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FEB | MAY 18

INNOVATION
Next-generation transport

ARTICLES

HSL Centre: NORTH SOUTH connection
Traffic control: Test pilots
Metro de Medellín: Exemplary endeavour
Jamaica's Sangster international airport
'Basque Y': Astigarraga-Irún line
Costa Rica: Routes to the future
Brand Spain: Fruit and vegetables

EDITORIAL

Unity makes strength

PHOTO_ELVIRA VILA

> The 50 years since the founding of Ineco have unquestionably been a decisive period for the history of Spain and its infrastructure"
>
> ISAAC MARTÍN-BARBERO
> President of Ineco

We begin by marking an historic anniversary: 50 years since the founding of Ineco (1968-2018), half a century during which we are proud to have had the opportunity to contribute to the structuring of the country through our involvement in the design and construction of major road and rail routes, port and airport development, urban transport and intermodal transport in Spain as a whole. It has unquestionably been a decisive period for the history of Spain and its infrastructure, and also for our growth and consolidation as a high-performance, flexible and technologically advanced public works engineering firm, which enables us to act as a trusted consultant in the eyes of our shareholders and as a valuable partner in the foreign market.

In addition to this celebration, I would also like to add the positive close to the year, promising portfolio prospects and our eager anticipation to support two of the Ministry of Public Works' major projects this year, namely the Innovation Plan and the Internationalisation Plan, programmes that will begin in February and will certainly provide a great boost to our technological and innovative capacity and open up new opportunities for collaboration with Spanish partners in order to continue with our expansion abroad. Both initiatives have enabled us to join forces and work together with other companies and institutions in the Public Works Group, and they will also soon be joined by the Sustainability Plan.

As unity makes strength, this issue also celebrates the connection of the high-speed lines in the north of Spain with those in the south and east, our work with Acciona to improve Costa Rica's infrastructure and the joint effort of all of Europe to give a final push for the implementation of BIM.

We thank Tomás Elejalde, general manager of Metro de Medellín, for giving us a full interview. And lastly, I would like to mention the exemplary efforts of our technical staff to make the advancement of high-speed rail a reality, as our readers will be able to see in the reports on the Central High-Speed Line in Madrid, the extension of the Basque Y in Guipúzcoa and the traffic control works on the line between Makkah and Madinah, a project that has successfully passed the first test of the entire 450 kilometres. ■

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ILLUSTRATION FOR TRANSPORT AND INFRASTRUCTURE INNOVATION PLAN | JAVIER JUBERA

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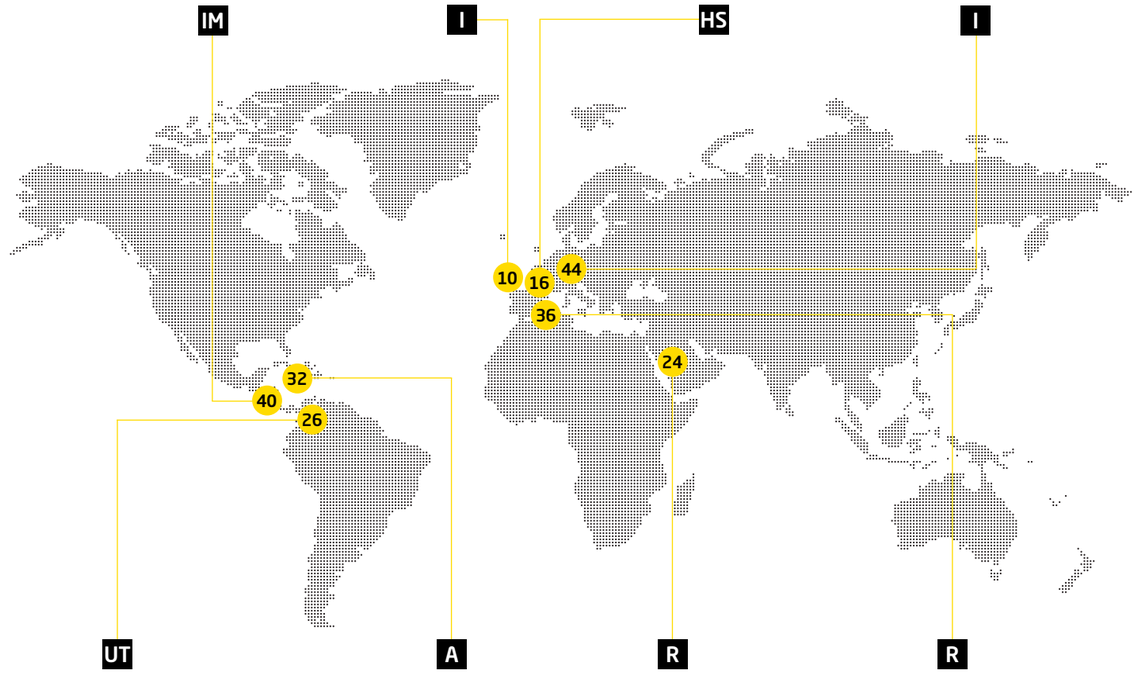
FEATURE ARTICLES
on the map

COSTA RICA
Intermodal
Ineco, in partnership with Acciona, is managing an infrastructure design programme (PIT), slated to run until 2020.

SPAIN
Innovation
In 2018, we will see the launch of a coordinated process to transform the Spanish transport system.

SPAIN
High Speed
The high-speed section that connects Chamartín station to Torrejón de Velasco will open in 2018.

EUROPE
Innovation
The EU BIM Task Group has published a manual to support the implementation of the BIM methodology in the construction of public works in Europe.



COLOMBIA
Urban Transport
Medellín was the first city in the world to use cable cars for public transport. We interview Tomás Elejalde, the general manager of Metro de Medellín.

JAMAICA
Aeronautical
Ineco celebrates a decade working for Jamaica's main tourist airport with a redesign of the check-in area and supervision of airfield works.

SAUDI ARABIA
Railways
Since 2014, a team of Traffic Control experts from Ineco has been working on the new 450-kilometre high-speed line between Makkah and Madinah.

SPAIN
Railways
ADIF has commissioned a team of Ineco engineers and technicians to undertake the project, management and technical assistance.

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AVE COMPLETES A TEST RUN OF THE FULL ROUTE BETWEEN MAKKAH AND MADINAH

The high-speed train that will connect the cities of Makkah and Madinah in Saudi Arabia has successfully completed its first test run along the entire route, reaching its top speed of 300 km/h. The Talgo train travelled the 450 kilometres of the Haramain project with the Saudi Transport minister, Nabil al Amudi, the Spanish ambassador, Álvaro Iranzo, and other local dignitaries and construction company representatives on board.

Ineco, along with eleven other Spanish companies (Adif, Cobra, Consultrans, Copasa, Imathia, Inabensa, Indra, OHL, Renfe, Siemens Rail Automation and Talgo) and two Saudi partners, is part of the Al Shoula consortium, which is responsible for design, construction, maintenance and operation.

SIGNING OF THE CONTRACT FOR THE DESIGN OF THE NEW TERMINAL AT THE AMSTERDAM-SCHIPHOL AIRPORT

At a ceremony held in the capital of the Netherlands, the Spanish-Dutch consortium KL AIR, made up of Ineco and Estudio Lamela, with KAAN Architecten and ABT, with the support of Arnout Meijer Studio, DGMR and PlaneGround, signed the contract for the international tender to design the new terminal at the Amsterdam-Schiphol Airport. The new terminal, which will be completed in 2023, together with a new boarding area, will enable the airport to handle up to 14 million more passengers a year, to help it to maintain its position as a European hub. Ineco will also carry out the preliminary design for the automated baggage handling system, one of the project's most complex challenges.

María Sánchez-Palomo, General Director of Operations; Miguel de Bernardo, Senior Technical Manager for Infrastructure Planning and Exploitation; and Juan Salañer, Business Director for Europe and North America, represented the company at the signing of the contract.

URUGUAY

PASO DE LOS TOROS-MONTEVIDEO RAILWAY LINE

The Ministry of Transport and Public Works of Uruguay has commissioned Ineco to provide technical assistance for the tendering of the contract to construct and maintain the railway infrastructure on the section between the Port of Montevideo and Paso de los Toros station. The 'Central Railway' project promoted by the government is the most important railway project in recent years in Uruguay. The construction and maintenance of the 273 kilometres of railway track between the Port of Montevideo and the city of Paso de los Toros, which involves upgrading the line to a higher standard to enable use by freight trains at 80 km/h and 22.5 tons per axle, represents an excellent opportunity to add the railway to the country's transport system. The upgrading of this line will facilitate the transport of raw materials to a new pulp mill belonging to the Finnish company UPM. The project was presented on 15 August 2017 to business leaders in a ceremony attended by the president of the Republic, Tabaré Vázquez.

CHILE

CONSULTING ON ASSEMBLY AND MANUFACTURE FOR METRO DE SANTIAGO

Ineco has begun providing advice on manufacture and assembly control for the new Alstom trains of Metro de Santiago de Chile. This comes after the company's previous involvement in developing the basic engineering phases, drafting bidding documents and supporting tender evaluation and contract awarding for the modernisation of the NS74 train fleet (currently made up of 49 five-carriage trains) manufactured in the 1970s by Alstom, which will be replaced by a new fleet consisting of 35 seven-carriage trains.

The company will be sending a multidisciplinary team to Santiago de Chile that will be responsible for technical assistance during testing and commissioning the prototype train.

SPAIN

50TH ANNIVERSARY

On 20 July, Ineco will celebrate the 50th anniversary of its founding in 1968. Over the course of the year, the company will be highlighting the most important dates in its half-century of history, a period that has been key to the development of transport and infrastructures in Spain, through its website and social media. In the image, the logo selected through a contest among the company's more than 2,500 employees.


The president of Ineco, Isaac Martín-Barbero, with the minister, Íñigo de la Serna.

Ineco has drafted the document, which includes 110 initiatives in 11 priority markets.

THE PUBLIC WORKS GROUP'S INTERNATIONALISATION PLAN

The Minister of Public Works, Íñigo de la Serna, last December, presented the Internationalisation of Transport and Infrastructure Plan 2018-2020, which comprises activities and initiatives to generate business opportunities for Spanish companies abroad and reinforce their international operations and the technological, innovative and corporate image of Spain.

In coordination with other stakeholders in the sector, Ineco has drafted this plan which identifies the operational and commercial synergies between the companies in the Public Works Group and the private sector, promoting collaboration between the stakeholders involved and the complementarity of jobs and services to improve international competitiveness.

The plan is structured around six lines of action and consists of 110 initiatives focused on 11 priority markets (Saudi Arabia, Australia, Canada, Colombia, the United Arab Emirates, the United States, Mexico, Norway, Peru, Sweden and the United Kingdom) and nine opportunity markets (Argentina, Chile, Denmark, Egypt, India, Israel, Malaysia, Morocco and Singapore). Projects with European institutions are also considered priorities because at the regional level, there are needs to which Spain can offer solutions that stand out above the other alternatives.

BRAZIL

SUPERVISION AND TECHNICAL ASSISTANCE FOR NEW TRAINS ON LINE 13 OF THE CPTM

The São Paulo Metropolitan Railway Company (CPTM) has awarded a consortium made up of Ineco, Ineco do Brasil, EBEI and MetroEng the contract for supervision and technical assistance in the manufacture and supply of eight new trains for Line 13 of the CPTM, which will connect São Paulo–Guarulhos International Airport with the city. Guarulhos is Latin America's busiest airport in terms of passenger traffic.

EUROPE

WORK FOR THE EUROPEAN UNION AGENCY FOR RAILWAYS

The European Union Agency for Railways has contracted a consortium led by Ineco to identify and gather data on the costs and benefits of the railway sector.

Ineco and its partner ECORYS will provide the Agency with the foundations for drafting its 2018 Rail System Report, whose purpose will be to verify whether the actions taken have had the expected effects on the railway sector. This is part of the Agency's work of monitoring the key indicators for the development of the sector. The consortium has designed a methodology that includes the distribution of questionnaires to the sector; analysis of information from public sources and interviews with the most important stakeholders in the European sector, such as national security agencies, infrastructure managers, operators, manufacturers, etc.

PHOTO: ELVIRA VILA

The winning teams during the ceremony held last November at Ineco's headquarters in Madrid.

SPAIN

3RD INNOVA AWARDS

Ineco has completed the third edition of its Innova Awards presented to the company's professionals. The three award-winning projects were SIMA, by María del Mar Jiménez, Alberto Antón, Héctor Damaso, Iván Hernández, Óscar Rocha, Daniel Zabala and Marta Ruano; the ERTMS railway capacity impact assessment method, by Silvia Domínguez, Laura, Alfonso Lorenzo and Daniel Berzal; and the Cityneco Smart City Platform, by Jesús Vázquez, Daniel Esteban, Francisco Javier Carvajal, Ana Olmeda and Rafael Ibáñez.

SPAIN

1ST GALILEO USER ASSEMBLY

The European Global Navigation Satellite Systems Agency (GSA) held its 1st Galileo User Assembly on 28 and 29 November 2017 at INTA (National Institute of Aeronautics) and the Global Navigation Satellite Systems Service Centre (GSC) in Torrejón de Ardoz (Madrid). In the image, the Ineco team –Antonio Águila, Alberto Santos, Rosa Mª Fidalgo, Carlos Hernando, Ana Meléndez, Ramón Hernández, Silvia López, Adrián Moreno and José María Berdoy– together with its partners Isdefe and Telespazio Ibérica, all of whom are responsible for the operation and maintenance of the Centre, which supports and provides value-added products and services to Galileo users. See more details at https://www.gsc-europa.eu/.

SPAIN

AWARD FOR MARÍA SÁNCHEZ-PALOMO, GENERAL DIRECTOR OF OPERATIONS

María Sánchez-Palomo, Ineco's General Director of Operations, has won the Award for Best Young Civil Engineer given by the Madrid Division of the Spanish Association of Civil Engineers. With more than eleven years of experience at Ineco, María Sánchez-Palomo has directed and managed important projects and was technical director of the Spanish Haramain Consortium.

TRANSPORT AND INFRASTRUCTURE INNOVATION PLAN 2017-2020
With a planned investment of 50 million euros over a period of three years, the Plan starts in February 2018 with the launch of cross-cutting initiatives and projects throughout the Public Works Group with the aim of integrating and coordinating all innovation-related activity.

ILLUSTRATIONS_**JAVIER JUBERA**

Next-generation transport

The Ministry of Public Works' Innovation Plan represents a commitment to digitisation, energy efficiency and sustainability reflected in 70 specific initiatives that have undergone a period of public consultation. February 2018 will see the launch of a coordinated process to transform the Spanish transport system to provide a high degree of personalisation and efficiency spearheaded by new technologies.

By **Ana Olmeda** and **Rafael Ibáñez,** civil engineers

Last November, **Minister of Public Works, Íñigo de la Serna,** presented the Transport and Infrastructure Innovation Plan 2017-2020, whose aim is to integrate and coordinate all of the innovation activities of the companies and institutions involved in the Public Works Group. With a planned investment of 50 million euros over a period of three years, the Plan starts in February 2018 with the launch of cross-cutting initiatives and projects throughout the Group so that 'it will function as a collaborative group working within a network', explained the minister.

