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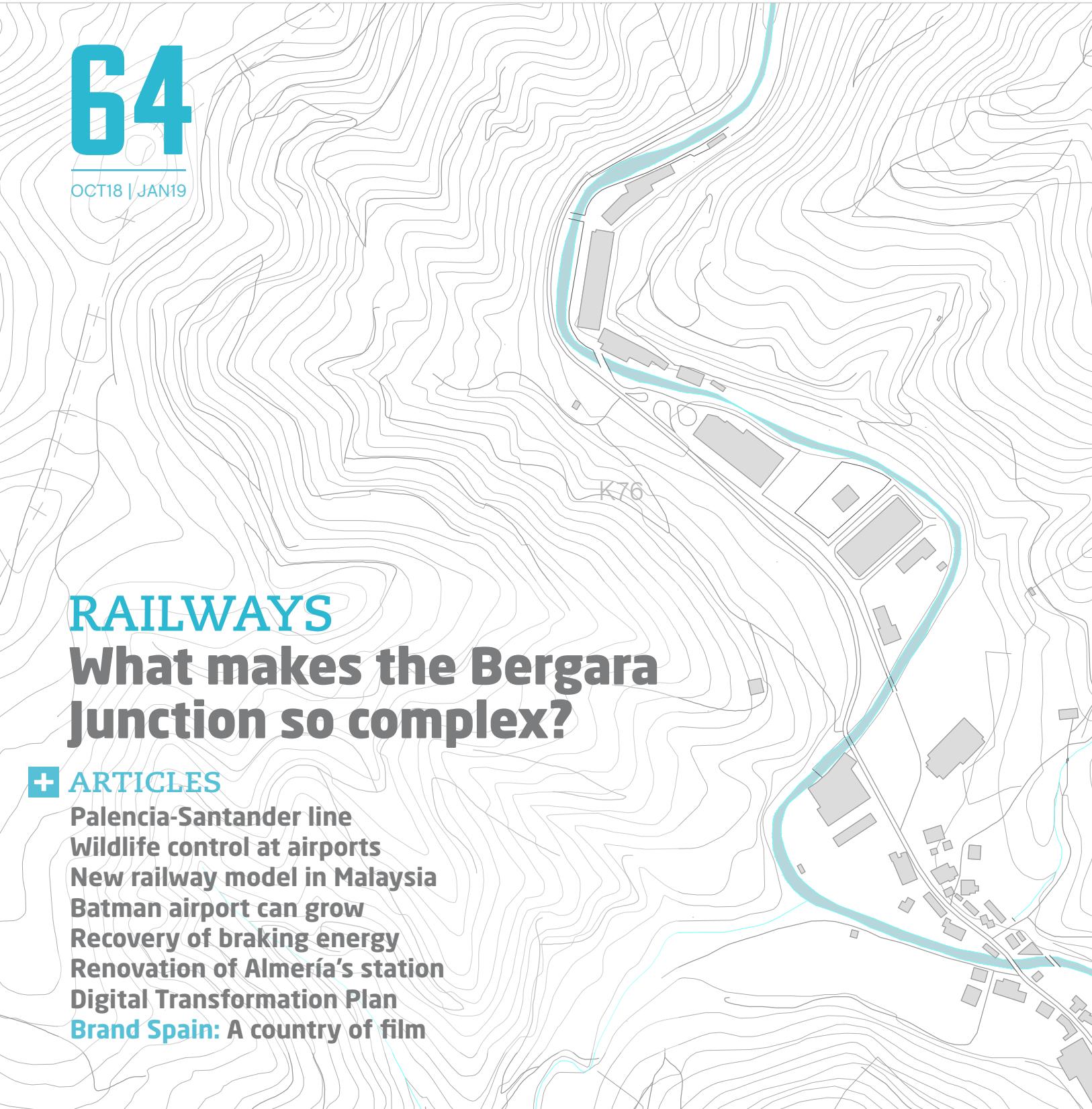

RAILWAYS

What makes the Bergara Junction so complex?

+ ARTICLES

Palencia-Santander line
Wildlife control at airports
New railway model in Malaysia
Batman airport can grow
Recovery of braking energy
Renovation of Almería's station
Digital Transformation Plan
Brand Spain: A country of film

1968-2018

THE JOURNEY HAS ONLY JUST BEGUN

We are turning 50. Half a century of great projects and important challenges successfully overcome. We look to the future with the same hopes and motivation as the very first day.
Because this journey has only just begun.

anniversary 50 ineco

EDITORIAL

50 years of engineering and talent

“The team of professionals who form part of the Ineco has enormous talent to continue designing the future”

CARMEN LIBRERO
President of Ineco

My first several weeks as president of Ineco have given me a first-hand look at the excellent work of a team that stands above the rest. A team with a long history –this year marks the 50th anniversary of the founding of the company– but above all, with enormous talent to continue designing the future.

Our condition as a public engineering firm drives us to continue contributing actively to the development of Spain’s infrastructure, and area where we will continue to focus a large part of our technical potential through the professionals who form part of Ineco, exporting the broad knowledge acquired in Spain to other parts of the world.

In this sense, within Spain, we continue to work with our shareholders on a very wide variety of projects throughout our country. This issue of *ITRANSPORTE* covers several examples, including the complex project to resolve the Bergara junction in the ‘Basque Y’ and the comprehensive modernization of the railway line between Palencia and Santander.

In parallel, Ineco’s participation in large-scale engineering projects around the world, such as the Makkah-Madinah high-speed line, which at the close of this issue is already a reality that is underway, or the recommendations for the design of a new model of railway management in Malaysia, continue to highlight Ineco’s position as a leader outside of our borders.

It is also important to emphasize our contribution in the development of new projects aimed at implementing efficiency, safety and digitization in transport systems. The designing of equipment that recovers and returns the surplus energy generated by train braking to the grid, wildlife control plans at airports, and the implementation of the Digital Transformation Plan 2018-2020, are clear examples of this. ■

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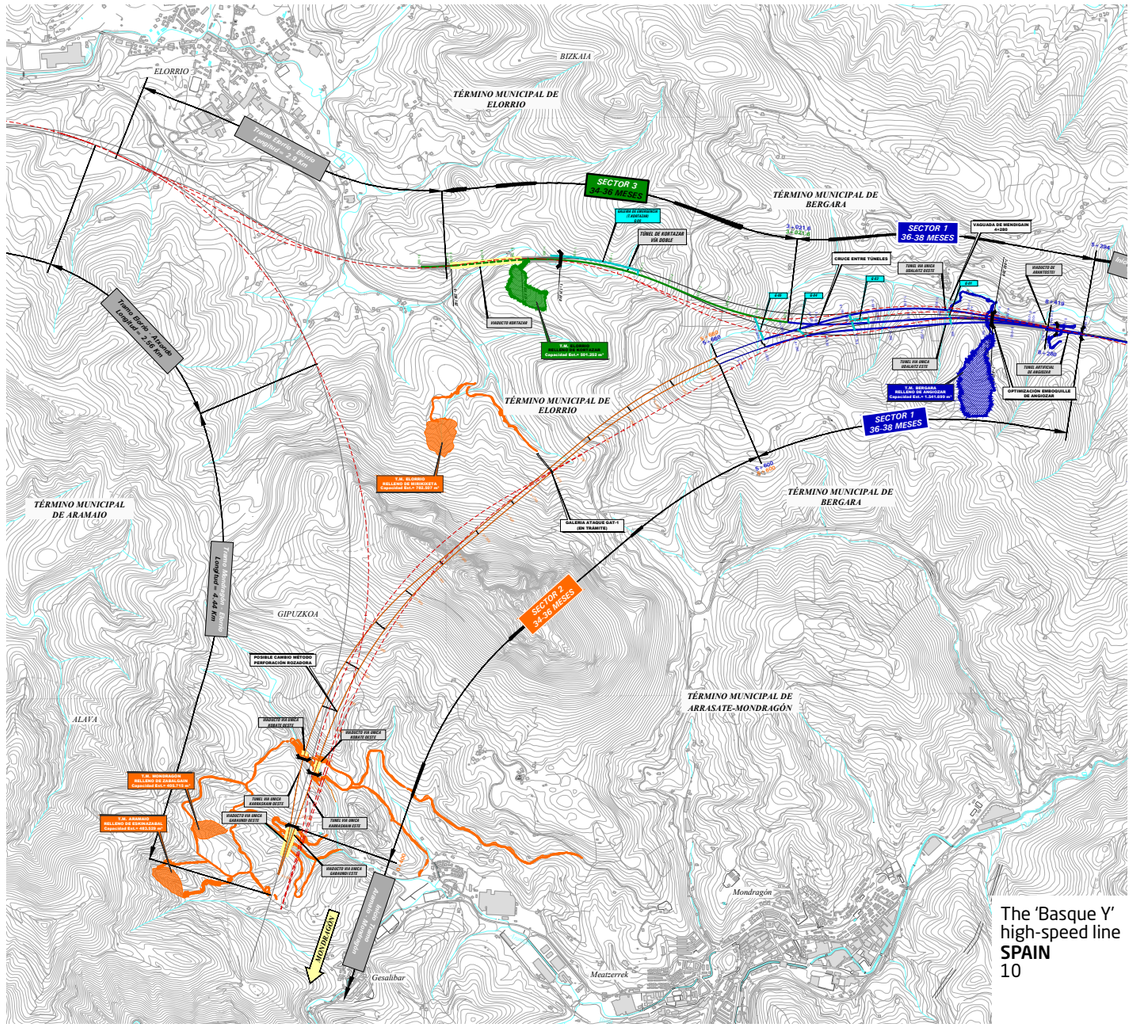

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Editor-in-Chief: BÁRBARA JIMÉNEZ-ALFARO – *barbara.jimenez@ineco.com* **Editorial Staff:** LIDIA AMIGO – *lidia.amigo@ineco.com*
Editorial Board: ISABEL ÁLVAREZ, MICHAEL ASHIABOR, NATALIA DÍAZ, JOSÉ GONZALEZ, RAFAEL HERRERA, JOSÉ Mª LLORENTE, RAFAEL MOLINA, SERGIO NAVARRO, FÉLIX ORTEGA, JAVIER SANCHO, JARA VALBUENA
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INECO, 50 YEARS OF HISTORY

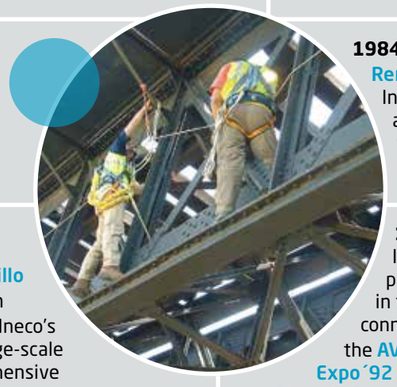
The path of Ineco's half-century of history parallels the history of Spain and its infrastructure.

