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FEB | MAY 2015

INTERNATIONAL AIRPORT  
JORGE CHÁVEZ IN PERU

## **Far afield**

EUROPEAN RAIL TRAFFIC  
MANAGEMENT SYSTEM (ERTMS)

## **ERA's advisors**

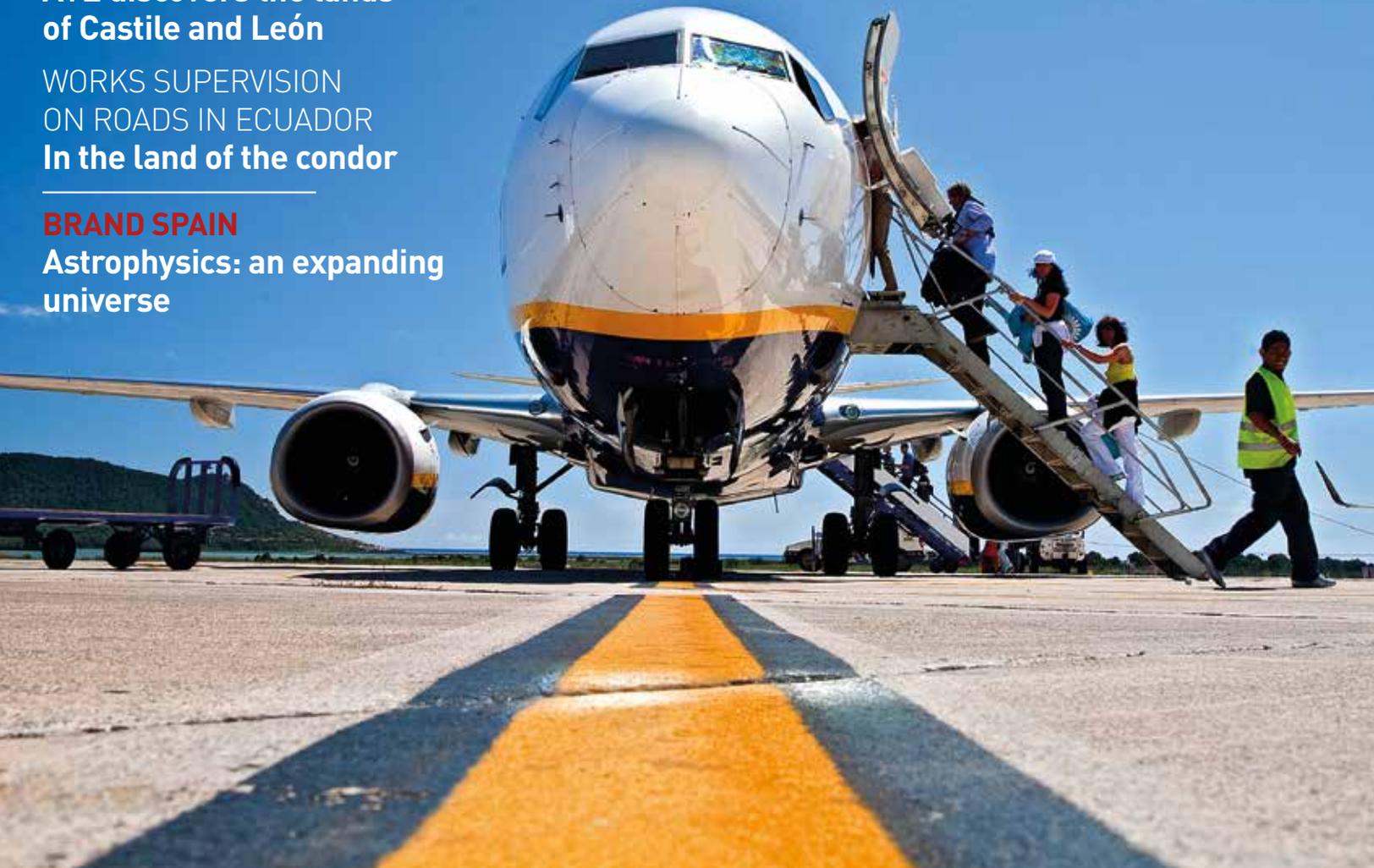
VALLADOLID-PALENCIA-LEÓN  
HIGH SPEED LINE

## **AVE discovers the lands of Castile and León**

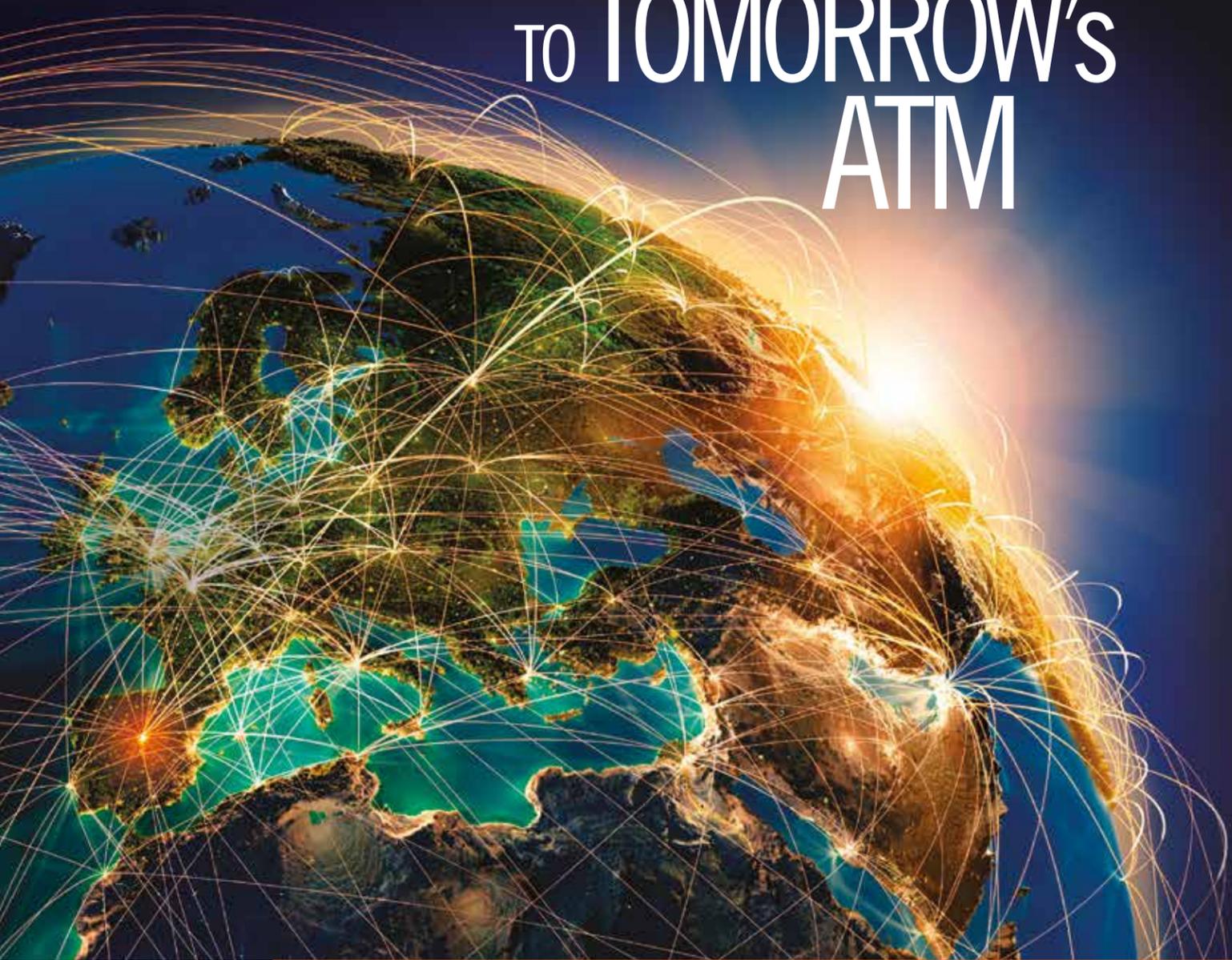
WORKS SUPERVISION  
ON ROADS IN ECUADOR  
**In the land of the condor**

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**Astrophysics: an expanding  
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## Editorial



**A**fter my recent appointment, I am honoured to introduce this issue to you for the first time, in which it is announced that, along with our aeronautical experience, Spanish high speed railway continues to be one of the greatest milestones of our work and, of course, of these pages. Here we describe how, throughout this year, another stretch of the Spanish High Speed Railway (AVE) will become real with the launching of the new line connecting Valladolid, Palencia and León, in the heart of the Castilian-Leonese's lands; or the progress in the Galician tunnels and the development of the European Rail Traffic Management System (ERTMS), in which Spain has been playing a significant role from the beginning.

**I would also like to highlight Ineco's vocation to contribute** to the socio-economic progress of other countries by making the most of their experience in the development of transport infrastructure in Spain, apart from actively participating in the exchange of knowledge and training engineering professionals in different institutions.

**This issue reflects once more that the company** continues consolidating its expansion and earning the trust of its partners and clients, both in Spain and abroad, as recent orders made in Latin America and Europe show. Technical knowledge, experience and reliability are the credentials upon which the prestige of Ineco and, by extension, of Spanish engineering has been built, a background that allows us to face 2015 with optimism, opening new markets, supporting the collaboration agreements that the Spanish Ministry of Public Works has undertaken abroad in recent years, as well as contributing to the maintenance and development of infrastructures in Spain.

**Regardless of the size and the sector we work in,** all Spanish engineering companies, like us, which have expanded abroad, share the same challenge: providing efficient and suitable solutions to the needs of society, thus contributing to the improvement of citizens' quality of life. I am convinced that clients and readers will appreciate the effort. I invite you to share our vision with us.

**Jesús Silva Fernández**

President of Ineco



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These tunnels are the keys to reaching Galicia via high speed. Ineco leads the works of La Canda tunnels, in the Lubián-Ourense stretch. These are two twin structures which are over seven kilometres long, single-tracked and connected with each other through a network of galleries.

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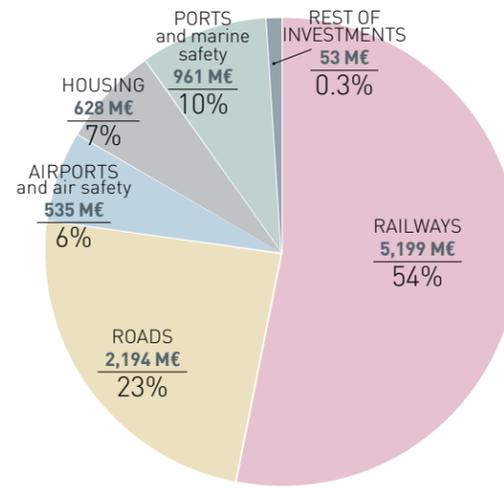
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COVER IMAGE: By Pablo Neustadt.

**Spain** The Ministry of Public Works will invest 6.6% more than last year

The Spanish Ministry of Public Works has submitted the 2015 budget: 17.50 billion euros, out of which 9.6 will be earmarked for investment and the amount remaining for current expenses. It is again railway transport, and specifically the completion of high speed works, where more than half of the budget will be spent: 54%, that is 5.20 billion euros. Twenty three per cent of the total will be invested in roads, mainly in new construction (1.16 billion) and



preservation (935 million). The ports and marine safety item was granted 10% of the investment, 961 million, and 6%, 535 million, corresponds to airports. As a noteworthy data, the Ministry has highlighted the expenses reduction by 4.8%, 404 million euros, and the general improvement in the public companies' accounts composing the Fomento Group.

CONTRACT WITH STRATEGIC SCOPE

**Ineco to supervise the ERTMS deployment all over Europe**

The European Commission has trusted Ineco with the coordination and supervision, throughout the following six years, of the deployment of the European Railway Traffic Management System (ERTMS) in all states of the Union.



The agreement, signed last December, includes the administration and management of the work programmes of nine corridors, the coordination among the different entities involved (infrastructure administrators, operators, national security authorities, interest groups of the corridors, European associations, etc.), the deployment management, and

the technical and economic supervision, as well as other communication and information support activities. Therefore, as from 2015 and until 2021, Ineco's experts will control and monitor the ERTMS deployment in the main nine

European corridors (see charts). As to the economic part, Ineco has partnered with E&Y, which will also participate in some communication and coordination tasks.

**Guarantees and efficacy**

The need to guarantee interoperability coordinating all works with efficacy and in a centralised manner, plus Ineco's professionalism accredited by years of collaboration, and its management capacity (see interview page 18), have led the EC to trust this task to the Spanish public engineering for a longer period and for the main corridors connecting EU's territories from north to south and from east to west.

**GOALS**

The main goal of this supervision agreement is guaranteeing that the implementation of the system in the corridors defined as priority is carried out ensuring its interoperability, coherence and compatibility with the rest of the network. The substitution of the current 20 different signalling and speed control systems for this unique system is essential for the development of the transEuropean railway system, while allowing the decrease of road traffic congestion. In total, since the procedures to implement the single system began, more than 65 projects partially funded with European funds have been started up in different stretches of tracks through the entire European network, which includes equipping the train fleet.

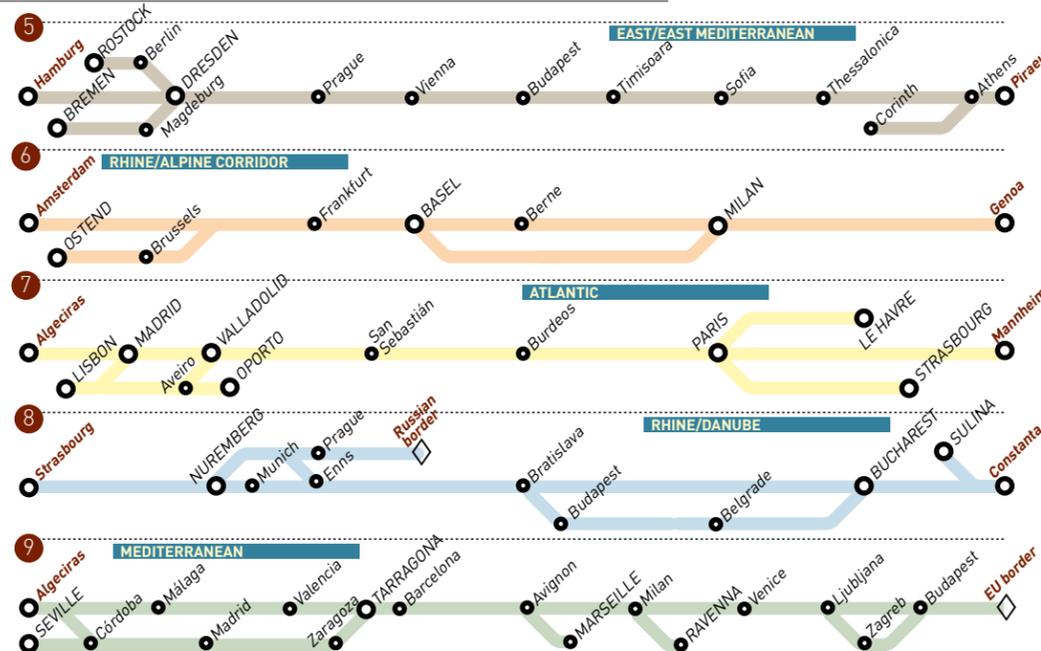
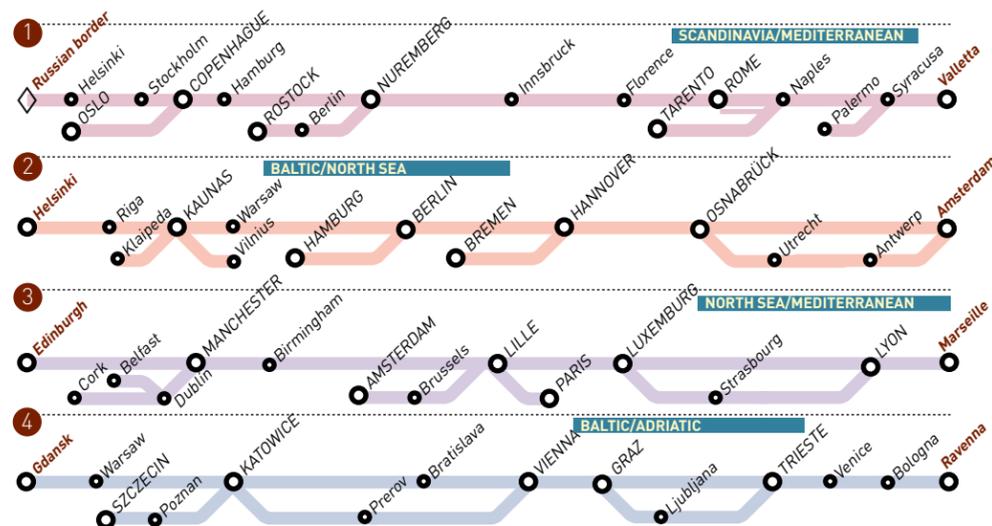


**Jesús Silva, Ineco's new president**

Since last November, Jesús Silva Fernández is the new president of Ineco. He previously held the position of Spanish ambassador in the Republic of Panama. He was born in Seville in 1962, and holds a BA in Law issued by Universidad Complutense de Madrid (UCM). He has also been Spain's ambassador before the OECS (Organization of Eastern Caribbean States), before the CARICOM (Caribbean Community), in Jamaica, the Bahamas, Antigua and Barbuda, Dominica, St. Lucia, and St. Kitts and Nevis. In addition, he was president of the International Seabed Authority's Assembly. Jesús Silva has also held the position of Cultural Counsellor in the Spanish Embassies of Berlin and Bonn, and director of the Office of the Secretary of State for International Cooperation and for Ibero-America. Apart from that, he was Spanish general consul in Rosario (Argentina).

EUROPEAN CORRIDORS

Deployment of the European Railway Traffic Management System (ERTMS) in the European Union's main nine corridors.



# News

Colombia

## New works for Medellin metro

Ineco is conducting the technical management and supervision of the design, manufacturing and start-up of three new units built by the company CAF for Medellin metro, in Colombia. The work includes validating design, supervising manufacturing and track testing. The company has also performed the supervision and technical management of the design, manufacturing and start-up of 13 train units –manufactured by CAF in Spain– and of the on-board signalling equipment (ATC) of 26 engine driver’s cabs.