Through the Plan, the Public Works Group is taking a major step forward in line with the European Commission's H2020 programme, a financial instrument that seeks to ensure competitiveness through research and innovation. At the national level, the Plan is part of the government's strategy on innovation, in which the Digital Agenda for Spain and the Spanish Strategy for Science, Technology and Innovation play particularly significant roles.

Thanks to the National Smart Cities Plan developed by the State Secretary for the Information Society and Digital Agenda (SESIAD) in collaboration with Ineco, Spain is a pioneer in the development of smart cities, having established a number of guidelines on platform interoperability that have become an international benchmark. The platform ecosystem proposed in the Innovation Plan follows these guidelines, ensuring that the different transport initiatives complement and can be integrated into the advances made in smart cities. The result is a common strategy based on a solid model.

The Transport and Infrastructure Innovation Plan also uses BIM *(Building Information Modelling)* as a cross-cutting element for all of the initiatives, given the strategic role that it needs to play in the future of Spanish innovation (see report on page 44).

A CUTTING-EDGE TRANSPORT SYSTEM

Transport plays a key role in the overall development of societies and their economies. The way in which people and goods move through an area largely defines its social, economic and environmental fabric, which is why actions in transport and infrastructure are a vital part of any basic strategy in the ongoing process of expansion and modernisation of societies.

For this reason, the Plan is committed to putting technology at the service of the citizen, using innovation to make advances in safety, accessibility and sustainability. These advances need to be accompanied by greater economic and social profitability through an increase in the efficiency and effectiveness of public and private investment.

THE AIM OF THE PLAN IS TO PUT TECHNOLOGY AT THE SERVICE OF THE CITIZEN, USING INNOVATION TO MAKE PROGRESS IN SAFETY, ACCESSIBILITY AND SUSTAINABILITY, ADVANCES THAT NEED TO BE ACCOMPANIED BY GREATER ECONOMIC AND SOCIAL PROFITABILITY THROUGH AN INCREASE IN EFFECTIVENESS AND EFFICIENCY IN PUBLIC AND PRIVATE INVESTMENT

The Innovation Plan is structured around four main dimensions to achieve these objectives: digitisation, Internet of the future, intermodality and energy transformation. Supported by these dimensions, the initiatives proposed in the Plan represent a great boost to the consolidation of a safer, more sustainable and accessible cutting-edge transport system, which will keep Spain at the forefront of innovation in transport.

FOUR MAJOR CORNERSTONES AND 70 INITIATIVES UNDERWAY

Drafted by Ineco, the Innovation Plan included participation by the heads of Adif, Aena, ENAIRE, CRIDA, Spanish Port System and Renfe. The opinions of other institutions, such as the Spanish Rail Research Laboratory (CEDEX), Spanish Maritime Safety and Rescue Agency (SASEMAR), the Ministry of Public Works and various private entities, were also taken into account. Four strategic cornerstones have been identified in the Plan: user experience; smart platforms; smart routes; and energy efficiency and sustainability. These cornerstones are structured in turn into 22 strategic lines, which have materialised into 70 initiatives.

User Experience is aimed at personalising the offering according to user preferences, providing them with products and services on demand. To that end, the concept of 'Mobility as a Service' and, in general, public-private collaboration models will be promoted. Several other initiatives will focus on the elimination of barriers, with the development and implementation of new booking, payment and validation systems focused on cybersecurity and fraud reduction.

Big Data will be the technological foundation that will enable personalisation of services and improved user experience.

The second cornerstone, **Smart Platforms,** is designed as a cross-cutting element that provides technological support to all of the initiatives in the Innovation Plan. Through these Platforms, information is collected and processed by the companies in the Public Works Group, improving efficiency, quality and security of the services offered.

The proposed platform ecosystem covers all modes of transport and is integrated with city platforms. The application of the BIM methodology in stations, airports and ports, and the promotion of the Single European Sky will play a special role in this ecosystem, which will also consider the inclusion of unmanned aerial vehicles.

Smart Routes are aimed at the digitisation of roads and railways, with the development of a framework for the implementation of connected and autonomous vehicles. One of the fundamental aspects will be the standardisation and regulation of vehicle-vehicle and vehicle-infrastructure communications.

In addition, modelling and forecasting systems based on automatic learning and data science will be developed to enable smart transport planning and management. Dynamic traffic control, early recognition of congestion conditions on roads and dynamic driving management are some examples of the application of these developments.

The fourth cornerstone of the plan, **Energy Efficiency and Sustainability,** focuses on achieving transformation towards a sustainable and energy-efficient transport system in order to reduce greenhouse gas emissions, rationalise the use of fossil fuels and facilitate the switch to new transport solutions. This line includes initiatives that promote the use of renewable energy generation systems, use of surplus energy for self-consumption or feeding back into the grid, promotion of electric vehicles and other vehicles with alternative energies in transport networks, among others. All of these measures seek to adapt transport elements and direct them towards more sustainable and effective models in order to enable Spain to position itself as a benchmark in the international sector.

Facilitating open innovation and encouraging start-up entrepreneurship through synergies with companies in the Public Works Group is also part of the initiatives of this fourth cornerstone.

The Plan aims to set up an innovative network that integrates and connects all sectors of society, encouraging investment in innovation by large companies and SMEs and actively involving universities, technology centres and entrepreneurs. Within this line, the creation of an 'Innovation Rail Hub' seeks to launch collaborative R&D projects that promote railway technology on an international scale.

EXPERTS IN PUBLIC TRANSPORT INNOVATION

To draft the Plan, Ineco's Department of Cooperation and Innovation collaborated with a team of experts in innovation from the companies and institutions in the Public Works Group. Adif, Aena, ENAIRE, CRIDA, Spanish Port System and Renfe, together with other institutions such as CEDEX and SASEMAR, worked with Ineco on the drafting of a common project: "We set out a road map – says **Rocío Viñas, Ineco's deputy general director of Cooperation and Innovation**– for the next three years with a strategy based on digitisation, the Internet of the future, intermodality and energy transformation." For Rocío Viñas, analysis of the current situation of innovation projects "reflected the importance not only of sharing knowledge and creating synergies in the Public Works Group, but also of reinforcing collaboration with universities, startups and other companies, fostering and promoting our innovative culture inside and outside the EU."

According to **Javier Rodríguez Barea, Renfe's manager of Transformation and Digital Innovation,** the interesting aspect about this project is that "citizens are at the centre of the Innovation Plan, which acts a great prescriber of a new, more personalised, door-to-door mobility service in an interconnected and smart world, where technology and digitisation are put at the service of the companies in the Public Works Group in order to transform our value proposition towards society and improve user experience in our services."

For **Antonio Berrios, deputy director of Strategic Innovation at Adif,** "one of the great contributions and challenges of this Innovation Plan is its cross-cutting vision within the Public Works Group, involving all companies making a technological leap to facilitate solutions that improve the capabilities of all of the modes of transport that travellers and goods units can use in their door-to-door mobility process."

Along this same line, **Juan Puertas Cabot, head of Aena's Quality, Excellence and Innovation Division,** adds that "effective innovation is always orientated towards known customers. The plan has combined the vision of the customer as a passenger on all modes of transport and as a citizen with their needs and expectations. This global vision is necessary to focus on effective innovation in global transport." Juan Puertas points out that instead of highlighting a single initiative, he would stress the importance of including energy efficiency and sustainability as one of the main cornerstones: "It links with the whole strategy of the Plan, which puts society as a whole at the centre. I believe that a company of the future must necessarily be responsible and innovation is an essential tool to incorporate sustainability into transport processes." In the case of Aena, within the framework of the Plan, the company is implementing the "digital transformation of the relationship with the passenger, where not only the necessary economic return is taken into account but also a focus on improvement of the passenger experience in the different steps of a customer's journey at an airport. The firm commitment to this project has been reflected in 15 digital innovation initiatives that will be implemented during the next year."

THANKS TO ICT, TRANSPORT SERVICES CAN BE BETTER DESIGNED AND MANAGED, ADDRESSING THE REAL NEEDS OF CITIZENS AND INTERACTING WITH THEM IN REAL TIME AND WITHIN AN INTEGRATED AND SUSTAINABLE TRANSPORT SYSTEM THAT IMPROVES ITS ECONOMIC AND SOCIAL PROFITABILITY

STRATEGIC CORNERSTONE	STRATEGIC LINE		INITIATIVES	AGENTS: MINISTRY OF PUBLIC WORKS	ADIF	RENFE	AENA	ENAIRE	CRIDA (ENAIRE)	SPANISH PORT SYSTEM	INECO	CEDEX	SASEMAR
E1 USER EXPERIENCE	E1L1-Mobility as a service	E1L1-1	National Mobility Plan as a service										
		E1L1-2	The Public Works Group as a data integrator	●	●	●	●	●	●		●		
		E1L1-3	Pilot project of mobility as a service in the Public Works Group		●						●		
	E1L2-Travel without barriers	E1L2-1	Development and implementation of advanced payment systems										
		E1L2-2	Development and implementation of ticketless validation systems		●	●	●			●	●		
		E1L2-3	Implementation of security controls without stopping		●	●	●			●			
		E1L2-4	Universal Accessibility Plan in the transport system		●	●	●			●			
		E1L2-5	Positioning inside transport terminals		●	●	●			●	●		
	E1L3-User profile	E1L3-1	Big Data and data science to improve user experience	●	●	●	●			●	●		
		E1L3-2	Creation of user profiles		●	●	●				●		
		E1L3-3	Creation of a marketplace in the Public Works Group		●	●	●			●	●		
		E1L3-4	Development of new operator-user communication channels		●	●	●	●	●				
		E1L3-5	Creation of a user-experience laboratory		●	●	●				●		
E2 SMART PLATFORMS	E2L1-Smart stations	E2L1-1	Smart station platform		●	●					●		
		E2L1-2	Integration of smart station platforms with city platforms		●	●					●		
		E2L1-3	Integration of BIM models into smart stations		●						●		
	E2L2-Smart airports	E2L2-1	Smart airport platform	●			●	●	●		●		
		E2L2-2	Integration of smart airport platforms with city platforms				●				●		
		E2L2-3	Integration of BIM models into smart airports				●				●		
	E2L3-Smart ports	E2L3-1	Smart port platform							●	●		
		E2L3-2	Integration of smart port platforms with city platforms							●	●		
		E2L3-3	Integration of BIM models into smart ports							●	●		
	E2L4-User platform	E2L4-1	User platform	●	●	●	●			●	●		
		E2L4-2	Integration of user platforms with other platforms and tools		●	●	●			●	●		
		E2L4-3	Integration with mobile applications that generate mobility data	●	●	●	●			●	●		
	E2L5-Goods platform	E2L5-1	Goods platform		●	●				●	●		
		E2L5-2	Integration of goods platforms with other platforms and tools		●	●				●	●		
	E2L6-Open data	E2L6-1	New business models with open data	●	●	●	●	●	●	●	●		
		E2L6-2	Definition of a transport open data catalogue	●	●	●	●	●	●	●	●	●	
		E2L6-3	Development of the Public Works Group's multimodal open data web portal	●	●	●	●	●	●	●	●		
	E2L7-New data sources	E2L7-1	Partnerships with companies that generate mobility data	●		●							
		E2L7-2	Exploitation of social media information for use in mobility and transport			●					●		
		E2L7-3	Use of mobile data for determining transport demand	●	●	●	●			●	●		
		E2L7-4	Integration of Galileo into the applications of the Public Works Group	●	●	●		●		●		●	
	E2L8-Single European Sky	E2L8-1	Smart ATM. Smart management of air traffic					●	●				
		E2L8-2	Platform for unmanned aerial vehicle traffic management					●	●		●		
		E2L8-3	Implementation of Big Data techniques in air navigation services					●	●				
	E2L9-Smart maritime management	E2L9-1	Smart management of maritime traffic										●
E3 SMART ROUTES	E3L1-Digitisation of roads and railways	E3L1-1	Standardisation of vehicle-infrastructure and vehicle-vehicle communications	●								●	
		E3L1-2	Implementation of predictive maintenance in transport infrastructures	●	●	●	●			●	●	●	
		E3L1-3	Positioning towards 5G networks	●	●						●		
		E3L1-4	New railway infrastructure safety systems	●	●					●		●	
		E3L1-5	Deployment of ERTMS across the national network		●							●	
		E3L1-6	BIM in linear infrastructures	●							●		
	E3L2-Modelling and forecasting	E3L2-1	Development of a national multimodal transport model for travellers and goods	●	●	●	●			●	●		
		E3L2-2	Pilot project for a transport demand forecasting model	●	●	●					●		
	E3L3-Smart territories	E3L3-1	On-demand transport system in rural areas	●							●		
		E3L3-2	Pilot project for dynamic public transport routes	●									
	E3L4-Logistics and goods	E3L4-1	Comprehensive observatory of transport costs	●	●	●	●	●	●	●	●		
		E3L4-2	Intermodality without barriers	●	●	●	●			●			
		E3L4-3	Implementation of last-mile services in the Public Works Group		●	●				●			
	E3L5-New transport paradigms	E3L5-1	Creation of a technology watch group		●	●	●	●	●	●		●	
		E3L5-2	Hyperloop strategy		●						●	●	
		E3L5-3	Unmanned aerial vehicle laboratory		●			●	●	●	●	●	
E4 ENERGY EFFICIENCY AND SUSTAINABILITY	E4L1-Renewable energies	E4L1-1	Promotion of energy generation, storage and distribution systems		●	●	●			●		●	
	E4L2-Decarbonisation	E4L2-1	Promotion of the development of a National Alternative Energy Action Framework for Transport	●	●	●	●			●			
		E4L2-2	National Infrastructure Plan for electric vehicles and other vehicles with alternative energies	●	●		●			●		●	
		E4L2-3	Implementation of efficient combined transport services		●	●				●	●		
		E4L2-4	Intermodal web portal for the tracking and monitoring of environmental indicators and objectives	●	●	●	●	●	●	●	●	●	
		E4L2-5	Application of photocatalytic technologies in transport infrastructures	●	●					●		●	
		E4L2-6	The bicycle as a cornerstone of urban mobility	●	●		●				●		
	E4L3--New infrastructures	E4L3-1	Optimisation and adaptation of transport elements towards more efficient and sustainable models	●	●	●		●		●			
		E4L3-2	Smart energy management systems in transport infrastructures	●	●	●	●			●			
		E4L3-3	Development of smart networks for decision making	●	●	●					●		
		E4L3-4	Identification of flight inefficiencies in terms of consumption, cost and emissions					●	●				
		E4L3-5	New techniques for controlling noise and soil pollution	●	●	●	●			●		●	
	E4L4-Autonomous vehicles	E4L4-1	Technical standardisation for the development of an Autonomous Vehicle Legal Framework	●									
		E4L4-2	Creation of a White Paper on the Ethics of Autonomous Vehicles	●									
	E4L5-Education, communication and entrepreneurship	E4L5-1	Education, communication and training activities	●	●	●	●	●	●	●			
		E4L5-2	Shared workspace options		●		●						
			Number of initiatives in which they participate	33	50	43	37	17	15	37	43	14	1

TABLE UPDATED ON 31/12/2017
The Plan has four strategic cornerstones, which are in turn structured into 22 strategic lines, which have materialised into 70 initiatives.