1968
Carlos Roa founds Ineco. Offices: Palacio Fernán Núñez (calle Santa Isabel 44, in Madrid).

1977
Preliminary project for the Madrid-Barcelona-Port Bou high-speed line. Metro de Bilbao Study.

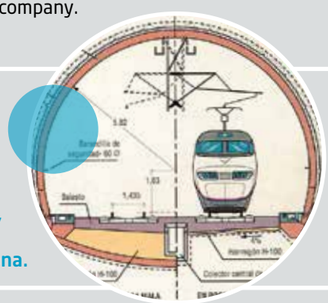
1981
The Metro de Bogotá study is presented.

1983
Tifsa created. Bridge inspections and acoustic tests begin.



1984
Renfe becomes Ineco's sole shareholder and transfers its project team to the company.

1989
Start of the Pasillo Verde in Madrid, Ineco's first large-scale comprehensive management of a project.



1992
Ineco participates in the work connected with the AVE to Seville, Expo´92 and the Olympic Games in Barcelona.

1993
Aena, created in 1991, becomes a shareholder. Start of aeronautical activity.

1998
Purchase of the current offices at Paseo de la Habana, 138, in Madrid. Drafting of the Master Plans of Aena's airports begins.

1999
FSAM Study, Futuro Sistema Aeroportuario de Madrid. Start of the large-scale expansions of the airports in Madrid and Barcelona and the work on the Madrid-Lleida high-speed line.

NEW MILLENNIUM
With the change of the millennium, in 2001, Ineco surpasses the one-thousand employees mark and expands its central headquarters with the new offices on Avda. del Partenón.

2000
Installation of ERTMS begins in Spain while the ENAM, the Study for a New Airport in Madrid commences. Ineco do Brasil, S.L. is created, with headquarters in São Paulo where the company collaborates with the CPTM.

2001
First work for Aena on the Plan Málaga for the expansion of the airport.

2002
Start of the project management and technical consulting on the Guadarrama tunnels and the San Pedro tunnels in 2003.

2004
First work in the airports of Cape Verde. Start of participation in SESAR, Europe's 'one sky" programme.

2005
The Ministry of Public Works presents PEIT 2005-2020, on which Ineco collaborated. Work on the Port of Valencia.

2006
First large contract in Mexico: the Buenavista - Cuautitlán suburban railway, for which a branch office was opened.

2007
Renovation Plan for First-Generation Highways. Period of projects in metros and tramways (Tenerife, Seville, Alicante, Belgrade, Algiers, Bologna, Bombay, etc.).

2008
The Ineco-Tifsa, Group declared "in-house resource of the Ministry of Public Works. Opening of the Madrid-Barcelona AVE.

2009
The A Coruña-Santiago section is opened and remodelling of the Sants (Barcelona) and Atocha (Madrid) stations is finished for the arrival of the new Madrid-Barcelona and Madrid-Valencia lines.

2010
Ineco and Tifsa merge under, with the Ineco name: combined total of approximately 3,000 employees.

2011
Intensification of international projects: Guadalajara-Colima highway, in Mexico; design and outfitting of the control tower at the Eldorado Airport, in Colombia.

RESPONSIBLE AND COMMITTED
In 2008, Ineco approves its first CSR plan and joins the Global Compact of the United Nations, signing and annually renewing its commitment to the 10 principles based on human rights.

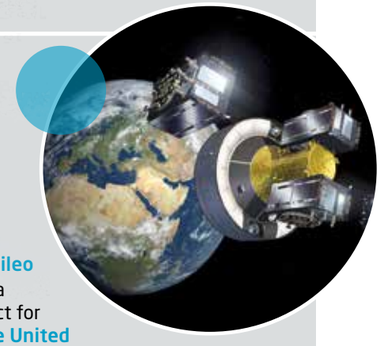
2012
International contracts awarded for the Makkah-Madinah high-speed line, the HS2 line between London and Birmingham, in the UK, and the São Paulo beltway, in Brazil.

2013
The AVE reaches the French border. The expansion of the Málaga airport concludes.

2014
ORAT of the new terminal at the Abu Dhabi airport. Contract signed with the EC to coordinate the implementation of ERTMS on nine European corridors. In Peru, work on the Lima and Chiclayo airports.

2015
Feasibility studies of the Delhi-Kolkata (1,500 km) and Bombay-Nagpur (800 km) high-speed lines. The high-performance sections to Palencia and León and on the Atlantic Axis, Santiago-Vigo are opened.

2016
Ineco participates in the management, operation and maintenance of the Service Centre for Galileo Users, and in a second contract for the HS2 in the United Kingdom.



2017
New terminal of the Schiphol airport, Amsterdam. The feasibility study of a 1,200 km high-speed corridor in Egypt concludes.

2018
Marks 50 years since the founding of Ineco. New remodelling of Atocha to make it a through station that connects all of the high-speed lines in Spain.

EXTENSION OF BARCELONA AIRPORT'S SOUTHERN PIER

Ineco has drafted the construction project for the redesign and extension of Barcelona-El Prat Airport's T1 southern pier for Aena. The purpose of the project, which was awarded in July, is to increase the number of parking stands and boarding gates for large capacity aircraft (types E and F) and enable the operation of international flights, which have increased in recent years.

UNITED KINGDOM

HIGH-SPEED MAINTENANCE FOR THE HS1

Network Rail, the public body that manages the HS1 (High Speed 1) line, which runs from St. Pancras station in London to the Channel Tunnel, has engaged Ineco to update the track maintenance procedures and implement specific regulations to ensure adequate upkeep of the infrastructure, which has been in operation for a decade.

Trains in the Saint Pancras Station, London.

HIGH SPEED

The 'AVE of the Desert' commenced commercial operation with its first official trip between Makkah and Madinah on 25 September. The event was attended by King Salman and several other Saudi dignitaries, along with the ambassador to Saudi Arabia and representatives of the Spanish-Saudi consortium of which Ineco is a member, responsible for the design, construction, outfitting of the 450-kilometre line.

ECUADOR

SUPERVISION OF ROLLING STOCK FOR METRO DE QUITO

Since the beginning of 2017, Ineco has been providing Metro de Quito with supervision of the entire process of acquiring rolling stock manufactured by the Spanish company CAF for the city's first metro line: 18 trains with six carriages each, auxiliary vehicles, workshop equipment and tools and spare parts. The company has gained extensive experience in design supervision, manufacturing and commissioning of all types of rolling stock since the 1990s both in Spain and abroad.

From left to right: Tamara Tolón (CAF), Miguel Mora (Metro de Quito), Franklin Chimarro (Metro de Quito), Jon Aizkorbe (Ineco), Alberto Vicente (CAF), Pablo Bielsa (Ineco), José Antonio Pernas (Ineco-Ecuador) y David Polo (Ineco-Ecuador).

INTERNATIONAL

INNOTRANS 2018

Ineco was present in the Spanish Pavilion of the trade fair, held in Berlin from 8 to 21 September, alongside 57 other Spanish companies coordinated by MAFEX.

COSTA RICA

ROADS

Ineco will be designing the project to widen a 25.2-kilometre stretch of road between San Gerardo and Barranca, part of the Northern Inter-American Highway, from two to four lanes, as part of the Ministry of Public Works and Transport Transportation's Infrastructure Programme (PIT), which is being managed by a consortium that includes Ineco and Acciona.

ARGENTINA

EXPERIENCE IN SLAB TRACK

The company provided the Ministry of Transport with technical assistance on slab track technology. The work culminated with several days of training in Buenos Aires that was attended by 40 technicians.

URUGUAY

TRACK INSTALLATION CONFERENCE

On 14 and 23 November, Uruguay's Ministry of Transport hosted technical conferences given by Ineco on the installation of new track on ballast, with 25 technicians from different official institutions and the deputy minister, Jorge Setelich, participating.

OMAN

NEW STUDIES

Ineco has prepared two studies to determine the potential impact of the construction of new developments on the safety of the Mascate airport.

PHOTO: UDALATXETIK IMAMON / FLICKR

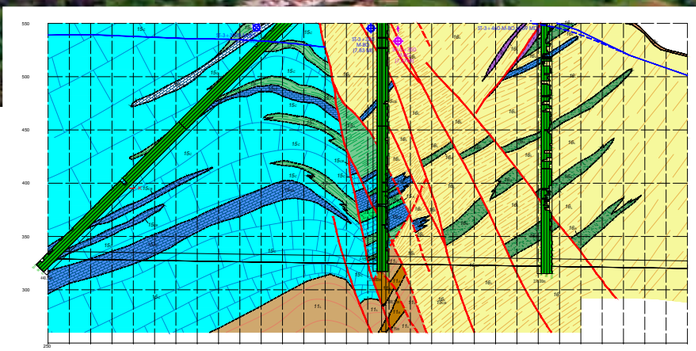
With a length of 21.2 kilometres, the Bergara junction is a stretch of the 'Basque Y' that runs through the municipalities of Arrasate (pictured), Elorrio and Bergara, and traverses part of the Udalaitz karst massif, an area with highly complex geology.

What makes the Bergara junction so complex?

A network of three tunnels consisting of a total of 5 tubes and 22 evacuation galleries excavated in a karst massif, a tunnel mouth over 40 metres high shared by three tunnels in a slope traversed by a geological fault and the presence of a protected species under a viaduct are just a few of the technical, geological and environmental challenges faced by the construction teams of the Bergara railway junction. It is a crucial project that will make it possible to split the high-speed line to connect the centre of the Iberian Peninsula to the three provincial capitals of the Basque Country and to France.

By **Noelia Alonso** and **Virginia Portal**, civil engineers, and **Pedro Benito,** public works engineer

This is a key project and the most complex one that Adif Alta Velocidad faces in the entire 'Basque Y' network, with Ineco carrying out the construction projects in collaboration with Basque railway company ETS. The result is a set of optimised projects in which the layout design of this network of railway tunnels was finally resolved with the decision to divide it into three sectors instead of the initial four.

