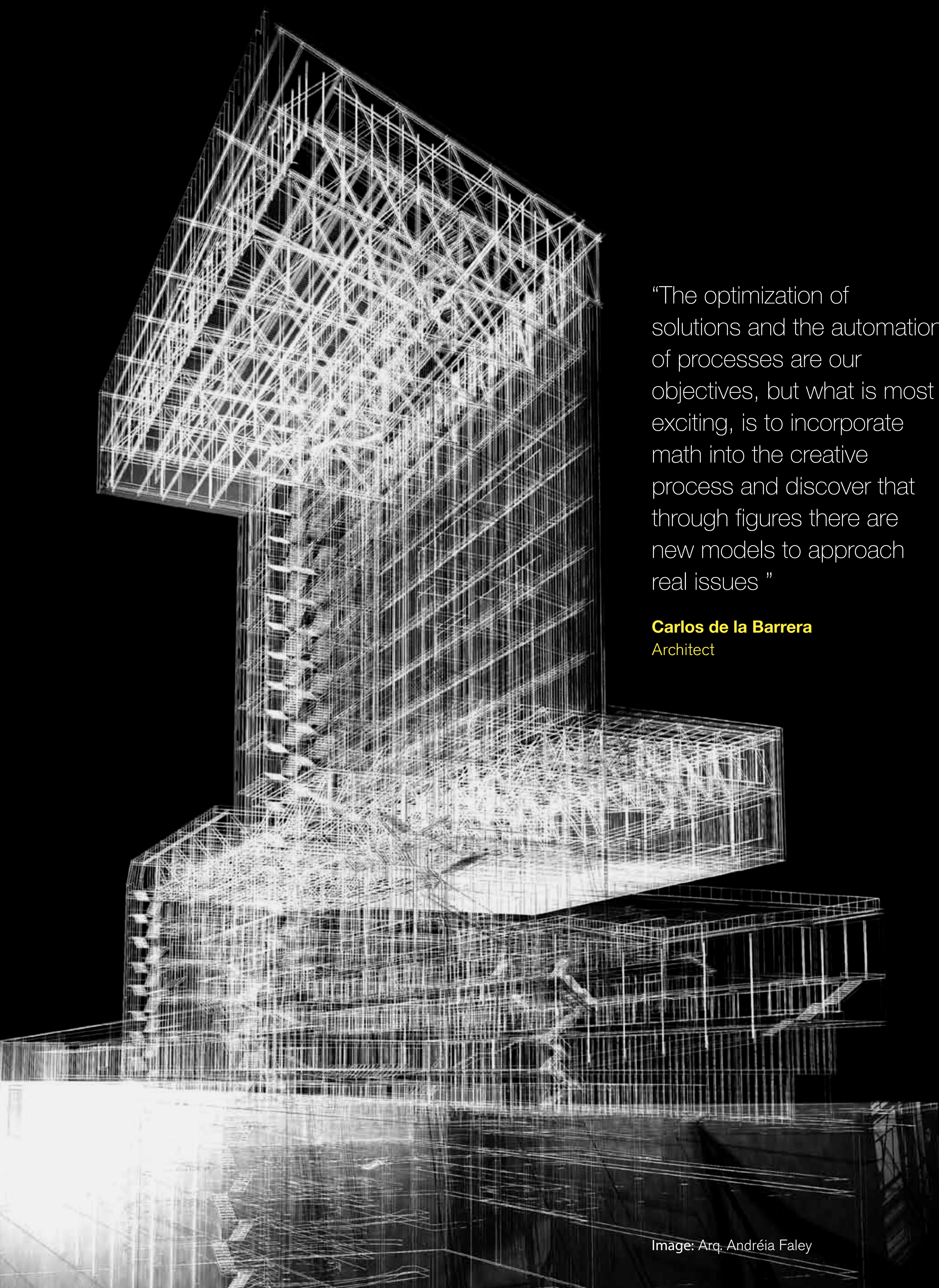
New tools which transform work processes.

1/ Production Scheme.

Architectural computer platform (Architecture, Systems, Structure, Budget, Planning and Maintenance).

Some results

Using BIM technology
(Building Information Modelling)



"The optimization of solutions and the automation of processes are our objectives, but what is most exciting, is to incorporate math into the creative process and discover that through figures there are new models to approach real issues "

Carlos de la Barrera
Architect

Image: Arq. Andréia Faley

Integral development of a project

BIM technology covers the design process and management of all information generated throughout the lifecycle of the building.

Using a parametric model, the geometry is calculated and defined in all disciplines, developing simultaneously reports, specifications and budgets. Subsequently the model will be linked with a viewer that incorporates the construction planning and to which the maintenance parameters are introduced. There are six dimensions to this process.

◣3D Geometry
Architectural project execution, facilities and structures

◣4D Time
Planning the execution times associated with the 3D model

◣5D Budget
Updating & monitoring

◣6D Facility Management
Management and maintenance plan

Benefits and values of this work process

RIGOR: Integral detailed monitoring. Collection of information in the areas, volume, structural behaviour, description of spaces, reviews, product specifications, etc.

CONSISTENCY: Thanks to the conceptual links between disciplines.

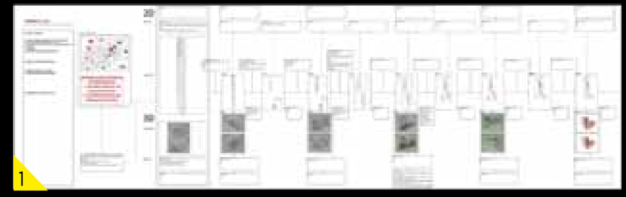
PROGRESS CONTROL: On-going assessment of the process.

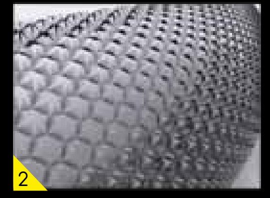
DISCIPLINARY INTEGRATION:
By transforming roles and profiles.

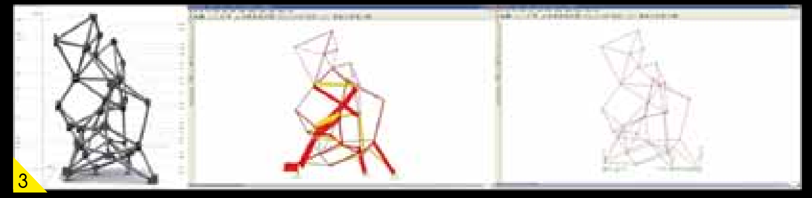
AUTOMATION: Parametric change management.

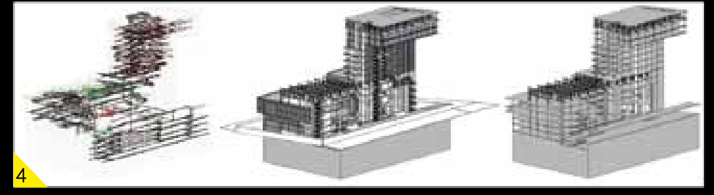
BUDGET CONTROL: Automatic updating of values throughout the building process of the model.

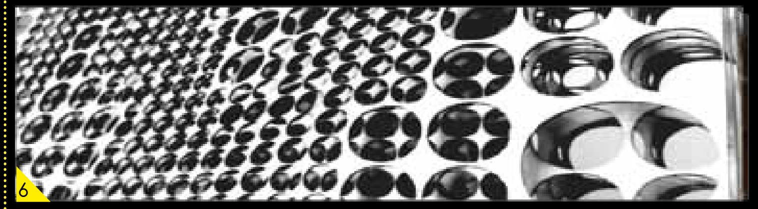
LINKS WITH THE MAINTENANCE:
Extension of building life cycle











1/ Conceptual development and thinking 2-3/ Generation 4/ Production
5/ Display 6/ Digital production

Image: Arq. Andréia Faley

Some results

Emergency call centre building, Barcelona

The future 112 building, Barcelona the largest and most comprehensive emergency call centres to be designed in Europe. All bodies and agencies related to the operational emergencies will share work space and protocols.