Of the 70 initiatives, **Jose Damián López, head of the Infrastructure Technology Department of the Spanish Port System,** highlights the Intermodality without barriers (E3L4-2) initiative, because the project "will enable the planning and optimisation of services and infrastructures dedicated to intermodal transport, as well as simplifying administrative procedures through centralisation in the Goods Platform, providing one-stop services and monitoring the status of goods at the same time." For José Damián López, the Plan also develops –in the field of R&D and innovation– the necessary relationships of trust between the companies in the Public Works Group, diversifying the risks and benefits associated with innovation, and increases "the value of expected results in all of the initiatives by adding to them the talent, knowledge and experience accumulated by the different organisations."

Fernando Fernández Martín, head of ENAIRE's European Convergence Division and responsible for the Innovation Plan, points out that it is difficult to choose from among the initiatives included in the Plan. While the Smart ATM initiative is key for ENAIRE (it addresses the evolution of the Spanish Air Traffic Management System to adapt it to the Single European Sky initiative), it would be unfair not to mention the *Platform for the management of unmanned aerial vehicle traffic*, because it faces the challenge posed by the arrival of unmanned aerial vehicles in our environment, on the one hand to encourage the development of new business models, while preventing this type of vehicle from posing risks for manned aircraft or citizens.

For **José Miguel de Pablo, director of CRIDA**[1], the Ministry's Innovation Plan "will enable the promotion and consolidation of the incipient implementation of Big Data techniques at the service of ENAIRE, therefore, improving the efficiency of aerial navigation services. The computing power that is currently available and the increasing degree of maturity of technologies such as Artificial Intelligence, Big Data and Machine Learning offer an alternative to the use of conventional techniques, allowing them to overcome their limitations." The Plan, he adds, "opens up a new horizon of possibilities that can range from improvements in available information and reliability and streamlining of decision making to the automation of processes through the development of intelligent predictive models. And all with one sole purpose: to improve the service provided to the passenger." ■

[1] *CRIDA is the ATM R&D+innovation Reference Centre, A.I.E. formed by ENAIRE, (66.66%), Ineco (16.67%) and the Polytechnic University of Madrid (16.67 %).*

NEW SECTION VIA A TUNNEL UNDER THE CAPITAL

NORTH SOUTH connection

THE HIGH-SPEED SECTION THAT CONNECTS CHAMARTÍN STATION IN THE NORTH OF MADRID (IN THE PHOTO) TO TORREJÓN DE VELASCO, 36 KILOMETRES SOUTH OF THE CITY, WILL OPEN IN 2018.

PHOTO_**ELVIRA VILA**

All high-speed trains from the north and north-west of the Iberian Peninsula, from cities such as León, Zamora and Valladolid, will be able to reach Valencia and Alicante by passing through Madrid via a new tunnel that links the Chamartín and Atocha stations. Likewise, for the first time, trains from southern or eastern Spain will be able to reach Chamartín directly and continue north on this new track, which, in the future, will also have a stop in Atocha once its new through-station has been built. This has been made possible thanks to the completion of a 35.86 kilometre-long stretch that runs between Chamartín station and the railway junction of Torrejón de Velasco, in the south of the Region of Madrid. The new line has 24 structures and a 6.8 kilometre-long high-speed tunnel that passes through the capital at a depth of 40 metres. Ineco provided technical assistance work and bridge and viaduct inspection of the new stretch for Adif.

By **Álvaro G. Tapia**, technical telecommunications engineer

This project, approved by the Ministry of Public Works in March 2015, is very important for Spain's rail network. When completed, the high-speed lines of the north, south and south east of the Iberian Peninsula will be connected by a 6.8 kilometre-long tunnel (7.7 kilometres including the tunnel bypass). The use of the international track gauge on the line will shorten travel times by 30 minutes by precluding the need for trains to pass through gauge changers. When the future Atocha through-station is built, Madrid's two high-speed stations will be connected.

The quadrupling of the track will increase the capacity of the railway infrastructure between Puerta de Atocha station and Torrejón de Velasco, where trains are diverted to the east or south of the Iberian Peninsula. The commissioning of these two new sections, in addition to the two existing ones, will alleviate the congestion on the saturated access lines to Atocha and speed up and facilitate greater density of rail traffic, thereby benefiting the Levante and Andalusia high-speed corridors, as well as removing the need for the existing north-south routes (such as A Coruña-Alicante, Alicante-Gijón, Alicante-Santander, etc.) to pass through several gauge changers.

OUTFITTING THE HS LINE

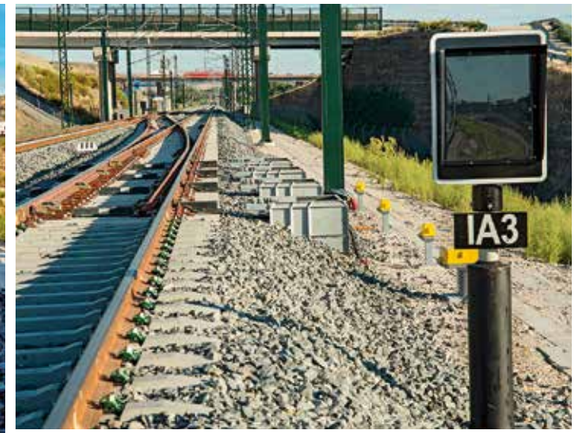
The work that the company Adif Alta Velocidad is currently completing includes track assembly, electrification and installation of safety and communications equipment, activities on which Ineco is collaborating by providing consulting services and technical assistance work for monitoring and supervision.

In terms of track assembly, the stretch is divided into two sub-sections: Chamartín-Atocha (8.21 kilometres), which consists entirely of slab track except for a small section on ballast in the transition area from double track to single track at the fork leading to the future through-station and provisional tunnel, and Atocha-Torrejón de Velasco (27.65 kilometres), where the track has been installed on ballast. The project also includes work on Chamartín station, where a railway yard with the UIC international gauge has been built at its southern end.

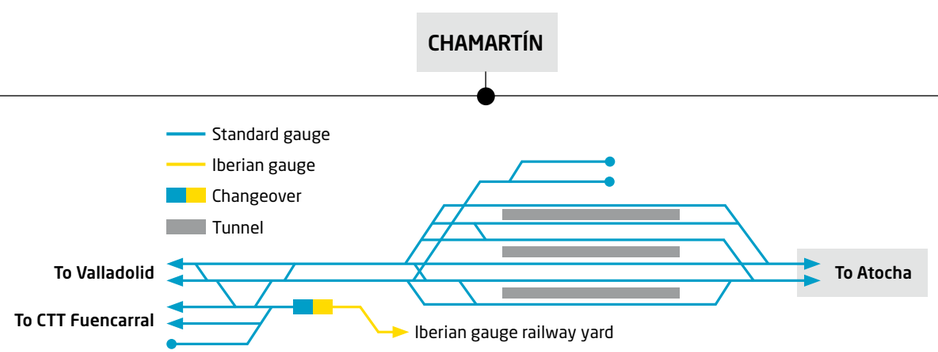
Regarding the connection of the Southern and Levante high-speed lines at Torrejón de Velasco, two parking tracks, each about 200 metres long, had to be adapted to high-speed line parameters.

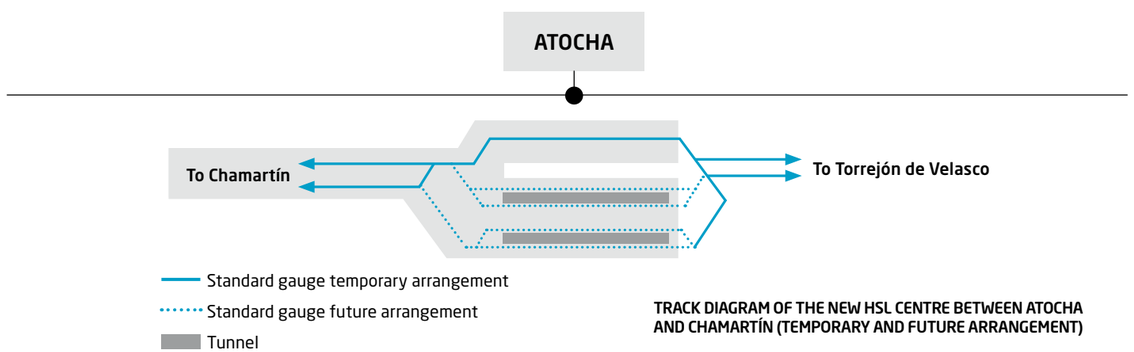
TECHNICAL ASSISTANCE
Ineco is providing technical assistance work for Adif related to the signalling, telecommunications and electrification. In the image, from left to right, Juan Antonio Sánchez, technician, and Álvaro G. Tapia, head of technical signalling unit, both from Ineco, next to a interface box.

WORK ON THE NEW SECTION
This includes the installation of interlocking systems, train protection systems, centralised traffic control, auxiliary detection systems, fixed telecommunications and protection and safety systems. Light signals, balises, point machines, power cabinets, falling objects detectors, hot box detectors, etc., have been installed. From Chamartín station -kilometre zero of the Madrid-Levante line, in the photo- to Torrejón de Velasco, ERTMS Level 1 has been installed as the main system and with ASFA as the backup system. The ERTMS Level 2 at the southern end of the station has been extended and transitions were introduced between the ERTMS and LZB systems at the Torrejón de Velasco fork to or from Andalusia.



THE NEW TRACK PASSING THROUGH VILLAVERDE
The commissioning of these two new tracks in addition to the two existing ones will alleviate congestion on the saturated access lines to Atocha and speed up traffic. In the photo, the tracks and equipment of the new section as it passes through Villaverde, south of Madrid.





TRACK DIAGRAM OF THE NEW HSL CENTRE BETWEEN ATOCHA AND CHAMARTÍN (TEMPORARY AND FUTURE ARRANGEMENT)

ALL PHOTOS_**ELVIRA VILA**

ATOCHA CHAMARTÍN TUNNEL
Madrid

THE DEEP TUNNEL THAT PASSES UNDER THE CAPITAL

The tunnel between the Madrid-Puerta de Atocha and Madrid-Chamartín stations is an essential infrastructure for the development of an international-gauge network in Spain, as it allows the interconnection of the high-speed lines that pass through Madrid, facilitating the interoperability of high-speed trains.

According to Adif, the tunnel, whose boring was completed on 11 February 2011, improves the operating model of the two Madrid stations converting them from a terminal configuration to through-stations. Commissioning of the tunnel will also facilitate high-speed train access to the Fuencarral railway workshops (in Chamartín) and Cerro Negro workshops (next to Atocha) for maintenance. Once the Atocha through-station is built, Madrid will have the luxury of having its high-speed stations connected, a situation that is still pending in other major European cities. Operators will be able to choose between Chamartín or Atocha stations for their high-speed train arrivals and departures to and from the capital.

With a length of 6.8 kilometres, the tunnel, whose boring began in 2010, runs under the city's main arteries and emblematic monuments and buildings such as the Puerta de Alcalá and the Archaeological Museum. Equipped with some of the most modern railway technology available in terms of safety and protection systems, it boasts a slab track with embedded rail, rigid overhead catenary, nine emergency exits and signalling and communication systems with a high level of safety. From the very start, Ineco participated by providing Adif with project and environmental management, geotechnical consulting, building inspection and acoustic monitoring services. Ineco was later responsible for technical assistance on track assembly, electrification and signalling.

NINE EMERGENCY EXITS

Constructed at a depth of about 40 metres, the tunnel features nine emergency exits, one per kilometre: three along Serrano and the others at Atocha, Calle Espalter, Plaza de la República Argentina and Calle Hiedra, Calle Alberto Alcocer and Calle Concha Espina. In the image, the emergency exit leading to Calle Espalter.

INSTALLATIONS ON THE CHAMARTÍN - ATOCHA - TORREJÓN DE VELASCO SECTION

SIGNALLING

▶**Enlargement of the electronic interlocking system** in Madrid-Chamartín high-speed train station, new electronic interlocking system at the Botanical Garden and modification of the system in Torrejón de Velasco.

▶**Equipment installed in the field:** audio frequency track circuits, electrohydraulic point machines, wayside LED signals, etc.

TRAIN PROTECTION SYSTEMS (ERTMS AND ASFA)

▶**ERTMS L1 train protection system and enlargement of ERTMS Levels 1 and 2,** at the southern end of Chamartín HS station and ASFA system as a second operating level.

▶**New ERTMS control centre, PCE.**

▶**Fixed and switchable ASFA and ERTMS balises,** implementation of transitions between the corresponding levels in each case (L2, L1, LZB) at the ends of the line.

FIXED TELECOMMUNICATIONS AND PROTECTION AND SAFETY SYSTEMS

▶**Fully-redundant fibre optic network** on both sides of track and fibre optic supervision system.

▶**Automatic telephone system.**

▶**Interconnection of the section's networks** with the CORE MPLS networks and the Madrid-Valladolid and Madrid-Levante sections.

▶**Video surveillance, access** control and anti-intrusion system.

▶**Integration of civil protection systems.**

AUXILIARY DETECTION SYSTEMS

▶**21 falling** object detectors.

▶**1 hot** box detector.

▶**Auxiliary detecion system telecontrol** for the integration and display of section detectors.

CENTRALISED TRAFFIC CONTROL (CTC)

▶**Enlargement** of Madrid-Valladolid and Madrid-Seville CTCs and adaptation of Madrid-Levante CTC

POWER SUPPLY

▶**Power supply** to the field equipment through a 750 V line from the line suppliers (technical buildings and signalling buildings).

▶**Electrical connections** for Chamartín-Atocha tunnel, technical buildings and electrical substations in Villaverde and El Hornillo.

BUILDINGS

▶**New technical building** at the southern end of Chamartín.

▶**Technical sites** at Canal del Manzanares and Cerro de los Ángeles.

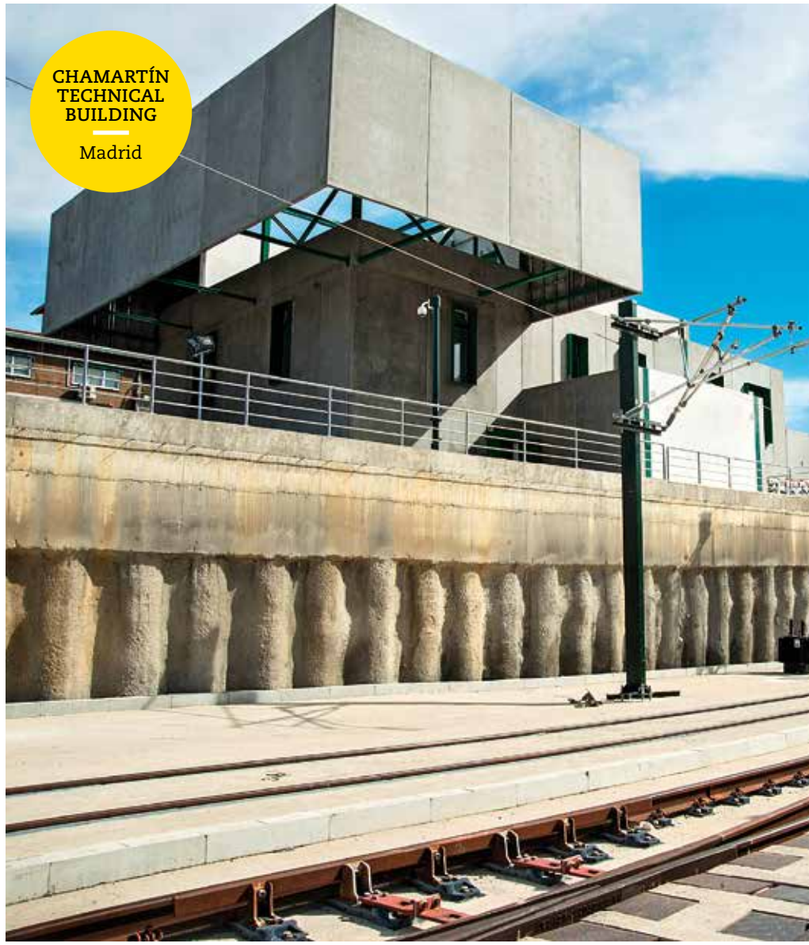
PROTECTION AND SAFETY SYSTEMS

A UNIQUE TECHNICAL BUILDING

The building has fibre-reinforced concrete panels and a tubular steel substructure, instead of the usual concrete walls, making it possible to optimize the installation of the façade insulation.