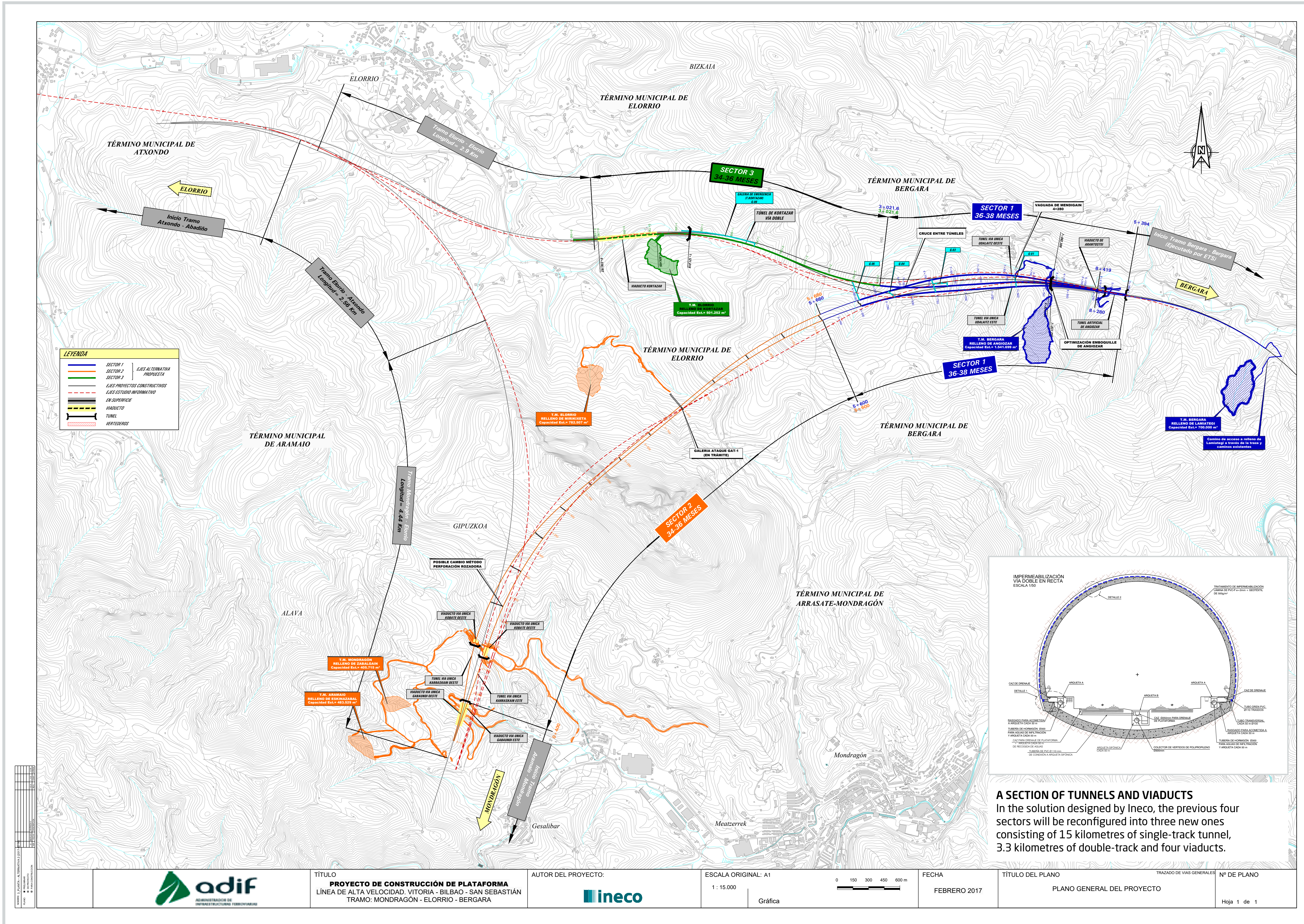


UDALAITZ TUNNEL
Part of the geomechanical profile of the Udalaitz Tunnel (Sector 2). Contact between karstified limestone and siltstone through a fracture zone.

The Ministry of Public Works plans to complete this high-speed line, which connects the centre and southeast of the Iberian Peninsula via Madrid to the Basque Country and France, in 2023. Last July, the contract was awarded for the last of the three stretches that make up the Bergara junction, which covers 21.2 kilometres and is dominated by tunnels and viaducts where the three branches that link the cities of Vitoria, Bilbao and San Sebastián meet. In total, 14.8 kilometres of single-track and 3.6 kilometres of double-track tunnel have been designed. The tunnels will be excavated using conventional methods with four points of attack.

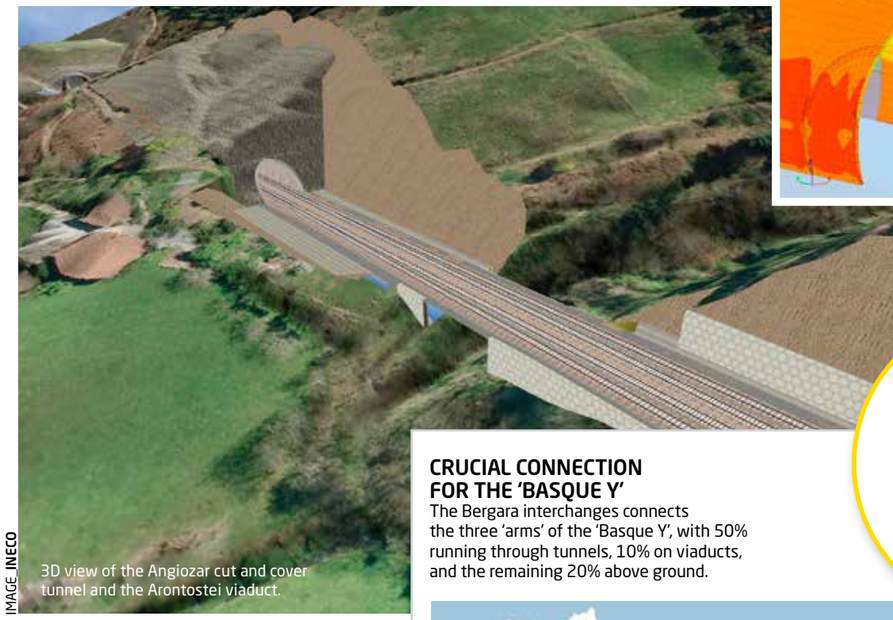
THE BERGARA JUNCTION, WITH CONSTRUCTION PROJECTS PREPARED BY INECO, IS THE MOST COMPLEX PROJECT THAT ADIF ALTA VELOCIDAD MUST UNDERTAKE IN THE ENTIRE 'BASQUE Y' NETWORK

All of the sectors have been designed for mixed traffic, with a maximum speed of 220 km/h and minimum speed of 90 km/h. To allow the tunnels to operate, each one has been designed with an independent drainage system for the collection of hazardous substances and contaminants. The project also includes all of the necessary safety measures, including 22 evacuation galleries between tunnels, as well as walls, drains, environmental integration, areas for ancillary facilities, repositioning of rights of way and affected services, inert waste dump and any other actions necessary for execution. After the works have been completed, the land will be restored to its original state.



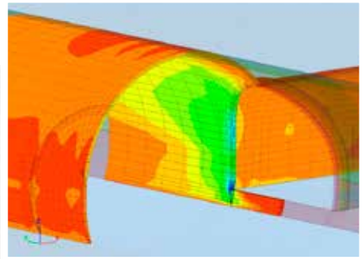
A SECTION OF TUNNELS AND VIADUCTS
In the solution designed by Ineco, the previous four sectors will be reconfigured into three new ones consisting of 15 kilometres of single-track tunnel, 3.3 kilometres of double-track and four viaducts.

PLAN_INECO



IMAGE_**INECO**

3D view of the Angiozar cut and cover tunnel and the Arontostei viaduct.



3D calculations of a tunnel junction with gallery.

CRUCIAL CONNECTION FOR THE 'BASQUE Y'

The Bergara interchanges connects the three 'arms' of the 'Basque Y', with 50% running through tunnels, 10% on viaducts, and the remaining 20% above ground.

MAP_**BASQUE GOVERNMENT**

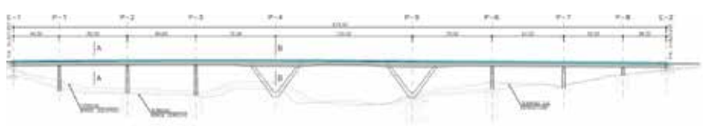
ALL OF THE SECTORS HAVE BEEN DESIGNED FOR MIXED TRAFFIC, WITH A MAXIMUM SPEED OF 220 KM/H AND MINIMUM SPEED OF 90 KM/H

The project is co-financed by the Connect Europe Facility (CEF) and the European Investment Bank (EIB).

The drafting of the projects involved optimisation of previous construction projects:

- Shorter timescales.
- Improved tunnel design in complex geological areas.
- Improved instrumentation measurements for the monitoring of works.
- Landfill management.
- Adaptation of designs to environmental protection requirements.
- Tightened budgets. ■

THE VIADUCT AND THE EUROPEAN MINK



The Kortazar viaduct, located in sector 3, consists of a continuous beam deck made from pre-stressed concrete and embedded into two V-shaped piles that act as fixed points. The project is the result of a study of several configurations that needed to take into account the impact of the central piles on both the N-636 road below and the habitat of a colony of European mink. In the image, the longitudinal cross-section of the Kortazar viaduct.

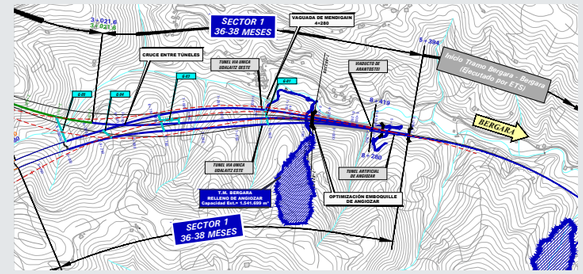
THE THREE PROJECTS AND THEIR BASIC ELEMENTS

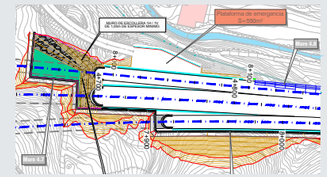
SECTOR 1

According to the plans, this stretch includes three tunnels (Udalaitz East, Udalaitz West and Kortazar double-track), a viaduct (Arantostei), two walls and the Angiozar artificial tunnel. The total length of the stretch is 5.14 kilometres (double-track equivalent). It consists of two single-track branches called the Mondragón-Bergara West and Mondragón-Bergara East lines, and a double-track branch called the Elorrio-Bergara line, 2.73, 2.69 and 2.42 kilometres long, respectively. The 3 branches are marked in blue in the image.