The implementation project was planned using BIM platform across all disciplines.

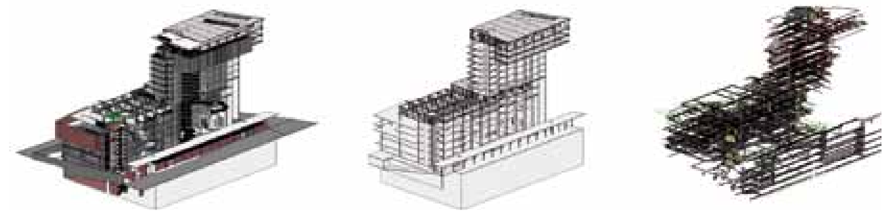
Throughout the project, the development process has included the design and management of all information throughout the lifecycle of the building.

The virtual model includes the Architecture, Structure and Facilities detailed models with details, materials and features. In addition, it has been possible to explore shapes and volumetric solutions without restriction, that have bee controlled parametrically.

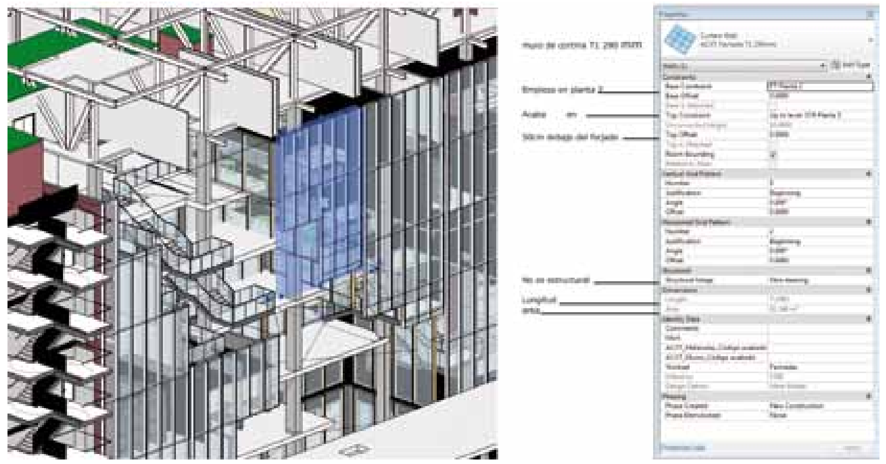
Furthermore, a library of the elements that contain the integrated parameters is generated from the outset, thus saving time in the execution of the project. Thus, from a budgetary point of view, it has been possible to maintain basic control from the start of the project aligning it with the preset restrictions set out by the client.

The use of BIM technology has permitted the development of the production information within 3 months.

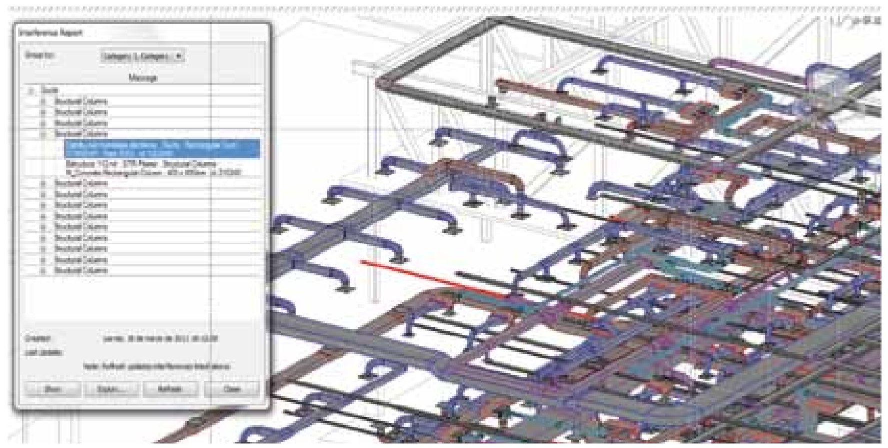
The main advantage has been the coordination of 3 disciplines and early detection of coalitions and interference.



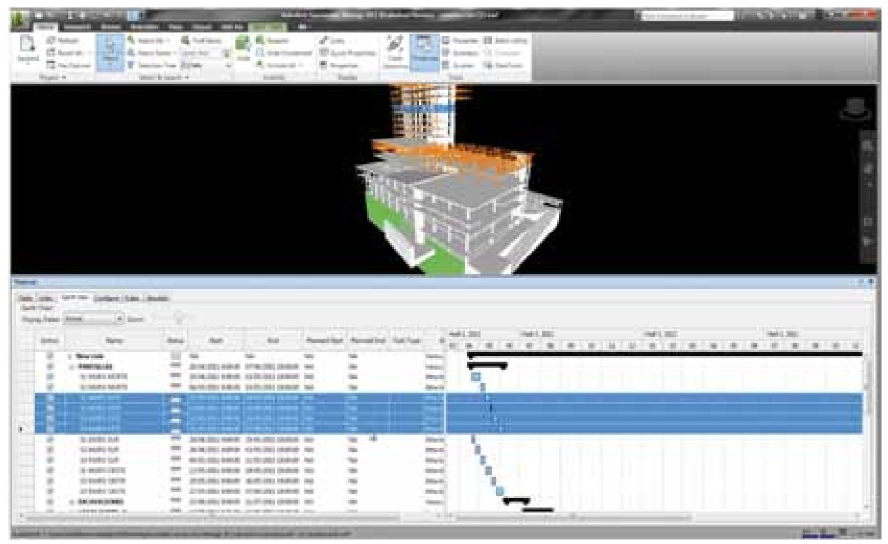
Integrated model. Architecture, structure, and facilities.



Detail 1. Revit ARQ, modelling and definition of main curtain wall.



Detail 2. Revit MEP ducts in silver type. Overlap with metal structure.



Detail 3. Model integration of all disciplines and linking schedules with the model.

Some results

Generation of unique surroundings

The Centre for Data Processing in Cerdanyola de Valles is a huge warehouse of processors that work 24 hours a day, 365 days a year. The facility can consume the same energy as a neighbourhood of 3,600 houses.

The envelope design was subject to a number of conditions - regulated lighting in the offices, impulsion ventilation from the courtyards, extract ventilation from the CPD and large structural concrete surface areas, maximum energy efficiency – meant working with a model based on the initial hypothesis, but which was optimized during the various stages of development, not only when developing the technical project but also during the execution of the work.

Using algorithms, we have studied the best pattern for perforation of the steel plates to achieve an adequate level of light in the office area.

