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Oman hops on the bus

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Ahmed Al Bulushi
CEO of Mwasalat

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Air navigation in Taiwan
Variable gauge technology
Brand Spain: Greenways

EDITORIAL
Strengthening ties

The Bus Transport Strategic Plan for the Sultanate of Oman will provide the country with a public transport that is modern, efficient, sustainable and equipped with smart technology. The project involves a complete overhaul of both the supply –including new urban and interurban routes– and management of this means of transport in the Sultanate, where the use of private vehicles is heavy.

Throughout these pages we are privileged to have the perspective of Ahmed Al Bulushi, who is piloting the transition towards the future of the company Mwasalat, the national bus operator of Oman. We also address other works abroad, such as that carried out with Aena Internacional at the airport in the capital of Angola –4 de Fevereiro International Airport (Luanda)– the only international airport in the country for which Ineco conducted the operational safety study. Finally, we have dedicated an extensive report to the aeronautical study conducted for the expansion of the Port of Kaohsiung in Taiwan, where the installation of high-altitude cranes may interfere with international airport operations.

Internationalisation has irrefutably been a key event in recent years, a result of the experience and knowledge acquired over the course of decades developing Spanish infrastructure. In this regard, I am pleased to announce the contract signing with the Costa Rican Ministry of Public Works and Transport for management of the Transport Infrastructure Programme (PIT). It is a new opportunity to strengthen ties with a country that Ineco has collaborated with for years, and that we wish to continue supporting in its development.

With Ineco's new showroom –described on the inner pages– we strive to reflect the know-how of Spanish construction and engineering firms and their experience and impact around the world. The new Centre for Interpretation –which I invite our clients and friends to come visit– was recently inaugurated at our central headquarters in Madrid. It is a visit that I am sure will provide great insight into the scope of our works.

Finally, we complete this space with articles from our experts on highly-specialised projects such as variable gauge facilities –a technology pioneered by Spain–, water studies to protect high-speed lines or Big Data and transport. With the publication of these studies and works we hope to contribute to the dissemination of these new technologies in addition to engaging our readers. ■

> "We are privileged to have the perspective of Ahmed Al Bulushi, who is piloting the transition of the company Mwasalat towards the future"

JESÚS SILVA FERNÁNDEZ
President of Ineco

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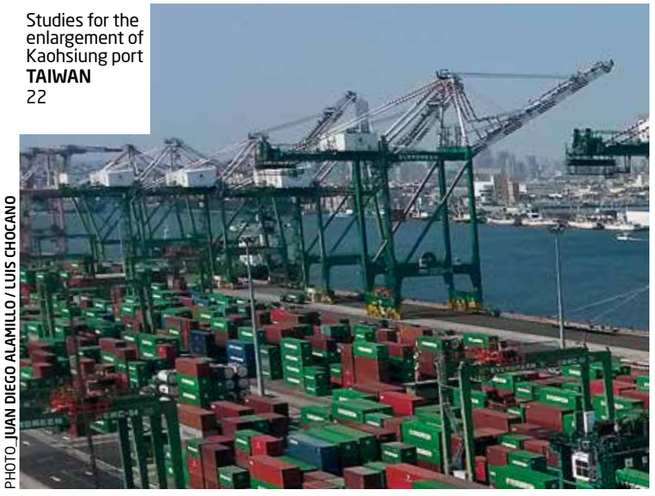

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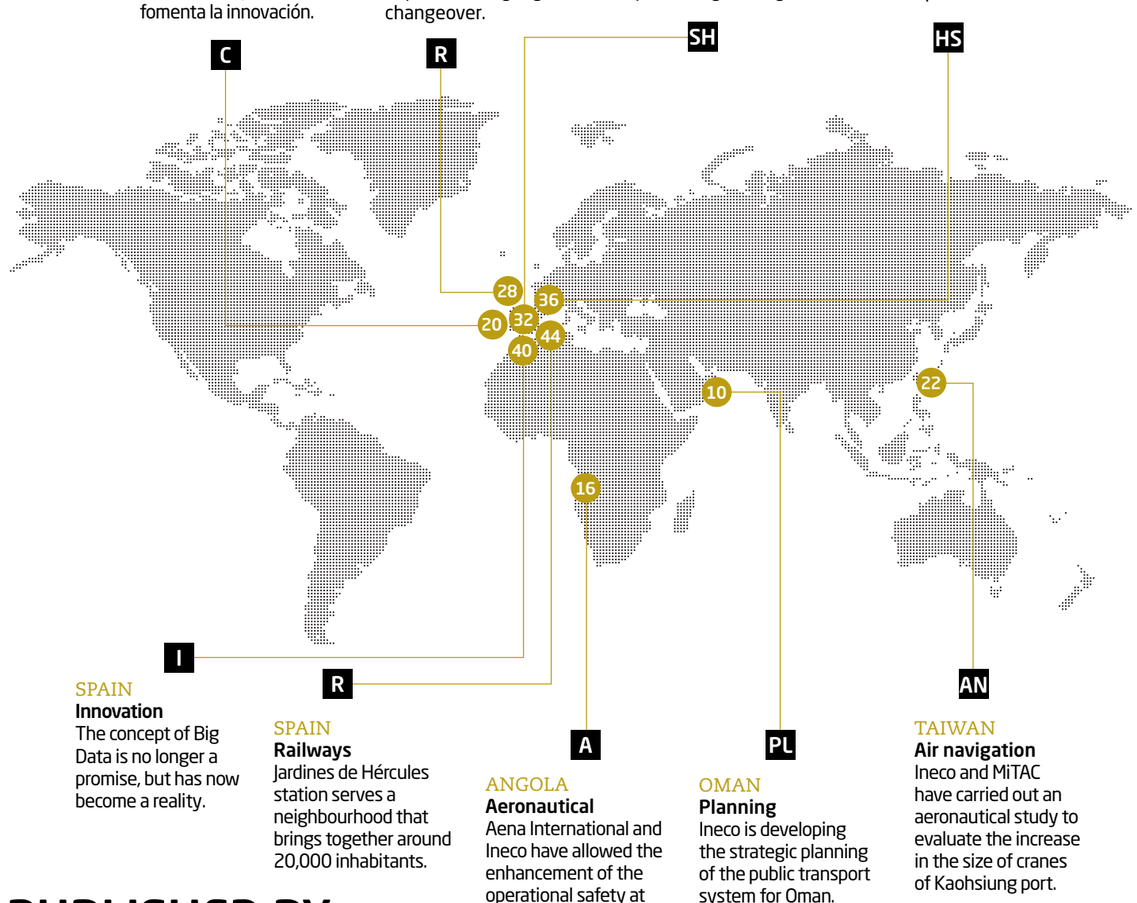

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Ineco colabora con las administraciones en esta novedosa fórmula de licitación que fomenta la innovación.

SPAIN
Railways
Ineco brings more than two decades of comprehensive experience in gauge changeover.

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Showroom
A way of representing the leadership and good performance of Spanish engineering.

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High speed
Ineco has recently carried out a hydrological study of the high speed lines in operation.

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The concept of Big Data is no longer a promise, but has now become a reality.

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Jardines de Hércules station serves a neighbourhood that brings together around 20,000 inhabitants.

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Aeronautical
Aena International and Ineco have allowed the enhancement of the operational safety at Luanda airport.

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Ineco is developing the strategic planning of the public transport system for Oman.

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Ineco and MiTAC have carried out an aeronautical study to evaluate the increase in the size of cranes of Kaohsiung port.

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SPAIN

IMPROVEMENTS ON LINE 5 OF THE MADRID METRO

Ineco has begun technical studies to modify the alignment and infrastructure of the line 5 track of the Madrid Metro. Specifically, the works –which were tendered within the Framework Agreement signed by both companies– refer to the section between the stations of Eugenia de Montijo and Aluche. The studies have the objective of increasing the speed in this section. The modification requires actions on foundations and structures, land treatment, soil-structure interaction, a study on filtration, alignment and the superstructure of the track, mapping, installations and environmental integration.

PHOTO_**PABLO NEUSTADT**

SPAIN

COLLABORATION WITH THE PRODIS FOUNDATION

Ineco has participated in the training days organised by the Prodis Foundation aimed at developing the professional abilities and competencies of people with learning difficulties.

These actions are part of the Master's in Provision of Business Services taught by the Prodis Foundation, with the aim of preparing its participants for employment. Created in the year 2000, the Foundation was set up with the intention of improving the quality of life of disabled people, helping them in their personal development and in their social and employment inclusion.

INECO, ADVISOR IN THE TRANSPORT INFRASTRUCTURE PROGRAMME

In March, Carlos Villalta, minister of Public Works and Transport of Costa Rica, signed with Jesús Silva, president of Ineco and Luis Baz, the general director of Acciona Ingeniería, the contract for the management of Costa Rica´s Transport Infrastructure Programme (PIT).

With an investment of around 450 million euros, the PIT's aim is to contribute to the development of local transport through the improvement of road and port infrastructure, facilitating the flow of trade and the regional economic integration of Costa Rica.

The PIT includes actions in seven road projects and three port projects, with works in renovation, reconstruction, paving, road enlargement, improvements to road safety, bridge enlargements and the construction and improvement of ports.

Ineco has been present in Costa Rica since 2004, where it has carried out works such as the National Transport Plan (see *IT38*), the Comprehensive Plan for the Modernisation of the Airport Network and the study on the implementation of a rail transport system in the metropolitan area of the capital, San José (*IT50*).

PHOTO_**ELVIRA VILA**

From left to right, Jesús Silva, president of Ineco, Carlos Villalta, the Costa Rican minister of Public Works and Transport, and Luis Baz, general director of Acciona Ingeniería.

SPAIN

PANAMANIAN AUTHORITIES VISIT INECO'S HEADQUARTERS

In April, Augusto Arosemena, Panama's minister of Trade and Industry visited Ineco's corporate headquarters. The minister attended along with a representation of Panamanian business leaders and members of the Panamanian government, who visited Spain in order to attend Panama Invest Madrid 2016. Augusto Arosemena was accompanied through the new corporate showroom by Jesús Silva, president of Ineco, Ana Rojo, Engineering and Services managing director, and Ignacio Fernández-Cuenca, Corporate managing director.

Ineco is currently developing the National Collection and Treatment of Waste Plan 2016-2026, which will define the measures necessary to resolve the problems of waste management in the Central American country. Between 2009 and 2010, the company was responsible for defining the strategic plan for the airport development of the country.

PHOTO_**ELVIRA VILA**

PROGRESS IN THE IMPLEMENTATION OF BIM

The third meeting of the BIM (Building Information Modelling) Commission, which was held in February, was presided over by Mario Garcés, subsecretary of Public Works, and was participated in by Jesús Silva, president of Ineco, who presented the programme for 2016. Ineco supports the Ministry of Public Works in this Commission, which seeks to drive forward the implementation of the BIM methodology in Spain in which representatives of the public and private sector participate. This initiative wants to promote the use of this methodology throughout infrastructure life cycles, to rise awareness among public administrations about the establishment of BIM requirements in infrastructure tenders, to establish a regulation schedule, to develop national standards and to boost training in Spain. In the session the beginning of activities of the EU BIM Task Group in Brussels were also analysed. This group, co-financed by the European Commission, includes representatives from public administrations of 14 Member States.

On the picture, from left to right, Jorge Torrico, Ineco Project subdirector, Jesús Silva, president of Ineco, and Mario Garcés, subsecretary of Public Works.

SAFETY ASSESSMENT FOR PANAMA METRO

Ineco is carrying out the Independent Safety Assessment (ISA) of lines L1 and L2 of the Panama Metro for the company Alstom. Specifically, Spanish public engineering is carrying out the ISA for the revision and adaptation of L1, in commercial service since April 2014, increasing its capacity. The new trains of this latest line will have five cars instead of three, and the fleet will include 26 trains instead of 20, involving modifications to the tracks and installations, new supplies and other complementary works. In relation to L2, the ISA includes all subsystems, amongst others, rolling stock, a signalling system, energy supply, supervision and control of trains, communications and SCADA (Supervisory Control And Data Acquisition).

The ISA can only be performed by an accredited assessor and they are essential for ensuring that a new line is reliable and safe, and can enter into or continue in service. Ineco has the International Laboratory Accreditation Cooperation (ILAC) recognition as an inspection entity for the Independent Safety Assessment of railway applications at an international level. The company has been working for more than a decade carrying out independent safety assessments on the Spanish rail network, (see *IT56*).

INTERNATIONAL

PASSENGER TERMINAL AND WORLD ATM CONGRESS 2016

The company has participated, for another year, in the Passenger Terminal Expo 2016 fair, which was held in Cologne from 15 to 17 March. José Manuel Anguita, Business Development director; José Ángel Higueras, National Aviation and AMEA director; and Esther Barahona, Infrastructure Planning and Development Section technical manager, represented Ineco at this international conference in which the company had a corporate stand. This year, around 3,500 professionals and over 220 companies from the aeronautical sector from 85 countries came together.