Sector 1 complexities

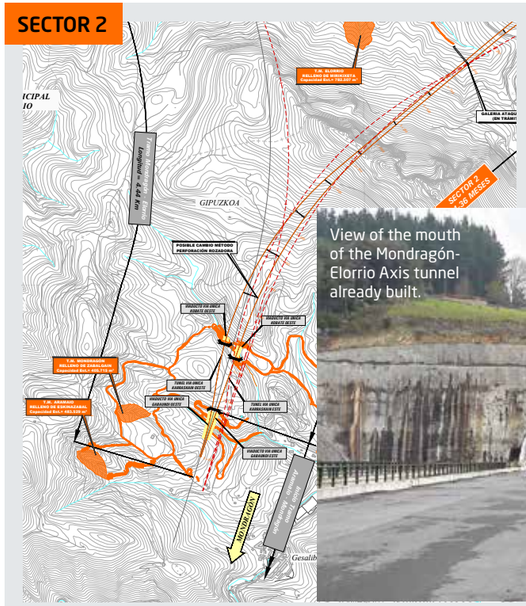
- Tunnel mouth for three tunnels in a complex area with minimal cover, difficult access and little space between the tunnel walls.
- Passage under a valley floor with minimal cover with ground treatments from the outside.
- Crossing of tunnels with tight distances due to layout requirements.
- Design of emergency galleries with complex layouts due to differences in tube dimensions.





ONE TUNNEL MOUTH, THREE TUBES. The tunnels will be excavated using conventional methods starting from the Angiozar tunnel mouth, which represents one of the most complex aspects of the project because it is shared by the three tubes, is very high (40 m) and has a geological fault running through it.

SECTOR 2



This section is made up of two lines and runs entirely through the municipalities of Mondragón and Bergara in Guipúzcoa, and Elorrio in Vizcaya. The total length of the stretch is 5.24 kilometres (double-track equivalent). The section is one of the two in which the Mondragón-Bergara route has been divided and it will contain four tunnels (Karraskain and Udalaitz West and East, respectively) and two viaducts (Kobate West and East).

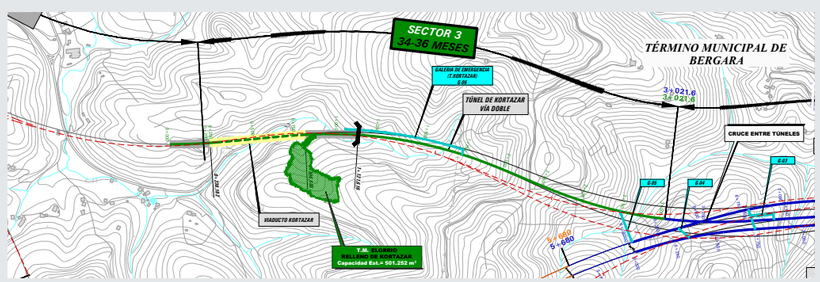
Given the length of the tunnels, a cavern has been designed with an intermediate shaft to reduce tunnelling times.

View of the mouth of the Mondragón-Elorrio Axis tunnel already built.

The tunnels in this sector will be excavated in the Udalaitz limestone massif and will feature voids and caves joined by karst conduits which could reach dimensions of several metres. These were key aspects that were taken into account in the design of the tunnels, especially when choosing the excavation method, drainage design, special treatments and health and safety during construction. One of the unique aspects of this section is the need to design a section of tunnels with sealed lining and a system to relieve the water pressure.

SECTOR 3

This section is laid out from west to east and runs through the municipalities of Elorrio and Bergara in the provinces of Vizcaya and Guipúzcoa, respectively. With a total length of 2.82 km, the section includes a double-track tunnel (Kortazar) with the corresponding evacuation gallery to the exterior and two consecutive viaducts at the tunnel exit.



PHOTOS_UTE RENOVACIÓN VÍA TORRELAVEGA-SANTANDER

From Castilla to the Cantabrian Sea

Ineco has drafted the preliminary studies and projects and managed the works for the comprehensive renovation of this 217-kilometre historic line that crosses the Cantabrian Mountains. Built 150 years ago, it is still a vital corridor both for freight –especially vehicles manufactured in Castilla y León– and for rail passengers. The duplication of sections of track between Santander and Torrelavega, which is expected to start in 2019, will complete improvements in speed, safety, passenger comfort and freight capacity.

By **Miguel Solana**, works coordinator in Cantabria, and **Jorge Rincón**, civil engineer

This is one of the oldest and most complex railway lines in Spain. At a length of 217 kilometres and used for mixed traffic (passengers and freight), it was electrified in 1951 and retains its original track layout and geometry, with extremely sharp curve radii and steep gradients that limit maximum speed. A century and a half after its construction, which was a colossal technical challenge since it had to pass through the Cantabrian Mountains, it is still a strategic rail connection between the Meseta Central and the Cantabrian coast.

Construction on the line began in 1850 and its purpose was to transport grain from the fields of Castilla to the Port of Santander, where it would be shipped to Britain. Today, it is an essential corridor for the Spanish automotive industry because it connects the four factories that Renault, Iveco and Nissan have in Castilla y León to the Port of Santander, which specialises in the shipping of vehicles. Before the works, the line could only handle freight trains with a maximum length of 450 or 500 metres. The construction of two 750-metre-long freight train sidings at Muriedas and Guarnizo stations represents a substantial improvement in transport capacity.

PHOTOS_INECO

A KEY LINE FOR THE AUTOMOTIVE INDUSTRY

The Palencia-Santander line is an essential corridor for one of the country's most important economic sectors, contributing 10% of GDP: the manufacture of vehicles and parts, 90% of which is exported abroad, and its associated industries. Spain is in fact the second largest manufacturer in Europe –the largest for industrial vehicles– and is ninth in the world, according to the Spanish Association of Automobile and Truck Manufacturers (ANFAC). According to the same source, Castilla y León currently leads production. The region boasts more than 180 parts and components companies and four Renault, Iveco and Nissan assembly plants located in Valladolid, Palencia and Ávila, which, in 2017, manufactured more than 582,000 vehicles (more than 20% of the total of 2.84 million).

The Port of Santander has close links with this industry, specialising as it does in the export of vehicles –almost half a million units in 2017– which arrive by road, but mainly by train: it is the only port in Spain where more automotive freight arrives by rail than by road (55% according to ANFAC). According to the Port Authority, the manufacturer Renault, from its car assembly plants in Valladolid and Palencia, provides the largest volume of vehicles. Hence the importance of increasing the transport capacity of the railway line, which until now had no infrastructure suitable for handling trains longer than 600 metres.

Preliminary study for a high-performance line produced by Ineco for Adif in relation to the section between Palencia and Alar del Rey.

But the Palencia-Santander line is not just an important freight corridor: almost half of its route –the section between Reinosa and Santander, featuring 26 stations–, makes up Line 1 of the region's Commuter network, a hub that is completed by two Renfe Feve lines (in metric width or narrow gauge). Within this section, in which Iberian-gauge commuter lines are operated, the works will involve duplication of the Torrelavega-Santander sub-section, for which Ineco has drafted the projects, improvement of accessibility to stations and sidings, and the removal of level crossings.

THE PALENCIA-SANTANDER LINE IS NOT JUST AN IMPORTANT FREIGHT CORRIDOR: ALMOST HALF OF ITS ROUTE MAKES UP LINE 1 OF THE REGION'S COMMUTER NETWORK

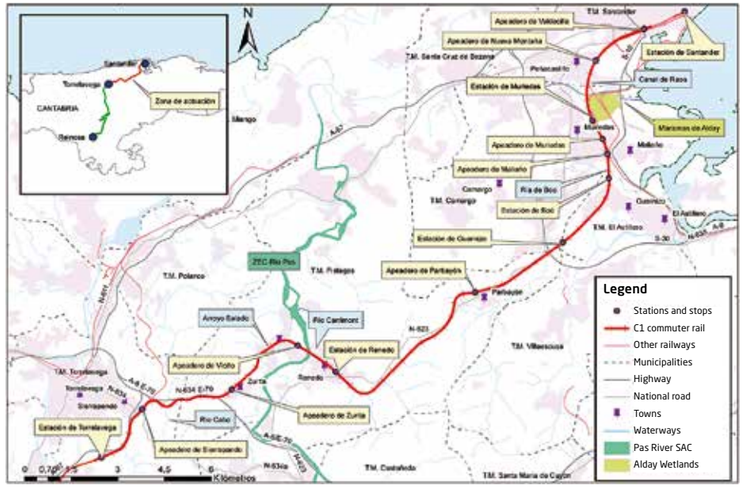
In recent years, the line's speed and capacity restrictions have caused issues regarding regularity, quality and reliability of a service used by almost 700,000 passengers a year. The renovation works have improved the safety and comfort of passengers and reduced travelling times.

IMPROVEMENTS BETWEEN TORRELAVEGA AND SANTANDER

In addition to the comprehensive renovation, Adif is undertaking another important project: works to widen track on a vital section of the line which connects Torrelavega and Santander. It is a 29.5-kilometre stretch that makes up Line C1 of the Commuter network and runs through the municipalities of Torrelavega, Piélagos, Astillero, Camargo and Santander. Overall, the project will increase the traffic capacity of the line in this section, thus reducing travelling times.

Ineco began work on the duplication projects at the end of 2015 and they are expected to be completed in 2019. The first step involved carrying out a financial and capacity analysis of traffic and user volume, as well as an environmental impact study. The basic project and later, the construction projects, were also drafted. In addition to duplication of the track, other actions will be included:

- Removal of level crossings and their replacement with six new crossings at different levels.
- Improvement of stations and stops: raising of platforms, renovation of canopies, installation of lifts, new shelters and underpasses at the stations of Torrelavega, Renedo, Guarnizo and Boo, and the stops of Sierrapando, Zurita, Vioño, Parbayón, Maliaño, Muriedas-Bahía, Nueva Montaña and Valdecilla.
- Works to adapt electrification and safety and communications facilities.
- Installation of acoustic screens: according to the results of a study carried out along the route, the Environmental Impact Statement provides for the installation of acoustic protection screens on various sections of the line.
- Adaptation of low and high crossings and bridges.
- Line enclosure, replacement of affected services and adaptation of cross drainage. ■



Track duplication of the C1 commuter rail line between Torrelavega and Santander.