Generation process of the façade: phase

<1.0> Implementation Project

The construction system for 3 initial project variables were defined

<2.0> Digital Prototype

The design of all the components of the façade system including the 3D building design was carried out with the company Acieroid

<2.1> Physical Prototype

This was produced with the industrial companies, Acieroid and IMAR, following which the presentation of the system was made to the client

<3.0> CFD (Computational Fluid Dynamics)

A study was carried out in conjunction with ADA to analyse the thermal behaviour of the air chamber. Using this analysis, it was determined how exactly the upper and lower openings should be to permit optimal drainage

<3.1> Light Simulation

Initial hypothesis and measurement of the luminance levels proposed in the production information

<3.2> Genetic Algorithm

Calculation process and partial results obtained until the final solution was reached. The optimization process measured on the plant

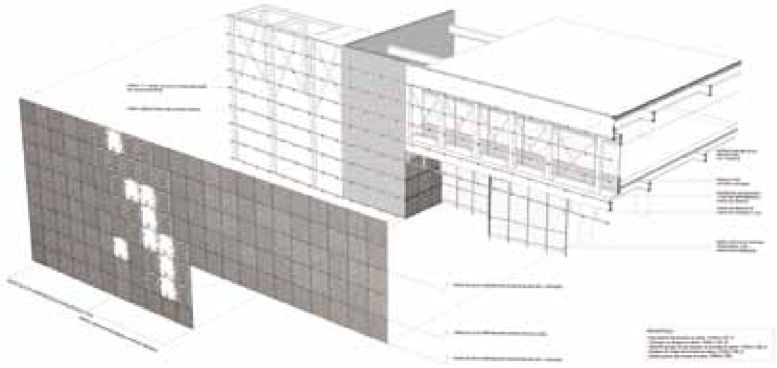
<3.4> Data transcription

Simulation of 1.40 X 1.40 pixels with assigned numerical values of transparency due to the inability to obtain a simulation of the entire façade at full-scale

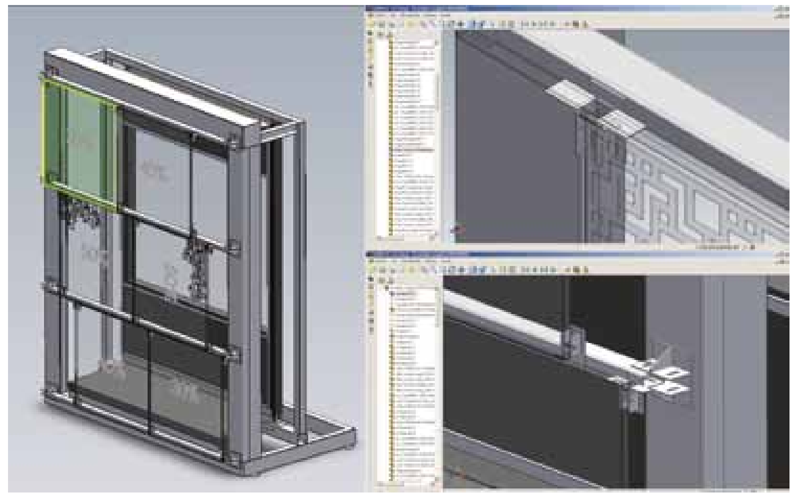
The transcript of these mathematical values to full scale was performed using software developed especially for IMAR, called Pixel Info

<3.5> Resulting pattern

Using another script developed specifically, the pattern obtained is sectioned into units of 1.40 X 1.40 with a default gap

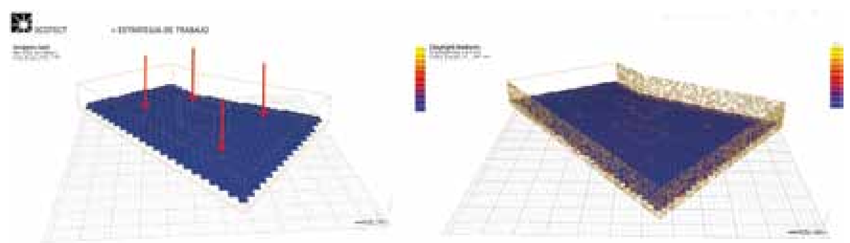


⊾ Production information



⊾ Digital prototype

⊾ Physical prototype. Assembled on site



⊾ luminance simulation

<3.6> Manufacturing unit

Finally, a new script was generated for the manufacturing of each of the units

<4.0> Mathematical optimization

The relevant optimization studies were carried out to transfer the results of the algorithm to the conditions of the tender (5 different types of veneer)

<5.0> Aluminium resistance studies

After testing the prototype on-site, the distribution of various stiffening elements were tested (solid areas)

<5.1> Abstraction Process

Conversion of the previous steps into figures to get the perforation values of the 5 veneer sheets

<5.2> Perception Analysis

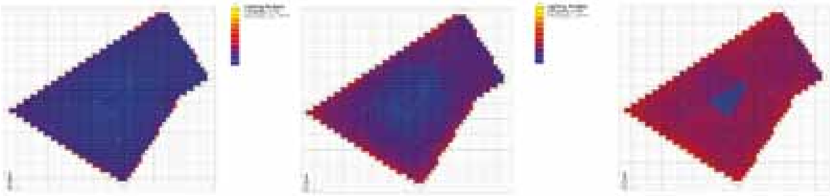
Establish the number of perforation holes and the scale. Sheets with the same transparency rate were compared; One of them had twice the number of perforations, while the second sheet was half the scale,

The latter obtained better results

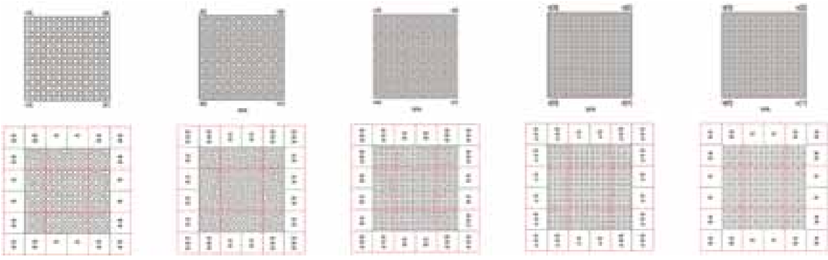
<5.3> Generation of manufacturing drawings

The final process was the production of 5 units as set out in the bidding contracts with the developer

◺ Genetic algorithm



◺ Genetic algorithm. Measured on plant



◺ Mathematical optimization

<6.0> Final image

"Programming allows us to give a precise answer to the conditions of environment, energy, and economy, transforming them into objects of measurable values and turning them into project tools from the outset of the project"

Magdalena Ostornol
Architect

Some results

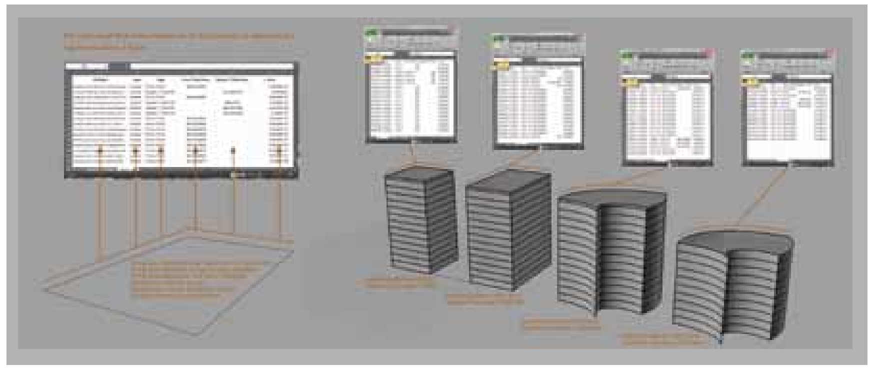
Applications and scripts developed by Idom

1/ Disruptive programs

Project: EMP
Project mental space
Year: 2012
Description:
Tool initially designed to enhance the creative capacity of a team; its development allows the project to be integrated with the commission, linking the creative process with systems that incorporate quality management, cost and schedule.