Moreover, World ATM Congress held its fourth edition in Madrid from 8 to 10 March. Ana Pastor, minister of Public Works, accompanied by Jeff Poole, general director of CANSO, opened the fair. The minister visited, along with Julio Gómez-Pomar, secretary of State for Infrastructure, Transport and Housing, and Carmen Librero, general secretary for Transport, the joint stand of the Public Works Group (Ineco, ENAIRE and SENASA).

From left to right, Rodrigo López, Laura Serrano, Farah Baroudi, Blanca López and Álvaro Morillo, of Ineco, at the World ATM Congress.

IMPLEMENTATION OF THE ERTMS IN SLOVAKIA, SLOVENIA AND THE CZECH REPUBLIC

The works of coordination and technical supervision in the deployment of the European Rail Traffic Management System (ERTMS) which the European Commission has commissioned to Ineco (see *IT53),* have included, in recent months, three informative workshops in Slovakia, Slovenia and the Czech Republic.

Silvia Domínguez, Beatriz Sierra, Virginia Álvarez and Diego Sanz, of Ineco, were responsible for this work, which aims to provide the knowledge of ERTMS experts to the cohesion countries, to facilitate its implementation in a coherent, interoperable manner and gain successful projects.

Ineco was also present at the latest international ERTMS conference of the UIC, with a panel in which the objectives were transmitted, as well as the main lessons learned during the functional monitoring of the ERTMS system. From 2015 to 2020 Ineco experts are responsible for the control and technical monitoring of the deployment of ERTMS in the nine main European corridors.

KAZAKHSTAN / AZERBAIJAN

BUSINESS MEETINGS

In April, an Ineco delegation travelled to Kazakhstan and Azerbaijan to meet with representatives of their governments and the main transport companies. They also participated in two business forums held in Astana and Baku, accompanying the minister of Foreign Affairs, José Manuel García-Margallo along with representatives of other Spanish companies. In both meetings Spanish companies were invited to participate in the development of the infrastructure of their countries. In 2014, Ineco carried out the feasibility study for the Pavlodar tram in Kazakhstan.

On the picture, Sergio Navarro, business delegate in Europe and Jesús Silva, president of Ineco, alongside Ablaliyev Satzhan Aitenovich, vice-president of the Roads Committee; Potlov Dmitriy Vladimirovich, vice-president of the Transport Committee; and Yerbol Aitbayev, vice-president of KAZDORNII.

PROJECT MANAGEMENT OF THE ENLARGEMENT OF FUJAIRAH AIRPORT

The company is carrying out the project management and supervision of the design and construction of the enlargement works of Fujairah international airport, in Abu Dhabi (UAE), which plans to triple its cargo operations over the next decade.

Abu Dhabi Airports Company (ADAC), the project developer, has taken charge of the works to adapt the infrastructure to the predicted growth and their implementation is planned for the end of the year 2018.

The works to be performed by Ineco along with its partner PMDC (Project Management and Design Consultants) involve the comprehensive management of the project and the supervision of works, which include the building of a new air traffic control tower, the enlargement of the runway, and the building of a new emergency runway, as well as new rapid exit taxiways. Furthermore, the traffic guidance equipment and the meteorological system will be completely updated, a new electrical power plant and substations will be built and the existing CNS systems will be improved (ILS, DVOR). Ineco's tasks cover both the project management –control of deadlines, costs and contractual aspects– and the supervision of the whole project, from the design phase to construction and implementation.

Oman hops on the bus

Ineco is developing the strategic planning of the public transport system for the Sultanate of Oman, which has released a fleet of buses equipped with the latest technology and new urban and interurban routes.

By ***ITRANSPORTE*** and **Juan F. González**, civil engineer

Oman aims for an urban and interurban transport system that is modern, efficient and sustainable, covering all modes of transport and driving the country's social, economic and tourism development. With these objectives, Ineco is carrying out comprehensive advisory and consulting work in the country for the proper planning and implementation of the system.

The company has thus drafted the Bus Transport Strategic Plan for Mwasalat, the public transport operator, formerly known as ONTC (Oman National Transport Company). The Plan, drawn up in conjunction with Grupo Ruiz, includes an extensive programme of actions such as the deployment, already underway, of the public transport network of Muscat, the capital, the implementation of new urban transport services in other cities such as Salalah and Sohar, and the extension of the current interurban transport network. It also includes an infrastructure investment programme (bus stations, workshops, parking areas, etc.), the implementation of new management and operation service technologies and the definition of financial plans.

From left to right: Faiz Al Haddabi, Planning supervisor and Mohammed Al Ghafri, Supply Chain manager and Project director, from Mwasalat; and Juan F. González, from Ineco, boarding one of the new vehicles.

By 2014, Ineco had carried out a Public Transport Master Plan for Muscat for the Oman Ministry of Transport and Communications (see *ITRANSPORTE* 54), which set out, among other actions, to create a sole public transport authority, to gradually implement a network of new routes and to construct a reserved platform (bus lanes). The Plan also involved the Ministry of Transport and Communications as well as other public bodies and entities, such as the Royal Oman Police, the Ministry of Tourism and the National Planning Council.

RELIABLE AND MODERN PUBLIC TRANSPORT

These projects have represented a milestone in the strategic planning of the country's public transport system. They are the starting point where the Ministry of Transport and Communications, through Mwasalat, has begun to implement new routes and to renovate the fleet of buses.

The new phase is reflected in the complete overhaul of the company's corporate image, which has been renamed Mwasalat, "transport" in Arabic, and has unveiled a new logotype, inspired by the sails of the dhows, traditional Omani sailing vessels, in reference to the future public transport network.

THE GOAL OVER IS TO CONSOLIDATE A RELIABLE AND MODERN PUBLIC TRANSPORT SYSTEM

The new fleet's first 40 urban buses have been running on the five new urban routes in the capital since last November, a great success among passengers. Equipped with the latest technology, these low-floor buses have an air conditioning system, extendable ramps for wheel chairs and passenger-information systems. In addition, another 10 buses, designed for long distances, have also begun to provide inter-urban services, specifically between Dubai and Salalah, among other destinations.

The goal over the next few years is to consolidate a reliable and modern public transport system, which is environmentally-friendly and equipped with smart technologies, that contributes to and strengthens the socioeconomic development of Oman.

1

1
From left to right: Juan F. González, from Ineco, Faiz Al Haddabi, Planning supervisor, Ahmed Al Azizi, Infrastructure manager and Steven Lucas, Planning manager, at Ruwi Station in Muscat.

2
Eva Hitado, Emilio Miralles and Juan F. González, from Ineco, along with representatives from different public transport organisms.

2

3

3
Depiction of the bus lane on Qaboos Sultan Road, one of the main arteries in Muscat.

4
Inside of the new urban buses: manufactured by the company VDL, they are completely accessible thanks to their low floors; they are equipped with air conditioning, information screens for passengers and both interior and exterior cameras.

4

5

PHOTO_IAN SEWELL (FLICKR)

7

6

8

5
Bahla fort, west of Muscat.

6
Muscat seafront, next to the bay.

7
The wadis, with over 60 around the country, are spectacular oases with natural pools suitable for bathing.

8
Seaside pool at the Chedi Hotel in Muscat.

TOURISM BOOST

The population of Oman, 4,301,825 inhabitants according to data from 2015, is concentrated in the country's major urban centres: Muscat, the capital, on the northeast coast, Sohar, to the north, and Salalah, in the south. These cities are all port cities, while the latter two are also industrial centres. Other important cities include Nizwa and Duqm. However, the population density is low for its territory of over 309,000 km^2, similar to that of Italy. It is noteworthy that 44% of residents, almost all in urban areas, are foreign workers in addition to being of a very young age: 68% are under 30 years of age according to data from the National Statistics Centre.
This population has come to the country attracted by the dynamism of its economy which is fifth among the economies of the Persian Gulf and 65th in the world according to the International Monetary Fund. Although it is the fifth exporter of oil in the region, Oman is carrying out various strategies to diversify its economy. These strategies include boosting international tourism, which has grown 12% over the last 15 years according to data from the World Tourism Organization. The sector is expected to account for 3% of GDP by 2020.

The development of a multimodal public transport system is key to achieving this, along with the construction and deployment of hotel and leisure infrastructure around the country. A government agency was created in 2005 for this purpose and is promoting several tourism projects: conference, leisure and sports centres as well as golf courses and hotels. We can highlight, for example, the Oman Convention & Exhibition Centre, the Alila Jebel Akhdar Resort and The W Hotel, in addition to the renovation of some of the major international hotels which belong to the government.
From a visitor's perspective, Oman boasts several attractions which are not yet well-known worldwide, including a great variety of landscapes and climates, from the inland desert climate and its wadis and canyons, to the tropical climate in the south or the milder coastal plain climate with practically untouched beaches. Tour operators offer packages that include sports and adventure activities such as scuba diving, cave exploration and trekking, as well as wildlife observation–birds, whales, dolphins, tortoises, etc., as, due to its geographical location, Oman is found on the migration routes of several species.

This is in addition to the urban culture and shopping opportunities offered by the capital, Muscat, which includes music, cinema, theatre, modern shops with international brands and souks, or the traditional markets. The country's millennia-old history is reflected in the cultural and natural assets declared World Heritage by Unesco, such as the archaeological sites of Bat, Al-Khutm and the Al-Ayn necropolises, located inland, which date back to 3000 B.C.; the 2000-year old falajs or irrigation systems, The Frankincense Trail in Dhofar, to the south; and the fort of the oasis of Bahla, to the west of Muscat, one of the most spectacular among the many located throughout the country.

AHMED AL BULUSHI

"The new services are receiving a very positive response from passengers"

CEO of Mwasalat (formerly known as ONTC), the national transport company founded in 1972. The company is currently engaged in a profound process of transformation to become a modern and efficient public transport operator that is committed to cutting-edge technology.

The years 2015 and 2016 are being very intense for the development of Mwasalat. What actions have you completed so far?
During November 2015, occurring simultaneously with the celebration of 45th year of the Renaissance of Oman, a key milestone was achieved by the company: Mwasalat unveiled a new company identity and the spinal route of Muscat public transport system was implemented, while the existing routes were renovated with brand-new and modern fleet. This was the first step of a long process that will see a substantial number of routes being implemented in Muscat during the following years. The modernization of the company has not been limited only to urban transport in Muscat, Mwasalat intercity and international services were also improved as part of this renovation process with brand-new fleet with the highest levels of quality and safety.

AN EXPERIENCED MANAGER
Ahmed Al Bulushi holds a Master's degree in Management and Information Technology from Bond University (Australia) and Higher Diploma in Accounting. He has over 17 years of experience and has held different positions during his career such as director of Financial Affairs for the Royal Court Affairs. Ahmed is also Board Member of Muscat Securities Market and Oman National Engineering and Investment Company.

The new Muscat services have changed the public transport landscape in the city, what has been the people's reaction to the new services?
People's response to the new bus services in Muscat has been very positive. Passengers are very satisfied with the new features in the bus. The buses are low-floor, air-conditioned and equipped with cameras and informative screens. From the demand's point of view, the launch of these initiatives can be seen as a great success since public transport demand has substantially increased: more than 600,000 passengers used the Mwasalat service in Muscat in the first 70 days, averaging around 9,000 passengers every day. These figures contrast with the average of 3,500 passengers per day before the launch of the new services.

Regarding the future, what future actions is the company planning?
A number of ambitious plans are awaiting for the company such as the expansion of the city and intercity bus fleet in order to implement new urban bus routes in Muscat, to establish new urban bus routes in other strategic cities of the Sultanate and to reinforce or extend the intercity routes with new services to other destinations or greater frequencies for existing routes.

Intelligent Transport System (ITS) is key element for the modernisation of the company. What ITS are you planning to implement?
We are planning to implement smart ticketing, passenger information systems, automated vehicle management systems, etc. All this initiatives will help to improve transport system and mobility, reduce traffic associated problem, enhance the economy and, finally, help to continue the economic and social development of the Sultanate of Oman.

Public transport sector is very particular in Oman, what challenges is the company facing in this sector?
The main challenges is the regulation of the sector. Mwasalat needs this regulation: firstly, to regulate the taxi sector so they become a professional and complementary activity to bus services; and secondly, to regulate the passenger land transport market, so the coexistence of public (Mwasalat) and private bus companies is achieved with adequate competence conditions. Fortunately, the work is under progress with the recently approved Land Transport Law that was elaborated by the Ministry of Transport and Communications, which is the first step to regulate the sector.

How would you assess Ineco's work and what is its role in the development of Mwasalat?
Ineco is developing for Mwasalat a comprehensive Master Plan that will chart the road map for the company's evolution into an international-class bus operator over the period 2016-2040. The Master Plan is aimed at transforming Mwasalat into a world-class public bus transport operator. We really appreciate the involvement, flexibility and know-how of the Ineco's team working in this project. Ineco has successfully demonstrated in the past months that they are a team of highly qualified professionals that can bring international best practice tailored to our needs and context. ■

4 DE FEVEREIRO INTERNATIONAL AIRPORT
The departures terminal of the 4 de Fevereiro International Airport, built in the 1960s and renovated in 2009, which today has a capacity for 3.6 million passengers per year.

Building trust

The airport of Angola's capital Luanda has once more benefited from the experience of Aena Internacional and Ineco to improve operational safety. Works are underway to complete and expand those that were carried out in 2012.