The technical building at Chamartín station on the Madrid-Chamartín-Torrejón de Velasco section has two floors to house equipment for services (power, batteries, telecommunications and signalling) as well as offices, storage areas, access roads and a platform for loading and unloading. The Siemens-Thales Joint Venture constructed the building from a project drafted by Ineco, which also provided site management with technical assistance.

In spite of the industrial nature of this type of technical building, an appearance that fit better with the urban environment was sought and achieved thanks to the choice of prefabricated GRC concrete panels (fibre-reinforced concrete), which required minimal thickness, with stiffness provided by the tubular steel substructure. The space gained was used to install the insulation, which is continuous across the façade, minimising the number of thermal bridges. This prefabricated panel system makes it possible to have many different tones, textures and designs. These details make these walls different from typical concrete infrastructure walls and make them resemble prefabricated architectural finishes used in urban construction.



CHAMARTÍN TECHNICAL BUILDING
Madrid

WATCH THE CALCULATIONS

The commissioning of the section of high-speed line between Madrid-Puerta de Atocha station and Torrejón de Velasco, slated for 2018, required the inspection of 34 new structures with a total length of 3.1 kilometres, a job carried out by Ineco for Adif.

By **Pablo S. Gareta,** civil engineer and **Jorge Navío,** forestry engineer

MADRID-LEVANTE HS VIADUCT
Torrejón de Velasco

Last summer, Ineco began carrying out load tests and inspections on all of the structures of the section between Atocha and Torrejón de Velasco of the new Levante rail access, which passes through the southern part of Madrid and the towns of Villaverde, Getafe, Pinto and Torrejón de Velasco. In total, the new tracks have 34 structures and more than 2.5 kilometres of viaducts. The work to be carried out on bridges, pergolas and viaducts in this type of contract includes full verification of the condition of the structures, consisting of formulating inventories, preliminary inspections, bridge instrumentation, carrying out load tests, as well as calculating the bridge behaviour during testing, and ending with the main inspection of each structure and completion of A1 (communication of inspections to the register of railway bridge inspections) and A2 (load test report) procedures. All of this is collected and published in the final load-test report. This ensures compliance with the mandatory Instruction on Railway Bridge Technical Inspections (ITPF-05), which regulates both inspections and load tests carried out on newly constructed bridges, as is the case, and even on service bridges.

COMERCIO STREET VIADUCT
Madrid

ABROÑIGAL VIADUCT
Madrid

▸Abroñigal viaduct
The Abroñigal viaduct is located near Atocha station, next to the C-4 commuter rail line. It covers a length of 144.5 metres and is built with three spans on a large metal structure with reinforced box-girder elements and welded joints, forming a thick sail-shaped lattice, with a reinforced concrete deck on floor slabs, joined to metal girders by metal connectors. The track layout is straight but eccentric towards the left-hand side.

The bridge can only be accessed through abutment 1 (Atocha side), fitted between the tracks on the left-hand side and the embankment towards Calle Embajadores. The access tracks to Adif's Entrevías workshop and the road tunnel from Calle Embajadores to the same workshop run beneath it. This was a vature. The structure consists of two metal lateral lattices on both sides of the railway platform, connected every 3.50 m by metal beams on which the concrete deck rests. It has a total length of 129.5 m, distributed over 4 continuous spans. The viaduct construction was executed in such a way as to minimize the disruption of public roads and rail traffic.

Its most significant infrastructure –in addition to the Chamartín-Atocha tunnel mentioned above– include the provisional tunnel under Atocha station, 879 metres long and consisting of single track, the Perales cut-and-cover tunnel (390 m), and the viaducts over Calle Comercio and the C-5 commuter rail line (127 m), the Abroñigal viaduct (149 m), the Santa Catalina viaduct (429 m over the M-40, and a total of 649 m), the 1.1 viaduct over the Madrid-Levante HSL, Seville branch (1,079 m) and the pergola over the Madrid-Seville HSL (93 m).

THREE UNIQUE METAL VIADUCTS

Of the 34 new structures, three unique viaducts stand out for their location, design and construction process:

▸Comercio street viaduct
This is a 129.5 metre-long bridge with steel structure and auxiliary elements weighing 1,130,000 kg over Calle Comercio and the C-5 commuter rail line (Móstoles-Humanes). Its highly complex construction is due to the viaduct structure with a variable radius of curconditioning factor for both the construction as well as the load test and the inspection.

▸Torrejón de Velasco: viaduct over the Madrid-Levante HSL
The section between Torrejón de Velasco and the branch that connects to the Madrid-Andalusia high-speed line runs between the municipalities of Torrejón de Velasco (Madrid) and Yeles (Toledo), and corresponds to the branch that connects the Madrid-Castilla La Mancha-Valencian Community-Region of Murcia and Madrid-Andalusia high-speed lines. The railway track is over 7 kilometres long. This section's most notable elements include the construction of a 1,079 metre viaduct and a pergola 93 metres long.

In the case of the load test, in order to avoid interfering with the lower track, the vertical sag or deformations of the metal deck of span 10 was measured using a laser.

In terms of the inspection, it posed the usual difficulties of a viaduct of this size, such as inaccessible metal elements, except for the deck, which has hatches in the bottom sheet in sections 9 and 11, next to the part that joins to the concrete deck. ■

A Talgo train during the dynamic tests managed by Ineco's Traffic Control team.

PHOTO_DANIEL BENITO

Test pilots

Since 2014, a team of Traffic Control experts from Ineco has been working on the new 450-kilometre high-speed line between Makkah and Madinah, from the construction phase to the management of tests before the line opens for commercial operation.

By **Javier Pulido,** civil engineer, and **Daniel Benito,** public works technical engineer, head of the Haramain Project's Traffic Control team

The responsibilities of the Traffic Control manager include managing the different operations carried out on and near the track in order to ensure safe and proper functioning, whether they be construction activities or train and subsystem tests. However, given the international nature and complexity and magnitude of the project (it is very similar in length to the Madrid-Seville high-speed line in Spain), work on the new line between Makkah and Madinah has an organisational and operational structure that is different from the structure used in Spain.

The Traffic Control work is based on the *Procedure of Traffic Control in Construction Phase for HARAMAIN HSR*, or *PTCH* as it is known in Saudi Arabia. This regulation, drafted by Ineco, was prepared from the Spanish version, and excellent results have been achieved in terms of railway safety over these years thanks to its correct application. This regulation is the standard reference for the Traffic Control manager and workers from other companies involved in the project, and is essential for ensuring successful daily interaction between them.

For the first time, Spanish High Speed (AVE) technology has been introduced to Saudi Arabia, a country in which the presence of railways is limited or non-existed in cities such as Jeddah. Much of the construction work on a high-speed line begins in the work bases, which serve as headquarters for Traffic Control managers in their daily routines. In the case of Saudi Arabia, Ineco staff teams have been living in camps alongside these work bases –such as the one in Rabigh– in order to be as close as possible to the works, reduce travel time and minimise the risk of accidents.

The Traffic Control manager has full authority over the operation of the different activities carried out on the track for its safety and optimum functioning. Whether operating from an auxiliary control centre, the main control centre or with a walkie-talkie, he provides all necessary information to the train drivers and is responsible for running the trains at intervals between stations and supervising, for traffic control purposes, the activation of junctions and remotely controlled systems by installation companies .

Traffic Control teams like the one working on the Haramain Project must be able to communicate successfully and overcome the language barriers that exist between workers from many different countries, including Pakistan, the Philippines, India, Bangladesh, Sri Lanka, etc., in addition to Spain. ■

In the image, Ineco's Traffic Control team in Saudi Arabia last November. From left to right: Samer Yousef, Traffic Control manager; Juan José Lozano, Operations manager; Daniel Chantada, Traffic Control manager; Javier Pulido, Haramain Project manager; Daniel Benito, Haramain Project manager; Ahmed Bakkali, Traffic Control manager; and Juan Carlos Fernández, Traffic Control manager. The final member of the team is Traffic Control manager Álex Barbancho.

PHOTO_MIGUEL A. LÓPEZ GALÁN

Installation of a turnout on the Makkah-Madinah line with different track machinery during a track closure. In the foreground, a track-laying machine, in the middle, a turnout installation gantry, and, in the background, a locomotive with towed platforms.

MEDELLÍN
In the centre of the image, the Rafael Uribe Uribe Palace of Culture, and, in the foreground, Metro de Medellín's Line A.

Metro de Medellín, exemplary endeavour

Medellín was the first city in the world to use cable cars for public transport. On these pages, we interview Tomás Elejalde, the general manager of Metro de Medellín.

In recent years, Medellín has won a number of awards for management and urban planning, culminating in 2016, with the highest honour possible for a city: the Lee Kuan Yew World City Prize. This prestigious prize –whose only previous winners are the cities of Suzhou, New York and Bilbao– is awarded after thorough assessment of specific initiatives to transform urban environments, generating social, economic and environmental benefits that serve as a model for communities around the world.

The management of transport in the city of Medellín has much to do with this success. More than 20 years of 'Metro Culture' have resulted in a significant decrease in inequality and an upsurge in civic spirit and modernity. With its positive and uncompromising policy of social transport, for the past 22 years, Metro de Medellín has been the torch bearer lighting the way to new paths for this city of 2.5 million inhabitants, which used to be synonymous with danger. Medellín's public transport network, which today boasts a metro system, Metrocable, buses and bicycles, and is accessible through a single-ticket system, has managed to unite the city's districts and pull its people out of the ghettos. It has also helped reduce traffic congestion and noise and pollution levels. What is more, it has become an exemplary urban transport system thanks to the participation of citizens.

In an interview with *ITRANSPORTE*, Tomás Elejalde, the general manager of Metro de Medellín, tells us that "Metrocable is one of our most innovative projects because, although cable car technology has existed for many years, Medellín is the first city in the world to use it for medium-capacity public transport and integrate it into a multimodal network like the one operated by Metro de Medellín." Elejalde adds that this system was necessary due to the Medellín metropolitan area's geographic characteristics and location in a narrow valley whose mountainsides are home to people with limited economic resources. "Thanks to the Metrocable lines, the inhabitants of these districts are now able to integrate with the rest of the territory rapidly, economically and safely. We currently have four in commercial operation, one under construction and another one whose construction contract has just been awarded," he concludes.

Since 2011, Ineco has collaborated with Metro de Medellín on, among other work, upgrading its fleet, overseeing the design, manufacture, reception and commissioning of its new CAF trains, including onboard signalling equipment (ATC).

PHOTO_ OFFICIAL GUIDE OF MEDELLÍN (FLICKR)

METROCABLE
Over the past 20 years, there has been a noticeable decrease in inequality and an upsurge in civic spirit and modernity. In the image, Line K in the direction of Santo Domingo Savio.

PHOTO_METRO DE MEDELLÍN

TOMÁS ELEJALDE

“‘Metro Culture’ can be defined as the building of a civic culture framed by respect and solidarity”

Tomás Elejalde has been with Metro de Medellín for more than 20 years and has held different positions of responsibility. Before his appointment as general manager in 2016, he worked for four years as head of Operations, Planning and Projects for the Metro de Medellín integrated network, a multimodal system that began operating in 1995 and which currently has two metro lines, four Metrocable lines (cable cars for urban passenger transport), two BRT (Bus Rapid Transit) lines and one tram line. Considered as an international benchmark, Metro de Medellín has become a symbol of cohesion, social welfare and environmental sustainability.

EXPERT IN URBAN TRANSPORT
Tomás Elejalde was educated as an engineer at Cologne University of Applied Sciences and studied Business Administration and Economic Engineering at the University of Mönchengladbach in Germany. In this interview, we ask him about the future plans for a network that covers more than one million journeys per day in a city with a challenging geography.

What is the key to successfully managing the operations of a complex network that includes metro trains, buses and now also trams, in addition to Metrocable?
The most important aspect is having a team that is flexible enough to understand that they are part of a multimodal network, while at the same time, having the specific technical training required to address the specific aspects of each mode of transport. This refers to operations and maintenance because customer service is completely integrated. The goal is for users to experience a sense of continuity in their journeys regardless of the transfers they make; this is why all of the staff who come into contact with users have the same training and work under the same service parameters.

Coordinated operation is possible because we have a main control centre that provides us with a complete overview of the operations of the different lines. Because it is an interconnected system, what happens on one of them can have repercussions on others. The operation of all of the lines is controlled from the same point, and this enables us to make comprehensive decisions in real time.

> “Metro de Medellín is a multimodal system that currently has two metro lines, four Metrocable lines, two BRT lines and one tram line”

How important has intermodal integration been in this stage?
The different modes of transport that make up our system are integrated at the physical, operational and fare levels. The physical level is important because it ensures that users experience a sense of continuity in their journeys, no matter how many transfers they have to make. Operational integration, which consists of a single company operating the four modes of transport, makes it possible for timetables and standards of service to be the same, and also makes it easier to have a complete overview of the operation of the system, which facilitates decision making in real time. Fare integration is achieved thanks to the Civica card, a contactless payment method that allows users to travel on the different modes of transport with a single payment.

What would you highlight about your expansion plan?
The Metro de Medellín Expansion Plan is one of the five plans that make up the 2006-2030 Confidence in the Future Master Plan, which was drafted taking into account the existing plans of the 10 municipalities of the Aburrá Valley Metropolitan Area. This makes it possible to articulate the 19 projected transport corridors in the same way that the city/region is projecting its development. In addition, the inclusion of the Expansion Plan in the Master Plan ensures that the new lines that are being developed have the human, physical and technological resources needed for proper implementation.

> “The intention is for users to experience a sense of continuity in their journeys regardless of the transfers they make”

Another important aspect is that the 19 corridors defined in the Expansion Plan have been designed to cover current and projected demand, but the technology to be used has not been established *a priori*. This decision is made on the basis of a multi-criteria matrix which makes it possible to technically determine whether it is more suitable to build a tramway, Metrocable, BRT or heavy metro, or even adopt new technologies, in that particular corridor.

Lastly, I would like to highlight that the Master Plan is revised every five years in order to adapt to the dynamics of population growth and the way in which the inhabitants appropriate the territory. Last year, we made an adjustment that incorporated new criteria for the revision, among them linkage to the human mobility system and the structuring system –environment, landscape and public space– so that it can contribute more effectively to the sustainability of the city/region.

> “Fare integration is achieved thanks to the Civica card, a contactless payment method that allows users to travel on the different modes of transport with a single payment”

The Expansion Plan is accompanied by identification of possible funding resources, for which a Business Plan has been formulated to identify funding sources through non-fare resources which include businesses associated with transportation and the possible application of the value of the land generated by our system in each one of the planned corridors.