## Philippines CONSULTING WORKS

### Study for the development of an airport city on Negros Island

Ineco will develop a business plan for the economic and industrial development of the region next to the international airport of the city of Bacolod-Silay, on Negros Island, the fourth largest island in the Philippines. The first step is conducting a feasibility study of a new airport complex that acts as booster of commerce and exports, and promotes the productive development of the agricultural sector of the Negros Occidental region, where Bacolod-Silay airport is located. Businessmen and owners of the more than 200 hectares surrounding the airport have requested Ineco’s engineers to identify opportunities and logistic needs arising from the airport to boost the export of their products –Negros



Occidental produces more than half of the country’s sugar– and the industrial development of the region. Both the local government and airport authorities support the owners’ initiative, which the PEZA (Philippine Economic Zone Authority) has recently classified as a free-trade zone.«

## Chile SANTIAGO METRO

### Extension of modernisation works

Santiago metro has requested Ineco the extension of the modernisation works of the NS74 train fleet (currently composed by 49 trains with 5 cars each), manufactured in the 70s by Alstom (image). Nowadays, Ineco, which has also worked closely with Santiago metro in the drafting of the bidding terms and conditions and in the offer assessment process, is conducting technical advisory tasks of the detail engineering and the design of the modernisation process, along with Alstom’s engineers in Spain.

The Company will also conduct the technical assistance tasks of the manufacturing, testing and



commissioning of the first two trains until early 2016. In addition, it has recently begun the FAI (First Article Inspection) campaign of the main systems and new equipment in the suppliers’ factories.

Initial modernisation works include the improvement of the train’s image (both on the outside and in the inside), the comprehensive renewal of the traction chain, the installation of air conditioning systems, the comprehensive re-design of inner space, of the engine driver’s cab and of the command system, a new control and diagnosis system, the modernisation of access doors and the installation of communicating corridors, among other works. The modernised fleet will be finally composed by 35 trains with seven cars each).«

## FAIRS AND CONFERENCES

### Berlin/INNOTRANS Ineco is again present at the world’s greatest railway event

Spanish Minister of Public Works, Ana Pastor, visited Ineco’s stand at the 10th edition of Innotrans railway fair, which took place in Berlin from last September 23 through 29. It is the second time that the company participates in this event as part of a Spanish delegation composed by more than 50 companies, organised by the MAFEX railway association. Innotrans is the most important international railway fair in the

world. It takes place every two years and, in this edition, the tenth, gathered more than 100 countries and 220 companies from the railway sector. Among Ineco’s representatives we find: José Manuel Tejera, Infrastructure and Transport general director; José Anguita, commercial director; Rafael Molina, subdirector of Strategic Marketing and Communication; Javier Carabaño, Signalling and Communications subdirector;



Ana Pastor at Ineco’s stand in Innotrans.

Eduardo Marcos, Electro mechanic and Rolling Stock subdirector; and Juan Ramón Hernández, delegate in Europe.«



### Oman/PUBLIC TRANSPORT CONFERENCE First transport conference in Oman

Ineco has participated in the first edition of the Oman Public Transport Conference held in Muscat in October 2014. Organised by ORTA (Oman Road Transport Association), with the support of Oman’s Ministry of Transport, the event focused on public transport as booster for the economic and social development of the region. The project consists in the design of a new

transport network to provide the city with an efficient and sustainable public transport system.

José Manuel Tejera, Infrastructure and Transport general director, participated in the opening session. In addition, Emilio Miralles, head of Muscat’s work team, participated in the session devoted to Strategy and Future of Public Transport in Oman.«

### Madrid/4TH SESAR CONFERENCE Conference on Single European Sky

Spain’s capital city has hosted from November 25 through 27 the 4th SESAR Innovation Days 2014, organized by Eurocontrol. SESAR is the R+D European programme in charge of developing, in terms of technology and operation, the future air traffic management system known as Single

European Sky, where Ineco has participated with several projects.

José Manuel Rísquez, Víctor Gordo, Víctor Quiñones and Esther Fernández, along with Farah Baroudi, presented Ineco’s innovation projects HECCO, IMPULSE, the suite COVER and RUCCMAN in the event, which was attended by more than 300 experts in air traffic management.«

# Far afield

## Lima's airport is facing the biggest extension of its history

By *itransporte*, with the collaboration of J. Ángel Gómez-Briz and Víctor Pardo, aeronautical engineers

**The international airport Jorge Chávez will have Ineco's and its partner Cesel's services to supervise, until 2021, an ambitious extension programme that includes, among other actions, the construction of a second runway and new terminals for passengers and cargo.**

It has just received, for fifth year in a row, the award for the best South American airport, granted by the British consulting company Skytrax Research, and after 13 years of management, the concession holder LAP (Lima Airport Partners), boasts an achievement that now requires moving one step forward: extending the airport by almost duplicating its current area, to manage a volume of passengers that grows at a vertiginous pace: almost 12% in 2013 as compared to the previous year. To make a comparison, the average growth of the European Union airports in 2014, according to the data provided by ACI (Airports Council International) was 7.4%. Therefore, the four million passengers managed in 2001 became 14.9 in 2013, and LAP expects to end 2014 with more than 15.5 million.

### The biggest extension of all times

To manage the growing traffic volume, Lima's airport faces what will be the biggest extension to date: it will cover seven million m<sup>2</sup>. Ineco, as part of a consortium with Peruvian engineering company Cesel, will supervise the works until 2021, which

design and engineering were awarded to another consortium led by the Dutch multinational, Arcadis. The actions planned include, among others, the construction of a second 3,500-metre-long runway, and new taxiways, which are expected to become functional in 2021, as well as the extension of the aircraft parking apron. In the landside, new passenger and cargo terminals will be built, which are to be inaugurated in 2016, and road accesses to the airport will be extended.

Ineco shall report to OSITRAN (Supervising Agency of Investment in Public Transport Infrastructure Facilities), which would ensure the correct development of the works and compliance with the contract terms. Created in 1998, the aim of this state-owned body, which reports directly to the Presidency of the Ministers Council, is to govern and supervise the technical and financial actions of the thir-

ty concession holders that also manage many other railway lines, port terminals and airports throughout the country.

*Lima's airport is facing what will be the biggest extension to date: it will cover nearly seven million square metres*

Meanwhile, the Peruvian government, through the Ministry of Transport and Communications, has managed the expropriation of the lands adjoining to the airport to be delivered to the concession holder. In 2013, the latter has already started the environmental audit and fencing of the first plots delivered, nearly one million square metres.«

### Ineco's experience

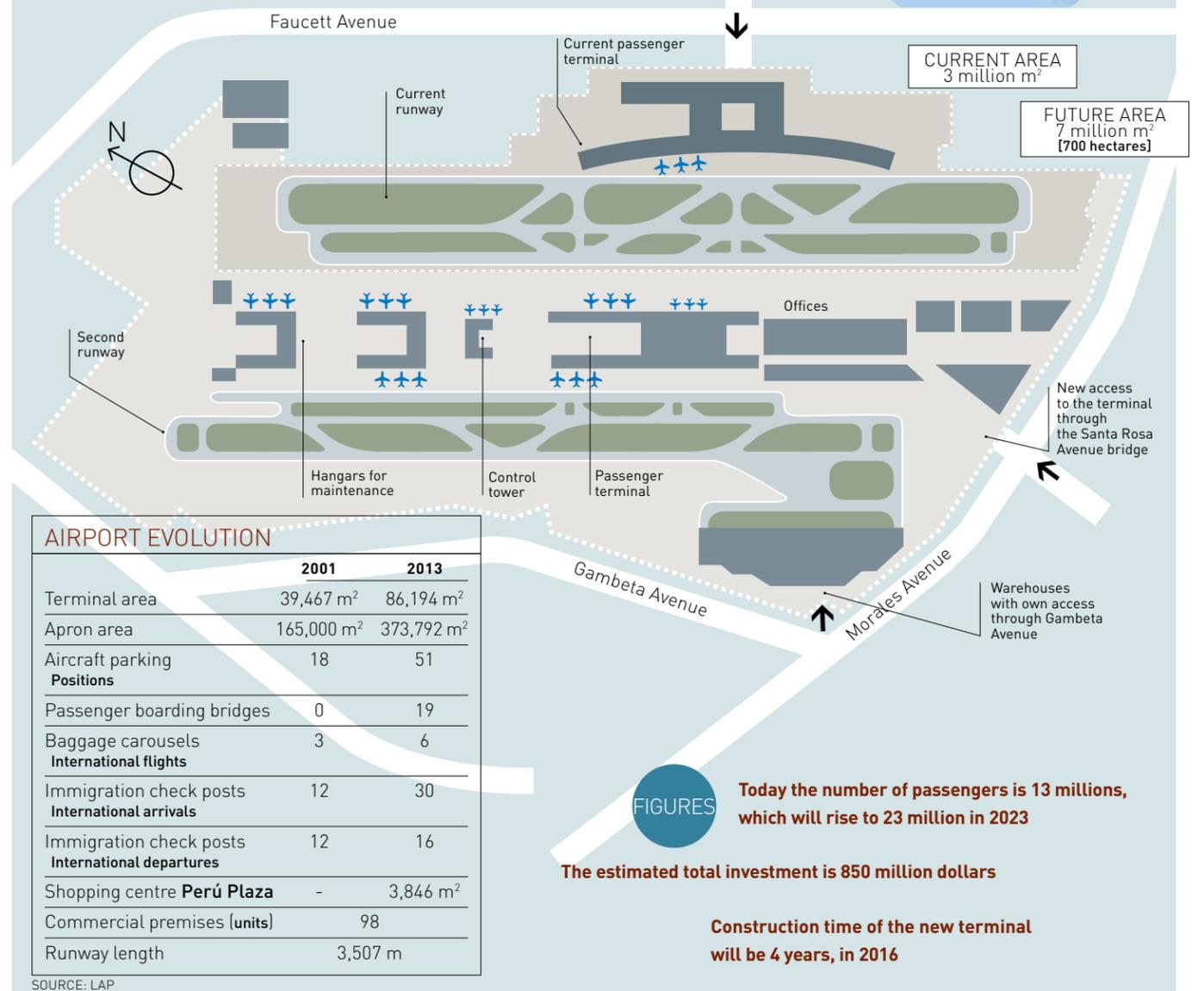
■ Ineco provides solid experience in project management of airport expansion. During the last 12 years, Aena, Spanish airport operator, has carried out extension and improvement works in its network of 47 airports, where Ineco has participated providing specialized consulting and engineering services.

■ Among other tasks carried out, the field inspection services, technical, financial and documentary control of works execution, the drafting of follow-up reports or planning have been included. The most important actions have been conducted

in the Adolfo Suárez Madrid-Barajas, Barcelona El Prat and Málaga airports, where both airfields and terminals have been extended. Ineco also collaborated in improvement projects involving other airports, such as those in Valencia, Alicante, Jerez, Córdoba and Ibiza.

■ Outside Spain, the company is currently in charge of the project management of the extension of Kuwait's international airport, which, like Jorge Chávez airport, will also have a second runway and a new passenger terminal, as well as a large area intended for air cargo.

### LIMA (PERU) New airport



# Peru has 145 aerodromes, 11 out of which have capacity for international flights, although the only ones in operation, besides Jorge Chávez, are Cusco, Arequipa, Iquitos and Pucallpa

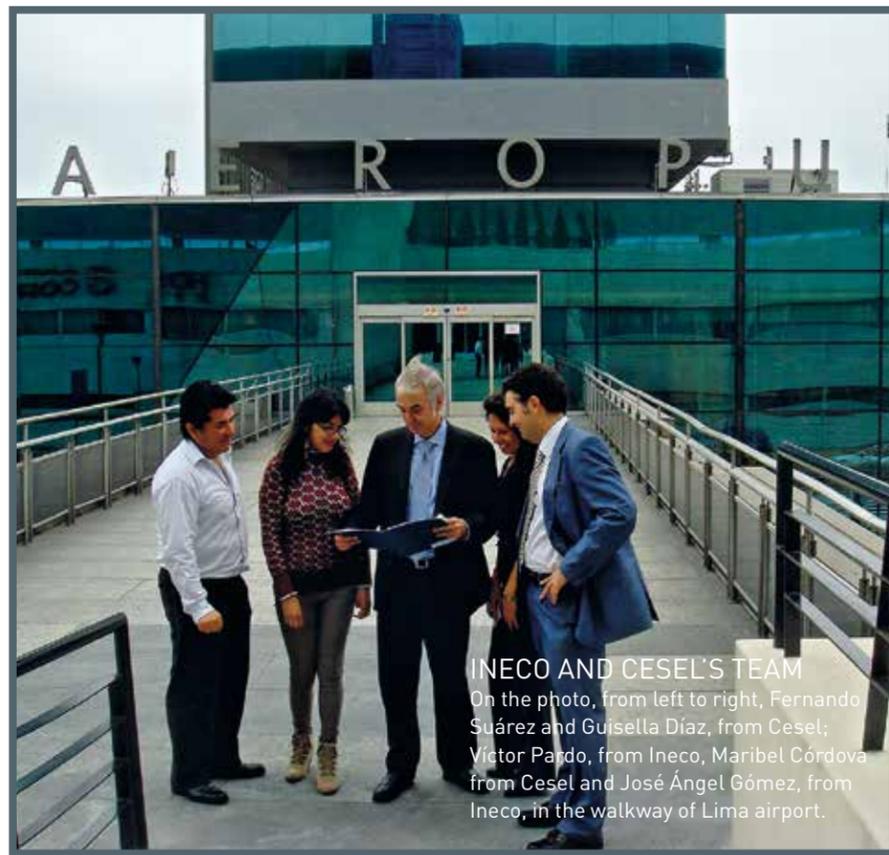


Commercial area of international airport Jorge Chávez.



Passport control.

PHOTO: MINISTRY OF INTERNAL AFFAIRS



**INECO AND CESEL'S TEAM**  
On the photo, from left to right, Fernando Suárez and Guisella Díaz, from Cesel; Víctor Pardo, from Ineco, Maribel Córdova from Cesel and José Ángel Gómez, from Ineco, in the walkway of Lima airport.

## HISTORY OF AN AIRPORT

Lima international airport, which bears the name of Peruvian aviator Jorge Chávez, was opened in 1965 and transferred to LAP in 2001. As provided in the concession contract, the new manager, today with German operator Fraport as majority shareholder, undertook the first extension and refurbishment stage of its facilities since 2004, while the demand of passengers, operations and cargo continued growing. At the same time, during 2013 and

2014 several improvements, such as the extension of passenger control and service points (passport control, payment of airport charges, etc.), installation of new car park controlling access systems and the opening of 11 new departure lounges, have been carried out.◀



Passengers disembarking.

## Air transport and economy

The need for extension comes from the dynamic nature of Peruvian economy, which, in order to keep up its intense rate of growth –around 5-6%– requires modern and efficient infrastructures, both in basic equipment and services such as transport.

### AIRPORTS

Peru, with a population of around 30 million inhabitants, has 145 aerodromes, 11 out of which have capacity for international flights, although the only ones in operation, besides Jorge Chávez, are Cusco, Arequipa, Iquitos and Pucallpa. The rest are domestic airports, 20 in total, plus 104 small aerodromes and 10 heliports. As far as management is concerned, the public-private collaboration model has been chosen, which the country approved in 1997. Through an international bidding process, in 2001, the first concession of Lima airport, for thirty years, was awarded; and in 2006 and 2010, another 18 regional airports were awarded for 25 years to consortia Aeropuertos del Perú and Aeropuertos Andinos del Perú, divided into two “packages” of twelve and six airports, respectively. The rest are managed either by the state through CORPAC (Peruvian Corporation of Airports and Commercial Aviation) or by local governments or communities (39 aerodromes and three heliports) or private mining, oil or agricultural companies (42, plus three heliports). Thus, near one third of the country’s facilities are related to the production of

raw materials, which are the backbone of Peruvian economy; especially minerals and metals: Peru is South America’s first and the world’s sixth producer of gold and silver, the third producer of copper, tin and zinc; and ranks among the 20 first producers of mercury, molybdenum, selenium, cadmium and iron. It also produces oil and natural gas. Air transport allows mobilising personnel and machinery to exploitation areas, which would otherwise be inaccessible, taking into account the fact that 58% of the country is covered by rainforest and another 32% is mountainous land.

*Peru received 3.1 million tourists in 2013 and intends to reach 3.4 million by the end of 2014, that is, with a 7.5% increase*

### TOURISM

The other economic sector which exerts decisive influence on the development of air transport is tourism: it is the third source of foreign currency and generates one million jobs. Nevertheless, in spite of occupying the world’s first positions in terms of cultural and natural heritage, a broad development margin lies ahead its tourist industry. As a result, Peru’s National Tourism Chamber (CANATUR), by the end of 2014 submitted a study that indicates that the current capacity of the airport Jorge Chávez, main entrance gate of international tourism, is limiting the expansion of the sector.◀



## VALLE SAGRADO, NEW AIRPORT

Although tourist offers are many and the country is gaining ground as gastronomic, nature and adventure tourism destination, the old town and Inca sanctuary Machu Picchu continues to be the main attraction. Around one third of all foreign tourists arriving in the country visit this enclave, declared World Heritage by UNESCO in 1983 and voted as one of the world’s modern Seven Wonders.

It is 130 kilometres from the city of Cusco, where the country’s second international airport, Alejandro Velasco Astete, is located. In 2013, it received 2.3 million passengers, a figure that has not stopped rising. However, its capacity is at a near-saturation point and has major limitations for air operations due to its location in the city centre and its altitude (at over 3,000 metres above sea level), which prevents aircraft from taking off and landing at night.

As a result, the Peruvian government has foreseen the construction of a new airport in the city of Chinchero, 29 kilometres from Cusco, which will occupy an area three times larger than the current one and will be able to operate 24 hours a day, with an initial capacity of five million passengers per year. In April 2014 the 40-year concession under BOT regime (Build, Operate, Transfer) was awarded to the Argentinian-Peruvian consortium Kuntur Wasi.◀

# Forever young

## Airports grow to face constant increase in air traffic

By *itransporte*

**Ineco has wide experience in enlargement and modernisation of airports throughout the world, as air traffic is constantly increasing: it is foreseen that it will be twice the current one in 2030, 3.1 billion passengers.**

Even economic recession has not reversed the trend of world air traffic grow, which according to ICAO (International Civil Aviation Organization) was 3.1 billion passengers in regular flights in 2013, 4.5% more than the previous year. By 2030, the forecast is that the figure will double, as the trend shows every fifteen years since 1977. In Spain, 187,405,129 passengers used domestic airports in 2013, according to data from Aena, the Spanish airport manager, which, in spite of being 3.5% lower than 2012, represents an increase of 47 million as compared to 2000 (140,991,621 passengers). In other words, air travel is growing everywhere in the world, which not only requires the construction of new airports, but also an effort of governments and airport managers to keep infrastructures updated.