With the collaboration of **Roberto Calonge,** industrial engineer and **Ángel Villa** (Aena Internacional), aeronautical engineer

Physical security and operational safety are a fundamental pillar of all aeronautical activity and are at the centre of all procedures affecting air navigation, passengers, airport staff and the airport itself: among others, the inspection of baggage and cargo, access control, airfield signalling, the maintenance of vehicles and facilities, and action plans in the event of an emergency or disaster.

Ensuring that all these elements comply with safety levels established in aeronautical legislation (and monitoring them through the use of quality indicators) guarantees not only reliable and efficient air transport, but also international recognition and greater attention from airlines, which can boost the airport's growth. It is for that reason that ENANA (the Angolan National Enterprise for the Operations of Airports and Air Traffic Control), which operates the country's airports and air navigation services, has again turned to the experience of Aena Internacional, which through Ineco has carried out its second project at the capital's 4 de Fevereiro airport. Preliminary studies were carried out in 2012 (see *IT48*), and are now being given continuity.

This first approach focused on the analysis and detection of potential risks and needs for safety, and the development of a total of 21 proposals for immediate corrective actions. These measures were grouped into 7 areas: infrastructure, equipment, airport services, documentation, real-time management, strategy and maintenance. In addition, Ineco and Aena Internacional developed operating and safety procedures and an Operations Management Plan (OMP), focusing on planning and real time. To raise awareness among airport staff of all the actions, a plan of training was delivered, totalling 196 hours for 220 participants. In addition to the safety proposals, a proposal for the commercial exploitation for the airport was also developed. This new project has seen advances in the development of these measures, which are specified in different plans. Works were carried out in two phases.

4 DE FEVEREIRO INTERNATIONAL AIRPORT (LUANDA)

Luanda airport is currently the country's only international airport. Built in the 1960s, it was expanded and renovated in 2009 and has a capacity for 3.6 million passengers per year. Over half of these are international travellers, with 65% coming from other African countries and 15% from Europe. The airport is both for civilian and for military use, and has two runways, 05/23 (3,715 x 45 m) and 07/25 (2,600 x 60 m). In terms of aircraft, it is worth highlighting the Boeing B737-700, which is used by the main airlines operating at the airport.

AIRPORTS IN RECONSTRUCTION

After a civil conflict lasting 27 years (from 1975 to 2002), Angola, which according to the World Bank currently has a population of 24.2 million, started its reconstruction. During the first 10 years of the century, it recorded dramatic economic growth, with average GDP growth above 11%. This was mainly based on the extraction of oil (Angola is the second largest producer in Africa, after Nigeria, and the eighth largest exporter in the world) and diamonds. Investment in all kinds of infrastructure, including for transport, is both a practical necessity and a crucial part of the economic diversification strategy. Regarding air transport, in addition to building a new airport 40 kilometres from the capital, which ENANA expects to be operational from 2017, works to renovate regional airports have been underway since 2008. These are distributed between the 18 provinces which make up the country's expansive territory of 1.2 million square kilometres. The 4 de Fevereiro airport, located in Luanda, has also benefited from renovation and improvement works, including consultancy from Ineco and Aena Internacional.

PHOTO_ DAVID STANLEY (FLICKR)

Above and right, Luanda's parliament and a panorama of the city. Below: the Ineco and Aena Internacional team; ENANA staff members at train

SAFETY AND EMERGENCIES

The airport safety programme assigns responsibility, competences and obligations in the area of safety between airport management and the departments that organise and provide the services involved; defines restricted areas and safety measures both in the air and on land as well as the regulations in force for vehicle checks, the control of weapons and hazardous substances and goods, and the transport of passengers who are ill, have been detained or deported or are deceased, etc. The emergency and contingency plans are designed to cover any serious situation affecting safety at the airport, from criminal acts to aircraft accidents inside or outside the premises of the airport. The objective of the contingency plan at 4 de Fevereiro airport is to identify and to coordinate what action protocols are to be followed in the event of an aircraft being hijacked or sabotaged, and, according to the level of threat, what measures must be taken by each body: airport staff, ENANA, armed forces, the police, the fire service, hospitals and medical services, etc. In parallel, Annex 14 of the ICAO requires that each airport have a specific plan for situations involving aircraft or aeronautical emergencies, such as accidents inside and outside the airport, and other situations such as natural disasters, accidents with hazardous goods or medical emergencies. The purpose of the emergency plan is to minimise the repercussions of such situations, to avoid the loss of human life, to safeguard the integrity of the facilities and to resume normal airport activity as early as possible. To that end, the document identifies possible risks and establishes command and communication procedures to be followed in order to avoid improvisation and the lack of coordination. The emergency plan includes the preparation and organisation of emergency drills in the airport and the drafting of a guide to carrying this out.

THE AIRPORT SAFETY PROGRAMME ASSIGNS RESPONSIBILITIES BETWEEN MANAGEMENT AND ORGANISATIONAL DEPARTMENTS

The project's scope also covers the Safety Management System (SMS), for which a gap analysis was carried out on the current situation, 10 procedures were drafted and a plan was established for the implementation of the System. Another crucial safety element, considered strategic by ENANA, is the training of trainers, for which a course is being planned.

APRON WORKS

A fundamental aspect of operational safety is that the aircraft parking apron or ramp and the taxiways are properly marked, in accordance with ICAO manuals. At Luanda airport, shortcomings were detected in this area, especially for aircraft stands. In addition, the apron is shared by different types of aircraft (planes and helicopters); this constitutes a potential hazard both for aircraft themselves and for people and vehicles. Three types of actions are recommended in response to this.

Firstly, a topographic survey at a scale that would allow plans to be drawn up. Secondly, the definition of requirements for the design of the apron, taking multiple factors into account: the air traffic volume and forecasts, the types and sizes of aircraft, and whether they are commercial, military or for general aviation, their stops (national or international, terminals, transit, etc.), margins of separation from other aircraft, buildings and objects, etc. It is also necessary to analyse the means of access to aircraft parking (autonomous or with the assistance of a vehicle to tow or push the aircraft) and the distance to other installations (terminal, hangars, etc.), aircraft's requirements of land-based assistance (fuel supply services, baggage handling, etc.). Additionally, the design of the apron should take into account the space available, the type of surface, jet blast, the time that each aircraft will occupy a stand and the time taken for another to occupy it, etc.

ADVANCES ARE ALSO BEING MADE IN THE COMMERCIAL DEVELOPMENT OF THE AIRPORT, A FIELD TO WHICH AENA INTERNACIONAL HAS CONTRIBUTED ITS BROAD EXPERIENCE

Finally, taking into account all these design requirements and in compliance with ICAO criteria, the signalling study and planning will be carried out. This will cover aircraft stands, taxiways, service lanes and helicopter pads.

COMMERCIAL PLAN

Advances are also being made in the commercial development of the airport, a field in which Aena has contributed ample experience (see *IT54*). To achieve an increase in non-aviation income similar to that of other international airports (in Aena's, this accounts for 26% of total income), an analysis was carried out into passenger demand, the most appropriate type and range of offering (including catering, duty-frees, VIP lounges, parking, etc.), and the design or layout of commercial spaces. The plan also included how the exploitation and contracting of the different spaces are to be carried out (direct exploitation by the operator, concession to third parties, etc) and how it is to be planned and managed. All of this is gathered in a business plan which included the participation of Carlos Porrón, from Aena Internacional. ■

EXPERIENCE

- ▶ Development and update of operating procedures for the two new runways and the new terminal T4 at Madrid-Barajas airport (2004-2006) and terminal T1 at Barcelona-El Prat airport.
- ▶ Support to Operational, security and services management at Aena's Central Services for more than 10 years.
- ▶ Support to the Spanish Aviation Safety and Security Agency, AESA, in authorising, inspecting and certifying privately-run airports for public use, and other tasks (2009-2011).
- ▶ Review and update of the Emergency plans and Self-protection manuals for the 47 airports and heliports in the Aena network.
- ▶ Process improvement at the Management Centre of Aena's H24 network (see *IT42).*
- ▶ Obstacle studies for various airports in the Aena network and for other international airports (Oman, Costa Rica...).
- ▶ Apron planning, design and signalling studies for airports in Spain (Madrid, Barcelona, Málaga, Alicante, Lanzarote...) and abroad: Nairobi (see *IT18)* and Kuwait.
- ▶ Planning and design of commercial spaces for Aena for more than 12 years.

PHOTO_CLEMENT123 INVESTIGATION (FLICKR)

“I’m looking for solutions with new technologies”

The new modality of Public Procurement of Innovation enables the identification and promotion of R&D+I projects that offer solutions when the current ones are not achieving the required result. Ineco collaborates with the administrations in this new form of bidding which encourages innovation.

By **Gemma Caballero**, civil engineer and **Antonio Gómez**, telecommunications engineer

It all started with an exceptional problem on a recently opened section of highway, in a mountainous area of Galicia. The very few 4 kilometres of the highway A-8 running through the Alto de O Fiouco (Mondeñedo, Lugo), has become a serious headache for its users, technicians and managers: the stubborn and thick fog, and at times, the strong wind which affects the highest passage of the highway (nearly 700 metres in height) cause constant traffic closures, without the various methods installed, which are effective for the rest of the roads, being able to resolve the effects of such controversial meteorology.

Finally, the Ministry of Public Works, with the support of Ineco, decided in 2015 to begin the search for alternative solutions to those currently existing in the market, through an innovative process of recruitment, the Public Procurement of Innovation (CPI, for its Spanish acronym). The aim was to develop a system of protection against the fog which would complement the measures that have already been installed, which practically cover the current state of the art in management and operation of roads (high reflectance signing, variable message panels, visibilemeters, fixed fog marker posts, section radar, etc.).

THE NEW PHILOSOPHY IS: IF IT DOES NOT EXIST IN THE MARKET, I ENCOURAGE IT TO BE RESEARCHED AND FOR INNOVATIVE SOLUTIONS TO BE PROPOSED

The main innovation of the process involves the participating companies proposing and developing new technological solutions, supported by the Public Administration, who defines the problem that needs resolving, establishes the validation criteria and functional specifications of the possible solutions and shares with the companies, in some of the more complex cases, the risks and benefits of R&D.

Other cases of research of innovative solutions have emerged in the port of Málaga, the Galician health service (SERGAS) or the Hospital of Córdoba. Almost all of the goods and services sectors need to retrain with the improvements that contribute new technologies.

The established method for finding solutions to these unsatisfied demands is revolutionising the current administrative culture: the usual requirements (price, minimal risk) are replaced with a support policy for the private innovation through the commission of developing solutions which don’t exist, boosting the R&D. The new philosophy is: if it doesn’t exist in the market, I encourage it to be researched and for innovative solutions to be proposed.

The CPI is a public action, supported by the Ministry of Economy and Competitiveness, for which administrations select R&D+I proposals presented by private companies, sometimes financed through the CDTI (Centre for the Development of Industrial Technology). The project, which was started by the Ministry of Public Works, consists of three phases: Preliminary Market Consultation, Pre-Commercial Public Procurement (development and prototype experimentation) and Commercial Purchase (implementation of the final solution in the section). The State contracting platform enables us to track the CPI contracts which have been carried out on the Ministry of the Finance and Public Administrations website (https://contrataciondelestado.es).

The first to support this type of recruitment is the European Commission itself, which has developed several “Guidance for public authorities on Public Procurement of Innovation” to advise on these procedures. Its vice-president Antonio Tajani argues in the prologue that “European public authorities all have a responsibility to favour innovation when producing and consuming goods and services. Public procurement of sustainable and innovative goods and services is one of the essential tools for stimulating new technological or service solutions while helping to create jobs and boost the competitiveness of European industry and SMEs. It also encourages more efficient public services”. ■

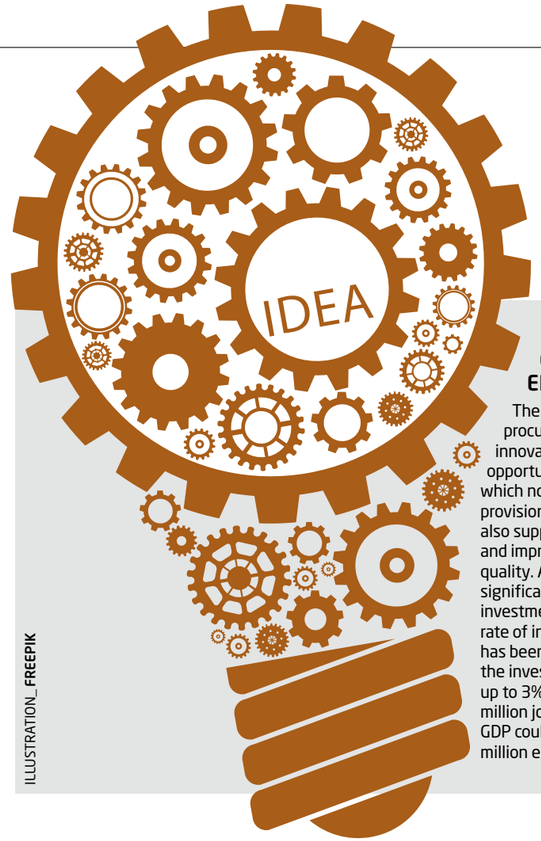


ILLUSTRATION_ **FREEPIK**

INNOVATION CREATES EMPLOYMENT

The strategic use of public procurement to encourage innovation is, in other words, an opportunity. A political strategy which not only improves the provision of public services, but also supports scientific production and improvement of business quality. A step forward which would significantly improve the share of investment in R&D+I, improving the rate of innovation in our country. It has been estimated that increasing the investment in R&D in Europe by up to 3% of the GDP by 2020, 3.7 million jobs could be created and the GDP could be increased by 795,000 million euros per year by 2025.