How many patents do you currently have and which one would you highlight?
Four patents have been granted to Metro. The first one was obtained in October 2015 after two years of research, which culminated in the creation of a *Vehicle Traffic Monitoring System* at the point of connection and operation between the cable, car, station and support clamp, in a cable car transport system. As the name indicates, the development is used to monitor the movement of vehicles. The second patent was granted in December 2015 for the *Hub for the acquisition of railway vehicles and acquisition method*, which optimises vehicle performance. Also in December 2015 and after 24 months of research, the company was awarded a patent for *Diagnovision*, a system and method for the inspection of the geometric parameters of railway vehicle wheels.

> "The Expansion Plan is accompanied by a Business Plan which makes it possible to identify funding sources through non-fare resources"

Lastly, in February 2016, Metro de Medellín received the patent for *Diagnodefect*, a device used for the automated inspection of the roundness of rolling stock wheels on rail tracks. Rather than highlighting one of them in particular, I would like to emphasise the collaborative work work with universities and local industry that underlies each one.

From the beginning, Metro de Medellín has added a social and even educational dimension to urban transport which has been called 'Metro Culture'. Can you explain what this is and who it is aimed at?

OTHER COMMERCIAL DEVELOPMENTS AND BUSINESS LINES

Metro de Medellín's Business Development Management is working on three lines with the goal of earning 10% of its revenue from businesses associated with transport by 2020:

1. TECHNOLOGY BUSINESSES

These operate the Civica system (contactless smart card used as a means of payment) to provide the electronic fare collection service in the area of transport, facilitating intermodality, access to city services and the activation of demand for the commercial sector. They also include businesses related to co-branded cards and digital marketing.

2. KNOWLEDGE BUSINESSES

These use the knowledge and experience of Metro de Medellín to support Latin American cities in the study, design, implementation and operation of comprehensive solutions for sustainable mobility. These businesses essentially include the planning and structuring and operation and maintenance of transport systems and sustainability, social management and 'Metro Culture'.

3. URBAN MANAGEMENT BUSINESSES

These seek existing opportunities in the areas of influence of public transport corridors. Sectors with high potential for hosting development and urban renewal operations are identified in the vicinity of Metro system stations. Analysis is part of the financial sustainability of the entire system, generating resources for its expansion, increasing the number of users and contributing to the consolidation of a sustainable city model. These businesses also cover the administration and exploitation of the company's property, either through the leasing of commercial premises, advertising or specific operations in the public space.

'Metro Culture' is effectively an educational and cultural initiative of Metro de Medellín which can be defined as the building of a civic culture based on respect for oneself, respect for others and respect for the public and calls for peaceful coexistence, good behaviour, solidarity and compliance with the basic rules of use of the system and the city's spaces.

Its target audience includes all of the company's stakeholders because 'Metro Culture' is an integral part of the strategic guidance. This means that when interacting with Metro de Medellín, all of the different stakeholders are impacted by it. Users, for example, receive ongoing training in the proper use of the system and the patterns of behaviour that must be observed in it, while enjoying opportunities that bring them into contact with the arts, music and literature during their journeys. Communities in the areas of influence are also participants in educational actions, as well as recreational and cultural activities. The Human Talent area endeavours to ensure that culture of the organisation, and with all stakeholders, also preserves the principles of 'Metro Culture'.

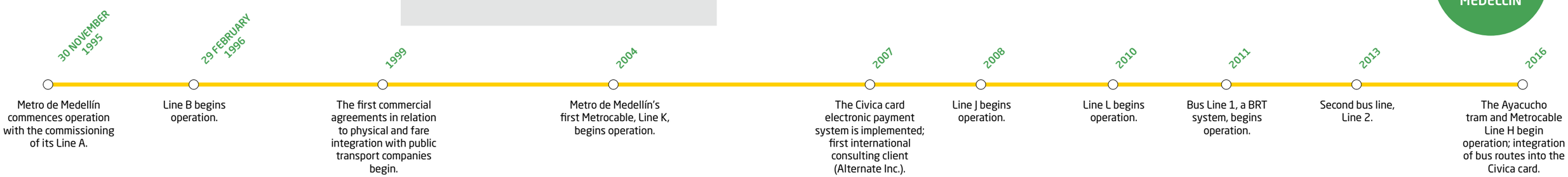
Innovation has always been one of your major commitments, what are your most innovative projects?
Without a doubt, Metrocable. Our Metrocable lines represent innovation in processes, as well as social innovation. Since cable cars are normally used in ski resorts, the operators have all of the summer months to perform major maintenance. In Medellín, because it is a public service whose malfunctions radically affect the most vulnerable communities, we have found it necessary to adapt maintenance routines in order to carry them out within no more than 10 days.

What would you say are Metro de Medellín's major milestones or achievements over the last 22 years of commercial operation?
As in any transport system, the beginning of the commercial operation of each new line is an important milestone. In addition to the milestones shown in the figure, there are others, even before the start of commercial operation. 'Metro Culture' began in 1988. Another milestone that we are very proud of occurred in 1999 when we were able, for the first time, to replace train wheels in our own workshops, instead of having to send them to Germany. This marked the beginning of a policy of import substitution and collaboration with academia and local industry.

2007 was also an important year, in which the company, Alternate Concepts Inc., an urban train operator from San Juan, Puerto Rico, became the first international client of the associated consulting business. Since then, we have carried out consulting, technical assistance and support work in the planning and execution of preliminary and operational stages of public transport systems, covering the management of operations, fare collection management, social management, communication and civic culture around sustainable mobility. Our main international clients include the cities of Panama, Lima and Rio de Janeiro. In Colombia, we have supported the cities of Bogotá, Cartagena, Bucaramanga, Ibagué, Santa Marta, Montería, Soacha, El Peñol and significant mobility policy agreements with Colombia's Ministry of Transport. ■

> "Communities in the areas of influence are also participants in educational actions, as well as recreational and cultural activities"

MILESTONES IN THE HISTORY OF METRO DE MEDELLÍN



SIR DONALD SANGSTER INTERNATIONAL AIRPORT
Ineco is working with the company MBJ Airports to produce a Master Plan and provide various specialized engineering and consulting services for both land and airside facilities.

On the shores of the Caribbean

Ineco celebrates a decade working for Jamaica's main tourist airport, located in Montego Bay: most recently, on a redesign of the check-in area inspired by the natural environment –the airport is located by the sea– and supervision of airfield works. A decade in which passenger traffic has continued to grow, reaching almost four million in 2017.

With the collaboration of **Roberto Serrano** and **Rubén Hernando,** aeronautical engineers

In December 2008, the initial meeting was held to launch the first Master Plan 2008-2028 for Sir Donald Sangster International Airport in Montego Bay, Jamaica's second largest city in terms of population and the tourist capital of the country. It was Ineco's first job, completed in 2009, at an airport that receives more and more visitors every year, almost four million in 2017.

The growth of the airport in recent years has required various expansion and modernisation projects implemented by its operator, the company MBJ Airports, which was granted a 30-year concession by the Jamaican government in 2003. Over the course of these ten years, Ineco has collaborated with MBJ not only by producing the Master Plan (see *IT24*), which it updated in 2015, but also by providing various specialized engineering and consulting services for both land and airside facilities.

TAXIWAY RESURFACING

The company is currently overseeing resurfacing work on the airport's taxiways, which is being carried out in stages so as not to disrupt operations. Although other

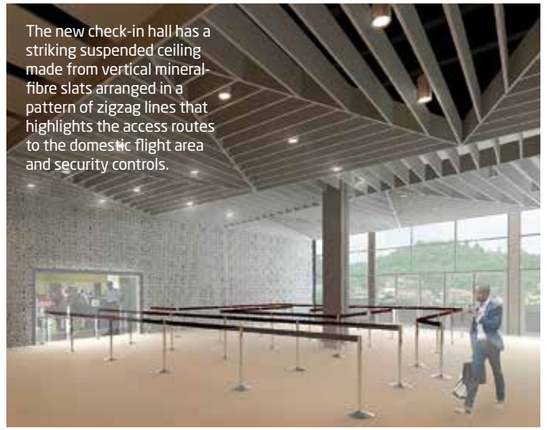
improvements were made previously to the runway, also under Ineco's guidance, (see the box at the end of the article), this is the first time that Sangster International Airport has undergone a project of such magnitude, with work also being carried out during the day.

This required careful planning and maximum attention to operational safety, and Ineco, in collaboration with the operator, was responsible for providing the contractor's personnel with specific training before the work started in 2017. Ineco also advised MBJ Airports on the design of the public tender for the works, which are expected to be completed by the end of 2018.

CHECK-IN AREA REFURBISHMENT

On the landside, the check-in area, which covers some 5,000 m^2 and boasts 100 counters, will also be modernised thanks to an Ineco design and architecture project. The design is inspired by the natural environment of the island, which attracts holidaymakers –mainly from the US and Canada, but also from the rest of the world– who come for its beautiful beaches, the warmth of its tropical climate and its lush natural surroundings. Diving is one of the most popular tourist activities, and the airport space has been designed to convey the seabed and coral reefs. The new design uses modern and sustainable materials to refurbish an area that shows signs of intensive use and the passage of time.

The floor will be covered with large rectangular tiles made of a special porcelain stoneware for high traffic, with a polished sand-coloured finish. The existing check-in hall has different heights and irregular planes that need to be made more uniform in the design, so two suspended ceiling solutions were chosen to fulfil this purpose, and, at the same time, differentiate the various areas: a suspended metal ceiling consisting of corrugated aluminium panels that evoke ocean waves in the check-in area, and another suspended ceiling consisting of vertical mineral-fibre slats arranged in a pattern of zigzag lines, which highlights the access routes to the domestic flight area and security controls. These materials form a lightweight and sturdy suspended ceiling that covers and adapts to the existing height differences, and leaves room for the installation of an efficient and completely renovated LED lighting system and upgraded HVAC.



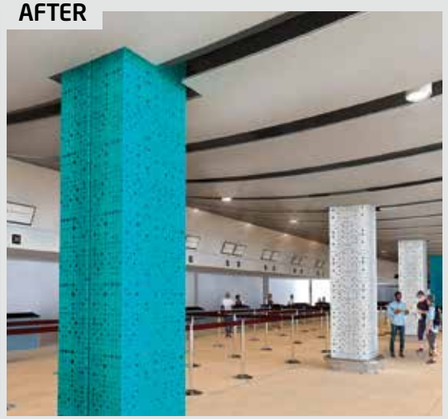
The new check-in hall has a striking suspended ceiling made from vertical mineral-fibre slats arranged in a pattern of zigzag lines that highlights the access routes to the domestic flight area and security controls.

THE USE OF BIM TOOLS HAS PLAYED A VITAL ROLE IN THE CLIENT'S DECISION MAKING

As different building services elements (fire protection, HVAC, electricity, etc.) cluttered certain walls and columns, a die-cut sheet metal wall covering solution in three shades of blue was selected, evoking the bubbles and the tones of the Caribbean Sea. The Ineco project also includes a complete refurbishment of the toilets on the landside, with improved accessibility and equipment. It should be noted that the use of BIM tools has played a vital role in the client's decisions to select the materials, colours and designs from among the different alternatives. ■

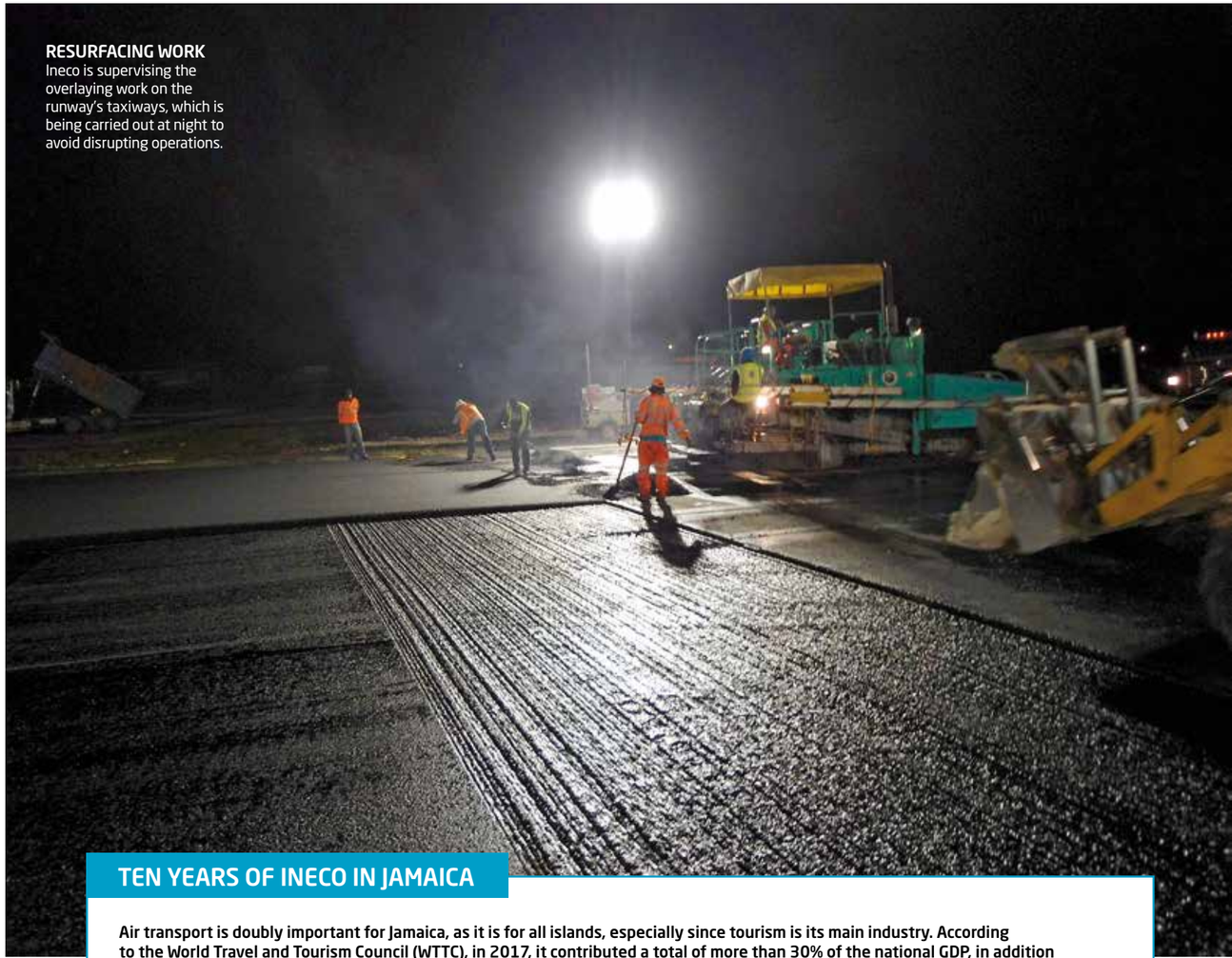
BEFORE

AFTER



The photo on the left. The existing check-in hall has different heights and irregular planes that needed to be made more uniform.

The photo on the right. The new design uses modern, sustainable materials to refurbish this area, which has started to show the signs of intensive use and the passage of time.



RESURFACING WORK
Ineco is supervising the overlaying work on the runway's taxiways, which is being carried out at night to avoid disrupting operations.