Miguel Solana, works coordinator in Cantabria, at Santander station.

RENOVATION OF THE CONVENTIONAL TRACK: MAIN ACTIONS

The works have been divided into four sections: Palencia-Espinosa (59.8 km), Espinosa-Mataporquera (50.3 km), Mataporquera-Torrelavega (76.9 km) and Torrelavega-Santander (29.5 km).

1. TRACK, PLATFORM AND SUPPLIES: replacement of sleepers with PR-01 monoblock concrete versions; replacement of rails with welded long bar of 60 kg/m on the first two sections and 54 kg/m on the last two; and replacement of ballast with A-type siliceous; raising and replacement of existing level crossings, and raising and replacement of A-type points with P-type on the first two sections and C-type on the last two sections; adaptation of drainage systems and structures.

2. ADAPTATION OF THE STATIONS of Muriedas and Guarnizo for trains 750 metres long.

3. ELECTRIFICATION: all assemblies and elements (cylindrical foundations, posts, general/secondary track equipment, conductors) have been replaced; and rigid gantries have been installed instead of funicular gantries. The overhead line has been replaced over the entire length of the line with type CR-160, compensated with double contact wire, which allows maximum speed to be increased from 120 km/h to 160 km/h. Because of this, the traction substations of Palencia, Monzón de Campos, Marcilla, Espinosa and Mave have been renovated.

4. STRUCTURES: reinforcement and improvement of bridges, tunnels and crossings.

MADRID-SANTANDER IN THREE HOURS

In October, the Minister of Public Works, José Luis Ábalos, pledged that Madrid and Santander would be connected by 2024 with a journey time of around three hours and stressed that the train would stop in Reinosa and Torrelavega. After his meeting with the president of Cantabria, Miguel Angel Revilla, the minister affirmed that to make this connection a reality "all of the projects that affect the new high-speed line between Palencia and Reinosa will be drafted by 2019," and that the intention is to "make public all other sections in what remains of the legislature."

In parallel with all of the actions mentioned above, the Ministry of Public Works has designed a new high-performance standard-gauge line between Palencia and Alar del Rey, for which Ineco drafted the preliminary study in 2016 (see plan above). In January 2018, the project obtained its Environmental Impact Statement and, in March, Adif Alta Velocidad announced the tendering of four contracts for the drafting of the basic and construction projects of the platform on the four sections into which the route has been divided: Palencia-Amusco, Amusco-Osorno, Osorno-Calahorra de Boedo and Calahorra de Boedo-Alar del Rey.

The station in Santander and its surrounding area will undergo a major transformation when it carries out the planned railway integration actions, for which Ineco is drafting the construction projects for the reorganisation of the station's spaces. These actions are included in a collaboration agreement signed in October 2018 by Santander City Council, the Cantabria Regional Government and Adif.

Santander station is a terminal railway station located in the Spanish city of Santander. It was opened in 1943 by Renfe following a project by the architect Luis Gutiérrez Soto and engineer Carlos Fernández Casado. In 2010, its rail services, which include long and medium-distance and commuter network, were used by around 850,000 passengers. It is located in Plaza de las Estaciones, near the city centre. Next to this Adif-owned station is the Renfe Feve station through which trains that travel on the narrow-gauge network run.

Recently, improvement works on the Muriedas railway terminal and its connection to the Port of Santander were put out to tender, with project financing from the Port Land Accessibility Fund.

Keeping wildlife at bay at airports

The presence of animals in and around airports can cause serious conflicts with aircraft operations. To reduce this risk, since 2017, Ineco has been collaborating with Aena to implement measures in all of Spain's airports in accordance with the guidelines of the Spanish Aviation Safety and Security Agency (AESA). This article describes some specific cases in which the company has participated in these efforts to make air safety compatible with conservation.

By **Jorge H. Justribó, Ana Palomo** and **María Montero,** biologists

Focal points of wildlife attraction (water points, landfills, dovecotes, etc.), favourable habitat environments in airports and their adjacent areas, aspects related to bird migration or any other circumstances that encourage the presence and concentration of wildlife in and around airports must be properly managed to prevent conflicts with aircraft operations.

Aena, as an airport manager, implements measures at its aerodromes to monitor and control wildlife populations in order to reduce the risk of animal strikes. These are implemented in accordance with the regulations of technical guides produced by the Spanish Aviation Safety and Security Agency (AESA), in particular CERA-09-GUI-001 for the preparation of Airport Manual AUP-17-ITC-113 *Preparation of wildlife and habitat studies in airport environments* and CSA-14-IT-025-1.0 *Special technical instruction for the drafting of airport wildlife strike risk studies*.

Airports and heliports, in turn, manage risks by implementing the guidelines in these guides, as established by Procedure 4.12 of the Airport Manual and in the respective wildlife control programmes. The scope of use includes aerodromes covered by Commission Regulation (EU) No 139/2014 of 12 February 2014, which establishes aerodrome requirements and administrative procedures in accordance with Regulation (EC) No 216/2008 of the Parliament and of the Council, and by Royal Decree 862/2009 of 14 May, which approves the technical standards for the design and operation of aerodromes for public use and the certification and verification regulation

PHOTO_ MIKEBERT4 / FLICKR

Ineco has produced information guides describing the most common birds for Aena's staff at the airports of El Hierro and Jerez (pictured) and also for students training at the Jerez Pilot School.

A white stork's nest near Huesca-Pirineos Airport will be moved in order to prevent incidents with aircraft.

PHOTO_ MANUEL PORTERO / WIKIMEDIA COMMONS

RELOCATION OF A WHITE STORK'S NEST AWAY FROM HUESCA-PIRINEOS AIRPORT

The presence of nests of certain species in airport environments can pose a significant risk to airport operations, either by the birds being run over, struck or sucked into aircraft engines.

In the specific case of Huesca-Pirineos Airport, the presence of a white stork's nest in the municipality of Alcalá del Obispo could have interfered with airport operations, so the airport applied for a permit through the Aragonese Institute of Environmental Management (INAGA) to remove it and implement deterrents and corrective measures.

Three types of actions were carried out in compliance with the resolution issued by the INAGA:

1. **Removal of nests:** removal of the nest using cranes and/or climbing equipment.
2. **Deterrence:** installation of measures to deter reoccupation of the church. The chosen measure was the placement of low-voltage electrified cables that are harmless to the storks, but prevent them from perching and rebuilding the nest.
3. **Alternative corrective measures:** an alternative nesting platform will be installed in a location that does not affect the airport.

PHOTOS_**INECO**

Falconry is one of the most effective methods for the removal or exclusion of wildlife. In the image, wildlife control with different falconry birds at Málaga Airport.

PHOTO_**PACO MARÍ / KUTXA FOTOTECA**

The naturalist Félix Rodríguez de la Fuente was a pioneer in Spain in the use of falconry birds at airports.

TRAINING GUIDES

In order to improve the reporting of sightings and incidents at airports such as El Hierro and Jerez, a number of guides have been produced describing the most common birds that pose a risk due to their size and weight. The aim is to train airport staff to better identify these species, particularly birds, on the air side of the airport.

In the case of El Hierro Airport, located on the coast of the island of El Hierro in the Canary Islands, there is a notable presence of seabirds, as well as other species associated with aquatic and grassland environments. The guide lists the 16 most relevant birds in regard to aviation safety, and includes their movement patterns, distinguishing features for identification, conservation status and the periods of the year in which they can be observed.

Jerez International Airport, which handled one million passengers in 2017, an increase of 14.1%, has had a wildlife control service for a number of years. It uses various methods for deterring, capturing and repelling wildlife. The guide is used to train students at the Jerez Pilot School to enable them to identify which wildlife poses a risk and to report bird sightings. The guide lists the 15 most relevant bird species with respect to aviation safety, and includes instructions for correct identification, information about flows/movements within the airport and details on the focal points of attraction identified in the environment.

IN ORDER TO MANAGE WILDLIFE, IT IS NECESSARY TO IMPLEMENT METHODOLOGIES THAT PROVIDE DATA FOR UNDERSTANDING BASIC POPULATION DYNAMICS, HABITAT SELECTION AND MOVEMENTS WITHIN THE AIRPORT

for airports and other aerodromes for public use.

Within this context, since April 2017, Ineco has provided technical assistance to Aena for the implementation and monitoring of programmes that offer different alternatives for wildlife population management at airports. The company has also drafted training documents to help staff at certain airports to identify species and improve the reporting of sightings of birds that could interfere with air operations.

WILDLIFE MONITORING METHODOLOGIES

In order to manage wildlife populations, it is essential to implement methodologies that provide data for understanding basic population dynamics, habitat selection and wildlife movements, mainly of birds, within the airport. Ineco's technical assistance includes the implementation of methodologies for the monitoring of wildlife based on basic parameters related to abundance, density, distribution, flows and sampling of focal points of attraction in order to assess their significance in terms of potential risk of collisions with aircraft. Census methodologies for birds and mammals are currently being designed in compliance with AESA's instructions. The idea is to carry out repeatable and comparable standardised samplings over time to enable analysis of the evolution of animal populations and determination of wildlife flows/movements that could affect operations.

The target animal groups are diverse and their significance varies depending on the airport, but they are essentially birds and mammals. Mammals may pose a risk to operations as in the case of ungulates (roe deer and wild boar) or may cause strikes because they themselves constitute focal points of attraction by representing a food source for other animals such as birds of prey. This is the case with lagomorphs –small herbivorous mammals such as hares and rabbits– a group on which work is being carried out to develop methods of monitoring and control in places with this type of problem, through standardised censuses and population control protocols.