High measures

Ineco and the Taiwanese company MiTAC have carried out an aeronautical study to evaluate the increase in the size of cranes of Kaohsiung port, maintaining the safety of air operations in the adjacent aerodrome.

Text and photos: **Juan Diego Alamillo** and **Luis Chocano**, aeronautical engineers

The cranes of the port are just 2 kilometres from Kaohsiung international airport.

Kaohsiung port, the largest in Taiwan and one of the most important ports in the world in terms of container traffic, is in full expansion with the construction of a new intercontinental container zone, a project that the Ministry of Transport and Communication of Taiwan and the Kaohsiung Port Branch (KPB) began in 2007. To increase its current loading capacity an increase in the size of cranes is necessary to about 150 metres in height in various docks of the port, which is equivalent to a building of 33 floors, such as the Agbar tower in Barcelona. However, the installation of such large cranes would be interfering with the current operations of Kaohsiung international airport, located just two kilometres away, and it would infringe upon the airport's protection areas. With the objective that the Taiwanese Civil Aviation Authority allows the installation of the cranes, the port authority of Kaohsiung has commissioned a study whose objective is to demonstrate that the cranes will not negatively affect the safety of air operations. This project is being executed jointly by Ineco and the local company MiTAC.

In the context of the project, Ineco has already carried out a series of key activities with regard to evaluating the feasibility of an increase in the height of the cranes. Firstly, Ineco engineers have analysed both the maximum heights that the cranes could reach in each dock of the port without interfering with the instrument flight procedures published (including take-off, approach and landing manoeuvres and flights en route), as well as the modifications that would be necessary in the flight procedures for these to be compatible with the heights of the cranes required by Kaohsiung port authority in each of the port's docks, thus ensuring the safety

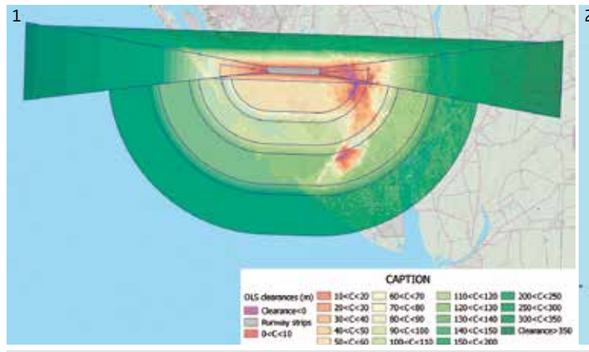
TO INCREASE THE CURRENT LOADING CAPACITY OF THE KAOHSIUNG PORT IT IS NECESSARY TO INCREASE THE SIZE OF THE CRANES TO ABOUT 150 METRES IN HEIGHT IN VARIOUS DOCKS OF THE PORT, WHICH MAKES IT NECESSARY TO MODIFY THE INSTRUMENT FLIGHT PROCEDURES OF THE AIRPORT

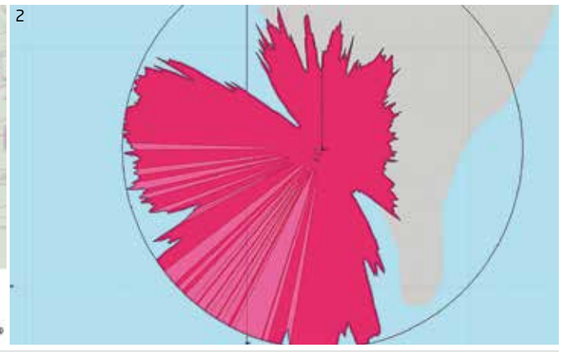
LOC and ILS manoeuvres protection areas.

INECO'S R&D TOOLS

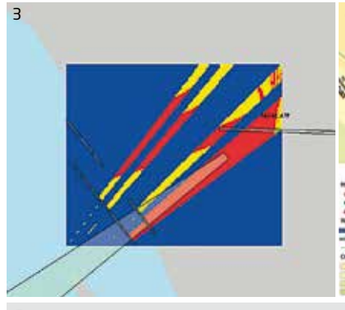
In the development of the programme, use was made of two of our own tools, developed through Ineco R&D projects: Impulse (in the case of studies about communications, navigation and surveillance systems) and Helios OLS (in the case of the analysis of obstacle limitation surfaces). Impulse is a software application that studies the way in which obstacles (in this case cranes) located in the environment of navigation and surveillance systems based on pulsed signals (such as distance measuring equipments, primary and secondary radars or multilateration systems), could affect the signal in the space of the equipment, also detecting potential areas or zones affected. This tool covers an important gap of applications of this type in the market and supports Ineco experts in the execution of these studies.

With the Helios OLS tool, based on a geographic information system (GIS) and an extensive database, the obstacle limitation surfaces of the aerodromes (in this case, in accordance with Taiwanese legislation) or the surfaces protecting air navigation facilities can be defined. The compatibility of specific elements such as cranes can also be calculated with it.





1. Height clearance to the OLS surfaces of Kaohsiung airport, obtained with Helios OLS.
2. Simulation of the radar coverage at an altitude of 1,600 feet, obtained with the Impulse tool.



3. Areas potentially affected by reflections of the radar signal in the cranes of terminals 3 and 4, at an altitude of 30 metres, obtained with Impulse.
4. Height clearance to the OLS surfaces of Kaohsiung airport -detail of Terminal 5-, obtained with Helios OLS. **5.** Modelling of the port for studies with Helios OLS.

WORK TEAM IN TAIWAN
In the image, the Ineco engineers Luis Chocano, on the left, and Juan Diego Alamillo, in the centre, along with MiTAC, port and airport staff on the runway of Kaohsiung airport.

of these operations in accordance with the procedure design standards of the International Civil Aviation Organization (ICAO).

Secondly, given that cranes of such large dimensions can be an obstacle for the correct transmission of electromagnetic signals of the air navigation facilities located in the vicinity, Ineco experts have studied their compatibility with all of the communications, navigation and surveillance systems that support the operations in Kaohsiung airport and in the surrounding air space, with 11 facilities in total being analysed, including instrument landing systems, primary and secondary surveillance radars, distance measuring equipment and communication centres. The examination of communications, navigation and surveillance systems (known as CNS systems) was carried out in terms of coverage and quality of the signal in space (through the study of potential multipath phenomena), with support from specialised radioelectric simulation tools.

Moreover, taking into account the new dimensions of the cranes, it was analysed in which way the obstacle limitation surfaces of Kaohsiung airport, established in Taiwanese regulations, would be infringed and recommendations were provided with respect to marking and lighting needs for the cranes that do so, in accordance with ICAO regulations. Lastly, Ineco provided the relevant recommendations regarding operations of the pilots.

The methodology for executing the previously mentioned analyses was also defined by Ineco, using for this purpose its extensive experience in studies of these kinds both in Spain and in other countries, and adopting the necessary hypotheses in each case, since cranes are mobile objects and since the model intended to be installed was not known.

As a result, the report shows, on one hand, for the 44 docks analysed the maximum achievable height compatible with the current instrument flight procedures, and the modifications necessary in these procedures (increase of the climb gradient in certain departures, modification of the operation minimums in various approaches, etc.) with regard to allowing the installation of cranes with the required height in each of the docks; moreover, with the objective of ensuring compatibility with current and future CNS systems, both the adaptations that must be carried out in the systems, when they are necessary and feasible, and the maximum heights that cranes can achieve to ensure that no adverse effects will occur (when there is no mitigation mechanism of this effect through the adaptation of systems) are depicted; lastly, the infringements of the protection surfaces over the 44 docks are detailed as well as the associated marking and lighting recommendations.

For years Ineco has carried out work relating to obstacle limitation surfaces, flight procedures or CNS systems in airports in Spain, Oman, the UAE, Cape Verde, Singapore and Kuwait, among other countries. ■

THE METHODOLOGY FOR EXECUTING THE ANALYSES WAS DEFINED BY INECO, USING FOR THIS PURPOSE ITS EXTENSIVE EXPERIENCE IN STUDIES OF THESE KINDS BOTH IN SPAIN AND IN OTHER COUNTRIES, AND ADOPTING THE NECESSARY HYPOTHESES IN EACH CASE

Variable gauge systems: from project planning to execution and vice versa

Spain is a pioneer and an expert in the automatic variable gauge changeover technology that enables trains to travel on different track gauges, a problem that arises in many areas of the world. Ineco contributes to this leadership more than two decades of comprehensive experience, covering all phases from project planning to execution and maintenance.

By **Silvia Casado,** civil engineer,
Lucas Campillo, industrial engineer and **José Ignacio Sánchez,** civil engineer

The problem of differing track gauges is not a uniquely Spanish one, but affects countries worldwide. According to the International Union of Railways (UIC, after its French name Union Internationale des Chemins de Fer), only 60% of the worldwide railway network uses standard track gauge (1,435 mm of separation between rails); moreover, it is not distributed evenly between continents. For various historical and economic reasons, the fact is that within the remaining 40%, there are more than 20 different measures ranging from 260 mm on some tourist railways in different parts of the world to more than 1,600 in the Spanish, Argentinean and Indian networks, among others. In Europe, there are four main track gauges: 1,000 mm (narrow), 1,435 mm (European standard), 1,520 mm (Russian gauge) and 1,668 mm (Iberian gauge).

The Spanish railway network measures 15,215 kilometres, according to 2015 data from the Ministry of Public Works. It is configured with three track gauges: the majority are 'Iberian gauge' (1,668 mm) and standard gauge (1,435 mm), which was used from the 1990s in the construction of all high-speed lines; these currently total 2,875 kilometres in length. Part of this (613 kilometres in total) operates with Iberian gauge, although it is equipped with multi-purpose sleepers which are easily adapted to standard gauge.

> ONLY 60% OF THE WORLDWIDE RAILWAY NETWORK USES STANDARD TRACK GAUGE (1,435 MM OF SEPARATION BETWEEN RAILS)

In the northern part of Spain (mainly Galicia, Asturias and Cantabria), there is also the 'narrow-gauge railway' network built in metric gauge (1,000 mm), with a total of 1,269 kilometres in length. Currently, this is used for commuter trains and some tourist services, such as the Transcantabrico or the La Robla railway. At all points where these networks meet, both within Spain and where they connect with the Portuguese and French networks, there is gauge changeover facilities.

SQUARING THE CIRCLE

There are a number of methods for solving the problem of track gauge: freight can be moved from one wagon to another or axles changed; passengers can be transferred onto a different train; or, there is the solution developed in Spain: the automatic variable gauge changeover facility. This is a railway installation which allows a train equipped with a variable-gauge axle or semi-axle system to automatically modify its axle gauge as it passes at a constant speed (approximately 15 km/h) without human intervention.

Spain has been a pioneer in these automatic variable gauge changeover systems since 1968, when the manufacturer Talgo began to run commercial services between Madrid and Paris (Irún changeover) and between Madrid and Zurich (Portbou changeover facility). Subsequently, another rolling stock manufacturer, CAF, developed its own technology, making different facilities necessary for each manufacturer. Today, technology has evolved towards a single platform for variable gauge changeover.

1. Multi-platform solutions. Tests with the BT on the TCRS3 prototype, launched by Adif in 2009. This was the first time a single platform was developed for the technologies of the manufacturers CAF and Talgo.

2/3. Variable gauge changeover facilities in León. The installations, located inside a building, comprise a 16 metre by 7.4 metre pit over which the dual variable gauge changeover facilities are installed. In addition to this, there are inspection pits to monitor train axles (before the changeover) on the Iberian gauge track (1,668 mm) and the 1,435 mm track.

4. Exportable technology. The latest-generation variable gauge changeover technology is not only suitable for Spanish track gauges, but also for systems in Germany (Rafil) and Poland (SUW 2000), which makes it exportable.

The next application for the automatic variable gauge changeover facility arose in the 1990s, with the first high-speed line running from Madrid to Seville. This was built in standard gauge, and three variable gauge changeover facilities were installed (at Atocha, Córdoba and Majarabique) to connect the line to the existing Iberian-gauge network. As high-speed infrastructure expanded, so too did automatic variable gauge changeover facilities. This has also made it possible, for a relatively low level of investment, to extend routes and reduce journey times for the conventional network.