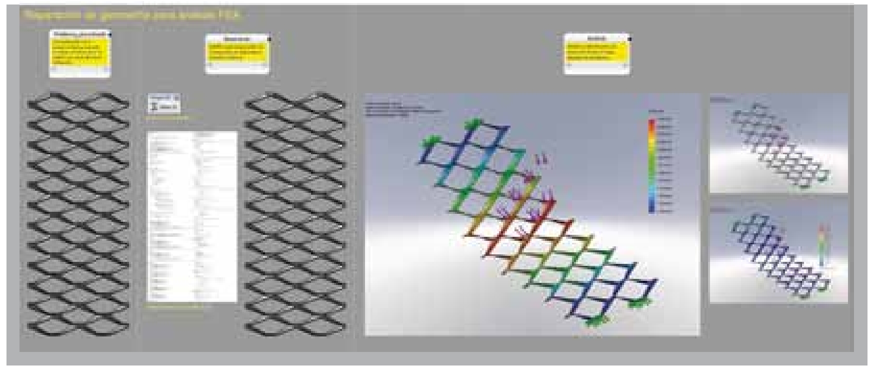
Example 1.1/ Internal use program for project management

Project: SrfDataToExcel
Year: 2012
Description:
The "SrfDataToExcel" quickly exports the areas, layers and basic properties of each element, and then calculates the ratios and overall measurements of the project. After analysing the information, the user can make changes again to the Rhino model and compare the changes with the previous model.



Example 1.2/ Internal use program to optimize processes

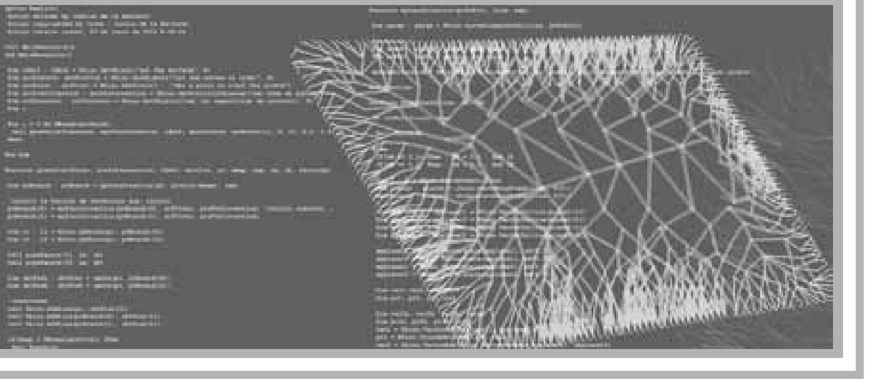
Project: KOMPO!
Year: 2011
Description:
Kompo! Is a program for repairing geometry that allows the structural calculation by FEA in Solidworks software. It was commissioned by the company IMAR to solve a problem they had with the program that produced expanded metal.



Example 1.3/ Program developed for external use (IMAR)

2/ Optimizers

Project: Progressive structures
(High-speed rail stations Poland)
Year: 2011
Description:
This program works by using a recursive algorithm that mimics the growth of trees. The node of each branch matches the pillars of the building and the length determines the length of a section of the structure. Therefore, for example, the greater the distance, the larger the section.



Example 2.1/ Generating script forms

Project: Non-uniform pattern generator for manufacturing
Emergency call centre building, Barcelona
Year: 2011
Description:
This application allows you to transform the brick façade generated in example 2.4 and generate the necessary plans for its manufacture, indicating the orientation and position of each brick in the façade.

Example 2.2/ Script optimization of manufacturing precesses

Project: Variable structures for roofs
(Rizhao Ecopark)
Year: 2011
Description:
Formal exploration for roof garden structures of a landscape project.

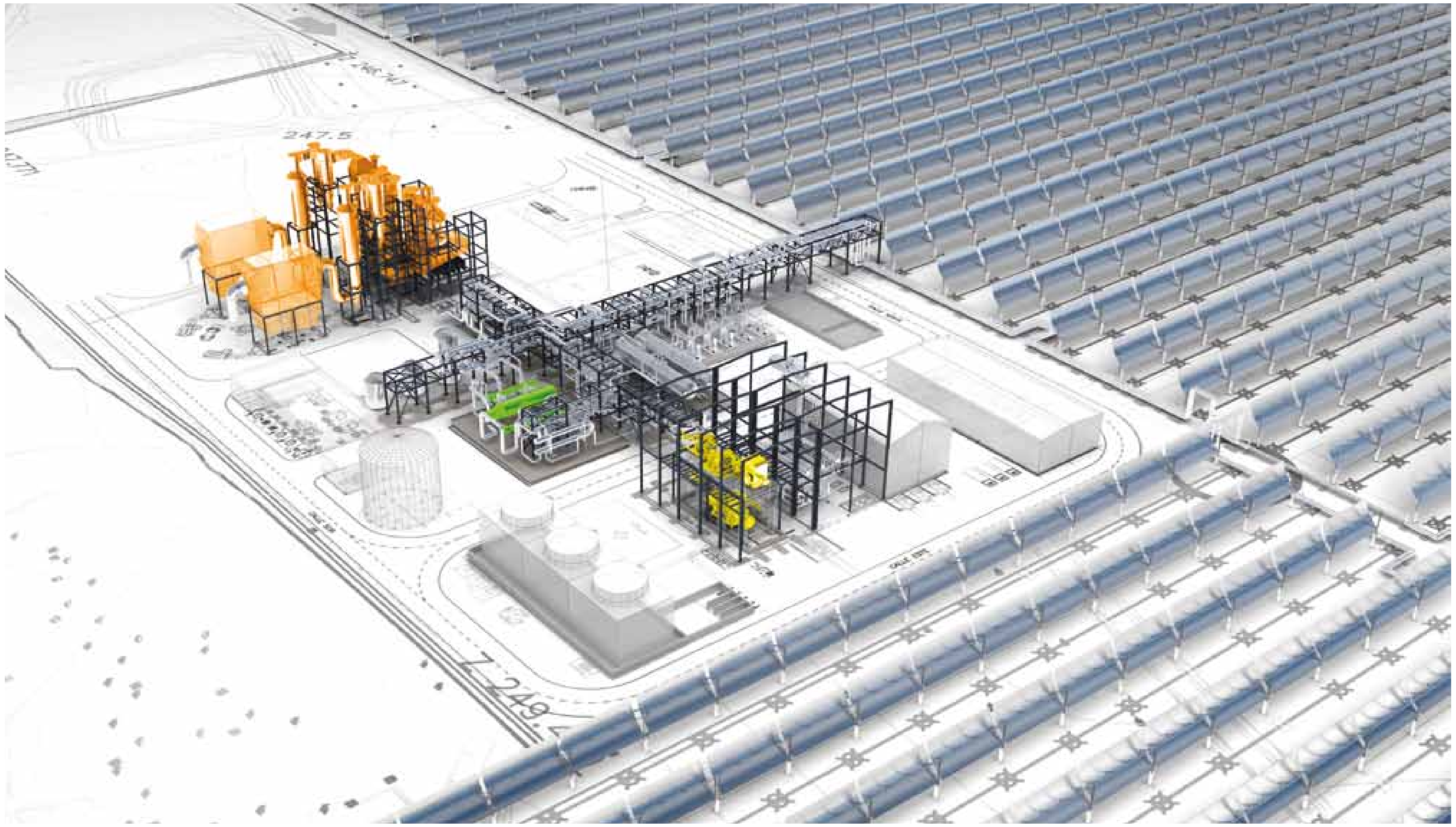
Example 2.3/ Script for project processes optimization

CONCENTRATED SOLAR POWER PLANT HYBRIDIZED WITH BIOMASS

In the municipality of Les Borges Blanques (Lleida, Spain) the world´s first concentrated solar power plant is being built on a commercial scale. The plant will be powered using energy from biomass in addition to solar, and will have a total output capacity (measured at the generator terminals) of 25 MW, generating 98,000 MWh/year. The Madrid-Barcelona high speed train crosses the site of the plant, with the tracks being flanked on either side by the solar field.