To face this growth, over the last few years, Spain has undertaken through Aena the enlargement and improvement of its airport network comprising 47 airports. Ineco has been rendering engineering and consulting services in these projects, from the project stage to works execution and subsequent commissioning, as well as in the update of master plans, environmental studies, etc.

The enlargement of Spain's two largest airports, such as Madrid-Barajas (1997-2006) and Barcelona-El Prat (1999-2009) has been a significant milestone in airport development. Likewise, during the first decade of 2000, the main Spanish tourist airports have been enlarged, that is Valencia, Alicante, Málaga, Palma de Mallorca, Tenerife North and South, and others such as Zaragoza or Vitoria (with significant cargo traffic), or others with remarkable low-cost airline traffic, such as Reus, Girona, A Coruña, Menorca, etc.

*Air transport is growing throughout the world, which not only requires the construction of new airports, but also an effort of governments and airport managers to keep infrastructures updated*

### Air transport on the rise

■ The arrival in the air market of low-cost airlines by the end of the 90s, as well as the development of wide-body aircraft such as Airbus A380 or Boeing B777 and B747-8, with higher capacity and autonomy, have been key factors in the global expansion of air transport.

Also, the concept of airports has been evolving, passing from being mere transport terminals to becoming

centres where business and passenger service activities, as well as cargo transport, have been increasingly gaining relevance. From an economic standpoint, tourism is closely connected to air transport. As a result, having modern and well-equipped airport infrastructures, dimensioned according to foreseen demand (and suitably calculating this) is essential.

### The value of experience

All this has contributed to generating a valuable know-how that Ineco has applied in its subsequent jobs. This is the case, for instance, of Operational Readiness and Transfer procedures (ORAT) of any new airport facility, which Ineco is carrying out along with Aena for the new terminal of the Abu Dhabi international airport (see *it51*). The Transfer Management of Aena pioneered the performance of these tests, which are currently common in airports throughout the world.

Ineco has also provided support to the Spanish airport operator in project management, a job that is currently being performed since 2012 at Kuwait's international airport and which has just started at Lima's Jorge Chávez airport in Peru. Before this, Ineco also performed



Eldorado airport, Bogotá.



ORAT experts, Abu Dhabi.

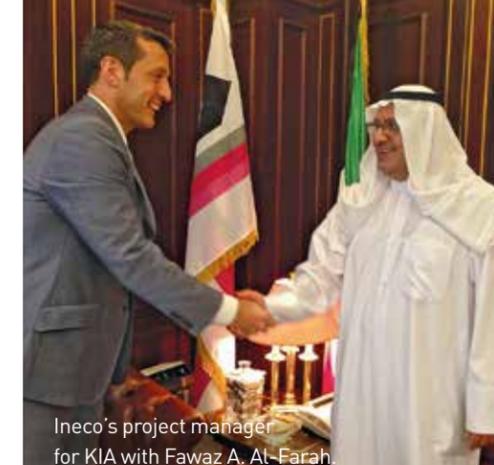


Strategic Mobility Plan (PEM), Ecuador. Rafael Correa with Ineco technicians.



### OVERALL PLANNING

An example of overall planning –including infrastructures, management and air space– is the National Air Transport Plan of Nepal.



Ineco's project manager for KIA with Fawaz A. Al-Farah.

project management in the enlargement of Pristina's airport, in Kosovo, (2011-2013); and between 2004 and 2005 led the consortium which undertook the enlargement works of Turin's international airport in Italy.

### Key element: runways

Other works are related to a key element in any airport system: runways. Modern wide-body aircraft intended for long-haul flights require runway lengths over 3,000 metres and pavements specially designed to withstand their weight, besides other safety measures, such as the installation of runway end safety areas (RESAs). This is not a trivial issue, as having capacity to safely operate large aircraft directly affects the possibility of reaching new destinations and attracting airlines, thus influencing airport competitiveness.

As a result, enlargement and repaving actions are being undertaken in many countries to adapt runways to ICAO's safety regulations, and Ineco has wide experience in this. This is the case of Sangster airport in Jamaica (2010), Rafael Nuñez airport in Cartagena de Indias and Alfonso Bonilla airport in Cali (Colombia, 2013) or Jorge Chávez in Lima, Peru (2011). In Chile, Ineco drafted the project for the construction of the second runway of the airport of the capital city, Santiago de Chile (2000). Although in another sector but also related to the need to maintain airfield operation at any moment, it is worth mentioning the Winter Plans drafted by Ineco for Madrid-Barajas (2009) and Heathrow (London, 2012) airports.

## Over the last 15 years, Ineco has performed different kinds of engineering and consulting works for over 450 airports in 28 countries. In this period, the world's air traffic has risen from 1.6 to 3.1 billion passengers

As far as airport building is concerned, Ineco's experience is broad: in Spain it has participated in the construction of the new terminal buildings of Ibiza, León, Zaragoza, Jerez and other airports. More recently, for Colombia's Eldorado airport, it dealt with the design and navigation systems of the new control tower (2013) and in Odessa (Ukraine) it designed the new terminal building (2011-2013). In 2007, the new terminal building of Boa Vista airport in Cape Verde was opened, designed by Ineco, which also supervised the works.

### Growth planning

An essential factor when it comes to airport growth is planning. Ineco has worked closely with Aena in conducting traffic forecasts in all its airports, a key element for determining infrastructure needs in the short, medium and long term. In 2008, the company opened the Air Traffic Forecast Office and designed for Aena an econometric model called PISTA (Integrated Prognosis of Air Traffic).

Furthermore, it has worked in the drafting and update of the master plans of the 47 Spanish airports, which deal with the main growth needs in terms of foreseen traffic until its maximum foreseen development; as well as in urban integration plans, which study the compatibility of aerospace activity with its surroundings. This was the goal of the Airport Vicinity Protection Area Plan drafted in 2011 for four airports of the Sultanate of Oman.

Thus, the experience gained in this field has also been put at the service of other airports outside Spain, with the drafting of the master plans of Kuwait international airport and the 12-airport group of

the Mexican Pacific –where Aena has a stake– both in 2013; the location analysis and master plan of the future Musandam airport, in Oman (2011), the master plans of Sal, São Vicente, Praia and Boa Vista, Cape Verde, airports in 2012, and Colombia's Cali and Barranquilla airports (in 2010 and 2008); or Sangster in Jamaica, in 2009.

Besides the master plans, the company has drafted different types of airport plans

*Ineco has worked closely with Aena in conducting traffic forecasts in all its airports, a key element for determining infrastructure needs in the short, medium and long term*

and studies to analyse the needs of airports facing air traffic growth, as the one performed in Mohamed V airport in Casablanca in 2011. An example of the need to adapt enlargement projects to traffic evolution is Jomo Kenyatta airport in Nairobi, Kenya. In 2008, the aeronautical authority entrusted Ineco the revision of the enlargement project –also including operational safety and economic-financial model– as an unforeseen increase in demand caused by the liberalisation of the air transport sector in Africa was observed.

On other occasions, a view of the whole airport network is required such as in the case of the Strategic Plan for Panama's

Airport Development in 2010. Other recent airport planning works on a national scale have been the feasibility studies and preliminary design of 50 regional airports in Brazil, currently undertaken by Ineco with its local partner ATP; or Ecuador's Strategic Mobility Plan (2013), which comprises all means of transport with a 2037 time horizon and includes four programmes with 13 actions for the country's 20 airports. The national transport plans of Algeria (2011), Costa Rica (2010) or Spain (PITVI, Infrastructure, Transport and Housing Plan 2012-2024) also contain the analysis of the airport network of each country and their relevant proposals. Following this planning line on a national scale, Ineco is currently drafting National Transport Models for Croatia and Malta.

Of another kind, but also related to airport expansion and growth plans are the studies of commercial areas and services performed for Aena. Outside Spain, in 2013 Ineco prepared the new commercial strategy for El Salvador's international airport, which not only includes a new concept and redesign of areas, but also a complete management strategy and a new concession model.

### Air navigation

But Ineco's activity and experience as far as airport enlargement is concerned is not only limited to infrastructure, but also comprises air navigation. Any airport enlargement implies the reorganization of air space and changes in operation procedures, as well as in navigation easements: this is the case, for example, of the study performed for the new control tower of Muscat airport, in Oman (2011). An example



Madrid-Barajas airport.



Odessa airport.



### INECO'S TEAM FOR BRAZIL'S PROJECT

Ineco is performing the works from its headquarters in Madrid, and together with ATP, they opened an office in Brasilia, where coordination of the consortium's jobs as well as formalities with Banco do Brasil and the Secretariat of Civil Aviation are carried out.



Ineco-KUD's team with Mona-Al Mutairi (in the centre), project manager of DCGA, Kuwait.



Alfonso Bonilla airport's runway, in Cali (Colombia).

of overall planning –including infrastructure, management and air space– is the Air Transport Plan of Nepal (in process), or those performed in 2011 for Egypt and Morocco. Concerning flight procedure design, it is worth mentioning those carried out for Omani airports in 2014, Changi airport in Singapore in 2013 or Bergen airport in Norway in 2011.

In terms of operational safety, for some years now, Ineco has been working closely

*In terms of operational safety, for some years now, Ineco has been working closely with Aena in the development and update of operation procedures and certification process after the enlargement of Spain's major airports: Madrid and Barcelona*

with Aena in the development and update of operation procedures and certification process after the enlargement of Spain's major airports: Madrid and Barcelona. Since 2009, it offers support to Spanish Aviation Safety and Security Agency in the authorization, inspection and certification of public-use but privately-run airports. In 2014, AESA authorised the company to perform aeronautical inspection actions. Thus, Ineco has undertaken jobs such as the safety studies of airports 4 de Fevereiro in Luanda (Angola, 2012) and Leonardo da Vinci-Fiumicino (Italy, 2014). By the end of 2014, it developed the Safety Monitoring Plan in Kathmandu airport (Nepal).«

# ERA's\* advisors

## Ineco supervises the deployment of ERTMS in European corridors

By *itransporte*, with the collaboration of **Beatriz Sierra**, industrial engineer and **Laura López**, Bachelor of Science in Physics

\*European Railway Agency

**Ineco's experience and knowledge in ERTMS has led the ERA to rely on the Spanish engineering company for the sixth consecutive year for technical assistance and supervision of ERTMS/ETCS interoperability in more than 40 European projects.**

The ERA's bidding process awarded to Ineco for the following year includes following up all of the TEN-T projects of the railway control systems (ETCS, European Train Control System) that were initiated between 2007 and 2013. The tasks requested comprise a total of 51 projects, 18 out of which were already completed

in previous years. The projects include, for example, implementing ERTMS in the Swedish, Belgian and Austrian network, equipping vehicles with ERTMS in Germany, Czech Republic and The Netherlands, and conducting different projects related to the corridors. In Spain, Ineco will continue to provide assistance in the deployment of ERTMS in RFIG, the future actions being the commissioning of Level 2 in the high speed line between Madrid and Valencia, or Córdoba-Málaga, the migration of lines to the 2.3.0d version, and the implementation of ERTMS in new high speed lines that are under construction.

The ERA (European Railway Agency) was created to promote safety and interoperability in the European railway network. As

far as the ERTMS is concerned, the agency is the system's authority and, as such, it is in charge of defining and updating its specifications. The ERA acts as technical advisor of the European Commission in ERTMS matters and has hired Ineco to assist them with the projects' technical follow-up.«

*The ERA (European Railway Agency) has entrusted a team of Ineco's railway experts the technical follow up of 51 European railway projects*



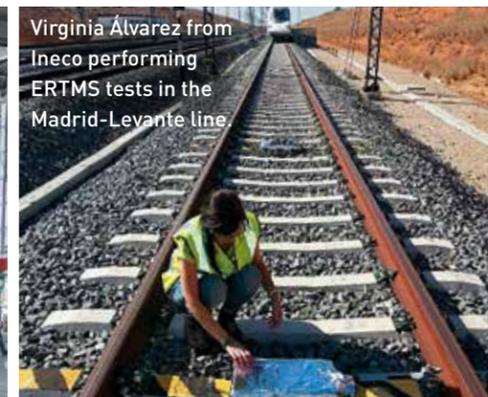
### TECHNICAL FOLLOW-UP OF EUROPEAN PROJECTS

Below, part of Ineco's team, from left to right: **Francisco Javier López** (BSc in Industrial Engineering), **Ernesto Virseda** and **Jorge Merino** (MSc in Industrial Engineering), **Silvia Domínguez** (MSc in Telecommunications Engineering), **Raluca Vlad** (BSc in Physics), **Beatriz Sierra**, **Diego Sanz**, **Bárbara García de Quesada**, **Virginia Álvarez**, **Alfonso Lorenzo**, **Ricardo Campo** and **Francisco Mayoral** (MSc in Industrial Engineering).



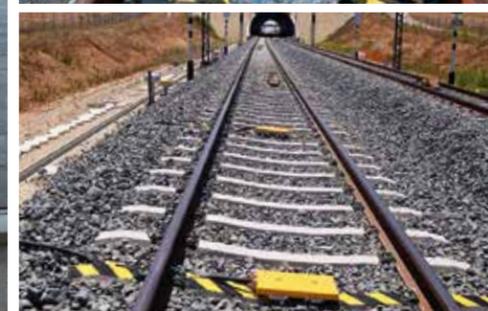
The passenger's safety and comfort are key goals for the deployment of ERTMS.

PHOTO: ELVIRA VILA



Virginia Álvarez from Ineco performing ERTMS tests in the Madrid-Levante line.

PHOTO: MIGUEL SIGUERO



### ERTMS BASIC CONCEPTS

**1\_ THE STABILITY ACHIEVED IN THE SPECIFICATIONS** after years of development has allowed for an increasing investment in ERTMS that is not restricted to Europe.

#### 2\_ TESTING STRATEGY

**Laboratory tests.** Many of the necessary tests may be performed in a laboratory. As a matter of fact, a Spanish centre, the Cedex LIF (Railway Interoperability Laboratory), has led the laboratory tests both of on-board equipment and infrastructure. Besides, there are two other centres in Europe, DLR and Multitel that, along with CEDEX LIF, compose the European laboratory network.

**Field tests** are essential to accredit compliance with some of the requirements when intending to obtain the EC certificate. Ineco's experts participate both in the acceptance tests with ADIF and in the

train-track integration tests needed for the placing in service.

#### 3\_ INTEROPERABILITY ASSESSMENT

The TSI (Technical Specification for Interoperability) of the CCS (Control, Command and Signalling Subsystem) defines the five essential requirements and processes to be performed to obtain the EC certificate of interoperability, Ineco's experts participate in these evaluation collaborating with the Spanish notified body, CETREN. In addition, national safety authorities and the ERA and the European Commission themselves supervise these processes.

#### 4\_ INDEPENDENT SAFETY ASSESSMENT

Safety is one of the five essential requirements established in the TSI and, therefore, requires an assessment to obtain the certificate of interoperability. Ineco is accredited as independent safety

assessor for the on-board and track side subsystems.

#### 5\_ THE FLEXIBILITY of the ERTMS system

makes its use possible both for high speed as well as for commuter lines (see *itransporte* 46).

#### 6\_ THE COMPATIBILITY OF VERSIONS

is essential to protect the investments carried out. The agreement signed by all the sector guarantees that the new trains shall be able to run through 2.3.0d lines (the version deployed in Spain) and the future B3.

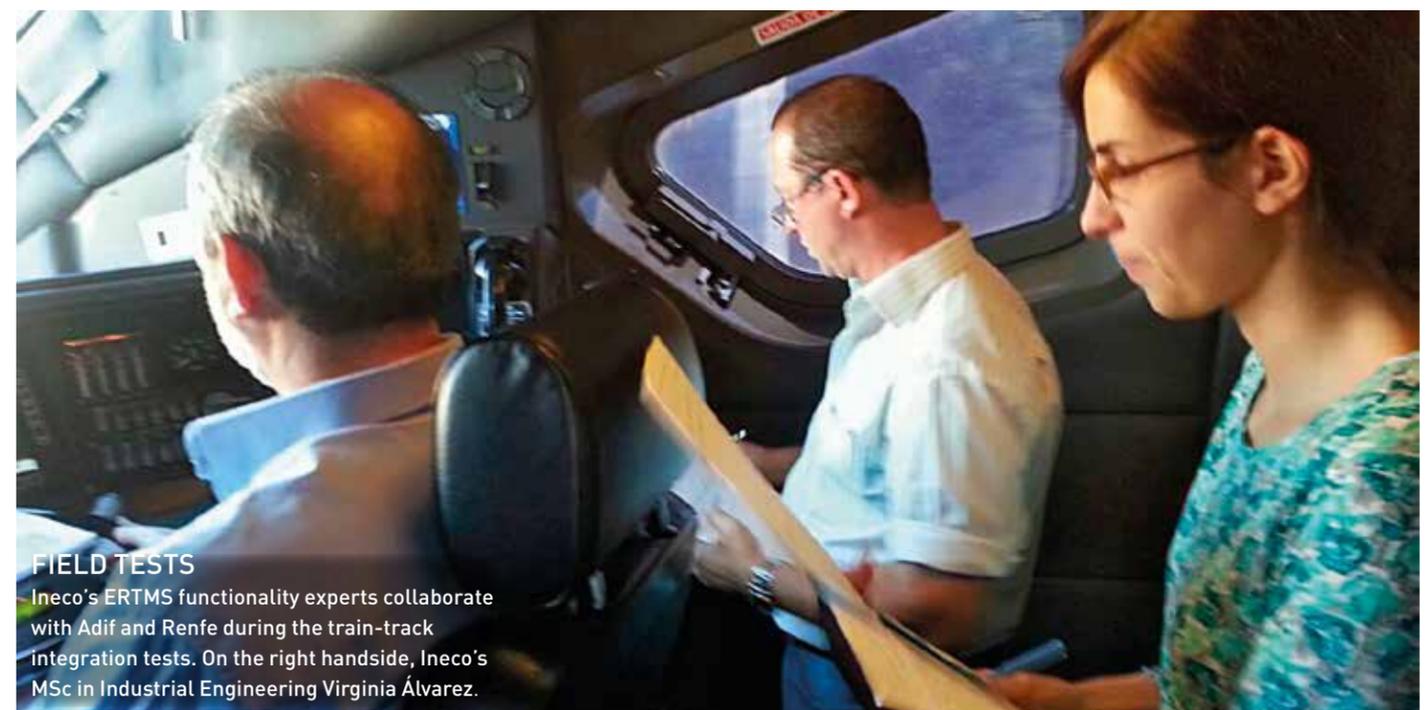
#### 7\_ THE RESEARCH.

Within the framework of initiatives such as NGTC and Shift2Rail work is being done on generating new train control systems that would merge the ERTMS with other urban control systems and on integrating functionalities such as ATO (Automatic Train Operation) and ATS (Automatic Train Supervision).