> FOR MORE THAN 20 YEARS, INECO HAS PARTICIPATED IN DESIGNING THE MAJORITY OF DIFFERENT GENERATIONS OF GAUGE CHANGEOVER FACILITIES

For more than 20 years, Ineco has participated in designing the majority of different generations of gauge changeovers. It has provided services to Adif, the Spanish railway infrastructure administrator, and to manufacturers in different aspects

of the development and implementation of this technology (see *IT22):* project drafting, technical assistance, project management, maintenance and exploitation for more than 20 automatic variable gauge changeover facilities across Spain. Currently, Ineco is responsible for the maintenance of variable gauge changeover facilities at Cerro Negro and Fuencarral (Renfe), Chamartín, Atocha, Majarabique, Alcolea del Pinar, Albacete, Valencia, Plasencia del Jalón, Zaragoza-Delicias, Huesca, Medina del Campo, Medina del Campo AVE, Zamora, Valdestillas, Palencia and León.

WHEN IT COMES TO MOVING OVER TO THE EXECUTION PHASE, IT IS ESSENTIAL TO HAVE COORDINATION AND FEEDBACK BETWEEN THE DESIGN AND PROJECT TEAMS IN ORDER TO PROMPTLY ADDRESS ANY DIFFICULTIES

A PRACTICAL EXAMPLE: THE LEÓN CHANGEOVER FACILITIES

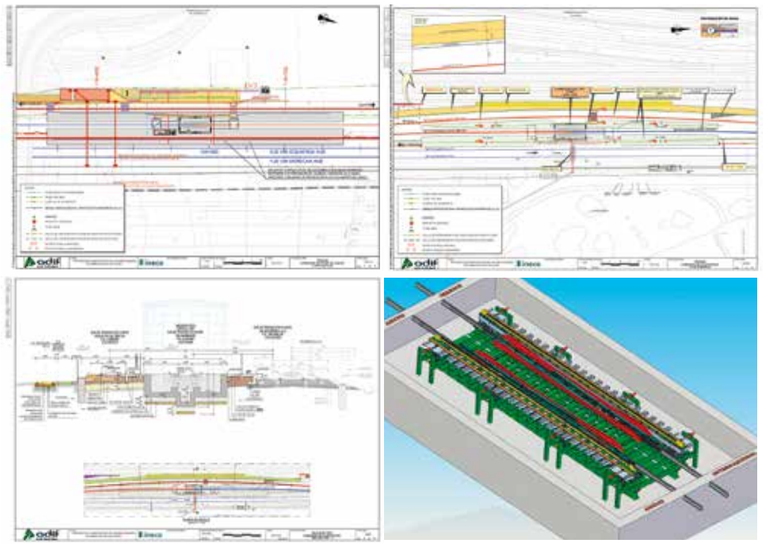
With the arrival of the North high-speed line to León, it became necessary to install gauge changeovers to enable connections from there to Asturias and Galicia on 1,668 mm track gauge. This would also reduce journey times from Madrid to Gijón, A Coruña and Ourense.

In this case, it was decided to install two changeovers instead of a single one, as this would facilitate direct services between Madrid and Gijón without stopping in León, improving reliability and capacity in anticipation of increased traffic in the future. In addition, the double installation meant that the journey time between destinations was reduced by 31 minutes, while a single gauge changeover would have increased it by 20 minutes.

FROM DESIGN TO CONSTRUCTION

There are multiple factors to consider when designing an automatic gauge changeover facility. These include: the type of changeover facility, depending on the different technologies in place (Talgo, CAF, dual or universal); the chosen location; the ownership of the land where the facility is to be built; the effect on other services; the connection between lines that not only have different track gauges, but also different energy subsystems (3 kV direct current and 25 kV alternating current) and command and control subsystems (ASFA and ERTMS). Similarly, it is necessary to take into account coincidence with rail beds owned by different bodies, the minimum lengths of access tracks to the changeover facilities, and the locations of drinking water and electricity supply lines. Technical difficulty also increases if, as is the case with León, construction is to take place in an urban environment.

When it comes to moving over to the execution phase, it is essential to have coordination and feedback between the design and project teams in order to promptly address any difficulties. In the case of León, for example, delays in obtaining the necessary land for the construction made it necessary to redesign the installations. Another example showing the importance of this combined work is related to the services affected by the construction, both internal (utilities and communications conduits) and external: gas distribution lines, sewerage network, electricity distribution, communications, etc. Data collection begins during the design phase and is completed during project execution. ■



Technical drawings for the double-changeover facility in León show the complexity of an installation of this kind, which is increased by its location in an urban environment. In the bottom corner, a diagram of a dual changeover facility: the train enters through the upper part of the tracks ('Iberian gauge') and exits through the opposite end (standard gauge).

A VARIABLE GAUGE CHANGEOVER FACILITY IS A RAILWAY INSTALLATION WHICH ENABLES A TRAIN EQUIPPED WITH VARIABLE GAUGE AXLES OR SEMI-AXLES TO MODIFY AXLE GAUGE AUTOMATICALLY WITHOUT HUMAN INTERVENTION

MOVING TOWARDS A UNIVERSAL TECHNOLOGY

▶ **The first generation of gauge** changeover facilities, which extended in line with the development of high speed, could only be designed for one of the two variable gauge axle systems that existed in Spain: first for Talgo's RD (Variable Gauge) and then, from 2000, for CAF's Brava (self propelled variable gauge bogie).

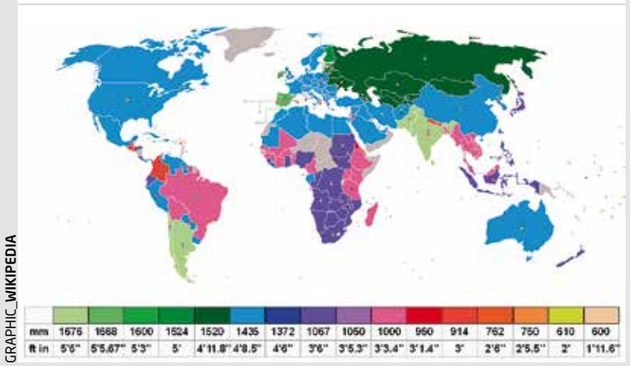
▶ **A gauge changeover system** was later developed that was suitable for both systems, named a dual changeover, which required less space. The first system of this type, the vertical TCRS2, was installed in 2001 on the Olmedo-Medina del Campo stretch. In 2007, the system was improved with the horizontal TCRS2 model, which simplified the structure and foundations and reduced changeover time from seven to five minutes. The first prototype was installed and tested in Chamartín (Madrid).

▶ **In 2009,** Adif began the design and construction of the first single-platform TCRS3 prototype, which combined the technologies of the manufacturers CAF and Talgo. This resulted in a considerable reduction in the masses in movement during the gauge changeover process, consequently also reducing the duration of the process from five to just three minutes. The first prototype was trialled and approved in 2011 at the Roda de Bará variable gauge changeover facility in Tarragona, while the first units of the series were installed in León (Madrid-Asturias high-speed line) in 2015.

▶ **From 2009,** with the support of the Ministry of Science and Innovation, a further step was taken with the Unichanger universal changeover facility project, denominated TCRS4, the fourth generation. In 2011, Ineco drafted the construction project at the trial and experimentation facilities associated to Adif's Rail Technology Centre in Málaga. In addition to changeovers between Spanish track gauges, this new generation also enables changeovers for the systems in Germany (Rafil) and Poland (SUW 2000), meaning the technology is exportable to other countries.

▶ **Currently,** the company is drafting plans for the Vitoria variable gauge changeover facility project and participating in the construction of the facility in Burgos.

World map, rail gauge by region



GRAPHIC_WIKIPEDIA

LUCAS CAMPILLO

Master in Railway Systems, expert in superstructure and variable gauge changeover facilities

A VALUABLE EXCHANGE OF KNOWLEDGE

The design, project drafting, construction and commissioning of a high-tech railway installation such as an automatic variable gauge changeover facility requires multidisciplinary knowledge of all the railway and industrial subsystems. Ineco has accumulated this knowledge over a period of longer than 20 years: having made such significant interventions both in the planning phase and in construction and maintenance, we have produced a process of lessons learned which has made us experts in automatic variable gauge changeover.

From the moment the contract is awarded, we bring together the "know how" acquired both in drafting projects and during the construction phase to address the many engineering challenges that arise during such a complex installation. This interaction is key to untying the Gordian knot that is often created by factors such as the location of the future automatic variable gauge changeover facility, period of execution or commissioning. But this flow of information generation and exchange does not stop with commissioning. This valuable exchange of information between the project planning and construction teams is continuous, leading to a constant improvement which is reflected in each new project, rationalising and reducing the cost of the infrastructure.

The degree of specialisation and knowledge attained by the company is shown in the technical support it is providing to the Spanish Ministry of Public Works in drafting future IFI regulations (Instructions for the Project Planning and Construction of the Railway Infrastructure Subsystem) expected to be approved later in 2016.

Ineco participates actively in the development, testing and implementation of automatic variable gauge changeover technology, both systems that are already in service (TCRS2 and TCRS3) and in solutions at the European level: the Unichanger (TCRS4) project, which can be applied to any geographic setting.

A new exhibition space at the corporate headquarters in Madrid

An open door to Spanish engineering

Conceived as a centre for interpretation, the space opened by Ineco at their central headquarters in Madrid has been designed to offer a tour of the main infrastructures around the world carried out by the public company and by other Spanish engineering firms. It is a way of representing the leadership and good performance of these companies and the knowledge of their professionals.

By ***ITRANSPORTE***
Photos: **Elvira Vila**

Spanish multinational companies hold leadership positions in sectors such as construction as well as air transport, airport and land infrastructure. Spanish engineering and construction firms participate in large civil works and infrastructure projects –such as the construction of the high-speed rail line between Makkah and Medina–, managing nearly 40% of infrastructures around the world. In order to make their achievements known, Ineco has opened this space with a tour that allows visitors to have a close-up look at the strengths of Spanish engineering.

THE ROOM HAS EXHIBITION TABLES SHOWING INECO'S AREAS OF ACTIVITY AND SOLUTIONS, AS WELL AS AN INTERACTIVE MAP OF THEIR MAIN PROJECTS

The room has exhibition tables showing Ineco's areas of activity and solutions, as well as an interactive map of the company's main projects worldwide and several examples of their most relevant efforts in innovation.

An informative panel provides a space for the main transport infrastructures developed in Spain, as well as ac-

LEGO SMART CITY

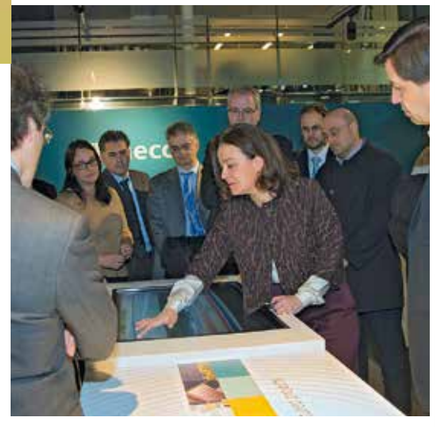
A model of a city of the future made with Legos allows visitors to visualise the possibilities of Smart Cities, intelligent cities that manage information through the intensive use of ICT in order to improve efficiency and sustainability, and to provide residents with a greater quality of life. Installing sensors makes it possible to obtain a multitude of data, from measuring the passage of vehicles on a street to determining whether a trash bin is full and needs to be picked up. Smart cities will boast a large number of sensors and operators such as CityIneco, an application developed by Ineco to regulate and coordinate their smart management. The exhibit also features an augmented reality simulation in which virtual elements are introduced into a real context using a tablet itself, thus providing additional information that is relevant to the final image being displayed. In the above image, the minister Ana Pastor next to Jesús Silva, the president of Ineco.

On the projection of the world map, geographic areas or specific projects can be accessed simply by activating each point as if it was a touch screen.

During his recent visit to sign an agreement with Ineco, Carlos Villalta, the Costa Rican Minister of Public Works and Transport, speaks with Jesús Silva, president of Ineco, while taking a walk through Ineco's new showroom.

tions of particular importance carried out by Spanish companies at the international level. Touch screens, interactive tables, tablets with augmented reality, videos –including the Ministry of Public Works' corporate video–, a drone and its recordings inspecting support devices on the Salobral viaduct (Spanish High-Speed Rail (AVE) Madrid- Valladolid), and the bridge on National Highway 403 near the El Burguillo Reservoir (Ávila), are some elements from the tour.

In addition to highlighting Ineco's main projects, at the modular tables visitors can access the company's projects by market and by mode of transport. On the left page, Ignacio Fernández Cuenca, Corporate Managing director, and below, Ana Rojo, Engineering Managing director, both from Ineco.