This plant is being developed and will be operated by the joint venture, UTE Termosolar Borges S.L., an alliance between the companies Abantia and Comsaemte. Legally, this is a new investment within the framework of "the generation of electricity from renewable energy sources" (Royal Decree RD 661/2007 of May 25 2007), that is embodied in a special regime of economic incentives guaranteeing minimum tariffs, necessary for the feasibility of a plant of these characteristics.

Shown here: The solar power plant constructed by Seridom in Palma del Río (Córdoba, Spain)



Sections of the plant

The solar field will take up most of the surface area of the plant with the production of steam through heat exchangers, the heating of the heat transfer fluid in the biomass boilers and energy production generated by the steam turbine being concentrated in the power block.

The solar field

The solar field has 56 parallel loops of 6 parabolic trough collectors (CCP´s), each one with a system of parabolic reflectors that concentrate the solar radiation on the heat collecting element where solar energy is transferred to a heat transfer fluid.

The heat collecting element or reflector tube is formed by a stainless steel inner tube through which the heat transfer fluid circulates. This tube is in turn encased in another glass tube creating a vacuum which acts as a thermal insulator (absorption rate of higher than 0.96 and thermal emittance below 0.10 at 400ºC).

The cylindrical parabolic mirrors are formed by a low iron content glass to a thickness of 4mm and a high performing reflective coating.

The parabolic trough collectors are aligned from east to west following the path of the sun. The solar field is completed with a network of pipes circulating the heat transfer fluid. The trough collectors will stretch to a distance of 100m with 15 meters between each row.

The biomass boilers

The plant will have two biomass heaters, each producing approximately 22 MWt. Another 6 MW heater will operate exclusively on natural gas, and as such the installed combustion thermal capacity will not exceed 50MWt.

It is envisaged that the biomass material will be forestry residue and dedicated energy crops. The biomass boilers will each have 10 MW natural gas burners, and as such the production of energy using natural gas will not exceed the 15% cap on energy sold to the open market, or 12% for the establishment of a fixed tariff based on annual production according to the Royal Decree 661/2007.

The natural gas used will come from a regulation and metering station (RMS) fed by an existing pipeline, and it will also be used in the steam turbine gland steam supply for plant start-up.

Provision of equipment

Both the field of parabolic troughs and the system of auxiliary oil heaters are configured in series, so that the heaters can work to complement the solar field. The plant can operate in biomass mode alone, allowing the turbine to operate at 50% of its maximum load.

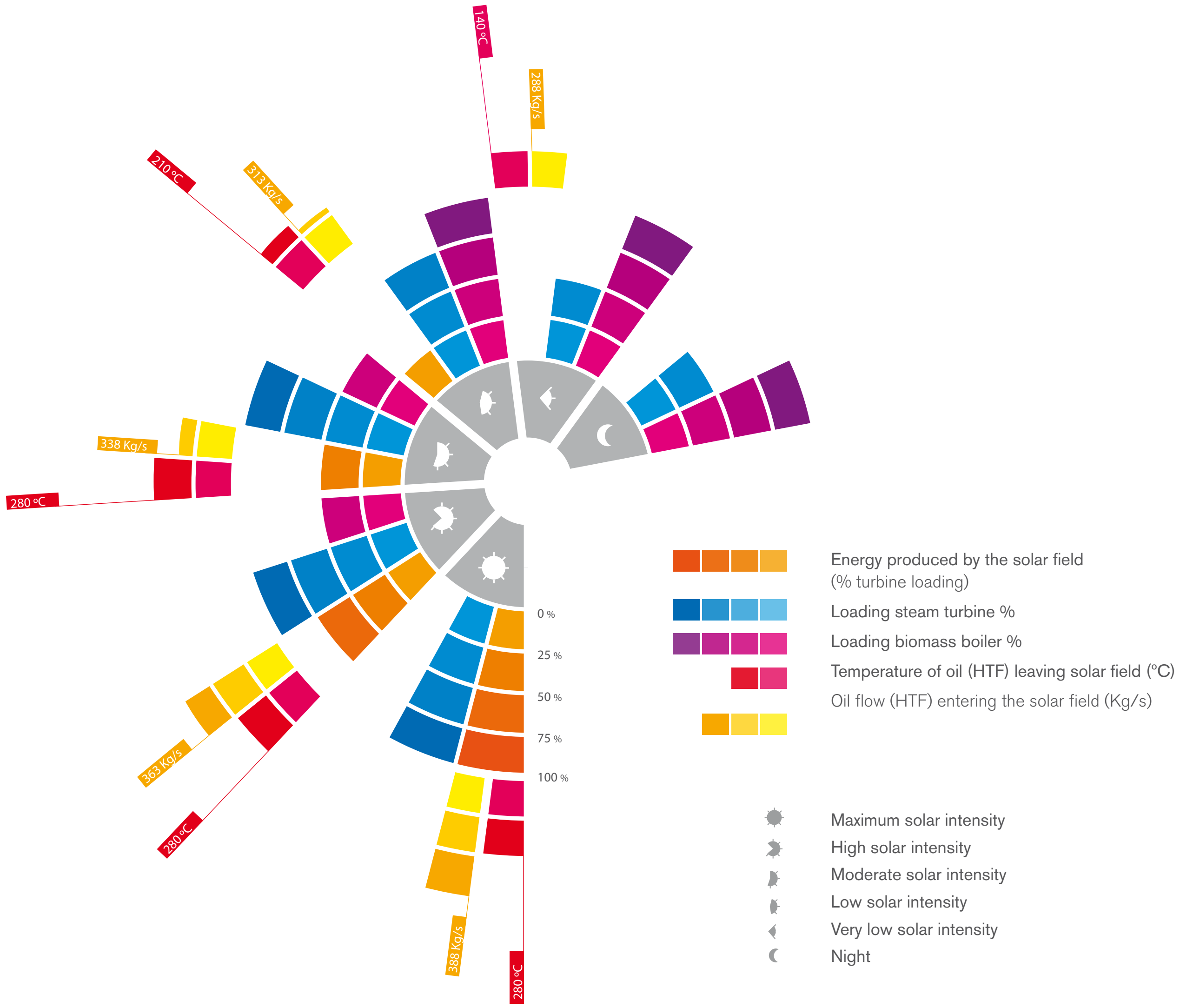
The power block will have a single shaft steam generator. The power cycle is based on technology for electricity generation that follows the process of the Rankine cycle with intermediate reheating.