# From the beginning, Ineco has been involved in the development of ERTMS (European Rail Traffic Management System), a project to which the Spanish railway sector has devoted all its strength since it started



**R+D+i LABORATORIES**  
Spain has had a high degree of involvement in the deployment of ERTMS. The images show CEDEX's railway interoperability laboratories in Madrid. Eurobalise and BTM antenna, EVC and traffic simulator.



**FIELD TESTS**  
Ineco's ERTMS functionality experts collaborate with Adif and Renfe during the train-track integration tests. On the right handside, Ineco's MSc in Industrial Engineering Virginia Álvarez.

## The European dream of interoperability

### Latest developments that have made it possible

It has been 25 years since 1989, when the European Union launched a programme to develop a system that permitted railway interconnection among all member countries, a "common language" that surpassed the systems, equipment and signalling barriers used in its extensive and varied railway network. The goal: being able to cross borders without having to stop trains, with a compatible operating and communication system and the necessary organizational and regulatory environment to guarantee its operation in complete safety. Since the beginning, Ineco has been

involved in the development of this system, the ERTMS (European Rail Traffic Management System), a project to which the Spanish railway sector has devoted all its strength since it started. Spain's technological peculiarity, with different gauges and equipment from different suppliers operating in its railway lines, drove the sector to pursue this challenge in the 80s... In 1992, coinciding with the inauguration of the first high speed line between Madrid and Seville, the Spanish government, state-owned company Renfe and, in particular, Ineco and CEDEX, worked

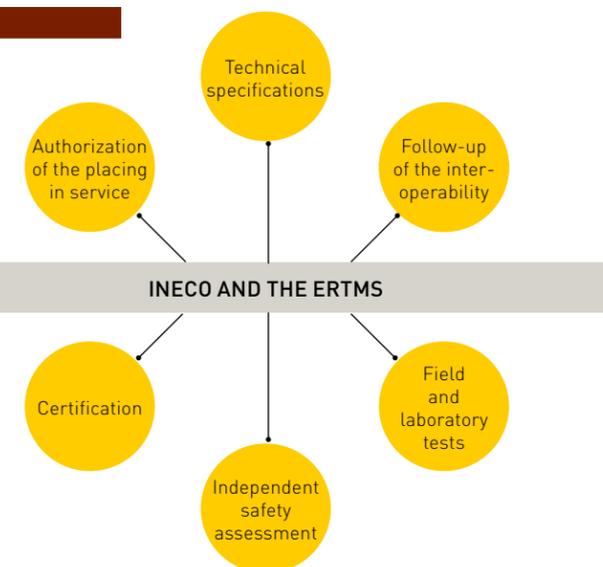
as catalysts of the railway European industry to agree on a common technical reference for all the countries [see *itransporte 32*].

**At present, there are more than 68,000 kilometres of ERTMS tracks contracted in the world with over 90,000 vehicles. Exceeding all expectations, almost 43% of these investments are made outside Europe.**

In Spain, ADIF's network has over 2,000 kilometres of lines working with ERTMS, mainly in high speed lines, but also in the commuter lines of Madrid. In addition, Renfe has over 400 vehicles equipped with ERTMS. The version deployed is now being migrated to 2.3.0d,

### SIX KEY TASKS

The ERA (European Railway Agency) was created to promote safety and interoperability in the European railway network. As far as ERTMS is concerned, the agency is the system's authority and, as such, it is in charge of defining and updating its specifications. The ERA acts as technical advisor of the European Commission in ERTMS matters and has hired Ineco to assist them with the projects' technical follow-up.



which is the first reference legal version of ERTMS/ETCS.

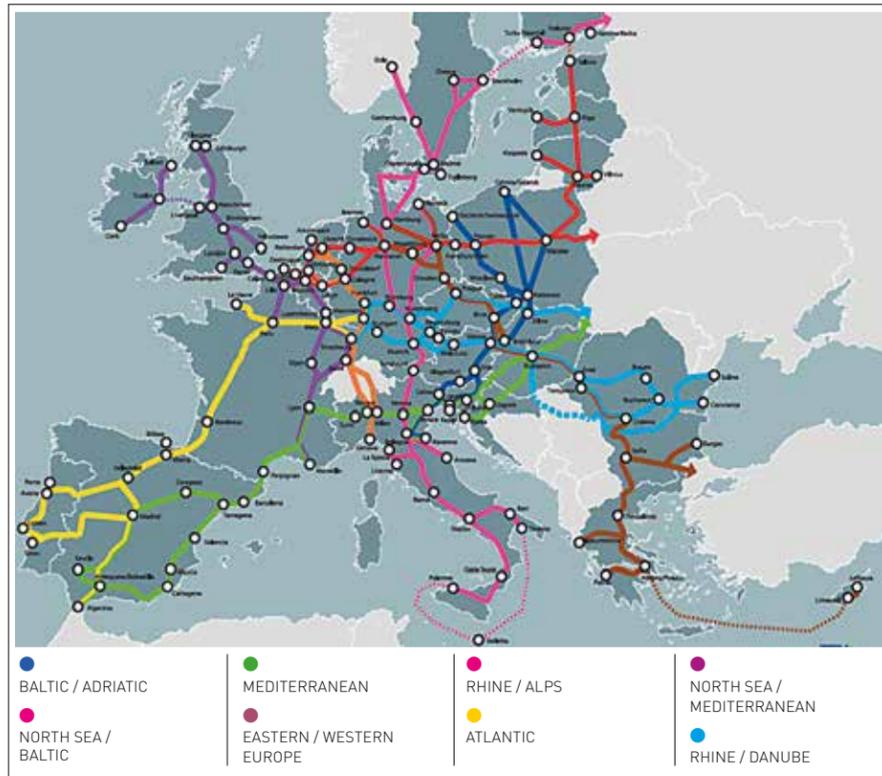
**As to the European** deployment Plan, it is not moving forward with the required speed specified in the TSI (Technical Specification for Interoperability) of the control-command and signalling, and the European Commission is imposing measures to get member States to comply with the established deployment plan, at least in the core nine European corridors. Apart from the TEN-T funds earmarked to the deployment of lines and vehicles in Europe, the Commission has launched an ERTMS Deployment Managers agreement that is expected to lead to the final consolidation of the ERTMS in Europe.<

At present, there are more than 68,000 kilometres of ERTMS tracks contracted in the world and over 90,000 vehicles. Exceeding all expectations, almost 43% of these investments are made outside Europe

# TRANSPORT THINKING

RAILWAYS | AVIATION | ROADS | URBAN TRANSPORT | PORTS

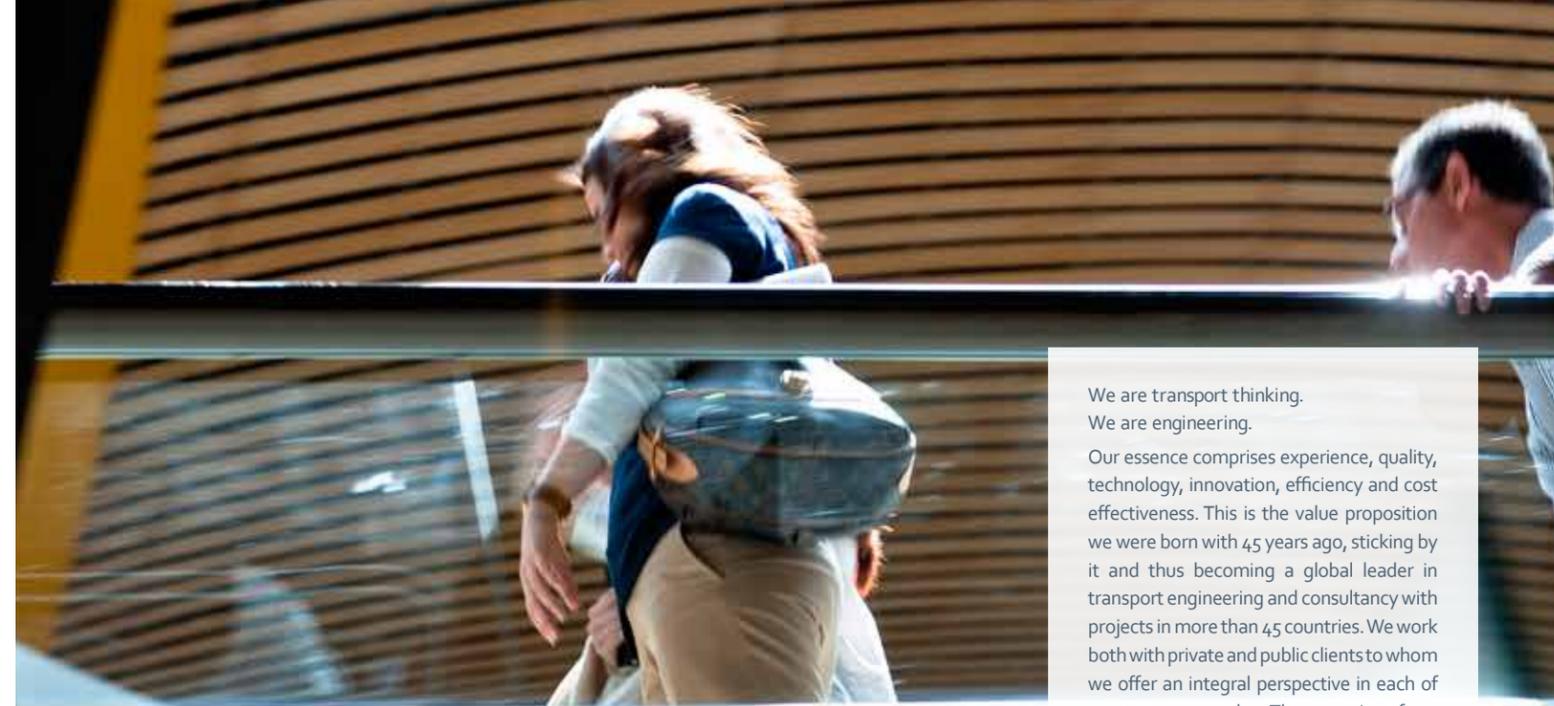
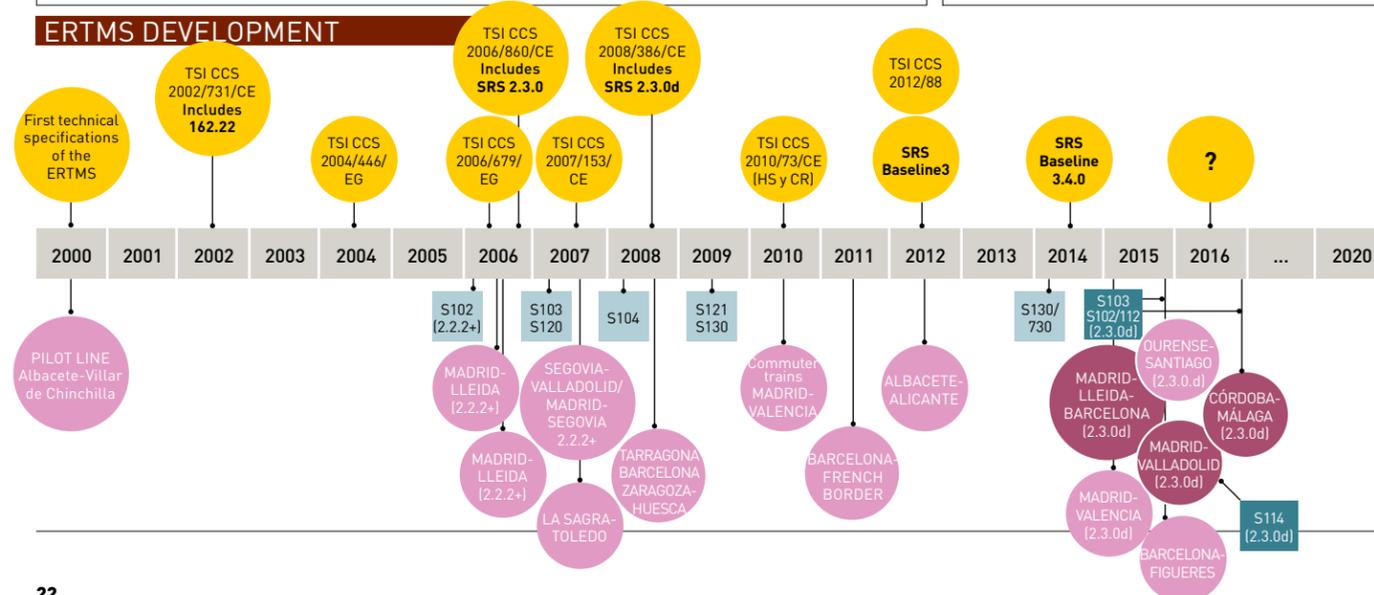
## EUROPEAN CORRIDORS



## SIGNIFICANT DATES

1994\_ The Spanish CEDEX is offered as laboratory for the demonstration of Railway Interoperability, a programme of the IV Framework Programme of the European Commission.  
 2000\_ The first European Directive related to Interoperability is signed.  
 2000\_ The pilot line Albacete-Villar de Chinchilla is equipped.  
 2006\_ The Madrid-Lleida line comes into service with the S102 train.  
 2008\_ MoU. The version 2.3.0d of the specifications is adopted, as the first reference legal version.  
 2010\_ ERTMS Level 1 comes into service in commuter lines in Madrid.  
 2012\_ MoU guaranteeing the compatibility of versions and approving the baseline 3.  
 2012\_ The Albacete-Alicante line comes into service; it is the first line equipped only with L2 and ASFA as back-up system.

## ERTMS DEVELOPMENT



We are transport thinking. We are engineering. Our essence comprises experience, quality, technology, innovation, efficiency and cost effectiveness. This is the value proposition we were born with 45 years ago, sticking by it and thus becoming a global leader in transport engineering and consultancy with projects in more than 45 countries. We work both with private and public clients to whom we offer an integral perspective in each of our transport modes. The expertise of our 2,500 professionals allows us to be what we are: transport at the service of society.



STRATEGIC MOBILITY PLAN, ECUADOR | AIRPORT EXPANSION PROJECT MANAGEMENT, KUWAIT | HS2 HIGH-SPEED, UK | HARAMAIN HIGH SPEED TRAIN MAKKAH-MADINAH, SAUDI ARABIA | MODERNISATION OF AIRPORT NETWORK AND REORGANISATION OF AIRSPACE, SPAIN | OPTM LINES, BRAZIL | HIGH SPEED RAIL NETWORK: INFRASTRUCTURES: SPAIN | HIGH SPEED RAIL NETWORK: TRAIN CONTROL SYSTEMS: SPAIN | SUPERVISING AGENT GUADALAJARA - COLIMA HIGHWAY, MEXICO | OPERATIONAL READINESS AND AIRPORT TRANSFER OF THE MTC OF ABU DHABI INTERNATIONAL AIRPORT

# AVE discovers the lands of Castile and León

The new line connecting Madrid and León in two hours is finished

With the collaboration of **Pedro Asegurado**, railway technician  
Photos: **Pablo Nieto**

**In 2015, AVE trains will be able to cross the high plains of Old Castile, travelling –in barely 65 minutes– the 166 kilometres that separate Valladolid, Palencia and León, three cities with more than 22 centuries of history.**

Like the main character of the stories of Spanish novelist, Miguel Delibes *Viejas historias de Castilla la Vieja* (Old stories from Old Castile), the high speed line will cross its fields in a short time “going around with its lordly bearings”. Without doubt, technology moves forward providing comfort and means for development, in this case, in an area of social and economic influence nowadays marked by the automotive, chemical, agricultural and wine industry, but also by its history, gastronomy and art.

Resident citizens and tourists, businessmen or students will be closer to the monumental cities of Valladolid, Palencia and León, and its wide and high plateaus that store up a cultural heritage influenced since the Middle Ages by the Romanesque

and Renaissance art, an extraordinary gastronomy, and a reference in the automotive and enotourism industrial sector: it is the only Spanish region with five protected designations of origin (Ribera del Duero, Cigales, Rueda, Toro and Wines from Tierra de León), thus offering some of the best white and red wines in the world.

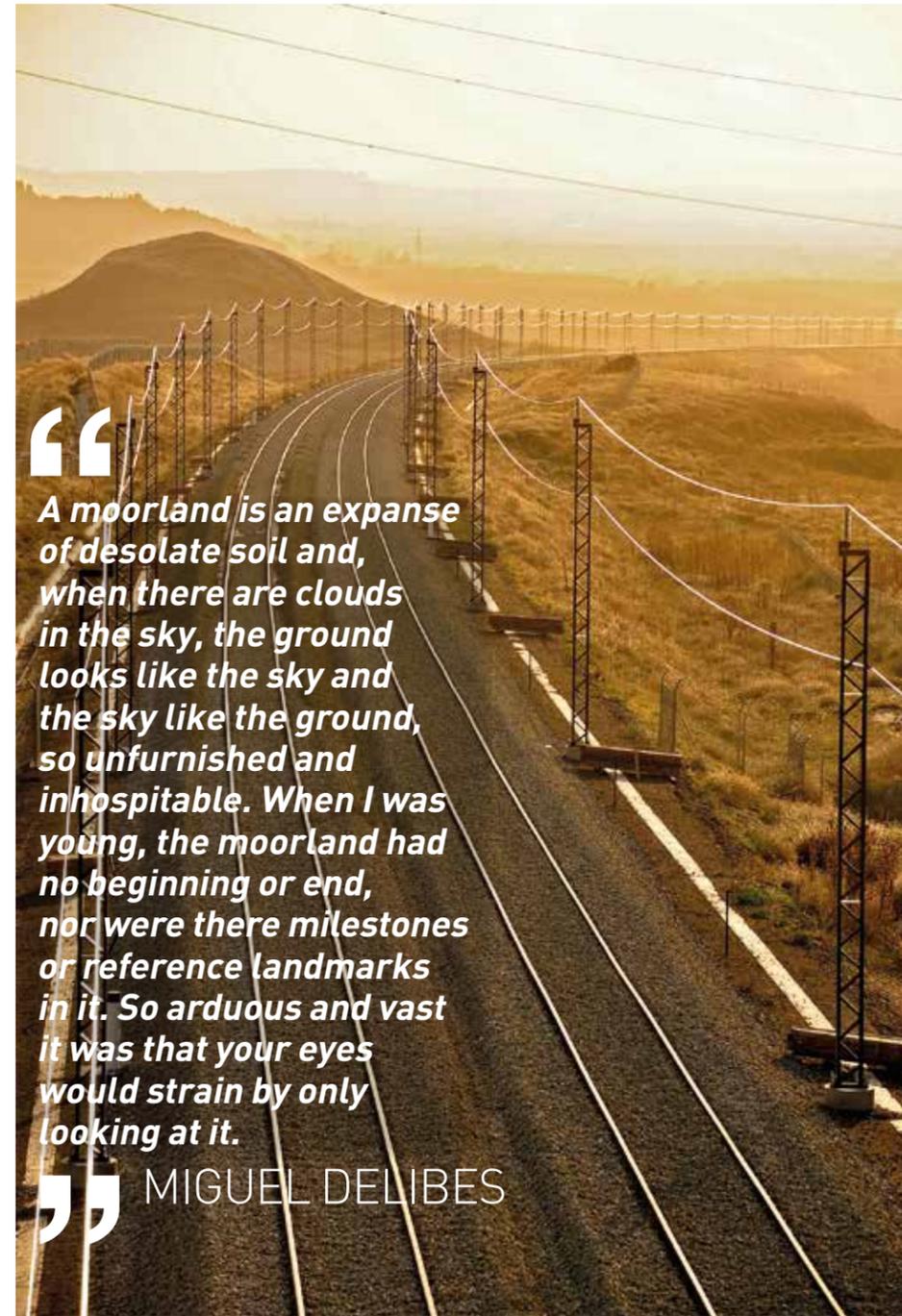
As indicated by Adif, the administrator of this infrastructure, “the construction of this line is aimed at ensuring continuity between the Madrid-Valladolid high speed line to the north and northwest, thus enabling connections to León, Asturias, Cantabria (through Palencia) and the Basque Country (through Venta de Baños). Apart from contributing to the socio-economic backbone of the Autonomous Community of Castile and León, it would substantially reduce travel time between Madrid and the Leonese capital.