THE OBJECTIVE IS TO SHOWCASE THE CONSTRUCTION IN SPAIN OF ONE OF THE GREATEST AND MOST MODERN INFRASTRUCTURE NETWORKS WORLDWIDE

The objective is to showcase the construction in Spain of one of the greatest and most modern infrastructure networks in the world, including roads, airports and railway lines, which has led to the consolidation of a powerful industry that is now a worldwide leader: next to construction companies, Spanish engineering firms stand out in the international market owing to their high degree of specialisation, experience and technological capacity. For years, Ineco has been taking a leading role in brand Spain infrastructure projects abroad, thus placing the public engineering company in the 38th position in the ENR (Engineering News-Record) world ranking of engineering firms in the transport sector. ■

LARGE PROJECTS AROUND THE WORLD:

- ▶ High-speed rail Makkah-Medina. Saudi Arabia - HARAMAIN
- ▶ Line 2 of the Lima Metro. Peru - FCC and ACS
- ▶ Tunnel under the Bosphorus Strait, high-speed rail Istanbul-Ankara. Turkey - OHL
- ▶ Panama Canal - SACYR
- ▶ East West Link Melbourne - ACCIONA
- ▶ California high-speed rail - ACS
- ▶ Line 1 of the Panama Metro - FCC
- ▶ Riyadh Metro - FCC, TYPSA and SENER
- ▶ East Anglia One Windfarm. United Kingdom - IBERDROLA
- ▶ Doha Metro - OHL

SPANISH ENGINEERING IN NUMBERS:

- ▶ 1st European highway and motorway network (over 14,000 kilometres).
- ▶ 5th place among the UE-15 countries for railway extension (nearly 14,000 kilometres).
- ▶ Most extensive high-speed railway network in Europe (3,000 kilometres in service), and 2nd worldwide after China.
- ▶ 2nd country in Europe and 4th worldwide for the greatest amount of airport passenger traffic.
- ▶ 2nd world power in desalination and water treatment technologies.

Flood risk

Ineco recently carried out a hydrological study of the high-speed lines in operation using two-dimensional models, with the aim of delimiting potentially floodable zones, detecting the critical points of each zone and analysing possible actions for improvement.

By **Leendert de Haan,** civil engineer and **Miguel Jerez,** agricultural engineer

In the course of the infrastructure inspection campaigns of the high-speed lines, deficiencies were detected in the drainage systems of some sections. These deficiencies are resolved within normal or intense levels of rainfall through enlargements and improvements of the drainage network, based on a localised supply of resources.

However, as has been demonstrated occasionally, there can be catastrophic levels of rainfall that exceed all forecasts or normal schedules. The magnitude of the rainfall, the gentle slope of the land, the low level of the tracks and the insufficiency of the drainage elements are factors that may result in incidents on the rail platform.

This is the case of the incident that occurred on 2 July 2014 on the Madrid-Alicante high-speed line, at the town of Alpera (Albacete). The intense rainfall in the zone caused a great accumulation of water next to the platform. The flow water dragged away the ballast, leaving the track without support and causing it's settlement. As a result of this incident, preparations began to commission Ineco with the study to determine the potentially floodable zones in the high-speed lines in operation.

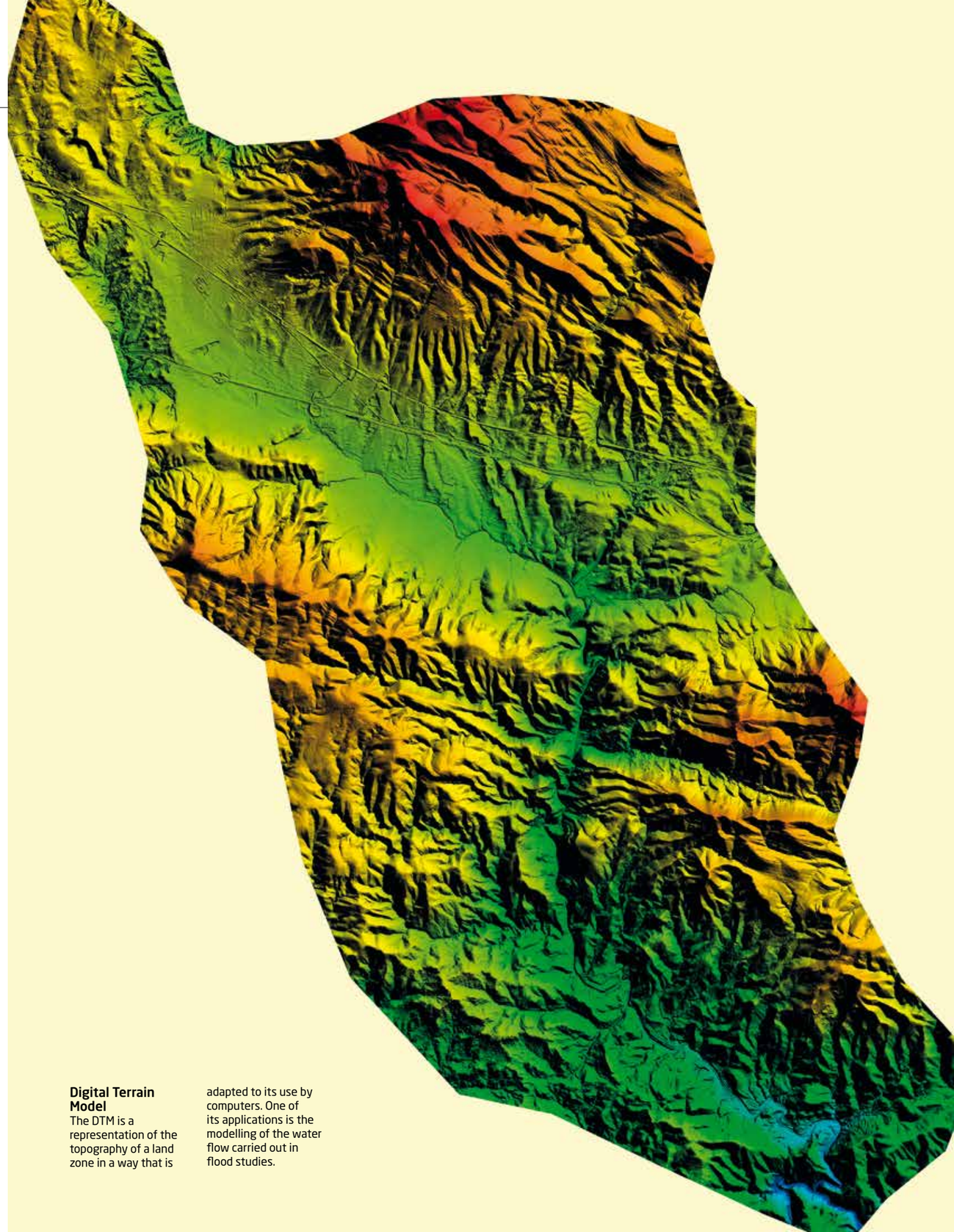
To achieve the improvement of the drainage network, it is necessary to realise a hydrological study using two-dimensional models, through the application of net rainfall (associated with return periods of 100 and 500 years) and the joint analysis of the transversal and longitudinal drainage system.

The models allow us to study the behaviour of the flow in interbasins and plain zones, as well as the height of the sheet of water at any point. The simulations consider the effect of flood abatement upstream of the works and the dam effect of existing downstream obstacles. Furthermore, the flow speed can be verified and zones with risk of erosion can be detected.

METHODOLOGY

Firstly, information about the layout and the drainage system is compiled to carry out an inventory of the crossing works. The existing inspections and the incidents registered are consulted.

THE MAGNITUDE OF THE RAINFALL, THE GENTLE SLOPE OF THE LAND, THE LOW LEVEL OF THE TRACKS AND THE INSUFFICIENCY OF THE DRAINAGE ELEMENTS ARE FACTORS THAT MAY RESULT IN INCIDENTS ON THE RAIL PLATFORM



Digital Terrain Model
The DTM is a representation of the topography of a land zone in a way that is adapted to its use by computers. One of its applications is the modelling of the water flow carried out in flood studies.

SECTIONS OF THE LINE ARE CLASSIFIED IN ACCORDANCE WITH IT'S RISK, DELIMITING POTENTIALLY FLOODABLE ZONES. THUS, PLANS ARE MADE SHOWING THE POTENTIAL FLOOD RISK AND THE RESULTS OF THE STUDY OF EACH AXIS ARE DOCUMENTED IN A REPORT

A hydrogeomorphological analysis of the track layout is carried out, allowing a selection of the sections to be studied with the two-dimensional models, while they are classified in accordance with their priority.

Next, the Digital Terrain Model (DTM) is prepared, for which the model is linked to the mesh size of 5m (data from the LIDAR flight of the PNOA, National Plan for Aerial Orthophotography) with topography at a scale of 1:1,000 for the trace of the line. Thus, a single DTM with a 2m mesh size is obtained, which incorporates the openings due to large crossing works in the line to be studied and in other nearby infrastructures.

In parallel, rainfall in each of the sections is obtained from the 'Maximum daily rainfall in the Spanish Peninsula' publication of the General Directorate of Roads of the Ministry of Public Works, in 1999. The intensity of the rainfall in accordance with its duration is calculated through the IDF (Intensity-Duration-Frequency) curves of the Spanish Meteorology Agency, AEMET. To obtain net rainfall, we consider, in addition to rain, the land retention with data of the GIS layer of the water flow supplied by the Ministry of Agriculture, Food and the Environment through its CAUMAX project.

The next step is to generate the two-dimensional model with the Infoworks ICM program. The model defines the land through a triangular mesh from the DTM data, using fracture lines that mark the main traces of the platform slopes, zones with a different mesh size (finer around the platform) and polygons with different land roughness. The model also includes other elements, including for example small drainage works, which simulate the flow in a one-dimensional way. Once validated, rain data can be uploaded and simulations in ICM can be performed.

RESULTS OF THE TWO-DIMENSIONAL MODELS

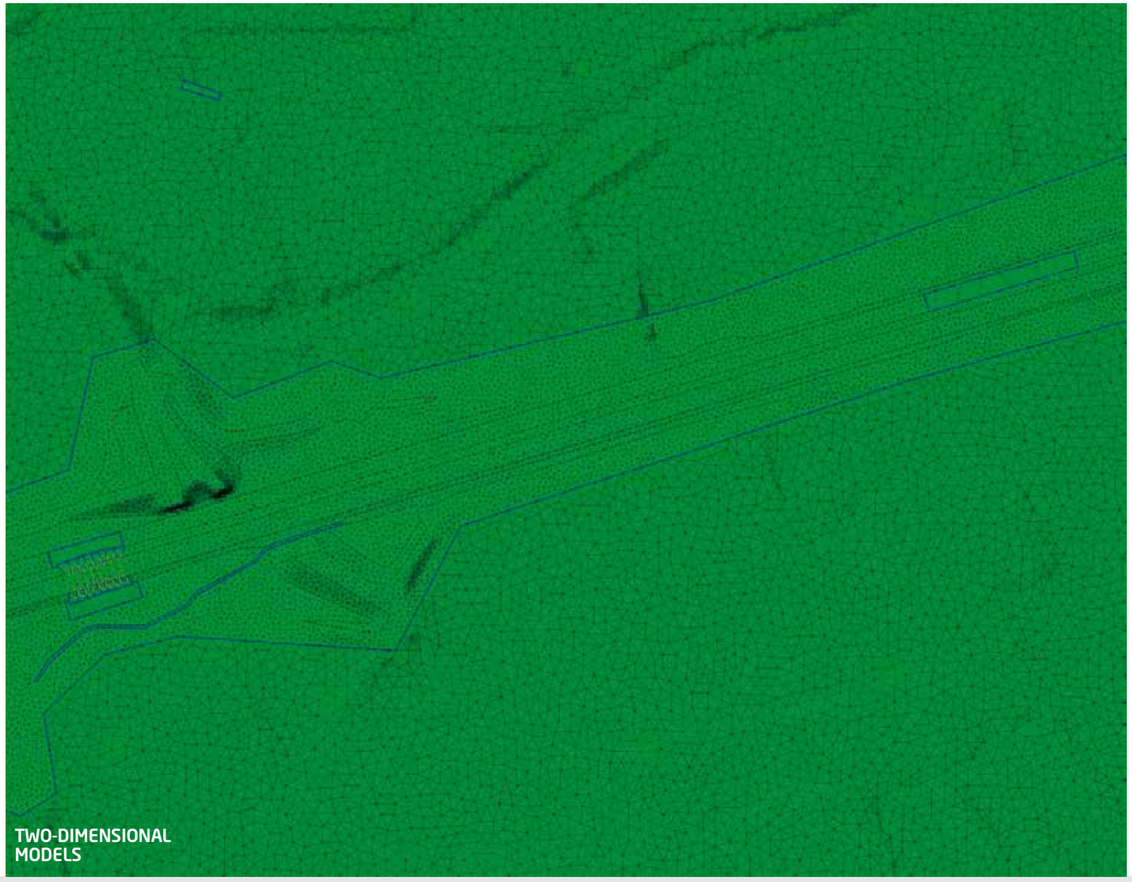
Firstly, six rain episodes are simulated corresponding to the return period of 500 years, whose duration is related to the concentration time of the most important basin. Once the simulations have been performed, it is checked whether the platform is affected.

If it is not affected, the process ends and the section would be low-risk. In the contrary case, it would be necessary to simulate the same episodes of rain with the return period of 100 years. If it is affected only for T500, the risk considered is medium. If it is also affected for T100, the risk is high.

According to the foregoing criteria the lines are classified in sections in accordance with it's risk, delimiting the potentially floodable zones. As such, plans are obtained to show the potential risk of flooding classified by sections of all lines. The results of the study of each axis are expressed in a report. In the four axes together 2,351 km of trace of route was studied and 89 2D models were made, with a total length of 810 km.