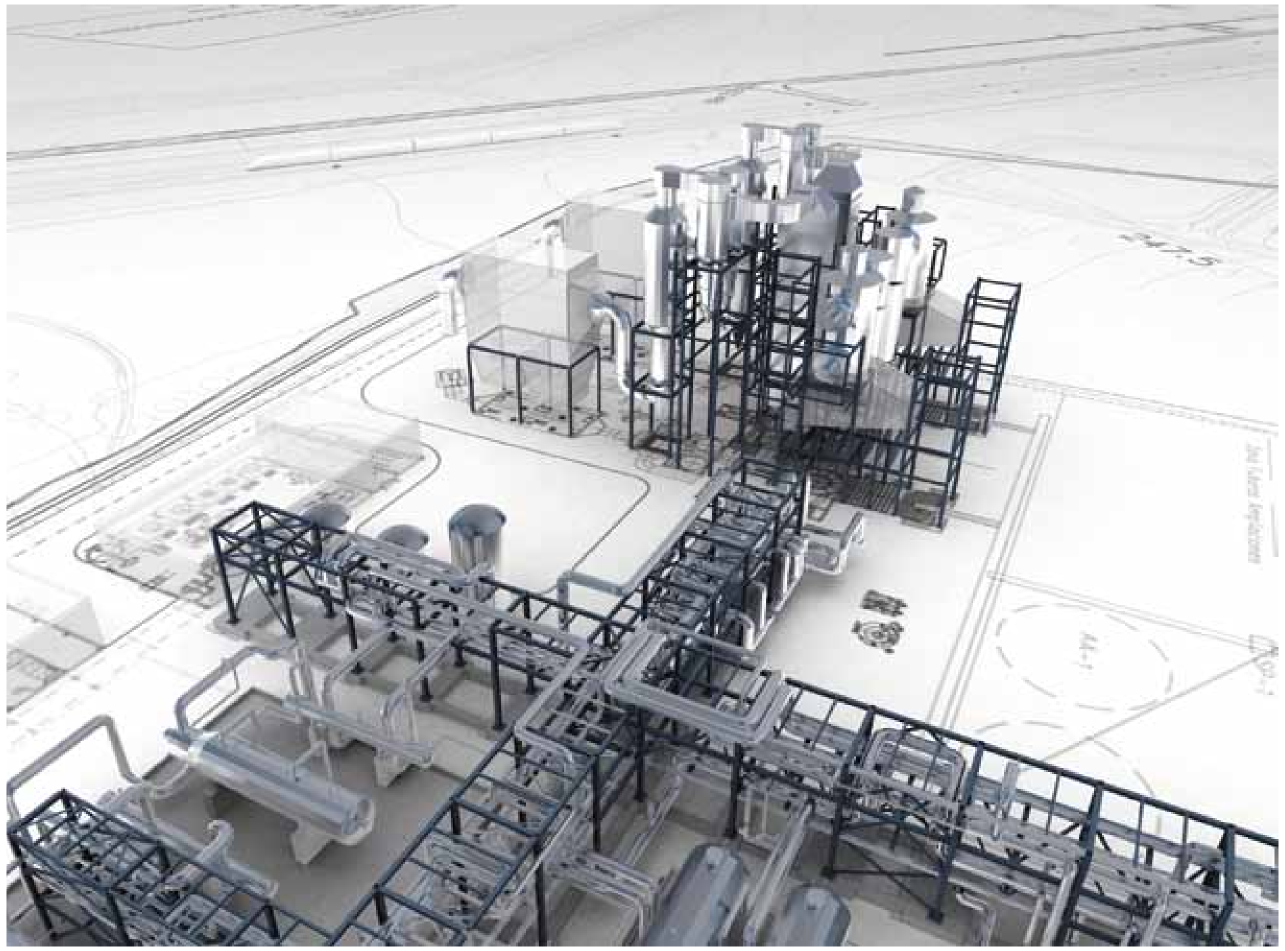
The heat transfer fluid system comprises the pumps that circulate the thermal fluid, two expansion tanks that absorb variations in the volume of the heat transfer fluid, and the heat transfer fluid purification system, in addition to an auxiliary pump.

Graphic image: Arq. Andreia Faley

“This is the first plant of this type to be built on a commercial scale in the world”.

Susana Martínez Escriche
Director of Thermosolar Projects





Operation

The plant can be operated in three modes:

Solar (daytime) – the turbine can operate at all power ranges until 100%.
Mixed mode (daytime) – the biomass boilers complement the solar field.
Biomass mode alone (night time) – the steam turbine can operate to a maximum of 50% of full capacity.

In addition, the 6 MW natural gas heater will make any necessary adjustments to the temperature level of the heat transfer fluid. These three basic operation modes combine to varying degrees on the loading of the turbine.

During the months from July to September, the solar mode will operate without the need for hybridization. During these months, the plant will shut down in "hot-standby" operation mode, allowing a quick-start once heat from solar radiation is available.

In the months of lower solar radiation, from October to June the plant will operate in mixed and biomass mode, 24 hours a day, 7 days a week (excluding the month of December for maintenance) maintaining a minimum load of 50% using biomass, therefore avoiding shutdowns and start-ups on a daily basis.

The plant will have three operational modes: solar alone (daytime), mixed (daytime), biomass alone (night-time). These operational modes will combine to varying degrees on the loading of the turbine as seen in the graph above.

Water treatment

The raw water required by the plant (500,000 m3/yr) will be extracted using gravity from the canal d'Urgell and stored in a storage pool in the proximity of the pant.

The water will be subjected to various filtration and purification treatment processes to reach the necessary level of quality for the mirror cleaning process and the supply neccessary for the cooling tower, closed cooling circuit and steam cycle.

Detailed view of the biomass heaters and heat exchangers. In the background, the Madrid-Barcelona high speed train which crosses the solar field can be seen.

BIOFUEL FROM ALMOND HULLS

"The Autonomous Community of Valencia is a pioneer in the use of natural waste for the production of high performance energy fuel"

Mar Casanova
Regional Secretary of Economy, Trade and Industry
of the Generalitat Valenciana (Regional Government of Valencia, Spain)

Over the centuries, Valencia has carried out intense economic activity and trade based around the almond. As such, it was only a matter of time before researchers came up with innovative applications for the abundant natural waste generated by this activity.

Close to Crevillent (Alicante), the world's first factory producing bio-mass briquettes from almond shells has begun operation.

The new factory which covers an area of nearly 10,000 square meters has the capacity to produce 32,000 tons of fuel using state-of-the-art machinery. This high performance fuel does not produce odours, smoke or sparks.

Furthermore, most of the energy used for this briquetting process is residual heat produced by the nearby power station which supplies the town of Crevillent.

01. Preparation

- Screening/sieving of the hull
- storage

02. Washing

- Activation of lignin
- Residual Disposal
- Homogenization of the material

03. Drying

- Pyrolysis
- Reduction in moisture content

04. Distribution

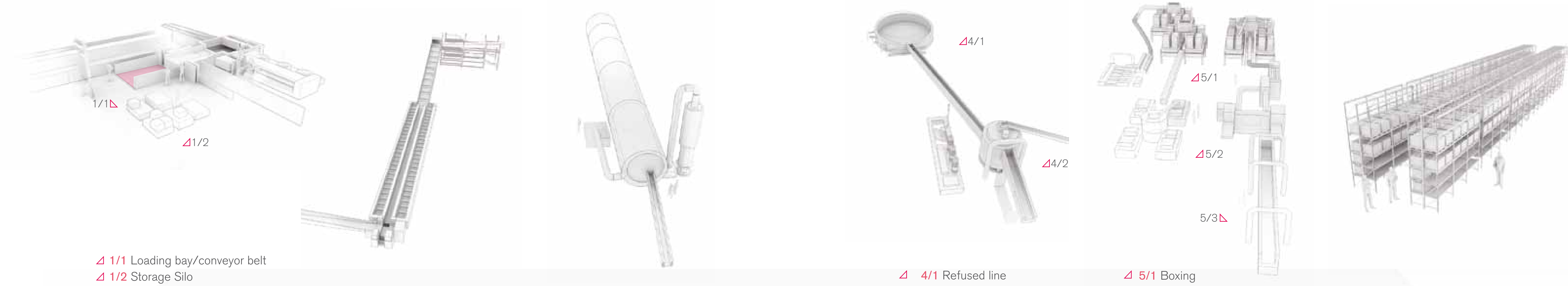
- Technology at field level
- Supply of equipment