### Traffic of travellers

The line is designed to passenger traffic, with international gauge (1,435 mm) and electrified with a voltage of 2x25 kV. Unlike the alignment of the North-Northwest corridor lines (León-Asturias and Ourense-

Santiago) so limited by the abrupt orography of the land, this line travels through the Castilian-Leonese high and plain lands, running between Valladolid and Palencia parallel to the Castile Channel, an hydraulic engineering work built in the 18th century. With few requirements of specific structures, it is worth mentioning the viaducts over the rivers Pisuerga (1,309 m), Esla (660 m), the Torneros pergola, and the Peña Rayada tunnel (1,998 m).

The works of the platform of Venta de Baños-Palencia-León stretch have been financed by the European Regional Development Fund (ERDF) through the 2007-2013 Castile and León Operational Programme, with a contribution of 102.7 million euros. Besides, it has received a contribution of 19.8 million euros from the TEN-T (Trans-European Transport Networks) for studies, projects and platform works of the Valladolid-Venta de Baños stretch. Besides, the line will have variable gauge changeover facilities, which would allow connecting the Valladolid-León high speed lines with the conventional gauge railway lines of Palencia-A Coruña and León-Gijón, including the Pajares tunnel.«



“*A moorland is an expanse of desolate soil and, when there are clouds in the sky, the ground looks like the sky and the sky like the ground, so unfurnished and inhospitable. When I was young, the moorland had no beginning or end, nor were there milestones or reference landmarks in it. So arduous and vast it was that your eyes would strain by only looking at it.*”

” MIGUEL DELIBES



### VALLADOLID

Once the capital of the Spanish empire in the 17th century, it has an old town where palaces, Renaissance courtyards, noble houses, churches, squares and parks are combined with residential buildings and commercial areas, along with a highly valuable museum heritage. With nearly half a million of inhabitants, the city has great industrial, commercial and university activity. The automotive sector is noteworthy –represented by Fasa-Renault– and its auxiliary industry, followed by that of food and agriculture processing and the metallurgical industry, being the administrative referent of the Autonomous Community.



### GRAPHIC OF THE ALIGNMENT



# According to Adif, the goal of building this line is to ensure continuity between the Madrid-Valladolid line to the north and northwest, thus enabling connections to León, Asturias, Cantabria and the Basque Country

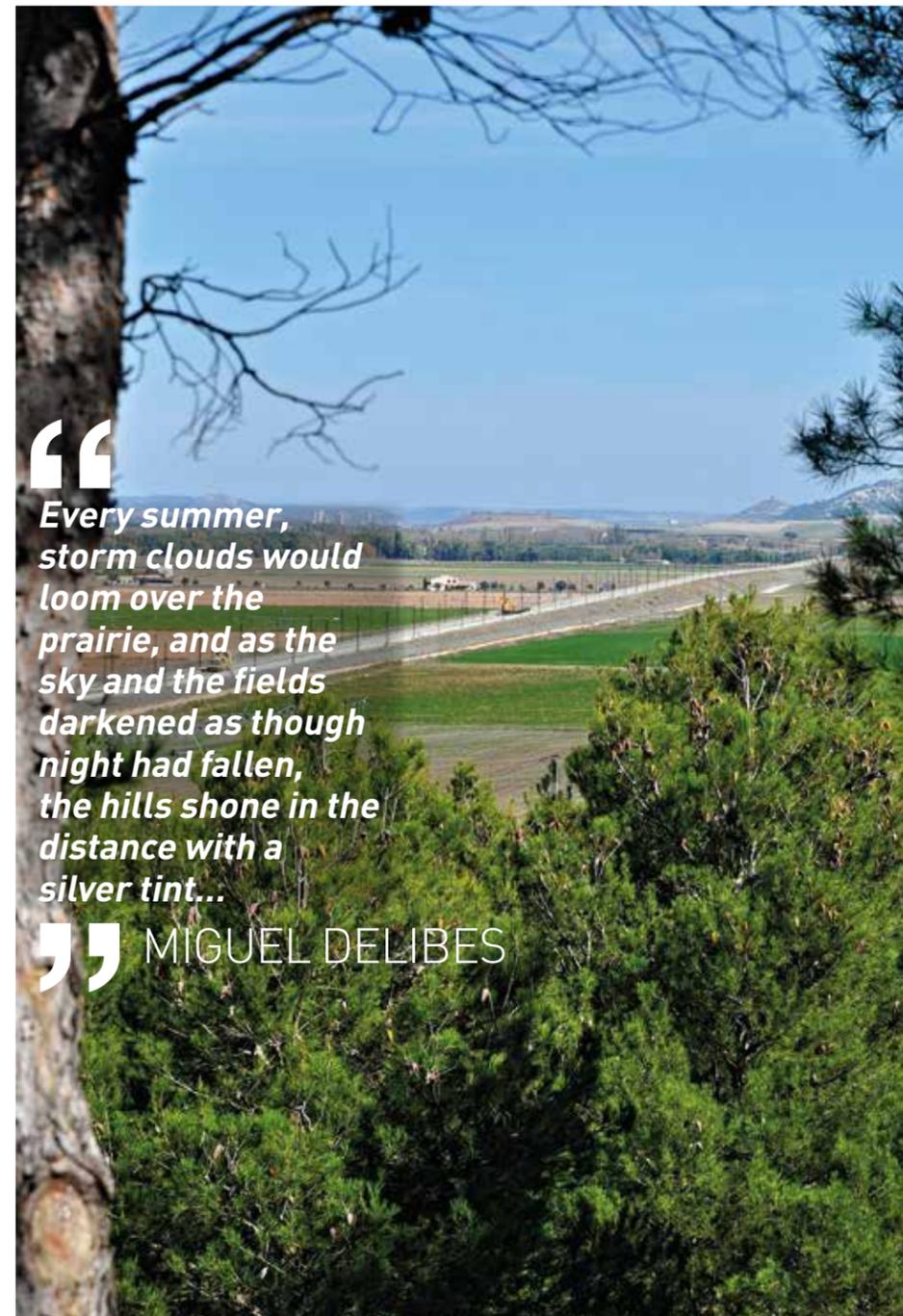
## Ineco's works

Ineco has been providing Adif with technical assistance since the beginning of the project. It has thus collaborated in the previous studies of the Villada HS maintenance base, in acoustic and vibration studies, track duplication projects in the access to Campo Grande station and the access to Integria workshop in Valladolid and to León station, where it has also carried out services for the management of the citizen information and service office.

Later on, the company provided Adif with technical assistance in the track assembly, switch assembly, signalling and communication installations, energy supply and catenary; and the regulation and management of train traffic processes and tests.

The company has also collaborated in the follow-up of the works with the SIOS system. In all, a team of more than 50 professionals from Ineco have worked since late 2010 in the construction of this new railway milestone.

MAIN DATA	KEY POINTS OF THE ALIGNMENT
<ul style="list-style-type: none"> <li>172.7 kilometres (HS alignment plus the north bypass of the Valladolid railway complex).</li> <li>Three stations: Valladolid-Campo Grande, Palencia and León.</li> <li>Line fit for passenger traffic.</li> <li>Platform width: 14 metres.</li> <li>Speed limit: 350 km/h.</li> <li>ASFA and ERTMS signalling system.</li> <li>Mobile communication system: GSM-R.</li> <li>Electric line 2x25 kV/alternating current.</li> <li>More than 30 switches.</li> </ul>	<p><b>NORTH JUNCTION</b>_The Valladolid exit and its connection to the new railway complex has a three-rail stretch and access to the Renfe Integria workshop.</p> <p><b>VENTA DE BAÑOS JUNCTION</b>_This junction is important due to the track bifurcation connecting Burgos, the Basque "Y" and the route to León through Palencia.</p> <p><b>VARIABLE GAUGE CHANGEOVER FACILITY IN PALENCIA</b>_This facility acts as the inflection point with high speed lines for trains running to/from Santander.</p> <p><b>TWO VARIABLE GAUGE CHANGEOVER FACILITIES IN LEÓN</b>_One of them will enable passing from high speed to the conventional network towards Galicia without entering the city, and the other will be used for trains going to Asturias.</p>

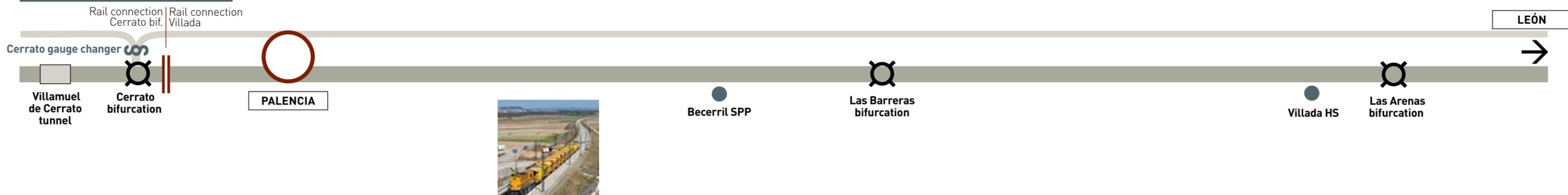


“  
*Every summer, storm clouds would loom over the prairie, and as the sky and the fields darkened as though night had fallen, the hills shone in the distance with a silver tint...*  
 ” MIGUEL DELIBES

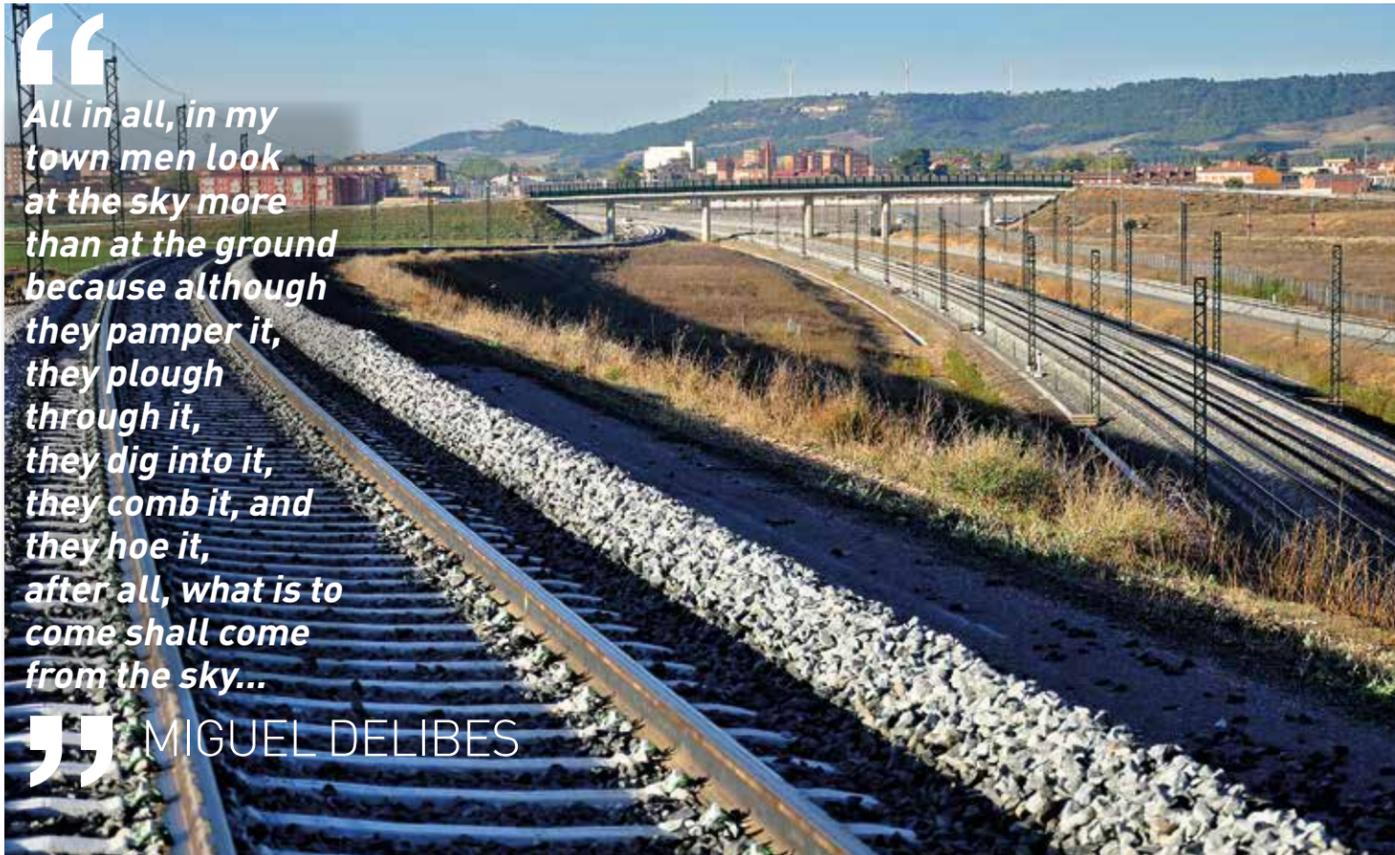


**PALENCIA**  
 Capital of the province with the greatest concentration of Romanesque churches in all Europe, highlighted by its inclination towards conservation and clean energy, with several actions aimed at improving sustainability. The city has dozens of green areas, pedestrian areas, bicycle lanes, etc., and promotes initiatives to improve water and waste management. Along with the automotive and chemical industry, Palencia has an agricultural sector that has inherited the flour and sugar industry of past centuries.

## GRAPHIC OF THE ALIGNMENT



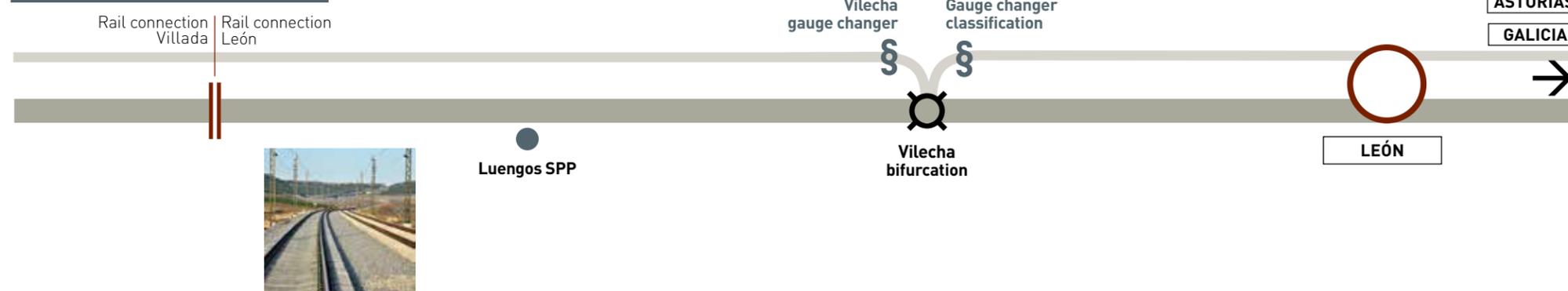
**Ineco has been providing Adif with technical assistance since the beginning of the project. In all, a team of more than 50 professionals from Ineco have worked since late 2010 in the construction of this new railway milestone**



“  
All in all, in my town men look at the sky more than at the ground because although they pamper it, they plough through it, they dig into it, they comb it, and they hoe it, after all, what is to come shall come from the sky...”

” MIGUEL DELIBES

**GRAPHIC OF THE ALIGNMENT**



**LEÓN**

Its quality of life is closely linked to the integration of modern services into the city, adding value to its architectural heritage, which includes one of Europe's most beautiful Gothic cathedrals. Innovation and technological development, driven by the support of the university, have been promoted with the implementation of several technological centres and with the arrival of important companies of the sector, such as Hewlett-Packard, SAP, Televent or Indra, as well as of the chemical and pharmaceutical sector.

**Juan Miguel Sastre Herranz**

Expert in railway operations



**A good opportunity for reflection**

In Spain, the conventional railway network has experienced chronic deprivations since its beginnings more than 150 years ago, among them, being conceived as a radial network intended to facilitate the communication to/from Madrid with almost all the capitals of the province, neglecting the communication between peripheral cities in general, which does not really match the distribution of the population throughout our geography.

The arrival of high speed in Spain, at first in an isolated manner with the Madrid-Seville line, and since then, making progress as a brand-new network, has meant an inflection point in the way citizens use railway transport and also in the way they perceive the system, going from an unstoppable succession of annual falls in market share to peaks of travellers never seen before.

**It has also changed, in a very positive way,** the overall perception that the general population has of railway transport, which is today highly appreciated, specially those services that offer an added value, as opposed to other means of transport, such as commuter services in very populated urban areas or high speed services in general.

An analysis of this network, of considerable length, reveals that, as it happens with the conventional network, it displays a marked radial nature. The stretches of the new high-performance lines that will soon be in operation will enable communication with less populated geographical areas that major lines normally do not reach, with lower traffic expectations than the latter. They are being built with simpler settings, thus enabling important economic savings. However, to prevent this design from becoming an important shortcoming in the future, it would be necessary to take some actions into account to be able to turn railway transport into an authentic backbone axis of mobility among all territories.