Lastly, we propose an action plan for all of the high-risk sections and for the medium-risk sections associated with the latter. We recommend analysing the 2D models, identifying necessary complementary data (photographs and detail topography), inspecting the area on the field, defining appropriate solutions, performing new simulations and, where applicable, drawing up the appropriate construction projects. Furthermore, the rest of the sections with a medium risk must be analysed to assess the need to carry out these actions on them as well.

Moreover, we recomend to identify other high-speed lines that will start operating soon, evaluate the available information on incidents, inventories and inspections, the documentation of as built projects and the availability of the topography (aerial photography track flights). ■



TWO-DIMENSIONAL MODELS

▶ **2D mesh.** Two-dimensional models use a mesh obtained from DTM data which represents the topography in the form of triangular prisms.
▶ **Flooding.** The maximum water depth recorded on land in the rain episodes studied can be viewed through shapes that reflect the flooding.
▶ **Risk.** The line is classified in sections in accordance with the potential risk of flooding, in accordance with the possible effects on the platform for the return periods studied.

New technologies in Big Data projects

Big Data is one of the trendy concepts in the current business landscape. It is no longer a promise, but has now become a reality both technologically and economically. We only have to observe the evolution of the global rise in the generation of information –where 90% of the existing digital information has been created over the last five years– in order to understand this reality.

By **Jesús Vázquez**, computer engineer

***CROSSING VALUES*, SAMUEL BIANCHINI, 2008.**
1st Biennial of Contemporary Art, Couvent des Jacobins, Rennes (France) from May to July, 2008.

PHOTO_SAMUEL BIANCHINI (ADAGP) HTTP://DISPOTHEQUE.ORG/ES/VALEURS-CROISEES

The growth projection by 2020 is almost 40ZB (zettabyte, 10^{21} bytes), the majority generated by human beings, followed by physical devices connected to the Internet. Another indicator that allows us to verify this trend is that the Big Data analytics and technology market grows at an annual rate of 20-30%, with an estimated world market of 50 billion euros by 2018.

But it is not simply the amount of data that makes the concept of Big Data unique. We tend to take this concept literally and associate it with a large amount of information, but, as we will see later on, a set of data must have more qualities in order to be considered Big Data.

DEFINITION OF BIG DATA AND ASSOCIATED PROBLEMS

We can talk about Big Data when large amounts of information are generated (Volume) very quickly (Velocity), with heterogeneous types of data (Variety). Recently, the industry has started to add a fourth 'V' to these three classic features (the three V's): Veracity. Given that a large portion of information is directly generated by people, it is necessary that the origin of the data be granted the quality of veracity. There is no point in having a full set of data that is not reliable.

To a great extent, the rise in Big Data technologies has been caused by the social networks, as far as the volume and variety of data are concerned, and by the marketing sector, with regard to the possibilities of demonstrating the value of all the information being generated. Banking is another classic sector that generates and exploits Big Data. The study of the information on uses and habits that can be obtained from banking information makes it possible to design products tailored to customers, or to predict behaviours, such as outstanding payments, according to the correlation of the information available. Engineering firms are also beginning to identify cases of use for which the capacity of Big Data analytics is a competitive advantage.

Finally, the field of the IoT (Internet of Things) and Smart Cities should be noted.

The concept of a Smart City involves an intensive use of information technologies for collecting and processing the information that the city generates using the sensors deployed or other data sources, such as traffic cameras or any other source of unstructured information.

> THE FOUR QUALITIES THAT INFORMATION MUST HAVE IN ORDER TO IDENTIFY WITH THE CONCEPT OF BIG DATA ARE: VOLUME, VELOCITY, VARIETY AND VERACITY

THE INDUSTRY'S APPROACH

Big Data projects cannot be efficiently addressed using traditional technologies. The requirements for storing and exploiting such quantities of data, with their qualities of velocity and heterogeneity, have forced the industry to design new technologies that make it possible to work with information in real time, including the previously mentioned characteristics of data volume and variety.

Among the different paradigms presented by the industry when tackling Big Data projects, we can highlight In-Memory (IMDB) technologies and Distributed Systems. In-Memory technology allows all of the information that is necessary to work to be loaded into a memory where the processing is much faster. Furthermore, solutions based on distributed systems are oriented towards parallel processing, allowing a complex problem to be broken down and sorted out by using different machines responsible for solving each part of the original problem. This breakdown allows for the use of affordable computers which together make up a large processing platform. The appearance of Open Source solutions such as Hadoop and Storm has supported this trend.

Additionally, there is a tendency to implement Big Data platforms using cloud services. The problem raised in Big Data projects is infrastructure dimensioning and scalability (growth potential). For this reason, these sorts of projects need to have an infrastructure that is elastic and which allows available resources to be expanded or reduced depending on our requirements at any given moment.

Solutions based on cloud services are going to take the place of private infrastructure contracting (on-premise), as this allows companies to be free from infrastructure installation and maintenance, in order to focus on tasks which contribute value to the project. We are no longer talking about acquiring machines (virtual or physical) where we have installed and configured our own solution, but rather about utilising the services we need at any given time, paying only for the processing time and the storage. For instance, if we need an automatic learning service where we can define a prediction algorithm that works with our own information, contracting the cloud service and only paying for the period of use is sufficient.

WHAT BIG DATA IS HIDING

Once we have this vast amount of data, how do we generate value from our information? There is a misconception that Big Data projects involve storing the existing information and applying a relatively complex technology to analyse what we can obtain. A Big Data project should begin prior to starting to compile information. It is necessary to be sure about the objectives that motivate the project and the type of information we need, as well as to consider all of the constraints involved in the collection and processing of this information.

As opposed to Big Data technology, classic Business Intelligence systems are based on the consolidation of the information which lets us carry out operations with that pre-calculated data. The new Big Data paradigm forces us, on one hand, to be able to analyse the flow of information in real time, and, on the other, to store the raw information. With regard to temperature sensors, for example, we need to record all measurements that the sensor has generated. It is not enough to simply control the average daily temperature, since having the additional information does not allow us to analyse details to be able to predict parameter behaviour or identify behaviour patterns. That is to say that we need to be able to store and analyse the information in its original form, or at a much lower level of detail than in traditional analytical systems.

BIG DATA IN ENGINEERING

The areas of application are far-reaching, ranging from solutions for Smart Cities to automatic learning techniques for predictive maintenance activities. At Ineco we are aware of the importance and the possibilities Big Data technologies have in the field of engineering. Therefore, the Information Technologies division studies and exploits the characteristics of Big Data in different areas. In terms of Smart Cities we work in different fields, among which we can highlight the Smart CityNECO platform, for the integration of information from the various city services (mobility, environment, etc.) allowing for a correct management based on the control panels of the different services provided by the city. In addition, also within the field of Smart Cities, but more specifically concerning the axis of mobility (Smart Mobility), Ineco works in the study and optimisation of mobility in cities by creating prediction and simulation environments in real time that allow the optimal mobility regulation parameters in the different areas of the city to be determined. This solution is based on integrating the simulation models, as well as on the automatic learning techniques, by working with the information concerning the city's state of mobility in real time.

> A BIG DATA PROJECT MUST BE SURE ABOUT THE OBJECTIVES AND THE TYPE OF INFORMATION WE NEED, AS WELL AS CONSIDER THE CONSTRAINTS INVOLVED IN THE COLLECTION AND PROCESSING OF THIS INFORMATION

Within the field of infrastructure maintenance, predictive maintenance is based on anticipating the problem before it becomes a reality, or before its state loses the optimal conditions. This way, we lengthen the time between maintenance activities, thus improving availability while saving on costs. In this field, we develop predictive techniques using measurements from different parameters thanks to sensors which allow a relationship with their service life to be established. The difference with traditional techniques lies in automatically combining all information regarding their state, characteristics, exploitation and environmental conditions.

Within the area of mobility surveys and capacity, Ineco works on a mobile device survey platform that allows all information relevant to these types of studies to be compiled, including the responses provided by the user, location information provided by the GPS, etc. Additionally, with regard to the answers given using natural speech, we can conduct what is called a 'Sentiment Analysis' (opinion mining) which lets us identify the speaker's attitude towards an issue.

Furthermore, we cannot forget that Big Data does not only consider alphanumeric information. Thus, another area of research focuses on image processing. The objective is to locate defects or objects in an automated way.

To sum up, we are undergoing a digital transformation which, combined with interconnection capacities, is exponentially increasing the amount of information generated. We live in the 'Time of Data' and the capacity to analyse that information is going to mark the difference in all fields of business. ■

An above-ground station with a unique geometry

Jardines de Hércules station, located to the south of Seville, in the district of Bellavista, came into service a few months ago to serve a neighbourhood that brings together around 20,000 inhabitants. With an above-ground hall and faceted metal structures, it stands out due to the originality of its design and the complexity in the execution of the work, both of which were carried out by Ineco for Renfe.

By **Marisa Guillamot** and **Cristina Palmero,** architects, and **Francisco R. Montón,** civil engineer and works director

The train halt owes its name to the new Los Jardines de Hércules development, a collection of 2,000 dwellings recently built 9 kilometres to the south of Seville. With the entry into service of this station of line C1, located on the Seville-Cádiz railway line, users can now reach the centre of Seville in just 10 minutes.

The new facilities are located to the north of the former La Salud station, and 120 commuter trains of C1 and C5 lines serve it every day, favouring fluid and rapid communication with Seville centre, from whose station –Sevilla-Santa Justa– travellers can link up with the rest of Renfe services (commuter railway lines, medium-distance trains and AVE).

Ineco carried out the drafting of the building project and all of the works inherent in the management of the works and coordination of health and safety, which include the elements of the raised station and its access, the zone of shelters and platforms and the technical services building. Its peculiar design, which places the accesses and the hall of the station on a walkway in the shape of an irregular spatial tube, has required complex execution and management work.

Thanks to its such unique geometry we were able to not modify the course of the railway line or its basic infrastructure, which allowed us to maintain the continual service of passengers and freight throughout the whole execution of the train halt.

Access to the hall is gained through automatic doors with a remote control mechanism and it is fitted with air conditioning. The hall contains self-service ticket machines, access control turning machines of a special width and the furniture and signage. The starting state for its design involves very limiting environmental conditions in relation to an already pre-determined structure, shape, dimensions and opacities. From this regular structure, the "game" of dislocating its structural joints begins, both vertically and horizontally, until a balance of the whole is achieved, resulting in an irregular structural frame, faceted in triangles.

This peculiar geometry of the walkway is developed along a transverse axis on the train tracks. The space has a closed and covered area –where the hall is located– and

INECO HAS CARRIED OUT THE DRAFTING OF THE BUILDING PROJECT AND THE WORKS INHERENT IN THE MANAGEMENT OF THE WORKS AND COORDINATION OF HEALTH AND SAFETY AND MANAGEMENT

COMPLEX WORKS WITHOUT INTERRUPTIONS IN THE RAILWAY SERVICE

Thanks to the unique geometry of the station, we were able to not modify the rail route or its basic infrastructure, which allowed us to maintain a continuous service of passengers and freight throughout the whole execution of the train halt. The process was as follows:

- ▶ Mechanisation of the walkway model to allow the transportation of the whole structure to the work zone in the segments of a greater dimension.
- ▶ Subsequent assembly of the sections planned, to be lifted as independent units.
- ▶ Lifting of the first section to the general tracks, of 20 metres in length at a height of 7.50 metres above the track, through two large tonnage cranes.
- ▶ Lifting of the second section to the track of the port of 29 metres in length, at the same seat level, through two large tonnage cranes
- ▶ The joining of both sections, implementation of reinforcements and execution of slabs for passage.

CONSTRUCTION
It was particularly difficult to join the sections that make up the structures of the walkways, masts and stairs. In the end it was resolved in a mixed manner through welded joints and bolted joints, according to the junction and the difficulty of executing it. The image below shows the lifting and placement of the first of the two sections that form the walkway of the train halt.

The station has two platforms covered by shelters which are accessed through the lifts and stairs from the upper floor. In the image below, there is an aerial view of the station where we perceive its irregular volume and triangular faceting with the widest zone (6.5 m) in the hall. The station was designed with a semi-curved side and its southern side has greater protection from the sunlight.

THE DESIGN AND DEFINITION OF SUCH A COMPLEX VOLUME IN SUCH A SHORT SPACE OF TIME WAS POSSIBLE THANKS TO THE USE OF A BIM TOOL

another open and covered zone, that leads to the access disembarkation area and the connection with the two platforms. As such, it has an uneven geometric shape, wider in the zone of the hall. The walkway is supported vertically on the masts of the lifts and on the intermediate pillars. These masts are also the horizontal supports of the structure for the loads of wind and earthquakes.

The work flow was carried out using a BIM model that, initially, served as a design tool with great speed in the execution of different design alternatives, subsequently to help external consultants in the calculation and dimensioning of the structure and, lastly, for the building development and its documentation. This BIM model was carried out with the Revit programme, taking advantage of the experience of the company in BIM until that date (new Odessa international airport, Elche station, etc.), which facilitated the idea of the design and its development in a very short space of time, just two months. The design and definition of such a complex volume in such a short space of time was possible thanks to the use of a BIM tool.