TEN YEARS OF INECO IN JAMAICA

Air transport is doubly important for Jamaica, as it is for all islands, especially since tourism is its main industry. According to the World Travel and Tourism Council (WTTC), in 2017, it contributed a total of more than 30% of the national GDP, in addition to generating 318,500 jobs (direct and indirect).

Residents and business travellers mainly use the airport in the capital, Kingston, which also manages 70% of the country's air cargo, while Sangster International Airport mostly receives tourist traffic. The work carried out by Ineco since 2008 includes planning, support for the development of tenders, site supervision and management, and project drafting.

▶ **Master Plan (2008-2009).** A Master Plan is a planning tool that makes it possible to anticipate the needs of the airport in the short, medium and long term, on the basis of different demand scenarios.

Ineco boasts extensive experience in this field, acquired in Spain's 46 airports and abroad. It is currently working on one for King Fahd International Airport in Damman, Saudi Arabia.

▶ **Project for a new fire station (2012-13).** The runway improvement work required the relocation of the airport's fire station. Ineco studied different sites and finally decided to locate it north of the runway, next to the security fence. The new building was designed with 1,529 m^2 of floorspace and an outdoor parking area for five fire engines. The building includes offices, rest areas, storage rooms and workshops, as well as an access road to the runway for emergency vehicles.

▶ **Project drafting, monitoring and supervision of various works on the runway and the construction of a new fire station (2012-2014).** The company drafted the project for extending the airport runway in the threshold 25; the project for resurfacing the perimeter road and constructing the fire station and its access road from the runway; and undertook monitoring and supervision of these works, which were carried out at night (in seven-hour shifts per night).

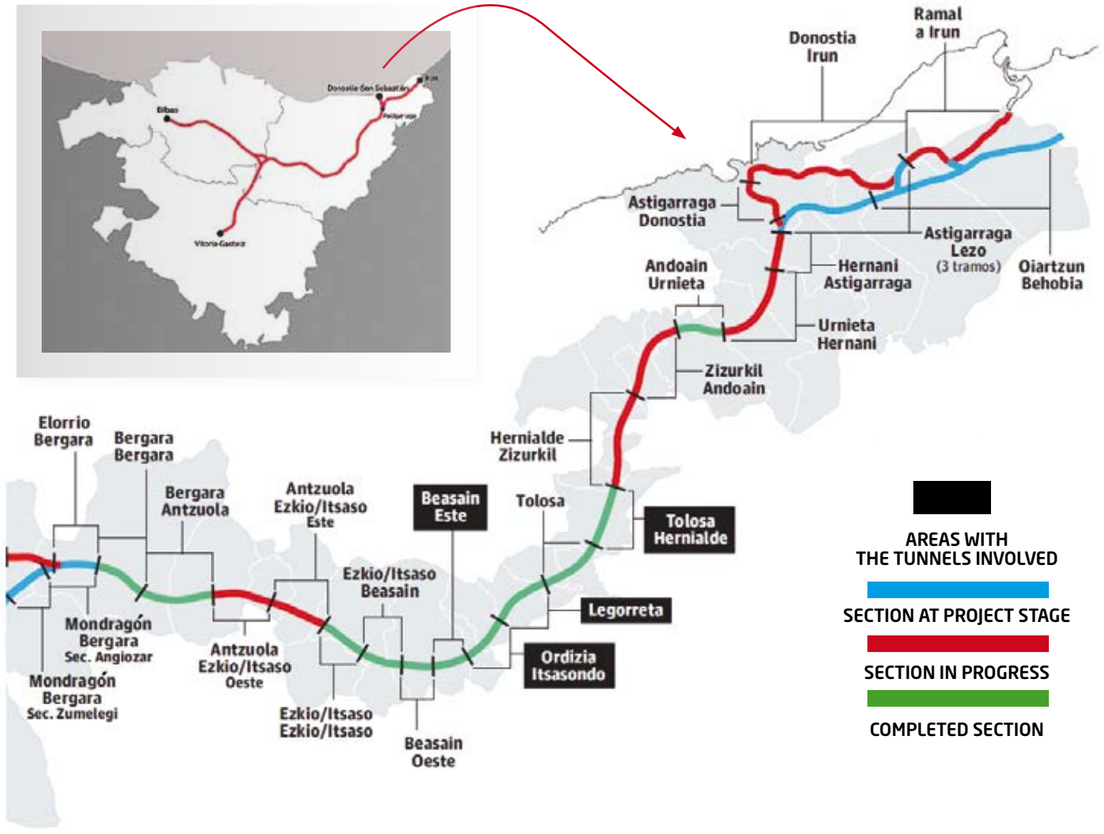
▶ **Update of the Master Plan (2015-2016).** Every Master Plan requires periodic updating based on the evolution of demand. Ineco started the updating of the Sangster Master Plan in August 2015, works that lasted for 16 months.

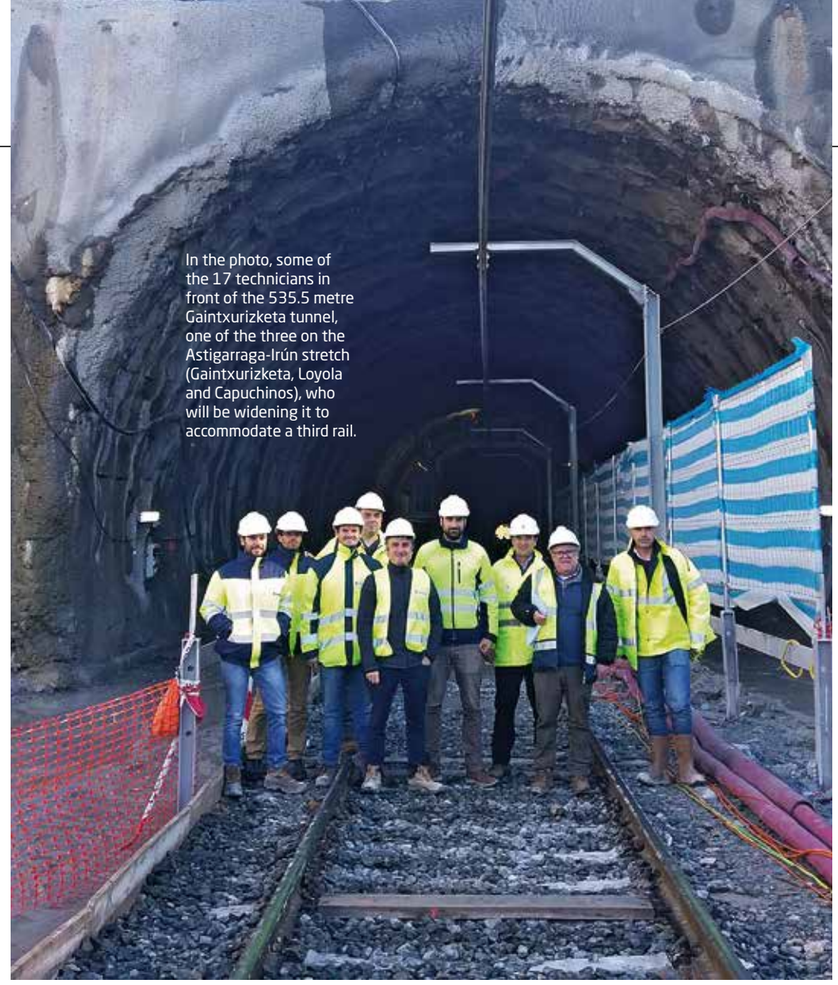
▶ **Design of the airfield's resurfacing works (2015-2016).** After the resurfacing of the runway in 2013, certain areas of taxiway and apron still needed improvement, and Ineco was responsible for drafting the preliminary and detailed design projects. The execution of these works started in July 2017 and they are scheduled to end in December 2018.

Major efforts to complete the 'Basque Y'

The project to adapt the Astigarraga-Irún line to the international track gauge with the installation of a third rail involves complex adaptation of all aspects of the existing line. This is particularly the case with the Gaintxurizketa tunnel, where an innovative tunnel boring machine, specially designed to allow trains to pass through, is playing a key role in the works. For the works on this line, ADIF has commissioned a team of Ineco engineers and technicians to undertake the project, management and technical assistance.

By **Eduardo Muñoz,** civil engineer, and **Antonio Piña**, public works engineer




In the photo, some of the 17 technicians in front of the 535.5 metre Gaintxurizketa tunnel, one of the three on the Astigarraga-Irún stretch (Gaintxurizketa, Loyola and Capuchinos), who will be widening it to accommodate a third rail.

The works to install a third rail on the Astigarraga-Irún stretch in Guipúzcoa will make it possible to extend the 'Basque Y' –the future high-speed line between Vitoria, Bilbao and San Sebastián– to the French border via the Madrid-Hendaya national gauge line.

The Basque Regional government and the Ministry of Public Works, through the Monitoring and Coordination Commission for the Construction of the New Railway Network in the Basque Country, agreed to accelerate the entry into service of the different stretches that make up this network in the area around San Sebastián. With this objective, at the end of 2011, it was decided to install a third rail on the national-gauge line between Astigarraga and Irún to enable high-speed trains to use the new infrastructure, make commercial stops in the centre of San Sebastián, at Atocha station and continue on to Irún and France without the need to perform reversing or gauge-switching manoeuvres.

The works executed by Adif, in which Ineco is participating, include actions on the infrastructure, track, catenary and safety systems along the 20-kilometre route, with the adaptation of tunnels, metal bridges, stations and stops for mixed traffic situations taking on special significance.

EXCAVATION WITHOUT DISRUPTING RAIL TRAFFIC

The installation of a third rail in a conventional, so-called 'old', network with a completely urban track layout is a complex task that encompasses all of the structural and technical aspects of the railway line. The most challenging action though is undoubtedly that of enlarging the three tunnels on the Astigarraga-Irún stretch (Gaintxurizqueta, Loyola and Capuchinos) in order to comply with the values established in the Railway Gauge Instruction. The return to rail freight transport involves the use of intermodal transportation and the need for increasingly wider gauges

THE WORKS EXECUTED BY ADIF AND INECO INCLUDE ACTIONS ON THE INFRASTRUCTURE, TRACK, CATENARY AND SAFETY SYSTEMS

THE MINISTER'S TWEET

The minister of Public Works, Iñigo de la Serna, on his first visit in February 2017, oversaw the start of these works, which will cost more than 160 million euros, including construction and supplies. Several months later, in September, he inspected the operation of the construction system and the possibilities it offers for adapting the network to the new needs of rolling highways.

on infrastructures that date back to the nineteenth century. Although these have been adapted over time, a major overhaul is now necessary in order to meet the new requirements. This represents a widespread problem for railway networks that must be addressed. In order to minimize disruption of rail services, Ineco has used a new construction system that has been implemented over recent years in Europe and introduced it in Spain. It involves making tunnel widening, excavation and new support placement work compatible with the passing of trains over an interior central track. This also has the added complexity of allowing trains to run on an electrified track.

To this end, Ineco technicians from all specialisations have designed a provisional arrangement that makes the widening machine compatible with the 3,000 V overhead lines.

THE DEVELOPMENT OF A PROTOTYPE TAILORED TO THE NEEDS OF SPAIN

The German firm Herrenknecht, a company with extensive international experience in the development of tunnel boring machines, has been in charge of adapting and developing its prototype to the current needs of the tunnels on the Astigarraga-Irún line.

Model TES D-835 consists of 4 modules, each with a different function (shield, excavation and shotcrete, pipe umbrella drilling and auxiliary facilities) that are assembled together. This model was designed to allow it to be used in other geological areas and to widen tunnels up to 2 metres.

THE PROGRESS OF THE 'BASQUE Y'

The infrastructure of the high-speed rail connection that will link the three provincial capitals of Euskadi with France and the rest of the Iberian Peninsula is currently being executed.

The 'Basque Y' is a 180.5 kilometre railway line –not including access routes to cities– which will connect the capitals of the three provinces of the Basque Region, Vitoria (Álava), San Sebastián (Guipúzcoa) and Bilbao (Vizcaya), by means of a high-speed network. It connects with the rest of the Iberian Peninsula and France, via Pamplona, through the Navarre Corridor and allows the Madrid-Valladolid-Vitoria line to be extended to the French border.

This line consists of two different branches: Vitoria-Bilbao, 90.8 kilometres, and Bergara-San Sebastián-French border, 89.7 kilometres. It will have six stations: Astigarraga, Bilbao-Abando, Vitoria, Irún, San Sebastián-Norte and Ezkio-Itsaso. The mountainous geography of the region has required the construction of 44 viaducts and 23 tunnels. ■

MODULE 1.
Vault support shield

Function: to support the original tunnel vault prior to and during final tunnel excavation and support work.

MODULE 2.
Excavation and shotcrete equipment

Function: to remove the original tunnel lining and excavate the ground until the final planned width of the tunnel is reached.

MODULE 3.
Drilling machine

Function: to execute micropile umbrella drilling inside the tunnel.

MODULE 4.
Auxiliary facilities

Function: to house the devices that enable the support, excavation and drilling units to operate.

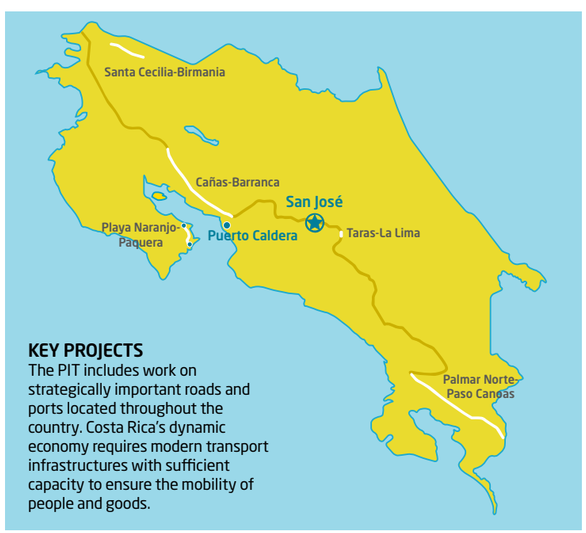
INECO PART OF A COMPREHENSIVE ACTION: PROJECTS, SITE MANAGEMENT AND TECHNICAL ASSISTANCE

Ineco has provided its services to Adif at all stages of the Astigarraga-Irún project. In December 2012, it drafted the functional project for Adif to integrate the Astigarraga-Irún stretch into the Basque Country's new railway network, which includes the infrastructure, energy, control, command and signalling subsystems. In the design and planning phase, the construction projects for the entire stretch were drafted: track assembly, overhead contact line and associated systems, facilities and signalling control points, train protection systems, CTC, auxiliary detection systems, fixed telecommunications and security systems.
In the construction phase, the company's experts are carrying out site management of the track, signalling and telecommunications and technical assistance and monitoring and supervision of the work of all specialisations. Their functions include qualitative, geometric and quantitative controls, budgetary monitoring with study of deviations, monitoring of work schedules, document control, issuance of reports, etc. Other companies executing the works include COPROSA (infrastructure and track), the Electren-Elecnor consortium (overhead contact line) and the Siemens-CAF Signalling consortium (safety and communication systems).