05. Briquetting

- Compacted under pressure
- Improved combustion

06. Packaging

- Boxed
- Shrink-wrapped
- bagged



- 1/1 Loading bay/conveyor belt
- 1/2 Storage Silo

- 4/1 Refused line
- 4/2 Distribution hopper

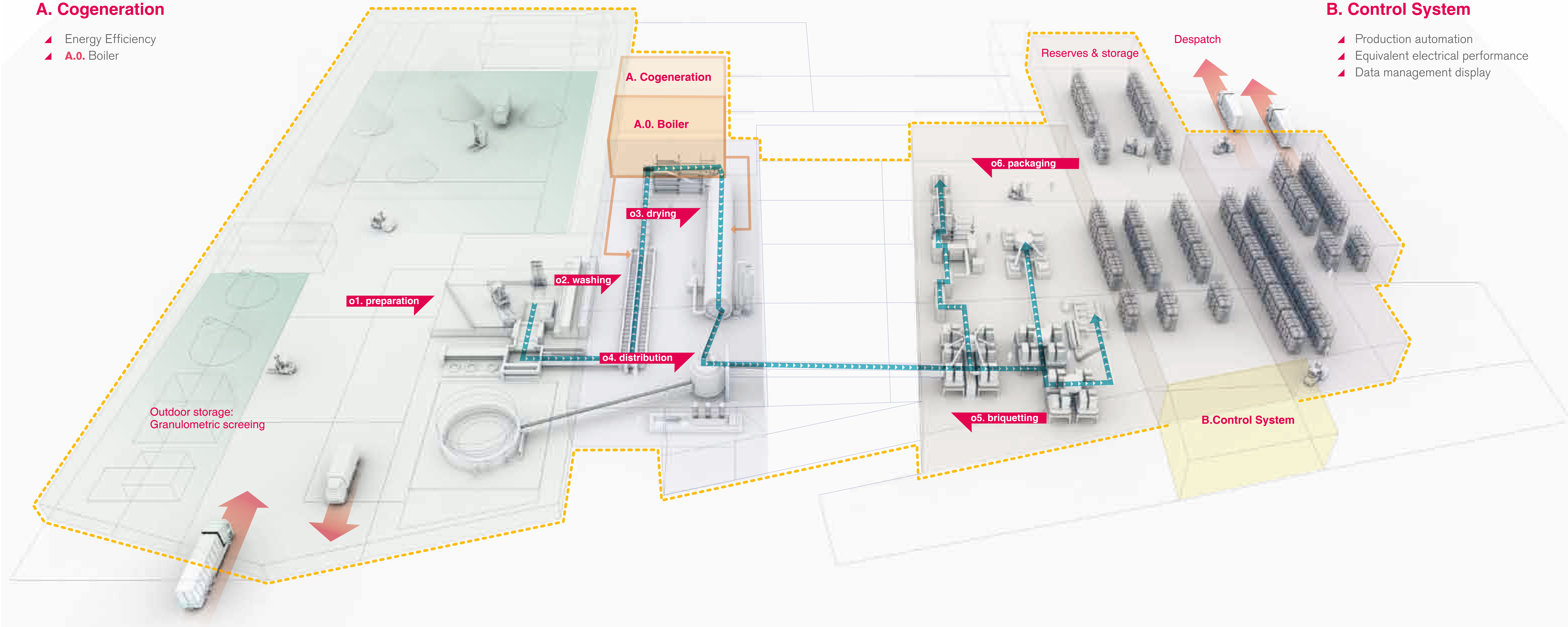
- 5/1 Boxing
- 5/2 Shrink-wrapping
- 5/3 Bagging

A. Cogeneration

- Energy Efficiency
- **A.0.** Boiler

B. Control System

- Production automation
- Equivalent electrical performance
- Data management display



Treatment

The hulls arrive by truck and are offloaded outdoors.

From the exterior loading bay the hulls are loaded into a hopper and fed into a storage silo; with a storage capacity of 100 m3 and capacity to supply the production process for up to at least 4 hours.

Average wash temperature

In this pre-wash process, the hulls are immersed in water at a temperature of between 60 - 65º C, for a varying length of time depending on production needs. The purpose of this process is threefold.

1. Hull washing, removing all soil residue resulting from harvest and storage, therefore reducing the level of ash produced by briquette combustion.

2. Homogenize the moisture level of the hull before passing to the drying process.

3. Activation of lignin, which will rise to the surface of the hull to act as a binding agent.

Pyrolysis

Drying time for the hulls is approximately 1 hour at a temperature of 160º C. The result of this process is twofold:

1. A reduction of the moister content of the hulls to a limit which will enable the briquetting process. This will ensure the optimal heat capacity of the briquette.

2. A pyrolysis process for the production of compact durable briquettes without additives.

On exiting the dryer, the hulls will have a moisture content of 2% and a temperature of about 130º C.

1/ Washing: activation of lignin
2/ Drying of hull

Cogeneration

The energy required for the drying process is obtained by a process of waste heat recovery from the exhaust smoke emitted from the 10 MW cogeneration system adjacent to the plant. The gases are introduced into a 4 MW boiler generating 5,500 kg/h of stream aided by an economizer.

Both the hot water needed for the drying process and the water required for the washing and prewashing processes come from the condensate collection generated by the dryer and water heated in the refrigeration process from the shroud of the cogeneration motors.

Distribution of the hulls

After leaving the drying tunnel, the dried hulls are transported along an insulated screw conveyor to a hopper distribution briquetting system.

From the interior of the hopper, three screw conveyors distribute the hulls to feeding hoppers to the three briquette groups.

Each feeding hopper has between four to six outputs that feed the briquetting equipment depending on whether the machinery is equipped with four or six presses.

The thermal insulation of the screw conveyor is achieved by a double chamber of hot air from a heater located in the drying area of the plant . The objective is to maintain the temperature of the hull above 12º C to facilitate compaction.

3/ Groups of briquetting equipment
4/ Briquettes leaving the press

5/ Shrink wrapping process
6/ Bagging process
7/ Boxing process

The material is compacted by compression

The briquetting equipment uses a press to compact the material, applying pressure of 160 bars for a complete cycle time of 24.6 seconds, reaching a density of 1.200 kg/m3 and weighing approximately 2.2kg per briquette.

Briquetting occurs in a chamber/mould which gives the material a "bone shape". This shape enables the briquette to be easily broken up into three equal portions for its final use. This shape allows oxygen to circulate around the pieces therefore making it easier for ignition and combustion.

Packaging

There are three production lines or groups of briquetting equipment.

Line 1, consists of six briquetting machines with a daily production capacity of approximately 4,000 kg/h, equivalent to 1,756 briquettes per hour.

Lines 2 and 3 consist of six briquetting machines, each with a daily production capacity of approximately 2,700, equivalent to 1,170 briquettes per hour.

Each of the three groups of equipment produces a finished product with different packaging.

Shrink-wrapped: The briquettes are grouped in a 3X1 matrix which is then automatically labelled with information about the product. The product is then wrapped in high density polyethylene plastic before passing through the shrinking tunnel.

Bagged: After leaving the press, the briquettes are transported to the big-bag loading carousel where the quantity is weighed to avoid overfilling the 500 kg bags.

Boxed: The briquettes are automatically grouped into blocks of 3X2 and then boxed in cardboard using automatic Wrap-Around Equipment..

Control

Using a SCADA control system, the process is started-up or shut-down and monitored, and all alarms and incidents are displayed as they occur.

The control system is based on a token ring UTP network using TCP/IP protocols. The network connects the different controllers to the corresponding equipment.

The PLC master is connected to the secondary PLCs and controls all communication requests while maintaining communication with the SCADA system.

The system incorporates an application which calculates the electrical performance, and other applications to display, manage and supervise the daily production as well as providing data output, reports, etc.

The boxes are transported to the pallet packing area, where two robotic arms load the pallet in mosaic formation. The output is 293 cases/h with 60 boxes per pallet.