**In this regard, it is worth mentioning the importance of joining,** by quadruplicating the Torrejón de Velasco-Madrid track and the Atocha-Chamartín tunnel, the high speed line network currently connecting Madrid with Catalunya, Levante and Andalucía, with that connecting Madrid with Castile and León, entailing a great impact for the services connecting Madrid with Galicia, Asturias, Cantabria and Euskadi. In addition, it is worth reviewing the functionality of a junction among lines to enhance their permeability, thus facilitating the creation of direct services between peripheral ends, and it is worth considering improving the supplementation among means of transport, to bring the high speed network closer to airports with long and medium-radius destinations by means of junctions functionally suitable, so that it does not entail a drawback in terms of travel time for the rest of train users.

# The European club of efficient airports

Ineco participates in the CDM rating of Madrid and Barcelona airports

With the collaboration of José María Berdoy, aeronautical engineer



Adolfo Suárez Madrid-Barajas airport / MAD.

PHOTO: AENA



Barcelona-El Prat / BCN airport.

PHOTO: AENA

With Barcelona-El Prat and Madrid-Barajas, there are already 13 European airports which are part of a select club called Full CDM.

Managers of Eurocontrol, which centralises European air operations management, have named Full CDM (Collaborative Decision Making) the capability of its airports to perform and share a thorough and real-time follow-up of all aircraft movements in the ground and in the airport surroundings. In short, an action plan to improve capacity, efficiency and safety of airports in Europe. In all, the largest airports of twelve cities, two of them in Spain, and those of Munich, Brussels, Paris-Charles de Gaulle, Frankfurt, Helsinki, London-Heathrow, Düsseldorf, Zurich, Oslo, Rome-Fiumicino and Berlin-Schönefeld have obtained this rating, the purpose of which is to improve airport capacity to absorb and manage air traffic, which largely depends on airfield and runway features, and on the design of ground operations. In the case of runways,

the capacity corresponds to the maximum number of aircraft take-offs and landings, taking into account the physical limitations which affect safety, such as turbulence generated in the trails left by airplanes in said manoeuvres. Likewise, airfield design (taxiways, aprons, etc.) of airport infrastructure and its management also decisively influence the efficiency of operations and the capacity to manage airport traffic.

### Traffic evolution forecasts

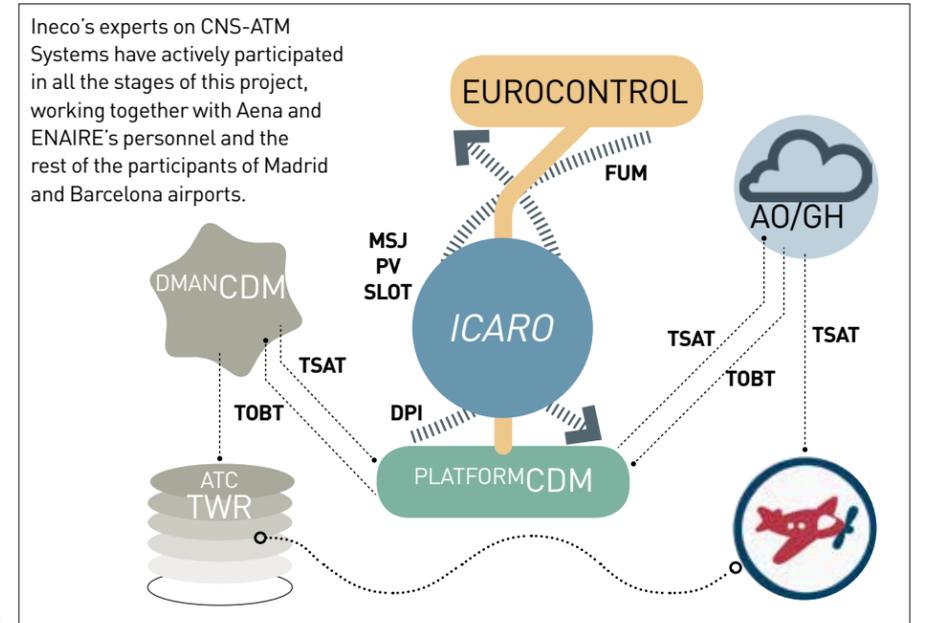
Although the current economic crisis may delay forecasts, a survey conducted in 2007 by the European Commission showed that, according to traffic evolution forecasts in Europe, the difference between capacity and air traffic demand would increase in such a way that "more than 60 European airports will find themselves in a heavily congested situation and the 20 largest airports will be saturated at least 8-10 hours per day by 2025." The report concluded that "this congestion would probably have a serious impact in the capacity of aircraft opera-

tors to respect their schedules, specially in large airports which distribute traffic (hubs) and would undermine the efficiency of the European air transport sector. Congestion will also generate environmental and safety-related costs, as the density and complexity of operations will reach an unprecedented level."

The need of a more efficient use of existing runways and of seeking more sustainable solutions from an environmental point of view led to the creation, among other initiatives, of the CDM (Collaborative Decision Making) project. This tool is meant to improve the efficiency of air operations by treating the aircraft land turnaround process based on the premise of sharing information of arriving and departing flight operations among the different stakeholders (handling, air traffic control, air companies and airport). This information is shared and processed to make it more accurate and complete. This is done to articulate measures which would reduce waiting time and accomplish more operating efficiency.<

## CDM coming-into-service

Aena and ENAIRE, together with INECO, have successfully completed the coming-into-service of this new version of 'CDM systems' at Madrid-Barajas and Barcelona-El Prat airports, which has involved changes in the systems it develops, specifically in the Aeronautical and Weather Information Management System (ICARO) and the automated Air Traffic Control System (SACTA). SACTA shares Air Traffic Control information with the systems that allow management of the aircraft parking apron, receiving TOBTs (target time to remove aircraft wheel props on departure) and publishing information on the TSATs (target time to start engines). On the other hand, ICARO provides the CDM platform with messages related to the flight plan, SLOT (foreseen time for take-off) messages and flight progress messages, FUM (Flight Update Information), and receives from the platform the messages which give information about the scheduled and real take-off time, DPI (Departure Planning Information), which are forwarded to Eurocontrol.<



### CDM implementation process

- Sharing information through a common repository called CDM platform with accuracy and punctuality.
- Managing aircraft taxing times in a flexible way, which vary according to operating needs.
- Improving take-off sequence.
- Improving efficiency in the European air network.

# In the land of the condor

## Ineco supervises the road enlargement Pifo-Papallacta and other six works

By *itransporte*, with the collaboration of Miguel Vila, civil engineer

**Ineco is supervising a total of seven road works in Ecuador, among which the enlargement of the section between Pifo, to the east of Quito, and Papallacta, stands out. This road is essential for the transport of supplies to oil-producing areas in the Amazon region, also rich in natural heritage, including the condor, the national emblem.**

**F**or the Republic of Ecuador, having wide, modern and safe roads is a matter of State importance: more than 63% of total foreseen investment until 2037 is earmarked for this chapter. To date, the renovation, enlargement or construction of some of the main roads, such as those connecting the ports of Esmeraldas and Guayaquil with the capital, Quito, or the bypass so called 'Ruta Collas', for example, already show vital improvements such as having reduced by half the time of goods transport or the time to access the new airport opened in 2012.

Within this context, the Ministry of Transport and Public Works (MTO) tendered in 2013 a total of seven road works spread throughout different locations of the country, which were awarded to the company China Road and Bridge Corporation. Later on, Ineco undertook the monitoring of the seven works batches (some of them already started). These tasks mainly

*To date, the renovation, enlargement or construction of some of the main roads already show major improvements*

consist in controlling the strict compliance with the builders' contract terms and agreed-upon execution terms, as well as environmental and safety regulations; ensuring technical quality both of materials and executed works, and informing all this to the Ministry on a regular basis.«



Road in Huigra. [7]



Enlargement Quito Avenue (Agrido Lake). [4]



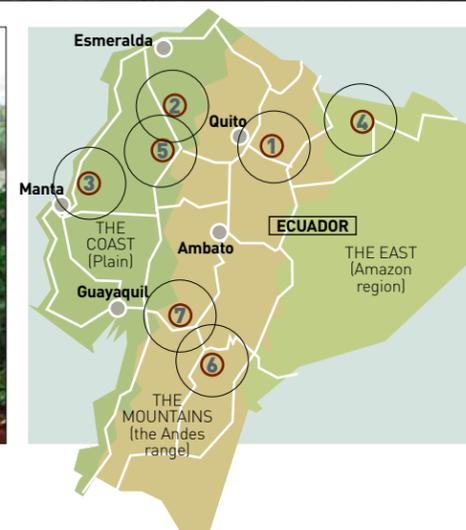
San Vicente Street. [3]



Pifo-Papallacta road. [1]



Bridge in Santo Domingo de los Tsáchilas. [5]



### Works supervised

- 1** Enlargement of road Pifo-Papallacta (provinces of Pichincha and Napo)
- 2** Execution of five bridges in the road between Puerto Quito and La Sexta, province of Pichincha
- 3** Road surfacing of boardwalk and downtown streets in the city of San Vicente, province of Manabí
- 4** Enlargement of Quito Avenue in Agrido Lake, province of Sucumbíos.
- 5** Construction of the bridges and sewers of the rural road ring in the province of Santo Domingo de los Tsáchilas: bridges Carre, Candelo, Congoma, La Chiva, Pupusa, Guanape, Salgana and Sandima; Sewers Guinchipe and Naranjo
- 6** Refurbishment of the road Delég-Surampalti-Bayandel, province of Cañar
- 7** Refurbishment of road Huigra-Piedrero, province of Chimborazo



Papallacta river. [1]

### Ineco in Ecuador

Among the most recent works, the following are worth highlighting:

- PEM, Strategic Mobility and Transport Plan.
- PEM's office: technical studies and advice for the concession of high-capacity roads.
- Ecuador's National Water Plan. Technical, legal and financial structuring of turning the section of E-25 between

Siete river and 'Y' of Tillales in the province of El Oro into highway.

- Preliminary design studies of Santo Domingo-Quevedo and Quevedo-Babahoyo and support to technical, legal and financial structuring of concession model.
- Drafting of final design of phase I of the new multi-purpose terminal of Manta port. Completed, in approval stage by MTO.

# Among all the works, the most emblematic is the enlargement to four lanes of the West-East road corridor that joins the towns of Pifo, to the east of Quito, with Papallacta

## ALL THE WORKS

### PIFO-PAPALLACTA CORRIDOR

Among them, the most emblematic project is the enlargement to four lanes (two in each direction) of the West-East road corridor that joins the town of Pifo, to the east of Quito, with Papallacta. The section, measuring 36.4 kilometres long, is part of the minor track E-28, which measures 187 kilometres long. It connects two important roads: Transverse Central (E20) in the city of La Independencia, with the Amazonian major road (E45), in the city of Baeza. Apart from the enlargement, these works include the construction of a three-metre wide bike lane (cycleway), and a new bridge over Tambo River.

These works, apart from multiplying the section's capacity, intend to completely renew the pavement, deteriorated by the passing of more than 3,000 vehicles per day, improve signalling, and reduce accidents. The corridor runs between the provinces of Pichincha and Napo, and it is of strategic importance since it is a key access road to the country's main oil-producing area. In addition, it joins the E-35 (Tambillo-Pifo-Tababela) from Pifo, which in turn forms part of the road system of the new Mariscal Sucre airport, northwest from the capital. In this end of the section, the city of Papallacta, next



to the natural reserve Cayambe-Coca, is located in an area of great tourist importance due to the richness of its natural heritage. Papallacta's hot springs take advantage of the volcanic-origin springs and the whole area is privileged for bird observation, which include the Andean condor, the Republic of Ecuador's national emblem. Ecuador's Ministry of Environment estimates that the wild population of this threatened



Bridge in Puerto Quito.

species is of about 50 throughout the country.

### REFURBISHMENT OF THE LEÓNIDAS VEGA BOARDWALK AND ROAD SURFACING OF SEVERAL DOWNTOWN STREETS

**SAN VICENTE, PROVINCE OF MANABÍ**  
It relates to an urban planning project in this coastal city affecting 12 streets surrounded by houses, a square and a beach, all of them deteriorated by the

continuous passing of vehicles. In all, the works comprise 9.29 kilometres long. Sewers and drinking water systems have also been renewed.

### CONSTRUCTION OF THE BRIDGES AND SEWERS OF THE RURAL ROAD RING

**PROVINCE OF SANTO DOMINGO DE LOS TSÁCHILAS**  
According to MTOP, this work will benefit more than 30,000 inhabitants

of the municipalities of Nuevos Israel, Los Naranjos, Puerto Limón, and Luz de América, which are mostly engaged in agricultural, livestock, commercial and tourism activities. The works consist in building the bridges Carre, Candelo, Congoma, La Chiva, Pupusa, Guanape, Salgana and Sandima; and the Guinchipe and Naranjo sewers.

### EXECUTION OF FIVE BRIDGES IN THE PUERTO QUITO-LA SEXTA ROAD

**PROVINCE OF PICHINCHA**  
It is related to those of Sabalo, Peligro, Silencio, Agua Sucia and Palestina. They all display roadway narrowing, which makes them dangerous for circulation. The works will enable their renovation and enlargement, which will entail an improvement in road safety.

### ENLARGEMENT OF QUITO AVENUE

**AGRIO LAKE, PROVINCE OF SUCUMBÍOS**  
The scope of these works comprises the enlargement of Quito Avenue, the main access to the city. The locality, named after the first oil well dug in the area in late 60s, is the capital of the country's main oil-producing area and the gateway to the Amazon region. It is also known as 'Nueva Loja' due to the number of inhabitants from Loja living in the south, who settled in the region when oil production began. The presence of the oil pipe system limits the execution of the works, since it entails certain construction restrictions.

## Ecuador's development, with an economy that has almost had a 5% annual growth since 2010, is related to the construction of transport infrastructures interconnecting the whole territory efficiently

### REFURBISHMENT OF THE DELÉG-SURAMPALTI-BAYANDEL ROAD PROVINCE OF CAÑAR

This work consists in asphaltting, constructing pavements and enlarging the roadway of a 7.4-kilometre road in this rural area, affected by high emigration rates. The work is part of a group of works of the MTOP (not included in the project) in the province of Cañar, which entail the refurbishment of more than 290 kilometres of roads for population exceeding 220,000 inhabitants, mostly devoted to agricultural and livestock activities.



### RENOVATION OF THE HUIGRA-PIEDRERO ROAD PROVINCE OF CHIMBORAZO

This road has a length of 74.5 kilometres, out of which the first 40 comprise mountainous terrains, and a width that stands between 7 and 9 metres. It often suffers land displacements in winter.«

### A country undergoing transformation

Ecuador's development, with an economy that has almost had a 5% annual growth since 2010, is related to the construction of certain transport infrastructures interconnecting the whole territory efficiently. Ecuadorian roads are classified in three categories: national (divided in turn into primary or 'major' and secondary or 'minor'), provincial and municipal (or 'cantonal'). Although the existing national road system, comprising 13,500 kilometres, provides services to 82% of the population, the goal is to cover the connecting lagoons between the three big regions of the territory: the coastal plain (the "coast"), the central area occupied by the Andes range (the "mountains"), and the Amazon region (the "East") rich with natural resources, specially oil, which in 2013 accounted for almost 54% of exports, according to the Central Bank of Ecuador's data.

As to roads, the goal is obtaining a 2,300 kilometres network of long-distance motorways and another 550 kilometres of urban and "suburban" highways. It is thus included in the Strategic Mobility Plan (PEM), prepared by Ineco for the MTOP, which in the current institutional framework is the body centralizing and coordinating planning that was previously divided into regional and local administrations. Submitted in 2013, the document describes the development of ports, airports,

roads and logistic areas as a basis to consolidate a structural transformation of the country's economy and society (see *itransporte* 48). For that, the Ecuadorian State has managed to increase its revenues by fighting tax evasion and renegotiating the Governments' contracts with oil companies. Most of these financial resources have been earmarked to programmes, infrastructures and sanitary, educational, energy and transport equipment, thus multiplying public investments from 829 million dollars in 2006 to 8.5 billion dollars in 2013.

A transformation that the current Government, in its second term in the administration, has been promoting since 2007 and which has been confirmed by international organisations: the World Bank highlighted that, in April 2014, poverty in Ecuador (measured by income) has dropped from 37.6% to 25.5% between 2006 and 2013, whereas the middle class has grown from 20% to 26%. In addition, the World Economic Forum accredits its development in its Global Competitiveness Report 2013-2014, prepared having surveyed citizens of 171 countries: the most notable improvements are in the fields of education, innovation and, precisely, in transport infrastructure, which all in all shows that Ecuador moved 15 positions in the ranking as compared to its previous position (it went from 86 to 71).«

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# Single-track twins

## Ineco is leading the works of La Canda twin tunnels

By Roberto Vilchez, civil engineer, work director



1\_Entrance tunnel mouth  
 2\_Exit tunnel mouth  
 3\_GAI 2 tunnel mouth

These tunnels are the keys to reaching Galicia via high speed. Ineco leads the works of La Canda tunnels, in the Lubián-Ourense stretch. These are two twin structures which are over seven kilometres long, single-tracked and connected with each other through a network of galleries.

The complex Galician orography and the natural barriers separating it from the plateau have historically conditioned the railway alignment in such a way that the region did not have a direct connection to Madrid until 1958. The high speed line that the Ministry of Public Works is building through Adif will enable a complete transformation in terms of travel times between the Galician Community and the plateau. It is designed for a maximum speed of 350 km/hour and

*The high speed line that Adif is currently building will enable a complete transformation in terms of travel time between Galicia and the plateau*

by the end of 2011 the stretch between Ourense, Santiago de Compostela and A Coruña came into service (see *itransporte* 44). The new access to Galicia starts in the junction of the Madrid-Valladolid line, in Olmedo, and ends in Santiago de Compostela, where it will be linked to another big railway structure, the Atlantic Axis, which will run from north to south along the Galician coast.



High speed line Zamora-Lubián-Ourense  
 Cavern belonging to La Canda tunnel  
 (left track), in the province of Zamora.