Routes to the future

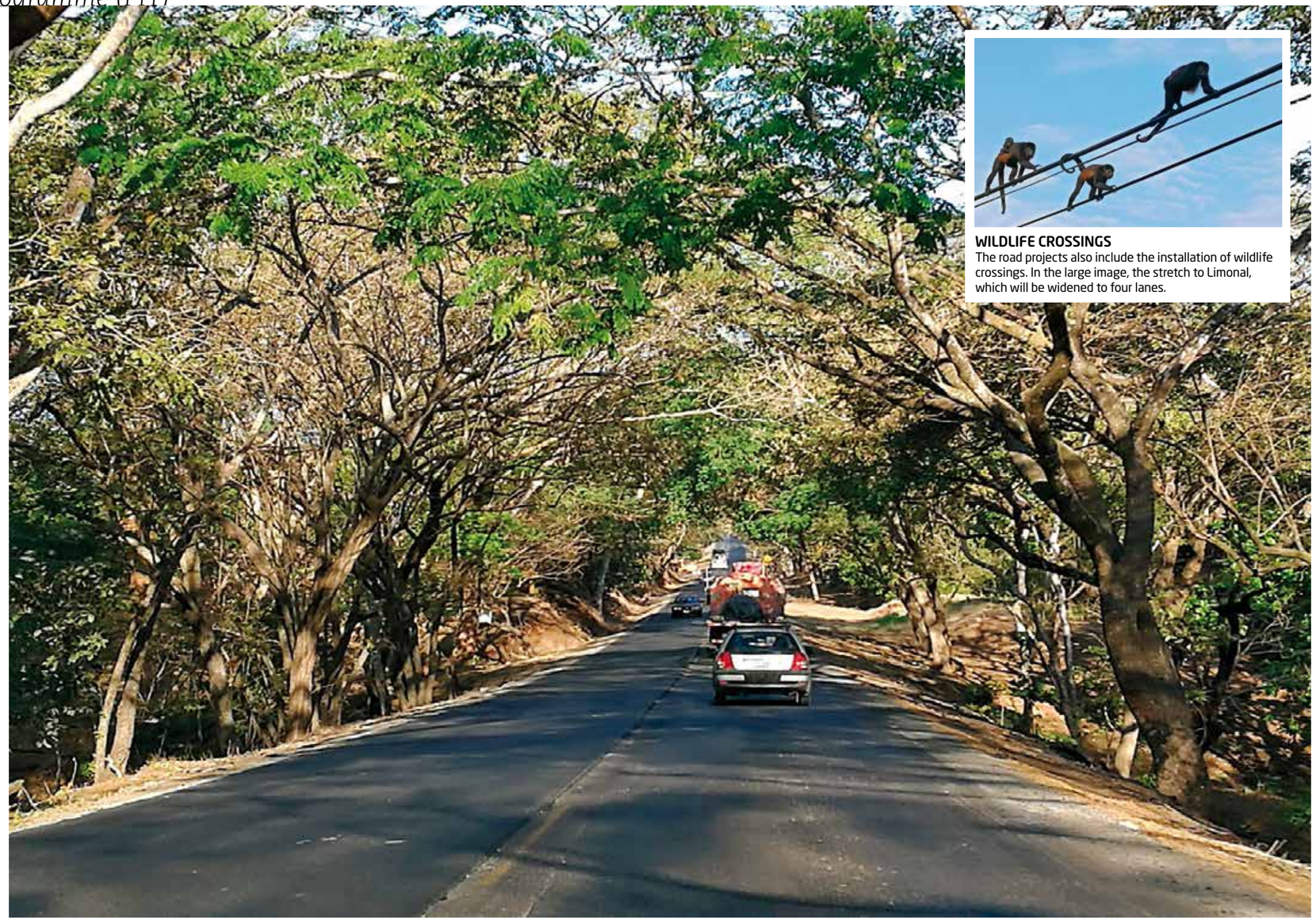
With 4.9 million inhabitants and an annual growth rate of more than 4%, over the last three decades, Costa Rica has managed to diversify its economy, based on tourism, services and exports. To ensure that growth does not stop, the country is striving to modernise its transport infrastructure. Roads and ports are critical, and Ineco, in partnership with Acciona, is managing an infrastructure design programme known as the PIT for the Ministry of Public Works and Transport (MOPT), slated to run until 2020.

With the collaboration of **Ignacio Gálvez,** civil engineer



KEY PROJECTS
The PIT includes work on strategically important roads and ports located throughout the country. Costa Rica's dynamic economy requires modern transport infrastructures with sufficient capacity to ensure the mobility of people and goods.

IMAGE_RAQUEL HERNÁNDEZ (INECO)



WILDLIFE CROSSINGS
The road projects also include the installation of wildlife crossings. In the large image, the stretch to Limonal, which will be widened to four lanes.

Over the last decade, Costa Rica has undertaken several action plans to improve its transport infrastructure, an objective with which Ineco has been collaborating since 2004 with work that has included a modernisation plan for the airport network, a National Transport Plan and a feasibility study for the implementation of a rail transport system in the metropolitan area of the capital, San José (see *ITRANSPORTE* 50).

Improvement programmes for all transport networks continue, and the Ministry of Public Works and Transport is now working on a new one, known as the Transportation Infrastructure Programme (PIT), financed by two loans from the Inter-American Development Bank (IDB) to the tune of 450 million dollars. To carry out all administrative, technical and environmental management of the projects, the Ministry, in collaboration with the IDB, issued an international call for tenders which was won by a consortium formed by Ineco and Acciona. Since mid-2016, the consortium has been responsible for the comprehensive management of the programme, which includes infrastructure projects of strategic im-

SINCE 2004, INECO HAS COLLABORATED ON SEVERAL PROGRAMMES TO IMPROVE COSTA RICA'S TRANSPORT INFRASTRUCTURE

INECO'S WORK

In order to ensure that all of the designs are carried out on time and, that they comply with all technical and environmental requirements, the Ineco-Acciona consortium acts as an overall manager and carries out a wide variety of administrative, technical, legal and environmental tasks, in addition to technical and economic-financial control and supervision.

Another one of the tasks of the consortium as the "execution unit" of the PIT is social management, which involves, for example, organising meetings with owners and residents, both to inform them about the projects and to hear their petitions and suggestions. These meetings also emphasize another very important aspect: road safety.

The internal operation of the programme is governed by the principles of the Project Management Institute, and progress is monitored continuously using a series of applications of the Programme Execution Plan (PEP).

portance for roads and ports which will complete and provide continuity to previous ones.

This is the case with the design of the upgrading and widening to four lanes of three stretches of the RN-1 Northern Inter-American Highway between the towns of Cañas and Barranca. This section is part of the Inter-American Highway, which is the name for the Central American section of the Pan-American Highway, an extremely long network of roads measuring 48,000 kilometres in total that runs the entire length of the continent from Alaska to Ushuaia in Argentina. The Costa Rican section of this road is of great importance for the internal mobility of people and goods. It crosses the entire country in two large sections, known as the Northern and Southern Inter-American Highways, and the PIT includes several design projects aimed at different points along this important road.

In terms of the Northern Inter-American Highway, the plan is to widen approximately 70 kilometres of road to four lanes on the Cañas-Limonal, Limonal-San Gerardo and San Gerardo-Barranca stretches. Also included is the construction of hard shoulders, pavements and pedestrian crossings in populated areas, crossings for wildlife and bicycle lanes. The MOPT, with the support of consortium staff, has met with the residents of the area to inform them about the projects, hear their questions and suggestions and promote road safety measures. This action will provide continuity to another one that started in 2016 on the 50.5-kilometre stretch between Cañas and Liberia, which was widened to four lanes in a previous programme, also financed by the IDB.

At the other end of the road, on the Southern Inter-American Highway, the PIT includes another important project: the upgrading and widening to four lanes of the 93-kilometre stretch between Palmar Norte and Paso Canoas. 75% of the international trade between Costa Rica and Panama passes through this city of approximately 11,000 inhabitants, with half of the city belonging to each country. The location of the border here means that road traffic of people and goods in both directions is intense: according to the MOPT's 2017 figures, an average of 7,297 vehicles pass through this point every day. In this case, the Ministry also met with those affected by the project.

The programme includes projects for road upgrades and widening in other parts of the territory as well, such as the 40.7-kilometre stretch between Birmania (Upala) and Santa Cecilia and La Cruz (Guanacaste) in the north. The works include improvement and adaptation of the stretch, including resurfacing, the installation of hard shoulders, drains, new bridges, improvements in road signs and installation of bus stops on the section between Birmania and Santa Cecilia; and the upgrading and/or widening to two lanes of the bridges on the road between Santa Cecilia and La Cruz, all on the RN-4. The designs are currently being finalised.

In the centre of the country, the PIT is considering designs for two interchanges (links), namely those in La Lima and Taras, located at the entrances to Cartago, Costa Rica's second largest city and an important industrial zone, dedicated above all to the technological sector and the manufacture of medical supplies. Freight transport activities and proximity to the capital, located only 24 kilometres away, cause congestion in this area, which the new links would alleviate.

To the west of the capital is the Nicoya Peninsula and the Gulf of Nicoya.

PIT, PROJECT BY PROJECT

ROAD DESIGN PROJECTS

Limonal-Barranca section

- ▶Widening and upgrading of Limonal-San Gerardo
- ▶Widening and upgrading of San Gerardo-Barranca

Design projects for other sections

- ▶Widening and upgrading of Cañas-Limonal
- ▶Upgrading of Playa Naranjo-Paquera
- ▶Interchanges La Lima-Taras
- ▶Upgrading of Palmar Norte-Paso Canoas
- ▶Upgrading of La Cruz-Santa Cecilia-Birmania section

MARITIME-PORT DESIGN PROJECTS

- ▶Upgrading and reinforcement of the Puerto Caldera breakwater
- ▶Pacific Port Master Plan, with emphasis on Puerto Caldera
- ▶Cabotage terminals for the Gulf of Nicoya

ADDITIONAL TASKS

To carry out the aforementioned projects, a multitude of additional tasks need to be carried out, such as the commissioning of road safety audits, financial audits, specific consultancies, road managers, works inspections, etc., which, in turn, are managed and supervised by the Programme Execution Unit.

ROADS AND PORTS, VITAL FOR COSTA RICA

In a mountainous territory measuring only 51,000 km², reduced land distances and difficult terrain mean that road transport is preferred over the railway. The road network has increased in the last 10 years by 7,470 kilometres, reaching more than 42,800, of which around 8,000 kilometres are state owned and the rest regional (cantons). Congestion, road accidents and the need to improve facilities and maintenance are the main problems, as set out in the 2015-2018 National Development Plan. Periodic reports, such as that by the National Laboratory of Materials and Structural Models (Lanamme), part of the University of Costa Rica, in 2017, reveal that, although the situation of the road network as a whole has improved, only 7.8% is in good condition and 42.5% (2,170 kilometres) is 'poor'. At the same time, the geographical situation of Costa Rica in the Central American Isthmus, with coasts on two oceans, means that its ports are of great importance, particularly for exports. The country has two main ports: Caldera, on the Pacific, and Limón-Moín, on the Caribbean. The latter's main business is goods traffic, especially agricultural -bananas, pineapples, coffee, etc.- and cruises. The positive evolution of the economy, which grew from 3.7% in 2015 to 4.1% in 2016, has increased the demand for port services, which is why facilities need to be expanded and improved in order to prevent delays. The country has other ports such as Puntarenas (fishing and cruises), which has a cabotage service between the towns of Paquera and Playa Naranjo on the Nicoya Peninsula. Other important ports are Quepos and Punta Morales on the Pacific.

PHOTO_ JEFF MOORE (FLICKR)

Ferry moored in the port of Paquera.

In one of the countries of the world with the greatest biodiversity, this sparsely populated area has two national parks and a large number of nature reserves for wildlife and other protected areas, as well as beaches and islands of great scenic and natural beauty which attract tourism. The PIT includes two design projects that would improve both land and maritime connections on the peninsula: the upgrading of the 25-kilometre RN-160 road that joins the towns of Playa Naranjo and Paquera and improvement of the facilities of the ferry terminals located in both communities. The design includes resurfacing and improvement of the geometry of the road by reducing the steepest gradients. Drains, wildlife crossings, three new bridges and a bicycle lane are also planned. In the towns, the plan is to build pavements and adapt the characteristics of the road to the urban setting with facilities such as pedestrian crossings and bus lay-bys.

MARITIME MODE

Maritime transport is also essential for Costa Rica in terms of goods: the PIT includes projects for upgrading and reinforcing the breakwater in Puerto Caldera, the most important port on the Costa Rican Pacific coast and the second largest in the country; in 2016, 5.5 million tons of goods, mainly grain, fertiliser, raw materials and flour, passed through it in bulk and in containers. It is also the main entry point for importing vehicles from Asia. It is connected to San José by Route 27, a 90-kilometre toll road managed by a concession company since 2006.

THE PIT INCLUDES PLANS FOR UPGRADING AND REINFORCING THE BREAKWATER IN PUERTO CALDERA, THE MOST IMPORTANT PORT ON THE COSTA RICAN PACIFIC COAST AND THE SECOND LARGEST IN THE COUNTRY

This action will join a series of modernisation and widening works not included in the PIT which will expand the current capacity and reduce vessel waiting times. All of this needs to be included in the Pacific Coast Master Plan, which is also part of the PIT. ■

THE INECO-ACCIONA TEAM

The team from the Ineco-Acciona consortium (part of which is shown in the photo) performs 'programme execution unit' tasks and is responsible for the planning and monitoring of all technical and administrative work in close collaboration with Costa Rica's Ministry of Public Works and Transport.

EU BIM MANUAL
A response to the new challenges facing European governments and public authorities to stimulate economic growth and competitiveness by providing value to the investment of public money through wider implementation of the BIM methodology.

THE EUROPEAN COMMISSION SUPPORTS THE IMPLEMENTATION OF BIM

EU BIM, a manual for efficiency

The EU BIM Task Group, founded by the European Commission and public bodies from 20 countries, has published a manual to support the implementation of the BIM methodology in the construction of public works in Europe, a sector that represents 9% of GDP and employs 18 million people.

By **Jorge Torrico,** civil engineer

The construction sector is strategically important for European economies in terms of production and job creation, accounting for 9% of GDP and employing more than 18 million people. It is an important engine of economic growth and an activity in which three million companies are engaged, most of which are SMEs.

It is, however, a sector that lags behind other industries in terms of digitisation and productivity rates. Several European reports have identified that the root causes of this situation are an insufficient level of collaboration between agents involved in the process, a low level of investment in R&D, and improvable information management.

The digitisation of the construction sector represents a unique opportunity to confront the significant structural challenges that still need to be addressed by taking advantage of the widespread availability of best practices developed in other industrial sectors, new engineering tools, digital workflows and technological skills for achieving higher productivity and creating a more efficient construction sector.

THE EUROPEAN COMMISSION SEEKS TO ENCOURAGE THE CONSTRUCTION SECTOR TO IMPROVE ITS PRODUCTIVITY AND EMBRACE NEW TECHNOLOGIES THROUGH DIGITAL TRANSFORMATION

The introduction of the BIM methodology in the construction sector represents a drive towards its digitisation. The wider use of technology, digital processes and automation undoubtedly helps to greatly improve our economic, social and environmental future.

This initiative, promoted by the European Commission, aims to encourage the construction sector to improve its productivity and embrace new technologies through digital transformation, an aspect in which this sector is lagging far behind: 95% of construction jobs in Europe are in small or medium-sized companies, and productivity has barely grown 1% in the last 20 years. EU BIM calculates that the implementation of this methodology will reduce the overall costs of the construction sector by between 10 and 20%, and also produce immeasurable social and environmental benefits.