HABITAT MANAGEMENT

To a large extent, control of wildlife at airports involves adequate habitat management. Airport habitats should be as unattractive as possible to wildlife. It is important to identify elements that attract wildlife, such as plant species that encourage nesting, feeding and shelter, the presence of roosting spaces, puddles etc. Different technical notes have also been developed regarding the application of new vegetation cover using hydroseeding or, for example, responses to airports about the suitability of the implementation of certain vegetation cover in the airport environment, analysing its suitability and proposing alternative crops that are less attractive because of reduced palatability or method of cultivation. ■

SINCE 2017, INECO HAS BEEN PROVIDING TECHNICAL ASSISTANCE TO AENA TO IMPLEMENT AND MONITOR PROGRAMMES THAT OFFER DIFFERENT ALTERNATIVES FOR WILDLIFE POPULATION MANAGEMENT AT AIRPORTS

ONLINE TRAINING

To develop wildlife risk management programmes, Aena requires the support of qualified staff with knowledge of the basic principles of wildlife management (habitat management, focal points of attraction, identification of species that pose a risk in the area, risk reduction or mitigation measures, etc.). To help in their training, Aena is preparing an online course to be given to staff involved in the operation, maintenance and management of its airports.

The course will provide basic and specific wildlife control training for staff in compliance with Commission Regulation (EU) No 139/2014 of 12 February 2014 laying down requirements and administrative procedures related to aerodromes pursuant to Regulation (EC) No 216/2008 of the European Parliament and of the Council. The content of the course will be tailored to the requirements of Technical Instruction CSA-16-ITC-110 Wildlife Control (Training and competence testing programme) and GM3 ADR. OPS.B.020 Wildlife Control Training.

PHOTO_**ARTHUR CHAPMAN / FLICKR**

Ineco works on improving lagomorph monitoring and control systems at the affected airports.

MONITORING AND MANAGEMENT OF LAGOMORPH POPULATIONS

The presence of lagomorphs can cause various problems, from damage to infrastructure due to burrow digging to broken wiring or creating foreign object damage (FOD) due to animals being run over by vehicles or aircraft taxiing on the runway. These prey species can also themselves be a focal point of attraction for predatory species that pose a risk to operations, such as birds of prey. Standardised methodologies are currently being developed to monitor lagomorph populations where this wildlife group is identified as the protagonist of risk, and management plans are being implemented to adapt to the population dynamics of these species in order to reduce their density on the air side of airports. Other proposals include the capture of animals during periods of the year in which successful reproduction decreases, with the ultimate goal of causing a negative population trend; management of crops in airports that require it to reduce habitat suitability; management of burrows by ploughing; and new methods of capture when needed.

Opening doors

Malaysia wants to modernise its railways to make them the main public transport option for its citizens. To do this, a consortium consisting of Ineco, Adif and two Malaysian companies has designed a new open-access model for railway transport in which ownership and management of the infrastructure are unbundled from operation, allowing new private operators to enter.

By **Javier Anibarro** and **Miriam Yepes,** economists

MALAYSIA
The metro passing through Semantan station in the centre of Kuala Lumpur. In the background, the Petronas Towers.

PHOTO_SIRAP BANDUNG

Malaysia, situated in the centre of Southeast Asia, one of the world's most dynamic regions, divides its territory between the Malay Peninsula, where its capital Kuala Lumpur is located, and the less populated island of Borneo in the north. The country, which has opted for a free market economy with intensive use of technology and capital, is in the middle of the ranking in terms of global development and aspires to advance further in the coming years by diversifying its economy –its services sector now represents more than 55% of its GDP– and investing heavily in infrastructure, especially in transport. The goal is to expand and improve its road and rail networks with projects such as the Pan Borneo highway, new metro lines in Kuala Lumpur and a high-speed rail link to Singapore, among other projects.

The rail network, including urban, commuter and long distance, is essential for the transportation of people and freight in this country of 32 million inhabitants with a high population density –97 inhabitants per km^2– especially concentrated in the metropolitan and surrounding areas of the capital. Because of this, the government has implemented plans to promote the use

The Petronas Towers.

PHOTO_DCUBILLAS

of public transport, proposing, along with the heavy investments in infrastructure, the application of a new open-access model of rail transport operation, to replace the current 'vertical integration.'

The open-access model in rail transport, through different governance schemes, is currently being applied in the European Union and other countries around the world. The model is based separating ownership and management of the railway infrastructure from operation, allowing different operators that comply with the established regulations to provide these services, thereby increasing competition and efficiency of the service. The model also includes the creation of a sole infrastructure authority and rail transport regulator which defines the technical and economic conditions for the granting of licences (as infrastructure managers or operators), establishes a system of incentives and penalties for operators and is responsible for safety certification. ■

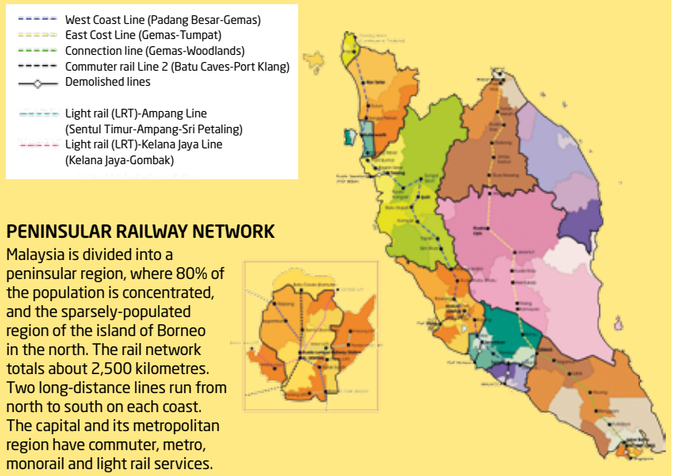
RAILWAY REGULATION EXPERTS

Ineco, in consortium with the Spanish railway infrastructure manager Adif and the Malaysian companies HSS Integrated and Wong & Partners (Baker & McKenzie International), has drafted a project for implementing the open-access framework in Malaysia's railways for SPAD (Land Public Transport Commission). Ineco has been providing expert advice to the Spanish government for many decades in connection with the reform of the rail sector after Spain joined the European Union in 1986. In Spain, the separation of railway infrastructure management and operation took place in 1995 with the creation of Adif and Renfe Operadora, as a result of the entry into force of the Railways Act, which Ineco helped the Ministry to draft. Internationally, in 2014, the company prepared a project to implement an open-access model for Brazil's railways.

The project for Malaysia's railways involved an analysis of the organisational, technical and economic/financial aspects, and contains recommendations for overhauling the complex legislative and institutional framework of the country's rail sector.

Rail transport responsibilities in Malaysia are currently divided among several bodies and entities under three different ministries. In 2010, with the entry into force of a new Land Public Transport Act, a new body, SPAD, was created under the auspices of the Prime Minister's Department to improve coordination and promote the use of public transport. SPAD *(Suruhanjaya Pengangkutan Awam Darat*, in Malaysian, Land Public Transport Commission) took over the planning and regulation of the railways (and some bus lines, such as route concessions). At the same time, the public enterprise KTMB, under the Ministry of Finance, is the operator of the peninsular suburban, interurban and freight line network, while infrastructure development is the responsibility of the Ministry of Transport through RAC (Railway Assets Corporation). In terms of light rail and metro, the public corporation Prasarana is both owner and operator of the Light Rapid Transit (LRT), Mass Rapid Transit (MRT) and Kuala Lumpur monorail systems, as well as operator of bus lines in three other cities in the country.

Against this backdrop, the proposed open-access model will be applied to the operation of the current KTMB network, with the exception of suburban services. Prasarana's metropolitan network will however be excluded from the new plan (the sole operator would remain and two licences would be granted: operator and manager), as will two public-private partnership (PPP) concession and association projects that are currently underway in the country: the future Malasia-Singapore high-speed line (for which Ineco conducted a demand study in 2014, also for SPAD) and the East Coast Rail Line (ECRL). The legal framework of both projects will not be amended, it has been proposed that the infrastructure manager should apply for the corresponding system manager and operator licence.



PENINSULAR RAILWAY NETWORK

Malaysia is divided into a peninsular region, where 80% of the population is concentrated, and the sparsely-populated region of the island of Borneo in the north. The rail network totals about 2,500 kilometres. Two long-distance lines run from north to south on each coast. The capital and its metropolitan region have commuter, metro, monorail and light rail services.

PHOTO_SIRAP BANDUNG

The monorail runs for some 9 km in the centre of Kuala Lumpur. It has 11 stations and approximately 68,000 users per day.

THE OPEN-ACCESS MODEL: MAIN PROPOSALS

▶ **In the proposed system, the SPAD would act as the sole authority for controlling and monitoring of the railway infrastructure and market and technical regulator,** and, would therefore, be responsible for granting manager and operator licences. This would require legal reforms.

▶ **Changes to the governance structure:** Ineco's analysis includes two options: one, to transfer the personnel, resources, much of the equipment and competencies in the field of infrastructure management from KTMB to RAC, which would become the owner and manager. However, given the complexity of the implementation of the aforementioned system, a second option has been proposed: RAC, which currently owns the infrastructure, would transfer its infrastructure operation to KTMB, or an independent third party, in exchange for an availability charge, and would keep the activities that are not strictly rail related, such as commercial development, property assets, broadband, car parks and advertising. The funds raised would mainly be used to reduce the availability charge. According to the proposed system, relationships between infrastructure managers and operators would be defined through contracts under the supervision of SPAD and between the operators and the government, in the event that the latter has to provide financing of services of public utility, but not for profit, with the appropriate control mechanisms.

▶ **Establishment of capacity allocation mechanisms:** this is a vitally important process for the proper functioning of a railway transport open-access model, and is carried out in two phases: reservation and allocation. First, the infrastructure manager will accept, in principle and on a provisional basis, all requests from operators for which there is available capacity. The final decision on the allocated routes must be justified by the manager and subject to SPAD's power to resolve disputes. Second, an annual schedule will be designed, subject to monthly, weekly and daily adjustments, to allocate reserved capacity and requests on specific routes. For the allocation of routes, criteria of free competition and certainty for operators will be applied, without undermining operational management.