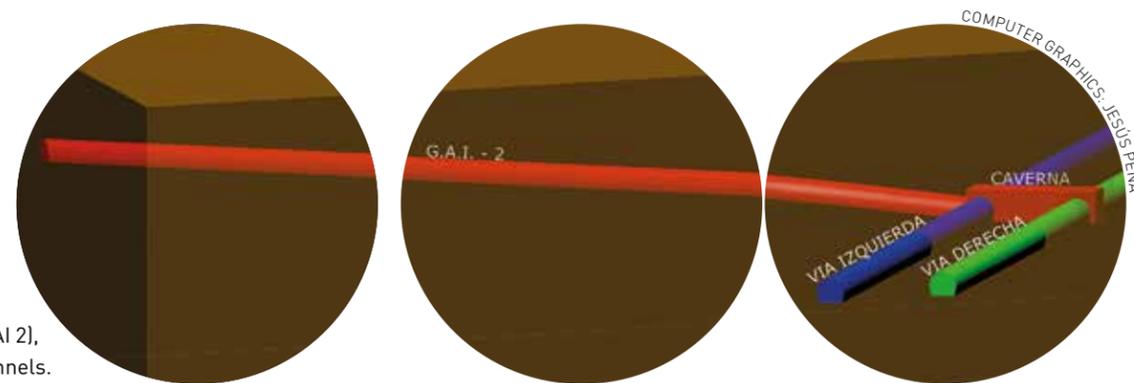
From the five stretches of the alignment comprising 434.8 kilometres in total, the most complex one from the orographic and geotechnical standpoint is that located in the entrance to Galicia: its 101.7 kilometres are between Lubián, Zamora and Ourense. Tunnels, 18 in total, were the choice to make the high-speed-specific alignment requirements compatible with the area's complicated orography. The main peculiarity that distinguishes this stretch from the rest of the line is that 77.8 kilometres out of the 100 kilometres of total length are built with two parallel single tracks with independent platform contracts. This is why the longest tunnels are bi-tube (one tube for each track). Ineco, which has collaborated with Adif in other points of the line, is also in charge of the construction works management of La Canda tunnels, located in the municipalities of Lubián and A Mezquita. They are two single-track twin tunnels that run parallel and will be connected to each other by 18 connection galleries and four installation galleries. In the entrance and exit tunnel mouths of both tunnels, artificial tunnels shall be built.



PHOTO: IGNACIO QUESADA

Performance of night works in working gallery nº 2 (GAI 2).

# The New Austrian Tunnelling Method (NATM) consists in excavating and, immediately after that, constructing a flexible support



3D view of the whole working gallery nº 2 (GAI 2), the cavern and the twin tunnels.



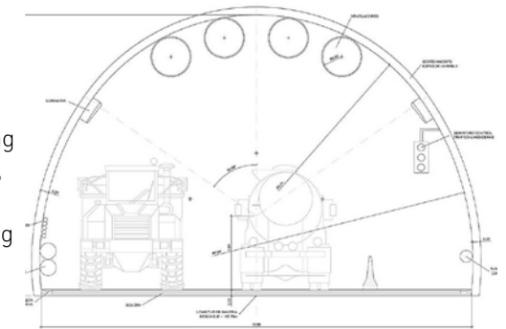
The cavern is located in the intersection of the main two tunnels.

PHOTO: IGNACIO QUESADA

## Building procedure: New Austrian Method

The construction of the tunnels is being carried out with conventional methods, that is to say, without using tunnel boring machines, and in concrete, using the New Austrian Tunnelling Method (NATM). It consists in excavating and, immediately after that, building a flexible support. The choice to excavate with explosives or with machinery is defined in each case, depending on the geotechnical quality of the rock excavated in each area.

Subsequently, impermeability and drainage works will be performed. According to the construction method used, which entails that the massif itself and the support should be sufficient to provide the cavern with stability, a continuous final concrete formwork lining shall be executed. The structural



GAI 2 tunnel section.

building projects, an intermediate working gallery ending in a cavern, located in the intersection of the two main tunnels, is projected to be built with the New Austrian Method. Therefore, two new areas of work were opened in each of the tunnels (one Ourense-bound and another Zamora-bound). Both works share the use of these galleries.

**In the case of intermediate working gallery nº 2 (GAI 2),** access is gained from N-525 road before the crossing below A-52 highway, within the municipality of Lubián (Zamora). It is 749.9 metres long and the profile has a maximum slope of 12%, needed to bridge the 90-metre unevenness, which is the difference in levels between the tunnel mouth platforms and the cavern. A platform has been built at the entrance, which is used as an area of auxiliary facilities.

On the other hand, to provide continuity and avoid the storing of possible subsoil water surfacing in the gallery, a release and drainage system that connects with the tunnel's main collector has been projected.«

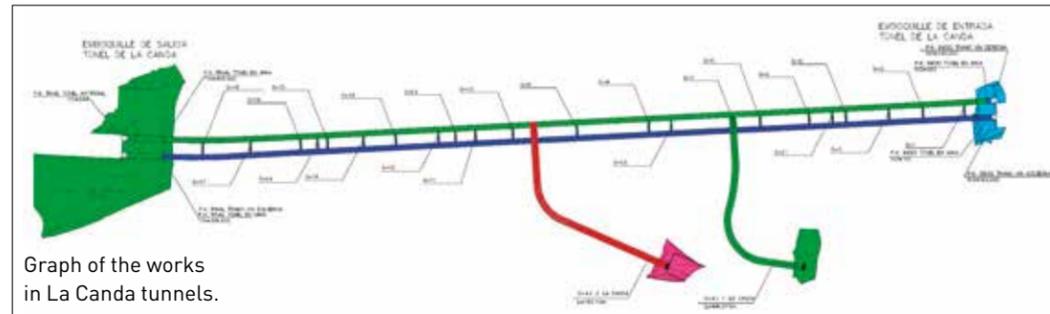
*The construction of the tunnels is being carried out with conventional methods, that is to say, without using tunnel boring machines*

purpose of this lining is to increase the security reached by means of the support to prevent the excavation from collapsing and to improve the tunnel service conditions (aerodynamics, ventilation, setting of services, etc.).

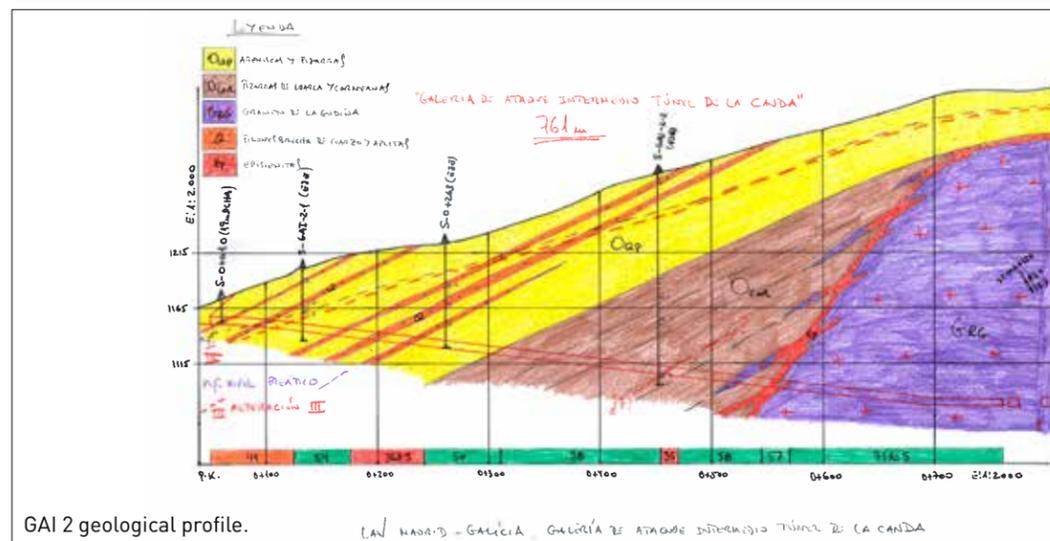
The construction of each tunnel is carried out from the related entrance and exit tunnel mouths. However, and with the aim of optimizing the deadlines of each of the

### Technical characteristics

	LA CANDA TUNNEL right track	LA CANDA TUNNEL left track
<b>Total length</b>	7,412 metres in the right track and 250.5 in the left track	7,244.5 metres in the right track and 33 in the left track
<b>Single-track tunnel</b>	7,201.5 metres long and 52 m <sup>2</sup> of useful section	7,206.5 metres long and 52 m <sup>2</sup> of useful section
<b>Intermediate working gallery</b>	One, 449 metres long in total and 88 m <sup>2</sup> of useful section	One, 711 metres long in total and 88 m <sup>2</sup> of useful section
<b>Connection galleries</b> (the project only includes building half the length of each of them)	18 connection galleries between twin tunnels and four installation galleries	17 connection galleries between twin tunnels and four installation galleries
<b>Two false tunnels</b>	At the exit on the west side, both in the right and the left track, with 79.5 metres each	At the entrance on the east side; in the right track (20 metres) and on the left (18 metres)
<b>Open-air platform stretch</b>	One per track, related to the joint tunnel mouth of the exit of the tunnels	
<b>Others</b>	Auxiliary installations, access roads, spillways, drainage, environmental integration, easement replacements, and affected services.	
<b>Track typology</b>	Slab track	



Graph of the works in La Canda tunnels.



GAI 2 geological profile.

## From a drone's eye view

### Ineco tests a drone to inspect railway tracks in Granada

The region of Andalusia, in the south of Spain, is the area that has been selected to study solutions to the impact caused by wind-blown sand and dust in suspension, high temperatures and thermal gradients in railway lines. Tests are comprised within Arid Lap project, an initiative launched by a consortium included in the Feder-Interconecta Andalusia 2013 programme, the goal of which is to minimise the risks caused by extreme climatic conditions on high-performance railway infrastructures located in arid regions. The project has received funding from the CDTI (Centre for

Industrial Technological Development), and is supported by the Ministry of Economy and the Innovation and Development Agency of Andalusia (IDEA).

Among the technologies used, the employ of drones or remotely piloted aircraft systems (RPAS) and the application of commercial satellites to the support and maintenance of infrastructure are considered.

The companies involved in this consortium along with Ineco are Adif, Elecnor Deimos, Inabensa, Nervados, OHL and Win Inertia. Other collaborating entities are: the universities of Granada, Madrid (UCM

and Seville, the Experimental Station of Arid Zones of the CSIC (Spanish National Research Council), Andalusian Association for Research & Industrial Cooperation and Andalusia's Foundation for the Aerospace Development.

On the other hand, Ineco is currently working on the innovation project *Microdrones for inspection of structures*, a study on the use of small RPAS (Remotely Piloted Aircraft System), which can be equipped with video recording systems. In this way it is possible to reach areas of difficult access in the inspections of infrastructures. «

Ineco's civil engineers David Oliver and Alejandro Martínez during the tests performed on the old railway

track connecting Alquife mines (Granada), with a RPAS helicopter of the company FADA-CATEC.



PHOTO: MANUEL JOSÉ LATORRE

## Covers under cover

### Ineco is developing new applications of two-dimensional flow models

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

**Two-dimensional flow models allow simulating precipitation on the covers of stations, airport terminals and other specific buildings. Ineco has studied the drainage system of the cover of the terminal building of Bilbao airport using this technology.**

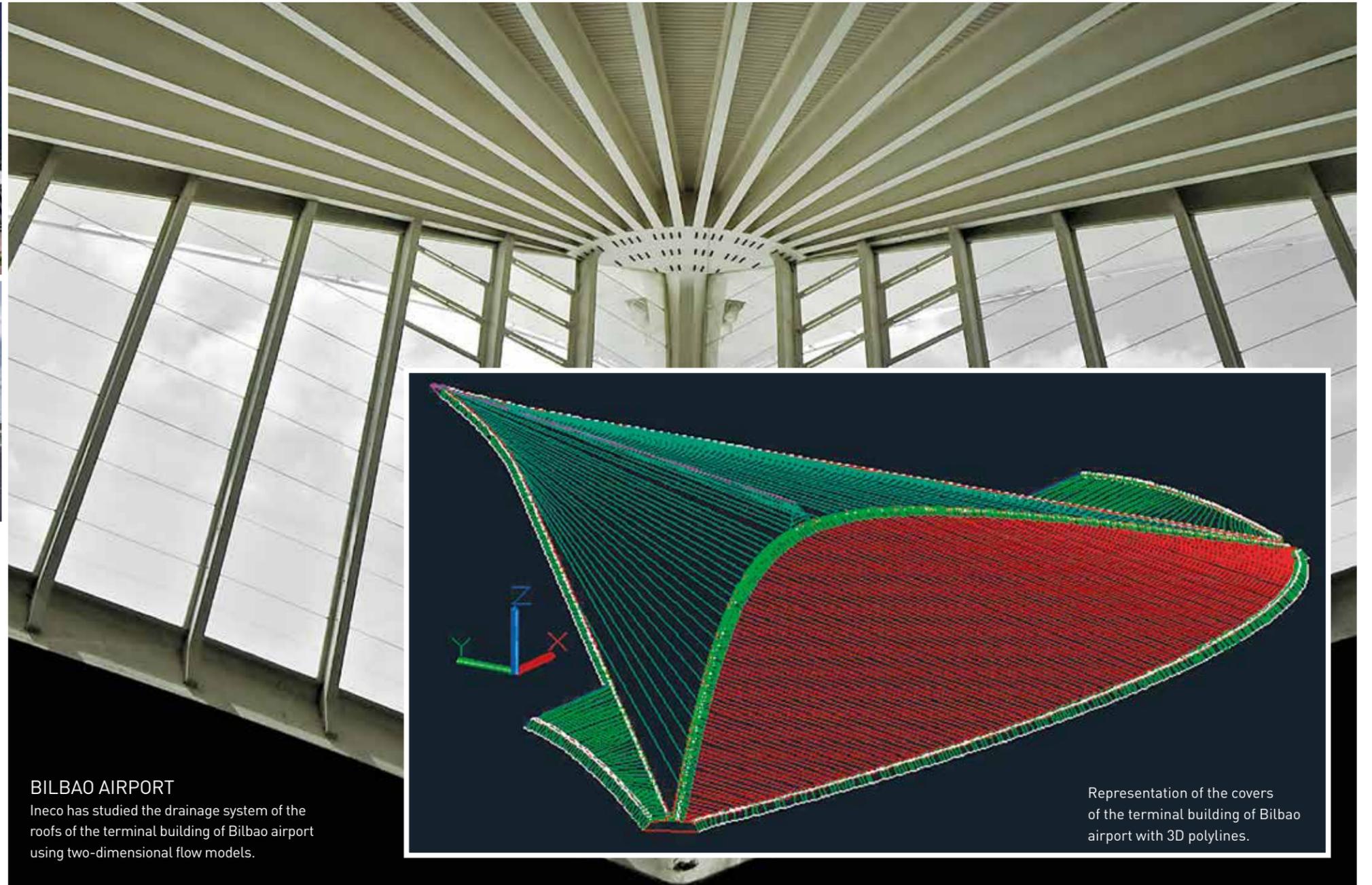
Ineco has wide experience in the use of two-dimensional flow models, in spite of being a newly emerging tool. Computer programme InfoWorks RS has been used in several extraordinary freshet simulations in natural water courses. Today, the mathematical model InfoWorks ICM, more advanced, globally integrates the basin model, being able to perform hydrology, sewerage and drainage system hydraulics, besides river hydraulics.«



### Hydraulic studies in Spain and Ecuador

In 2010, Ineco carried out an innovation project to study the effects of erosion in bridge piers using two-dimensional flow models. To this end, data were collected of the bridges studied until today, with different riverbed front shapes, sizes and slopes and with different flow rates. There are several factors interacting and involved in erosion, affecting the bridges that cross rivers and other water courses. Having a suitable model provides essential information to know how

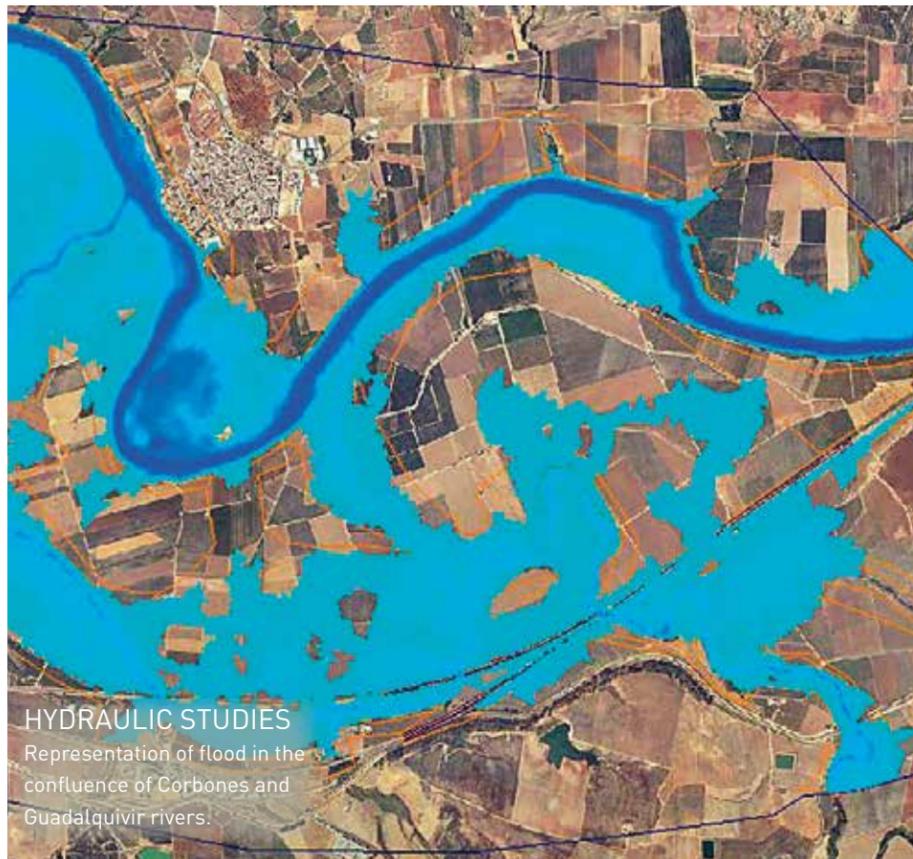
it affects structures and, eventually, to prevent possible collapse. The action of water wears away the piers and the abutments onto which the bridge is supported, but it can also wash the soil holding them, which is called undermining. The results of simulations performed with InfoWorks RS allowed observing the behaviour of flow essential parameters in piers and with these data it was possible to improve erosion estimation [see *ittransporte 47*].



**BILBAO AIRPORT**  
Ineco has studied the drainage system of the roofs of the terminal building of Bilbao airport using two-dimensional flow models.