The EU BIM Task Group is made up of representatives from more than 20 European public authorities and brings together the collective experience of policy makers, managers of public assets and infrastructure operators

in the field. It therefore has a significant base of knowledge about the legislation, practices and customs of many countries which, although different, have similar problems in common.

The Manual, with collaboration by Ineco engineers Jorge Torrico and Elena Puente, representing Spain's Ministry of Public Works, includes case studies and examples of the evolution of BIM implementation in different European countries and aims to respond to the following questions:

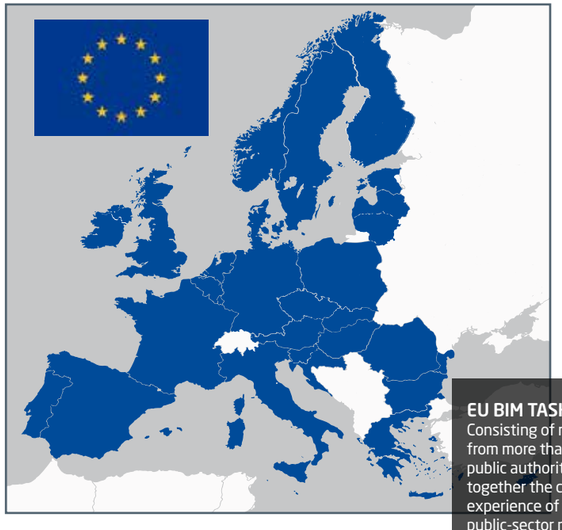
- ▶Why have other European governments adopted measures to support and encourage the adoption of the BIM methodology?
- ▶ What benefits can be expected?
- ▶ How can governments and clients belonging to the public sector offer leadership and work hand in hand with industry?
- ▶ Why is public leadership and harmonisation so important at European level?
- ▶ What defines the BIM methodology at European level?

The document is not intended as a guide for the management of the BIM methodology, but rather to offer a strategic and comprehensive overview of the steps to be taken to implement it by examining real experiences in recent years.

Aware of the role played by public authorities and European institutions in the implementation of this technological transformation aimed at improving the competitiveness of their industries, some governments are already taking the first steps to implement this methodology as a requirement in their tendering processes, a strategy that will result in significant improvement in services and cost savings in public works. This is the case in the United Kingdom since 2016 and France as of 2017, and it will be applied in Spain by 2019.

THE MANUAL INCLUDES CASE STUDIES AND EXAMPLES OF HOW BIM IMPLEMENTATION EVOLVED IN DIFFERENT EUROPEAN COUNTRIES

However, differences in the definition and practical application of BIM in each country can create obstacles and make the work of construction and engineering firms that operate in multiple markets even more difficult. Before this happens, Europe is seeking to agree on a common framework consisting of best practices and international standards accepted by both public institutions and the private engineering and construction sector. This is why, since February 2016, EU BIM has been working on the standardisation of BIM in Europe. Its objective in these two years has been to convey the benefits of this methodology in order to achieve –along with the support of private industry– digital transformation in the European public construction sector.



EU BIM TASK GROUP
Consisting of representatives from more than 20 European public authorities, it brings together the collective experience of policy makers, public-sector managers and infrastructure operators.

COMMUNICATION, KEY TO THE IMPLEMENTATION OF BIM

In order to achieve a common regulatory and operational framework, public authorities and private industry have initiated an ongoing dialogue that seeks to bring up to date, within a few years, a sector that is rooted in almost artisanal methods. The case studies from different countries examined in the EU BIM Manual are a preamble to the importance that information exchange, standardisation and digitisation will have over the coming years for the construction sector, which is unquestionably on the threshold of a profound and historic transformation. It is just a matter of time.

In Estonia, for example, the Ministry of the Economy's leadership in the initiative since 2014 and its commitment to the medium and long term has generated confidence in the sector and provided a clear outlook. The level of communication and commitment of the Swedish government has also been crucial in generating this confidence in the sector: the country's BIM Alliance Sweden was created in 2014 with 170 representatives from all public and private construction organisations, and in 2017, launched a strategic innovation programme called *Smart Built Environment* (SBE).

In 2015, Germany began designing a roadmap for digitisation in construction, an effort in which professionals from different areas have been involved and which will be implemented as of 2020. The Manual highlights the difficulty of communicating a strategic plan to a sector that employs six million people in Germany and making them understand how important it is for them. All in all, the reaction has been very positive.

CONSTRUCTION
The construction sector is an activity in which three million companies are engaged -most of which are SMEs- making it an important engine of economic growth.

The government of the United Kingdom, one of the most proactive, as part of its BIM implementation strategy, provided its suppliers with a reasonable time for adaptation: five years to bring themselves up to date from 2011. The United Kingdom also established a new legal framework within which to operate, and keeps the sector continuously informed through the government's official Internet pages. This is also the case in France, which has set up a complete website to provide in-depth information about its PTNB *(Plan Transition Numérique dans le Bâtiment)*, promoting a common work system. Every six months, the website publishes a survey or barometer that indicates how BIM is perceived by the construction sector in France. In the most recent survey, published in April, 80% of respondents said that they did not have enough information about BIM; nonetheless, it was used by 11% of professionals, in particular those working in new building construction (75%) and renovation (45%).

In Spain, responsibility for the initiative falls to the Ministry of Public Works, which created the es.BIM Commission in 2015. Among its different actions, the Commission has created the *www.esbim.es* website, which offers the possibility for the private sector to share the work it has carried out using this methodology in order to generate interest and motivation. The website also features a blog available to external collaborators, which acts as a forum for the exchange of opinions, and it published the results of the first survey for professionals carried out in the last quarter of 2016. At the time of the writing this article, the second edition is open to verify the progress made, both in terms of knowledge and the use of the BIM methodology in Spain.

In addition, since September 2017, the es.BIM Observatory for public tenders has been active with the aim of monitoring the evolution of the penetration of BIM in public tendering on a quarterly basis, both quantitatively and qualitatively. Thus far, two reports have been published and have made it possible to draw very significant conclusions.

95% OF CONSTRUCTION JOBS IN EUROPE ARE IN SMALL OR MEDIUM-SIZED COMPANIES, AND PRODUCTIVITY HAS BARELY GROWN 1% IN THE LAST 20 YEARS

Technology evolves at high speed and we just need to use it and incorporate it into our processes. Nowadays, thanks to BIM, it is possible to generate and manage all of a project's digital information through the formation of information models throughout the life cycle of a construction. It is, therefore, a method that provides total control of a building or civil works project from the design phase to final maintenance, facilitating real-time monitoring, decision-making and changes or corrections to plans before construction. It generates greater cost savings than current methods. What is needed to implement it? 'Complex, useful for my profession and expensive' is how the new technology was described in the last survey conducted in France. However, experts do maintain that the necessary training and technical means do not represent an insurmountable obstacle and that greater global adoption will be achieved through ongoing learning.

Ineco began using the BIM methodology in 2010 for its participation in several international projects, given its ease of use in collaborative working environments –with different teams separated by large distances– with a single centralised design. The company currently uses the BIM methodology in both airport and rail projects in Spain and abroad.

Its role in the EU BIM Task Group, representing the Ministry of Public Works, has been highly active and involves participation in its management committee together with Norway, Italy, the Netherlands, Estonia, Sweden, France, Germany and the United Kingdom. From the beginning, the need to look for common lines with Europe was perceived in order to ensure, as much as possible, a single methodology based on European standards. ■

Splendour in the garden

Spain is the world's number two fruit exporter –especially citrus, strawberries and stone fruit– and the fourth largest vegetable exporter, mainly tomatoes, peppers and cucumbers. It is also notable for its chestnut production and delicacies such as the black truffle.

Written by ***ITRANSPORTE,***
with the special collaboration of ***Sandra Jiménez Osorio**
(styling and food photography)

Spain, together with the USA, China, the Netherlands and Mexico, is one of the world's top five vegetable exporters.

In 2017, Spain exported more than 12.5 million tonnes of fruits and vegetables, according to figures from the Ministry of the Economy, Industry and Competitiveness' Directorate General for Customs. Ninety-four percent of the total went to Europe, while export volume to non-EU countries, especially Brazil, Morocco and the United Arab Emirates, increased by between 2 and 5%.

And that is because Spain, along with the USA and China, is one of the world's top five vegetable exporters: according to United Nations statistics from 2016, it was the second largest for fruit, behind the USA, and fourth for vegetables, behind China, the Netherlands and Mexico.

By product, citrus fruit, especially oranges, tangerines and lemons, is the crop that occupies the largest area in the country and is also the most exported. This is followed by strawberries and stone fruits, such as nectarines, peaches and apricots, a segment in which Spain is number one in sales abroad. Watermelons and melons are next on the list and have increased significantly in volume and value in recent years, as well as berries, such as raspberries and blueberries.

In regard to vegetables, tomatoes and peppers lead sales abroad. Within the European Union, Germany is the main customer: of the 3.2 million tonnes of fruit and vegetable products that it bought from Spain in 2016, more than 477,000 were of these two vegetables, as well as cabbages and cucumbers. In terms of total sales as a whole, these are followed by lettuce, courgettes and garlic.

For the Spanish economy, the fruit and vegetable subsector –concentrated mainly in regions such as Andalusia, Valencia and Murcia– is the most important in agriculture. According to Ministry of Agriculture figures, it generates 230,000 direct jobs –24% of the total sector– and another 100,000 indirect jobs, especially in handling and packaging. Spanish croplands produce more than 24 million tonnes of fruit and vegetables every year, 54% of which are vegetables, 24% citrus fruit, 11% non-citrus fruit, 9% potatoes and 2% nuts. About half of the total production is sold abroad.

TRACES OF HISTORY

History and politics have left their mark on Spanish agriculture since ancient times. For example, the **Romans** introduced certain intensive crops –such as the olive tree and others– in order to pacify the nomadic Iberian tribes by making them sedentary, and expanded other crops such as cabbages. The **Arabs**, after their arrival to the Iberian Peninsula from North Africa in 711, introduced new crops such as oranges, which are today Spain's star fruit and vegetable export.

Aubergines and garlic were used heavily in the cuisine of the **Sephardim** (Spanish Jews), who lived in what is now Spain before the arrival of the Muslims, until they were expelled by the Catholic Monarchs in 1492. Following the discovery of America by Columbus, new vegetables began to arrive from the 'New World', including potatoes, corn, peppers and tomatoes (which is actually a fruit and not a vegetable). Today, Spain is the second largest producer of tomatoes in the European Union after Italy and the ninth in the world, according to FAO figures, and has created its own varieties, such as the RAF (which stands for 'Resistant to Fusarium', a toxic fungus) and Kumato, by artificial (non-transgenic) selection.

BLACK GOLD... AND IT'S NOT OIL

One of the most complex, and therefore most profitable, crops, for which Spain has climbed to the top of the world rankings in just a few years, is the black truffle or *Tuber Melanosporum*. Farms in Soria and Teruel have achieved such abundant yields –although this varies depending on climate and other factors– since the 1970s that Spain has overtaken France in terms of high-quality harvests and lower prices. This fungus, which originated in Europe, is considered a culinary delicacy and is much sought-after in haute cuisine, with fresh specimens sold or auctioned at astronomical prices. Truffles are also sold vacuum packed and as part of other products: oils, honey, etc.

Black truffle is difficult to obtain –the white variety has never been successfully cultivated– because it only grows in symbiosis with the roots of certain trees, mainly woody species such as oaks, holm oaks and hazelnut trees. Cultivation requires long periods of growth and maturation of the symbiont (the plant-fungus pair) and calcareous soils. Also, the earth around the trees must be completely clear of other fungi and bacteria, meaning that it must be thoroughly cleaned before planting, and it has a limited life span: it becomes depleted after 20 or 30 years of production.

In Spain, the largest black truffle grounds are located in the provinces of Teruel (specifically in the region of Gúdar-Javalambre, in towns such as Sarrión), Soria and Castellón, in its north-western region of Alto Maestrazgo and town of Benassal. The success of these farms, which were established in the 1970s, is the result of intense agricultural and forestry R&D that has managed to take advantage of the favourable soil and climate conditions in these regions, while climate change and overexploitation have caused wild production to plummet in the rest of the world.

Although far from the high prices that truffles can reach, another vegetable delicacy that is experiencing an upsurge is the Spanish sweet chestnut *(Castanea sativa)*. About 3,500 tonnes of this nut are shipped every year to different parts of the world, distributed to more than 60 countries. Galicia is the region with the highest production, with the El Bierzo region in northern León a distant second. ■

***Sandra Jiménez Osorio** is a food stylist and renowned *instagrammer*. *https://www.instagram.com/sandrajimenezosorio/*

JORGE TORRICO LIZ

"The introduction of BIM is an essentially collaborative process"

After more than two years of work promoting the BIM methodology in Spain, Jorge Torrico reflects on the implementation of this collaborative system, which is revolutionising the engineering and construction sector in Europe.

PHOTO_ELVIRA VILA

1 BIM IS A REVOLUTION... IS IT DIFFICULT TO UNDERSTAND?
I prefer to talk about evolution, although it does have some truly revolutionary aspects.

2 WHAT INTERNAL CHANGES DOES IT INVOLVE?
It is essentially a transformation based on a significant cultural change in which management of what has already been built plays a prominent role. Improvement in collaboration is fundamental. BIM is an essentially collaborative process.

3 WHAT ADVANTAGES WOULD YOU HIGHLIGHT?
I would essentially highlight improvement in quality, transparency, traceability and reduction of risks and uncertainties throughout the life cycle.

4 WILL HAVING OR NOT HAVING BIM BE A CRITICAL FACTOR?
In the short term, it could be critical but, in the medium term, not having it will mean being excluded.

5 HOW IS IT BEING RECEIVED BY THE SPANISH CONSTRUCTION SECTOR?
It has met with a good deal of scepticism because cultural change is not easy for such a mature sector; that said though, the transformation starting to gain a certain amount of momentum.

6 WHAT TIME SCALES ARE BEING APPLIED FOR PUBLIC TENDERS IN SPAIN?
The time frame is short-term. Within a year, it will already be present in building processes; however, incorporation will be gradual to allow the whole sector to adapt. ■

A NEW SYSTEM OF WORK IN EUROPE'S ENGINEERING AND CONSTRUCTION SECTOR

A civil engineer by profession, Jorge Torrico is Ineco's deputy director for BIM, as well as secretary of the es.BIM Commission of the Ministry of Public Works, a position that he has held for over two years.

He has more than 20 years of professional experience developing infrastructure and building projects. He represents Spain in the EU BIM Task Group, which is co-funded by the European Commission. He actively participates in methodology standardisation processes, both in Spain, for the Spanish Association for Standardisation (UNE), and at the European level, for the CEN/TC 442 workgroup, as well as the BuildingSmart Spanish Chapter. Working to spread knowledge of BIM, he collaborates with universities, professional associations and bodies in relation to this activity.

BIM *(Building Information Modelling)* is a work methodology that allows building projects or civil works to be jointly managed through the same digital environment. This means that all of the elements that form part of an infrastructure, including the facilities, are reflected in a single digital model and form a large integrated database that allows projects to be managed throughout their life cycle, from design to construction and subsequent maintenance.

BIM makes it possible to build in a more efficient way, reducing costs while allowing developers, planners, builders and other agents involved to work more collaboratively.

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