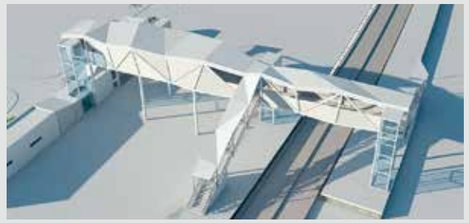
The lateral sides and roof of the walkway have diagonals and, as such, they function like lattices with elements working mainly through traction-compression. The lower side, having had to resolve both the structure of the floor and the overall bending behaviour, was resolved with parallel elements together, quasi perpendicular to the lower cords, forming an irregular Vierendeel beam. The structure of the slabs of the walkway floor was developed with a concrete slab on a corrugated sheet, which functions as lost formwork. The structure of the masts of the lifts consists of a spatial lattice formed by tubular elements of square section. It resists the loads of the lift itself, as well as those that the walkway transmits.

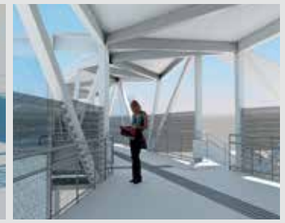
In accesses, walkways and disembarkation areas, mobility-accessible solutions have been installed in their finishes with the inclusion of tactile routing in accordance with the legislation in force and technical specifications of Renfe. ■

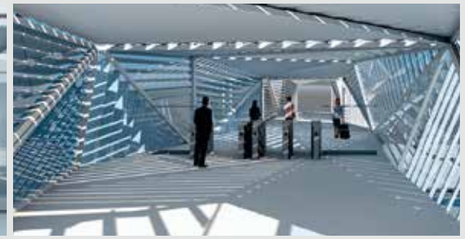
EXPERIENCE IN BIM

By **Cristina Palmero,** architect and BIM coordinator

Ineco has worked for years on developing projects in the BIM (Building Information Modelling) environment, from the carrying out of simple works such as for this station, designed with the Revit tool, to large and complex projects and airport building works, line, rail and building projects. Amongst its many advantages, the work with BIM tools allows, in each project, the total integration of the architecture, the structure and the facilities; it also offers different alternatives of materials, designs and finishes, calculation of its costs, simulations of its construction to be carried out including security and health, and to opt for the best technical and aesthetic solution in a very quick period of time and in a collaborative environment. From the start of the project to the execution of works and its subsequent maintenance, the access of all professionals involved in the latest version and its history facilitates the coordination of disciplines, conflict solution and its proper budgetary management.



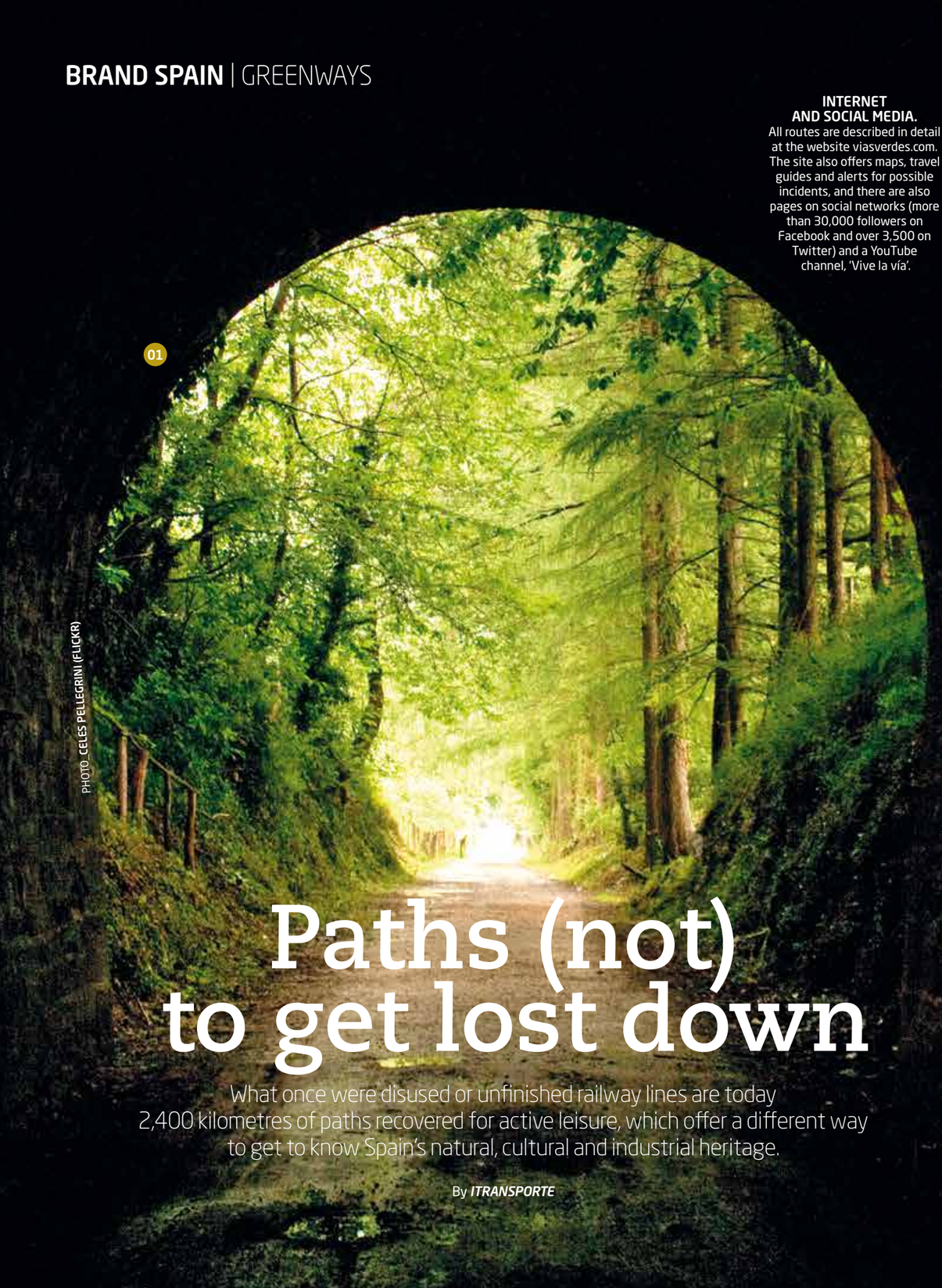




WALKWAY OF THE JARDINES DE HÉRCULES STATION DESIGNED WITH REVIT
The volumetric and structural irregularity of the walkway, as well as its various alternatives, were studied thanks to its modelling in Revit, which, in turn, allowed us to react very quickly in the event of changes and unforeseen events in the project.

PROJECTS IN WHICH INECO HAS WORKED WITH BIM:

1. Terminal building of Odessa airport, Ukraine.
2. Implementation of the new terminal building of the Abu Dhabi airport.
3. Enlargement of the check-in area of Sal Island airport, Cape Verde.
4. Enlargement of the terminal of Boavista airport, Cape Verde.
5. Terminal and RFFS of San Nicolás airport, Cape Verde.
6. Delta Junction, high-speed line (HS2) between London and Birmingham, the United Kingdom.
7. Terminal building of Simferopol international airport, Russia.
8. New international terminal and refurbishment of the existing terminal in Alfonso Bonilla airport, Colombia.
9. Cargo terminal of Boavista Island, Cape Verde.
10. Controller booth in Ibiza airport, Spain.
11. New Elche high-speed station, Spain.
12. Remodelling of San Bernardo station, Seville, Spain.
13. New hall of Barakaldo station, Spain.
14. New Urbinaga interchange, Bilbao, Spain.
15. New passenger building of Torredembarra station, Spain.
16. Torrelavega station, Spain.
17. Cali airport, Colombia
18. Radar building. Alicante airport, Spain.
19. Hangars. Córdoba airport, Spain.
20. Weather radar. Tenerife, Spain.
21. Falconry of A Coruña airport, Spain.
22. Proposal of the new ASA headquarters, Cape Verde.
23. New firefighter building in Ibiza airport, Spain.
24. Enclosure of Sants station, Spain.
25. San Andreu Comtal station, Barcelona, Spain.
26. Antequera station, Spain.
27. Master Plan of the new international airport of the Salah Aldeen region, Iraq.
28. Development of regional airports of Brazil.
29. Control box of León airport, Spain.
30. Northern access to the terminal building of Gibraltar airport, Spain.
31. Operations on the Departure floor of Lanzarote airport, Spain.
32. Remodelling of the shopping zones of Chamartín station, Madrid, Spain.



PHOTO_CELES PELLEGRINI (FLICKR)

Paths (not) to get lost down

What once were disused or unfinished railway lines are today 2,400 kilometres of paths recovered for active leisure, which offer a different way to get to know Spain's natural, cultural and industrial heritage.

By ***ITRANSPORTE***

INTERNET AND SOCIAL MEDIA.
All routes are described in detail at the website viasverdes.com. The site also offers maps, travel guides and alerts for possible incidents, and there are also pages on social networks (more than 30,000 followers on Facebook and over 3,500 on Twitter) and a YouTube channel, 'Vive la vía'.

The construction of a mining railway in Burgos at the end of the 19th century soon proved to be an economic failure, but the works led to the discovery of what are now considered some of Europe's most important archaeological sites: the Sierra de Atapuerca sites (03). A significant part of the old railway trenches have since 2004 been used as a 'greenway': a nature path that is signalled, equipped, closed to motorised traffic and conditioned for use by walkers and cyclists. Its 54 kilometres are part of a network of nature paths which, under the registered trademark 'Vías Verdes', currently includes 117 routes around all of Spain and more than 2,400 kilometres of track; another 200 are to be added to this by the end of 2016. Each and every one of these routes is built on old, disused railway lines, which in practice means that their layout and gradients make them suitable for all kinds of users, including children, elderly people and people with reduced mobility. When the programme was launched 23 years ago, Spain had 7,600 kilometres of track that was out of service, a third of which has now been recuperated for this new use.

CULTURAL AND NATURAL HERITAGE

Andalusia has one of Spain's longest greenways, the 128-kilometre Aceite route, which crosses Córdoba and Jaén through a landscape of olive groves. Inland, paths which are noteworthy for their length (at around 50 kilometres) are the greenways of Alcaraz in Albacete, La Jara in Toledo, Tajuña in Madrid and Eresma in Segovia. The latter also offers the attractive bonus of a visit to the monumental combination of the city of Segovia and its Roman aqueduct, a World Heritage site. However, this is not the only greenway that is close to a city of tourist interest: the 2.75-kilometre Itálica route allows a visit to Sevilla; the Santander–Mediterráneo railway route (14 km) approaches Burgos and its cathedral, a jewel of Spanish gothic architecture; the Oliver–Valdefierro Corridor route (2.6 km) passes the city of Zaragoza; and in Catalonia, the Carrilet route reaches its terminus in the old town of Girona.

Those who prefer to submerge themselves in history can visit medieval castles like the Valencia de Don Juan in León (Esla greenway, 11 km), the Bélmez castle in Córdoba (La Maquinilla greenway, 8 km) or the Biar castle (04) in Alicante (Xixarra greenway). On the Eo greenway (12 km), which runs between Asturias and Galicia, visitors can find prehistoric forts and dolmens; and on Huelva's Molinos de Agua route (33.2 km), there are mines and the remains of Roman roads and megalithic monuments like the Dolmen de Soto. On the Pas greenway, it is worth highlighting the prehistoric caves of Puente Viesgo; and in the town of Baza in Granada, on the Baza greenway, there is a group of historical monuments and an archaeological museum with Iberian remains. ■

PHOTO_VÍAS VERDES

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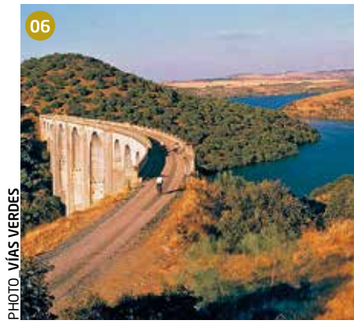

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LIVING TREASURES

The Iberian fauna is another natural treasure put in users' reach by the greenways. Vultures can be observed from the Préjano greenway in La Rioja and the Sierra greenway in Cádiz, for example. On the La Jara greenway (06) is Spain's oldest recuperation centre for birds of prey; and the Casa del Oso ('House of the Bear', 05) (Senda del Oso greenway) located in Proaza, Asturias, is dedicated to the conservation of the Cantabrian brown bear.

MORE THAN A MILLION USERS

The Vías Verdes programme in Spain, which has more than a million users per year, has received a multitude of awards, including several from the UN and another from the World Tourism Organization. The Ministry of Agriculture, Food and Environment is the main investor in the programme, with the Spanish Railways Foundation (FFE) taking responsibility for coordination and promotion with the support of Adif, the State railway infrastructure administrator. The programme also benefits from the collaboration of local and regional governments and various citizens' collectives. New routes are planned for 2016, such as the old Santander-Mediterráneo, Baeza-Utiel, Vía de la Plata (Plasencia-Astorga railway) and Guadix-Almendricos railway lines.

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