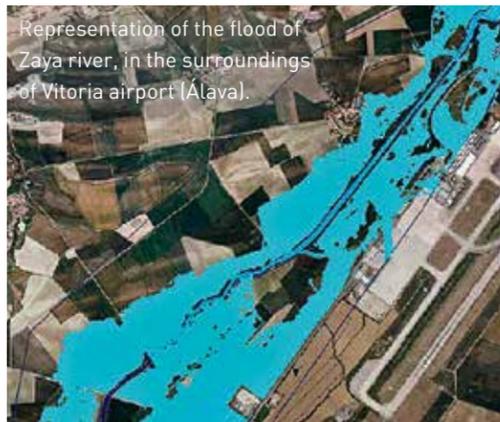
Representation of the covers of the terminal building of Bilbao airport with 3D polylines.

# Ineco has wide experience in two-dimensional flow models, both in studies on the erosion of bridge piers and in flood areas of rivers or specific buildings affected by rainfall

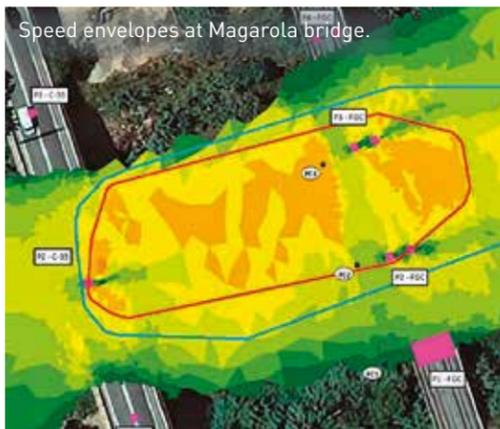


## HYDRAULIC STUDIES

Representation of flood in the confluence of Corbones and Guadalquivir rivers.



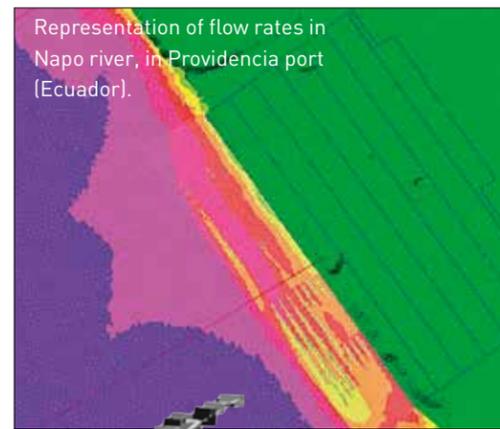
Representation of the flood of Zaya river, in the surroundings of Vitoria airport (Álava).



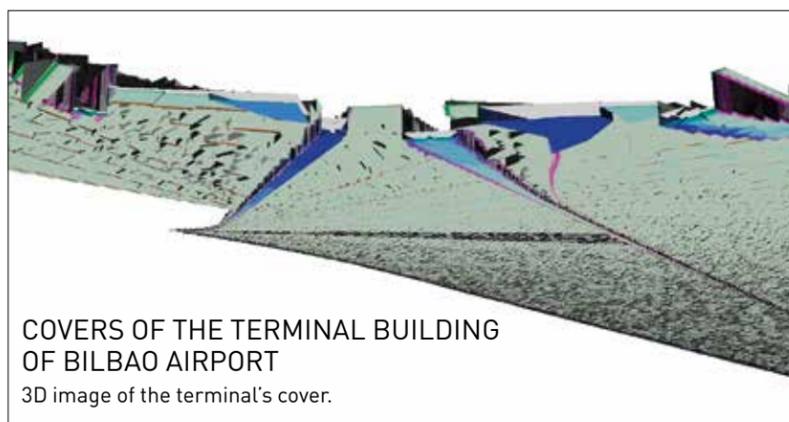
Speed envelopes at Magarola bridge.



View of simulation results on orthophoto.



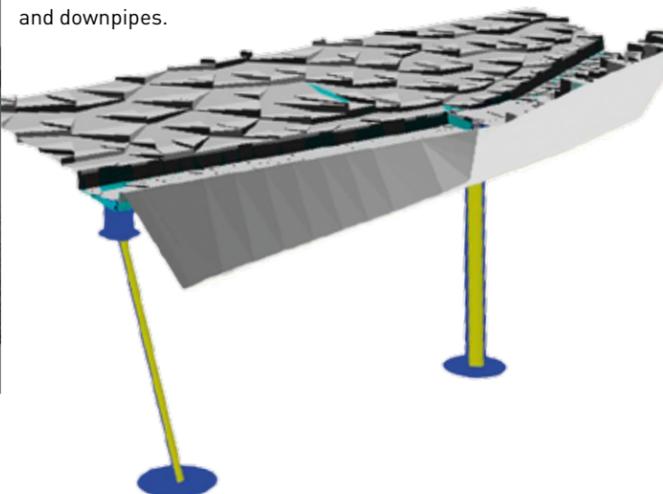
Representation of flow rates in Napo river, in Providencia port (Ecuador).



## COVERS OF THE TERMINAL BUILDING OF BILBAO AIRPORT

3D image of the terminal's cover.

3D view of section of cover with gutters and downpipes.



Liège railway station.

Later on, Ineco was involved in hydraulic studies of flood areas such as the confluence of rivers Corbones and Guadalquivir; Guatén river, in the area of Pantoja (Toledo); Zaya river, in the surroundings of Vitoria airport (Álava); the mouth of Magarola river, in Llobregat or Napo river, in Providencia port (Ecuador). In Spain, the Ministry of Agriculture, Feeding and Environment is promoting the general definition of flood areas in unstudied sections, being aware of the importance of

determining flood areas for the proper prevention of damage due to floods and for the preservation of the ecological status of rivers. Today, several service contracts are under execution for the definition of hydraulic public domain and flood areas in more than 15,000 kilometres of rivers and for the performance of hazardousness and flood risk maps of Directive 2007/60 on Flood Risk Assessment and Management in all river basin districts.«

## Digital models on the ground

Two-dimensional hydraulic calculation programmes need a Digital Elevation Model (DEM), as the two-dimensional grid will be created from the data of said model. It is possible to work with GRID-type models (for example, a dot cloud obtained with the LIDAR system) or TIN-type models (network of irregular triangles, from Shape files). Once the conditions of the area to be simulated are defined, the grid is generated, made up of triangular prisms. Then, the rainfall or the flow rate is introduced, the

simulations are performed and the results are analysed. The new applications of the programme InfoWorks ICM allow modelling hydrology, river hydraulics (including bridges, sewerage systems and other structures), water quality or real-time movement of structures such as gates, pumping, etc. InfoWorks ICM is more powerful and globally integrates the basin model, enabling the combination of 1D+2D models, besides one-dimensional and two-dimensional per se models.

## Drainage studies of specific covers

One of the applications that two-dimensional flow models allow for is the study of the drainage system of covers of stations, airport terminals and other specific buildings. The dimension requirements provided by the Technical Building Code are sometimes not applicable due to the peculiar design of some of these works, which need a specific study. In this case, the Digital

Elevation Model was obtained from the information on the geometry of the covers available in the project's plans. The covers are represented in 3D and a TIN area is created which defines the DEM. The general conditions of the area to be simulated and the specific characteristics of typical elements of covers, such as gutters or downpipes, are defined. Once the rain event is introduced, simulations may be performed and results may be studied.«

# An expanding universe

Spain has first-level facilities, a growing aerospace industry and a dynamic scientific community that accounts for 8% of the world's research about the cosmos.

By *itransporte*

PHOTO: DANIEL LÓPEZ (OT/IAC)

Most of the known universe is composed of matter and dark energy, two elements almost unknown to scientists, but which are causing the cosmos to continue expanding at a much faster speed than it was believed even after 13,810 million years since the Big Bang. These are just some of the most recent and shocking discoveries of the last decades, and Spanish scientists and advanced technological facilities have been involved in them.

Astrophysics has boomed until it became one of the most productive areas of Spanish science, despite budgetary restrictions. In the last meeting of the Spanish Society of Astronomy (SEA), held in September in Teruel in the presence of more than 300 scientists, it was shown that Spain contributes with 8% of the world's research in astrophysics. However, according to SEA, Spain only has six astronomers per million of inhabitants, almost half of that of France or Sweden.

**SCIENCE AND INDUSTRY**—This does not prevent the small but dynamic Spanish scientific

community from participating in big astronomical projects. Therefore, as member of the **European Space Agency**, it is part of the historical Rosetta mission, which has recently managed to take the Philae probe to the 67P comet, where it has landed. Or in the European Southern Observatory (ESO) in charge of the **E-ELT**: (Extremely Large Telescope) that is being built in Chile, with outstanding contributions from Spanish companies, such as Idom, Empresarios Agrupados, NTE-SENER or CESA. Another Spanish company, Asturfeito, built 25 of the 66 antennae that compose **ALMA**, the world's biggest astronomical project, a gigantic radiotelescope located in the Atacama desert, in the north of Chile. This is a sample of the power of the Span-

*Spain's geographical location makes our country a privileged observation point*

ish aerospace industry, a young but growing area, that according to TEDEA (Spanish Association of Technologies of Defence, Aeronautics and Space, grouping 80 companies) has a turnover of 10.3 billion euros –10% being earmarked to R+D+i–, accounting for 1% of the national GDP and generating 53,000 direct jobs.

**LOOKING AT THE STARS**—The geographical location of the country, in the south of the European continent, turns it into a privileged observation point. The territory of the Canary Islands, in particular, due to its proximity to the Equator and its weather conditions, offers the best observatory conditions. The Astrophysics Institute of the Canary Islands (IAC) manages the **Teide Observatory** on Tenerife island, and **Roque de los Muchachos**, on La Palma island, which began operating in 1985 and participate in multiple international research projects. The latter has what is currently the world's largest optic telescope, the **Great Telescope of the Canary Islands** or GTC, which has been in operation since early 2009 to observe visible and

## CAHA's stellar projects

**CALIFA** (Calar Alto Legacy Integral Field Spectroscopy Area survey): devoted to the study of galaxies. The project, unique in the world due to the scope and the technique employed, is of the legacy type, that is to say, the results shall be openly disseminated to all the scientific community. As a matter of fact, two public releases of data related to 600 galaxies have already been made. It involves 82 astronomers belonging to 25 institutes from 13 countries.

**ALHAMBRA** (Advanced Large, Homogeneous Area Medium Band Redshift Astro-

nomical survey): consists in a large-scale mapping of the cosmos that aspires to become the reference work on the history of the universe. The Spanish Mariano Moles leads a team of over 50 scientists from all over the world.

**CARMENES** (Calar Alto high-Resolution search for M dwarfs with Exo-earths with Near-infrared and optical Échelle Spectrographs): it is a spectrograph aimed at finding rocky planets similar to the Earth, detecting the oscillations they cause in the light of stars that orbit around them.



## The amazing research of the dark energy

Since 1995, Pilar Ruiz-Lapuente, astrophysicist and professor at the University of Barcelona, is part of the research team that in 2001 received the Physics Nobel Prize for discovering that the expansion of the universe is accelerating: the Supernova Cosmology Project, led by the American Saul Perlmutter, from the University of Berkeley, California. In 2014, the team received a new award, the Breakthrough award 2015 in Fundamental Physics section, which has the highest economic compensation.



Artistic representation of the future E-ELT. The lasers are part of the sophisticated optics designed to eliminate the distortion caused by the Earth atmosphere.

PHOTO: ESO/L. CALÇADAN, RISINGER (SKYSURVEY.ORG)

Great Telescope of the Canary Islands or GTC, in operation since early 2009.

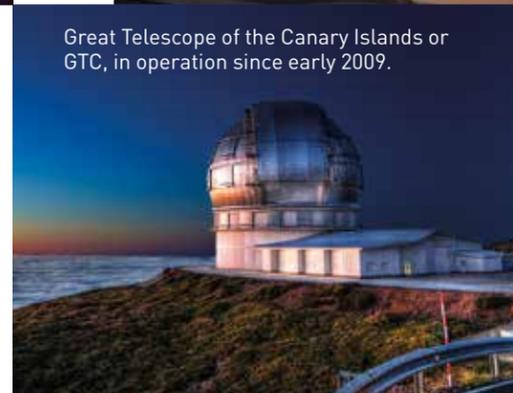


PHOTO: PABLO BONNET (IAC)

infrared light originated from the cosmos, focusing mostly on the study of black holes, the most remote and youngest stars and galaxies, and the initial conditions after the Big Bang. The Teide Observatory, located at an altitude of 2,400 metres, is mostly devoted to the study of the Sun.

The Canary Islands' astronomical facilities, after losing ground against Chile to accommodate the future E-ELT (which will have a 40-metre diameter), are now aspiring to house another giant, in fact, the world's largest E-ELT: it will

have a 60-metre diameter and will be part of the **Cherenkov Telescope Array (CTA)** of the University of Moscow.

However, the Spanish peninsula also has outstanding astronomical infrastructures: the **Deep Space Communications** Centre of the NASA, American space agency that is part of a network composed by two other centres located in the United States (Mojave desert, California) and Australia (40 km from Canberra) can be found in the centre of Spain, in the town of Robledo de Chavela, in the Community of Madrid.

The **Calar Alto Hispanic and German Astronomical Observatory (CAHA)** is located in Sierra de los Filabres, north of the Almería. The observatory, managed by the Max Planck Society (Germany) and the Spanish National Research Council (CSIC) owns three telescopes which work both on the optic (visible) and infrared ranges. It will start to be managed by Spain in 2018.

The **Javalambre's Astrophysics Observatory**, in Teruel (Aragón), is the newest facility

and has two telescopes of 0.8 and 2.5 metres diameter. The **Canfranc Underground Laboratory** is also located in Aragón and is managed by the national and regional government and by the University of Zaragoza. At 900 metres deep, it studies the dark matter of the universe, as well as other various materials by means of radioactivity measurements. It also performs geophysics and biology studies.

As to radiotelescopes –which are used to observe radio waves instead of light waves–, that of **Pico Veleta (Sierra Nevada, Andalusia)**, with a 30-metre diameter antenna, is one of the world's largest within its range. It is managed by **IRAM (Hispanic-French-German Institute of Millimetric Radioastronomy)**. Each year 250 scientists use the facilities. In addition, the **Yebes Astronomy Centre**, 40 km from Guadalajara (Castilla-La Mancha), houses two radiotelescopes (to study asteroids and comets), a small solar telescope and modern astronomical instrumentation laboratories. It is managed by the National Astronomical Observatory.«

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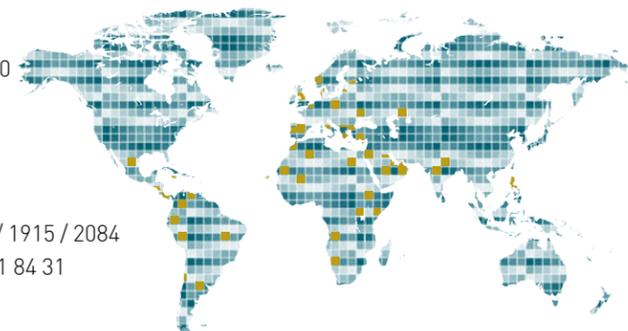
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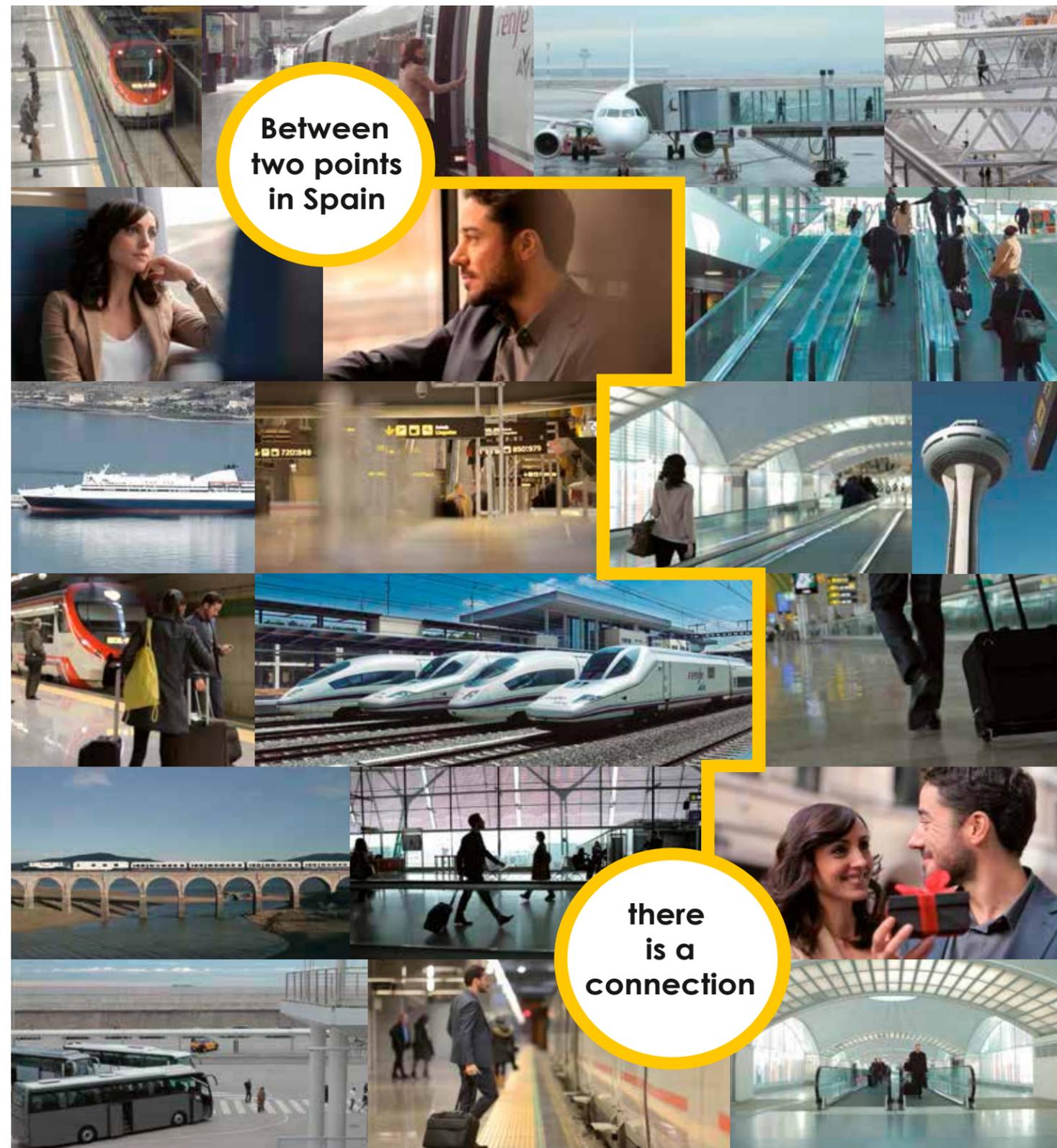
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