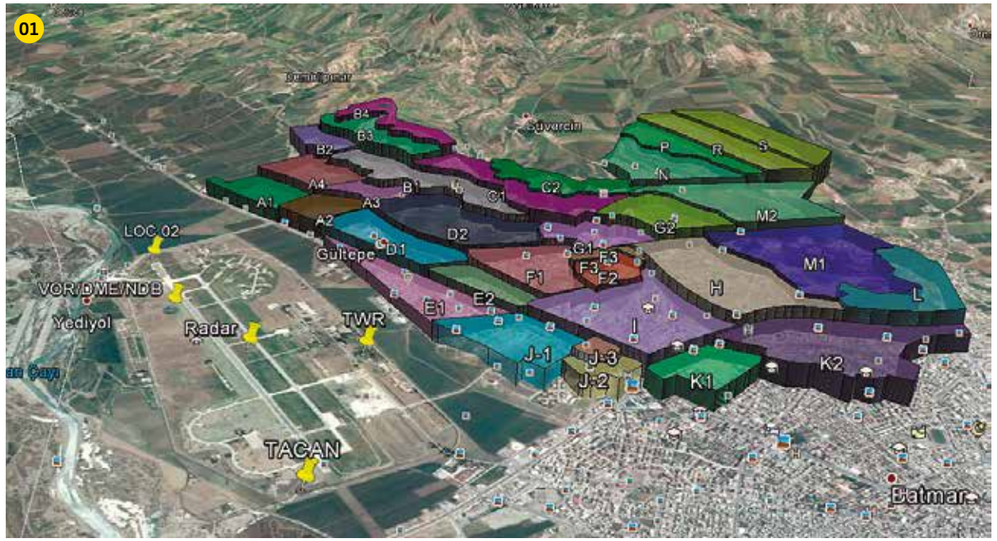
▶ **Charges to operators:** the definition of the correct economic model is considered crucial for a successful outcome of rail transport open access. The proposal in the case of Malaysia is a dual approach to charging for track access: one for freight and the other for passengers. Both consist of three charges: one for reservation and capacity, another for circulation and the third for traffic, all calculated according to the infrastructure owner's cost structure (the study includes a preliminary schedule). In addition, other charges will be established for ancillary services and use of facilities such as passenger stations, car parks, platforms, loading points and sidings.

▶ **Implementation of a system of incentives and penalties:** the aim of the performance management system is to promote the quality and punctuality of the service provided by the operators, as well as the quality and availability of the infrastructure managers.

▶ **Safety and interoperability:** it is necessary to create an infrastructure register and a vehicle register, as well as a body for the entire Malaysian network responsible for studying the causes of accidents and issuing recommendations. This function could be carried out by an independent department within SPAD or by an independent national investigation body. In addition, both managers and operators must develop a safety management system defined by SPAD. In terms of interoperability on international routes, SPAD will also be responsible for defining the technical specifications and unifying the technical parameters to allow authorisation for the operation of a foreign train within the Malaysian network. To do so, SPAD will need to sign mutual recognition protocols with the competent authorities of other countries and agreements to detail the specific requirements.

▶ **PESTLE analysis:** this type of analysis studies the influence of political, economic, social, technological, legal and environmental factors on a project. It is considered necessary for the regulatory impact assessment which must be carried out by the public authority before new regulations are included. Regarding political aspects, the conclusions of the analysis indicate that the new railway management model will contribute to improving organisational structure, reducing uncertainties and organising and clarifying the functions of the key stakeholders.
With regard to economic aspects, the introduction of free competition with new operators is expected to contribute to economic growth by increasing the competitiveness and productivity of companies and users, and reducing travel times and costs. It will also offer more reliable and higher quality transport. From the social point of view, the expected growth of the Malaysian population means that mobility needs to be improved. Regarding technological aspects, the new operators could introduce innovative technical solutions. In the legal field, the most important change will be the implementation of an unbundling a rail transport model in the peninsular network, with the respective capacity and load allocation mechanisms required. The main legislative changes will be established in an amendment to the current Land Public Transport Act 2010. SPAD must be empowered to grant licences and implement regulations related to infrastructure. Finally, in relation to environmental factors, the proposed model adopts the proposals of Malaysia's National Master Plan for Land Public Transport, which is committed to public transport, and rail in particular, in order to reduce pollution and congestion. The Plan aims to double the country's modal share of public transport to 40% by 2030.

▶ **Business sustainability report:** the study also includes a report in which a general estimate is made of the system's revenue and cost schedule to ensure its sustainability once the open-access model is implemented.



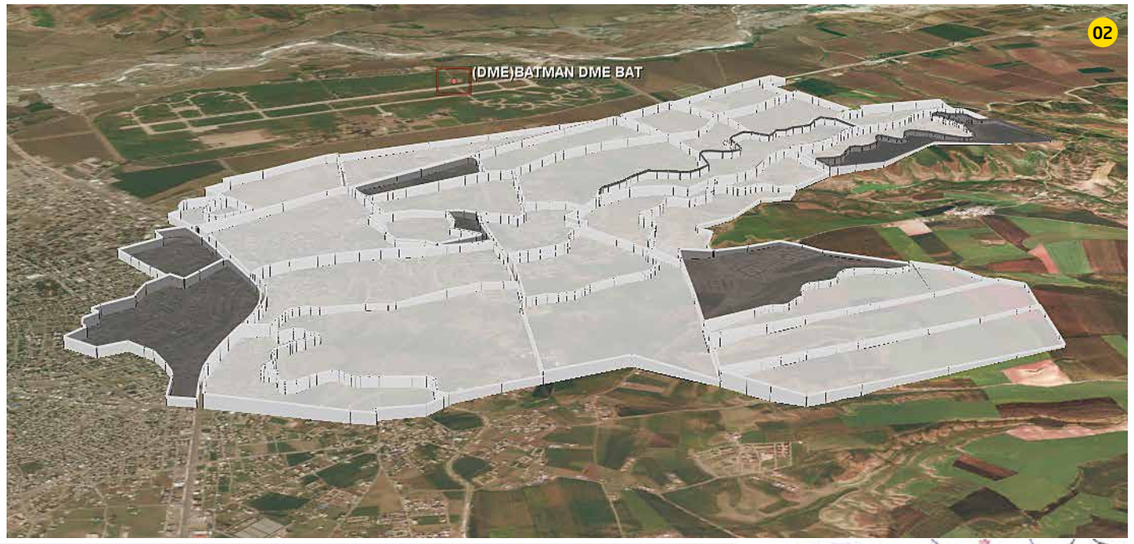
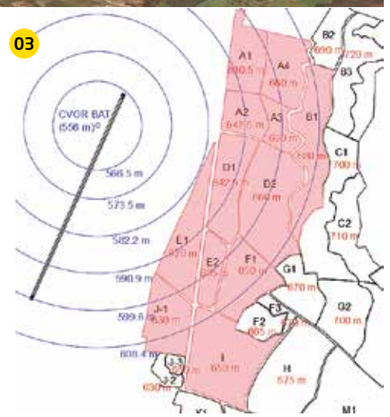


Figure 1. Location of the planned residential development under study with respect to Batman Airport and its CNS facilities (Google Earth).

Figure 2. Model of the planned urban development created using Navtools for the simulation of pulsed systems.

Figure 3. On-site representation and analysis of the BRA of Batman Airport's CVOR BAT equipment.

Figure 4. 3D representation and analysis of the BRA of Batman Airport's CVOR BAT equipment. Image created with Navtools.



ANALYSIS OF THE IMPACT OF OBSTACLES ON CNS SYSTEMS

Batman can grow

The construction of a large residential development and a new mosque in the vicinity of Batman Airport in Turkey could affect the safety of its operations. Ineco carried out studies to analyse the effect of these buildings on the radio signals of communication, radio navigation aid and radar equipment at this dual-purpose civil and military airport.

By **Carolina Ajates,** a telecommunications engineer and **José Mª Berdoy,** an aeronautical engineer

Today, air traffic controllers and pilots need to send and receive accurate and reliable information in order to operate safely. To do this, they use communication, navigation and surveillance (CNS) systems. These systems work by transmitting and receiving properly modulated radio frequency signals that propagate by means of spatial waves, that is, by direct line of sight between transmitter and receiver. This means that the presence of obstacles on the terrain can cause signal fading or amplification, and, in general, overlapping and distortion in the transmitted information.

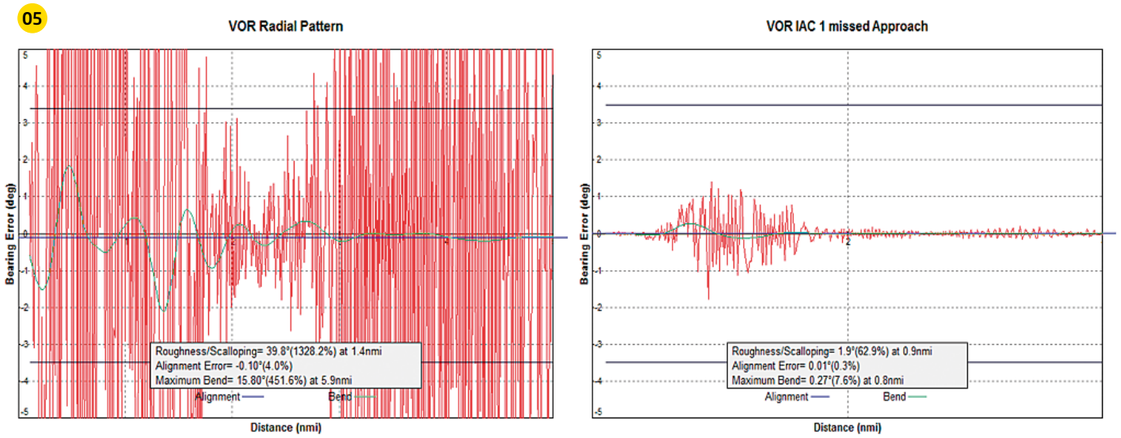
TODAY, AIR TRAFFIC CONTROLLERS AND PILOTS CAN OPERATE SAFELY THANKS TO CNS SYSTEMS

Simulation studies to assess impact on radio systems analyse the potential disturbances that physical obstacles could cause in radio wave transmission. These analyses are vital for air navigation because they make it possible to identify obstacles that are incompatible with the proper functioning and/or performance of the systems, ensuring that aircraft take-off, flight and landing operations are carried out correctly. Ineco boasts a long list of national and international simulation projects to assess effects on CNS radio systems, with more than two thousand studies carried out.