INNOVATION IN THE HEALTH SECTOR

The secret: focus on the user

For over five years, Idom has been driving innovation in the health sector in collaboration with both public and private institutions. The user has always been at the epicentre of the practical approach taken by Idom.

Model and device design

The innovative impulse of Idom has been focused on two areas: the design of organisational models to facilitate innovation in health institutions, and specific medical device design.

The model for the management of innovation in the hospital environment is a perfect example – currently in operation in the Sant Joan de Déu hospital in Barcelona, - incorporating healthcare assistance, medical technology, life sciences, information technology, organisation and management, and infrastructure and services.

The model, called "Innovative Hospital" promotes top-down and bottom-up innovation, while at the same time ensuring strategic alignment and the participation of all professionals.

Innovation forum

Photos: Conference on Robotics in April 2012

Piezoelectric scalpel

Alberto Vizcargüenaga & Alexander Aviles testing the prototype

Innovation in health institution forum

For four years now, Idom has been promoting the "Forum for health innovation", an initiative undertaken in collaboration with other institutions of the sector and which aims to promote the exchanges of best practices and innovative experiences among health professionals.

In early 2012, two forums were held. The first took place in the Clinical Hospital of Zaragoza and was organised by Idom in collaboration with the Aragon Institute of Health Sciences (I+CS), focusing on innovation in hospitals. The forum was attended by executives and hospital managers in the Aragonese public health service.

The second took place in Barcelona and dealt with the topic of robotic services. The forum brought together the representatives of the major health institutions in Catalonia. The special guest star was Nao, a small humanoid robot. Examples were presented of robotics in services as diverse as rehabilitation, assistance to elderly, autism therapy, and telepresence in intensive care units.

Redesign of piezoelectric scalpel

An example of the redesign of a device carried out by Idom is that of the piezoelectric scalpel of the Biotechnology Institute BTI. The study focused on optimizing the design of the hand-piece, improving its features to meet the demands of the professionals using the device. The manufacturing process to improve the repeatability of features between different units has been studied.

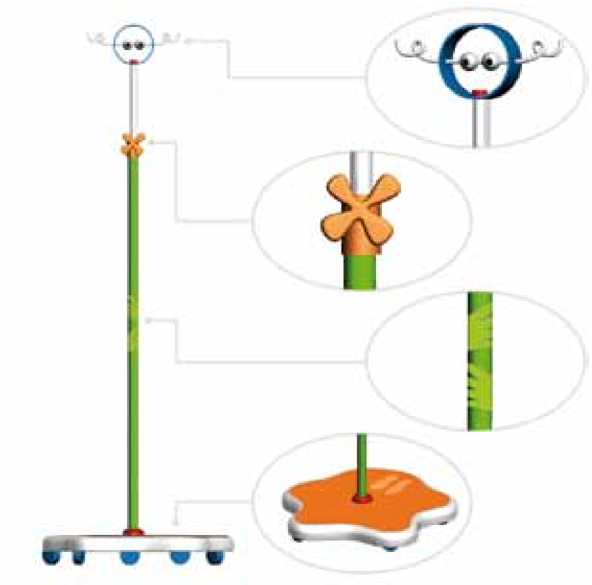
The piezoelectric scalpel allows cutting into the bone without damage to the soft tissue. It is used in fields such as dentistry, maxillofacial surgery, orthopaedics, neurosurgery, etc.

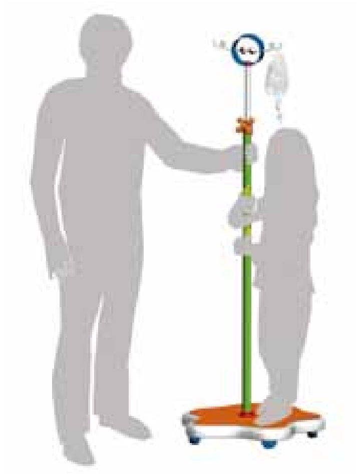
This instrument replaces the tools powered by micro-motors that have limited access to complicated areas and can damage the soft tissue. The friction generated by micro-motors causes heat, which can in turn damage the tissue near the bone. As a result, the traditional device requires irrigation, difficult to incorporate into the design.

The piezoelectric scalpel offers greater precision and cleanliness in the tool-bone interface in relation to the traditional instrument. The heat generated is also lower and the risk of contamination during procedures is lessened.

"When children find the hospital to be an environment of fun and games, the recovery process is accelerated"

Dr. Jaume Pérez Payarols
Innovation Director of the Sant Joan de Déu Hospital





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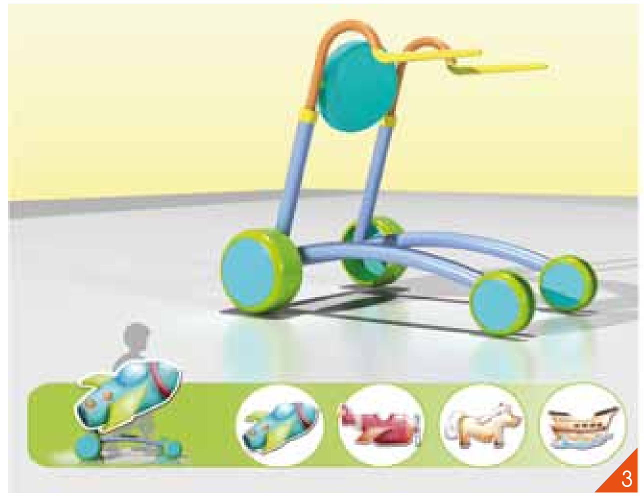

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Redesign of pediatric devices

It was in the context of "The Innovative Hospital", that the idea arose to organise a design competition to solve the specific needs of children, involving both health care professionals and young designers.

Three editions of the design competition organised jointly between the innovation area of Idom, the Sant Joan de Déu Hospital and the Llotja School (Barcelona Arts and Crafts School) been held.

In the first edition (2009), the contest centred on the idea of Guillermo Puche, head of the outpatient department. This professional had found that children were using the IV pole as toy, climbing on the base and rolling down the aisles.

"That's when we realised that this device could deliver more value than that of just holding a bag of serum," says Dr. Jaume Pérez Payarols, innovation director of the hospital. "The IV pole could be an item of play, fun, educational, and additionally represent emotional value."

Under these premises, the first challenge proposed for the Llotja School students in 2009 was to redesign the IV pole for paediatric use.

1 / IV Pole
Design / "Benny" by Raquel Melero

2 / Walker
Design / "Diver pasos"
by Noelia Vallano

3 / Chair-stretcher
Design / "Silla Simpati'k"
by Benjamin Migliore

The IV pole

15 students from the second year of the school specializing in product design participated in the contest. The students had the opportunity to visit the hospital, to see first-hand the context in which the IV pole was being used. The most voted entry was a design called "Benny" by the student Raquel Melero, a proposal which was expressive, fun and intuitive. Based on the winning design, the hospital has produced a series of 10 IV poles which are currently being used on different wards in the hospital, and have proved to be a great success with the children.

The walker

The quality of the results obtained encouraged the organisers to repeat the competition in 2010, taking inspiration from the rehabilitation walkers, once again with the objective of introducing funny and motivating elements to an inanimate cold item. On this occasion, the winning project was "Diver pasos" by Noelia Vallano.

The chair-stretcher

In 2011, the theme was the "chair-stretcher", this time with the objective of meeting a need for hospital logistics. The design of Benjamin Migliore was the most voted. In addition, the team of engineers and designers or Idom Innova carried out a parallel study which resulted in the subsequent design of a chair-stretcher responding to the needs of both the hospital and users (patients, relatives, and hospital staff), thus reaching a level of development prior to the prototype.

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