As a result of an ambitious urban development plan and a new mosque, the company is currently working in the city of Batman in the Southeastern Anatolia region of Turkey. The city, which is close to the border with Syria, has more than 300,000 inhabitants and gets its name from the Batman River, which flows through it. It is connected by flights to the cities of Ankara, Istanbul and Izmir from its joint civil and military airport, which was opened in 1998 and is located just seven kilometres from the city cen-

INECO BOASTS A LONG LIST OF SIMULATION PROJECTS TO ASSESS EFFECTS ON CNS RADIO SYSTEMS

Figure 5. RESULTS OF CVOR ANALYSIS. Example of results obtained from a simulation using the OUNPPM tool of an approach manoeuvre supported by the CVOR BAT system. Out-of-tolerance results of the originally proposed residential development (on the left) and admissible results for the scenario proposed by Ineco (on the right).



tre. The oil reservoir in the area –Batman has a refinery and gas pipeline– is its main source of wealth. It also has a food and craft industry, and a university that is part of the Erasmus programme.

AN AMBITIOUS URBAN DEVELOPMENT PLAN NEXT TO THE AIRPORT

The implementation of an urban development plan covering more than 2,500 hectares east of the airport led the multinational company AERTEC Solutions to commission Ineco to carry out an analysis of the potential impact that the buildings between 5 and 90 metres high in this residential development would have on the airport's civil and military CNS systems. The study also included identification of plots whose buildings would be most detrimental to operations and established limitations in height or maximum elevation to ensure the safety of the airport.

The studies carried out by Ineco to analyse the impact on radio systems harmonise the proper functioning and performance of CNS facilities (existing or planned) with international regulations and the requirements of the International Civil Aviation Organisation (ICAO) with the presence of new buildings (e.g. new hangars and terminal buildings), facilities (e.g. wind farms and power lines), infrastructures and urban developments in the surrounding area. To carry out these analyses, the company's experts usually rely on the regulations of each country (in Spain, for example, the Navigation Easements Decree) and international regulations, standards and recommendations. Ineco has managed to develop its own methodology based on the document *ICAO EUR DOC 015 (3rd edition)*, European guidance material on the management of applications for new buildings or facilities in airport surroundings and the main international reference document for their impact on radio systems. This methodology consists of two steps. First, analysis of whether the obstacles under study infringe upon (geometrically cut) a set of imaginary protected zones called building restricted areas (BRAs). What this study actually does is screen elements. For elements that do not infringe on these areas, additional analyses are not usually required and their installation or construction can be immediately approved. For obstacles that do infringe upon any of these areas, a specialized analysis or radio simulation needs to be carried out, and the findings will determine whether the facility or building is admissible, admissible with restrictions or should be disallowed.

> THE STUDIES CARRIED OUT BY INECO TO ANALYSE IMPACT ON RADIO SYSTEMS HARMONISE PROPER FUNCTIONING AND PERFORMANCE OF CNS FACILITIES WITH THE PRESENCE OF NEW BUILDINGS

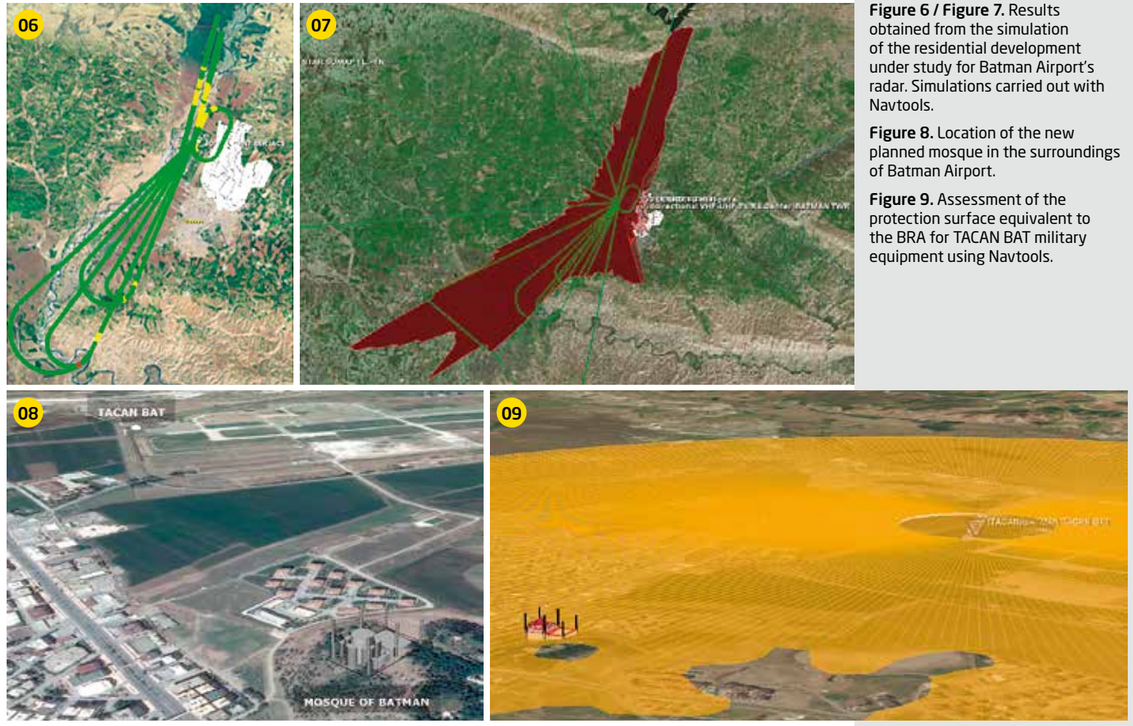


Figure 6 / Figure 7. Results obtained from the simulation of the residential development under study for Batman Airport's radar. Simulations carried out with Navtools.

Figure 8. Location of the new planned mosque in the surroundings of Batman Airport.

Figure 9. Assessment of the protection surface equivalent to the BRA for TACAN BAT military equipment using Navtools.

In the case of the planned urban development near the Batman Airport, the maximum construction heights proposed on all plots infringed on the airport's BRA. As a result, the effect of all of the plots on each system was analysed individually and as a whole, and other planned infrastructure and the impact of existing elements were also taken into account.

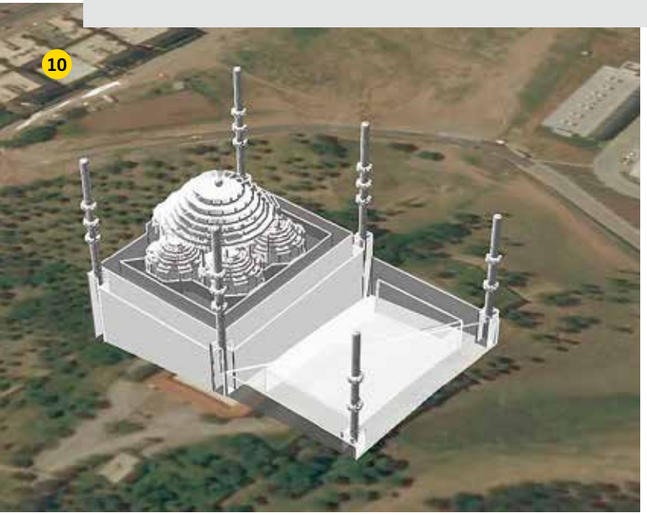
The simulation tools used made it possible to analyse different scenarios and anticipate the potential impact on CNS systems, both in the case of continuous-wave and pulsed systems. Thanks to these tools, it was possible to reproduce the geometry of the plots that make up the urban plan using flat rectangular plates (OUNPPM) or prisms (Impulse/Navtools). Navtools, was developed by Ineco and allows analysts to manage all aspects of the studies (CNS system parameters, obstacle modelling, graphical and numerical representation of results, etc.).

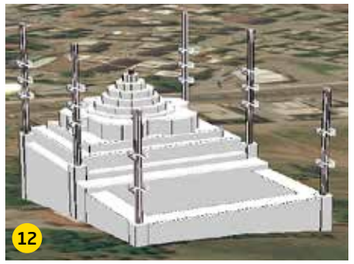
As a result of the simulations and the multicriteria analysis, it was concluded that the presence of buildings in several of the planned plots could affect the CNS systems and, ultimately, therefore, the safety and/or regularity of Batman Airport's operations. The analysis specified the building plots that needed to be reconsidered, maximum building heights and the areas where additional analyses should be carried out once more detailed information on each building became available. It also provided guidance on construction materials, including recommendations to avoid metal finishes, such as aluminium and steel on façades. The use of cranes for construction also needed to be taken into account and analysed.

> NAVTOOLS WAS DEVELOPED BY INECO AND ALLOWS THE ANALYST TO MANAGE ALL ASPECTS OF THE STUDIES

Figure 10 / Figure 11 / Figure 12. Elevation and plan views of the 3D model of the mosque used for the TACAN simulations carried out with Navtools.

Figure 13. Construction sketch of the new mosque.





THE FINDINGS OF THE STUDY REVEALED THAT THE PLANNED MOSQUE DID NOT CAUSE SUBSTANTIAL ADVERSE EFFECTS ON THE TACAN BAT FACILITY DURING IAC AND SID MILITARY PROCEDURES

THE NEW MOSQUE

The new mosque project, featuring six 50-metre minarets, could potentially interfere with the tactical air navigation system (TACAN) located at the military air base south of Batman Airport. As it is a military system, the ICAO does not consider this type of equipment in BRA analyses. Consequently, Ineco needed to study civil systems that could be considered equivalent (DVOR/DME) to perform analysis of the surfaces or areas in which buildings and their heights should be restricted.

As with the urban plan, Ineco used its extensive experience to assess the infringement of these areas and in the subsequent simulation studies that were required. Thus, simulations were carried out to detect potential radio signal coverage losses and to assess the possible occurrence of errors and/or loss of responses as a consequence of multipath phenomena caused by reflection and refraction of signals off the new mosque. To perform the relevant simulations, CAD tools and the most appropriate software were used. These tools use mathematical algorithms to provide accurate results when the largest dimension of obstacles is at least 10 times the wavelength of propagated radio frequency signals. The algorithms implemented in these tools have been validated successfully in many real flight inspection tests.

The findings of the study revealed that the planned mosque did not cause substantial adverse effects on the TACAN BAT facility during IAC and SID military procedures. ■

PABLO RODRÍGUEZ GONZÁLEZ

Expert on air navigation systems and simulations to assess impact on radio systems.

WORK ROUTINES NEED TO BE SIMPLIFIED BY INCREASING DIGITISATION

After more than 2,000 simulation studies over 15 years, the new technologies that we have developed enable innovative changes to be made in operating methods.

Simulation studies to assess effects on CNS (communication, navigation and surveillance) radio systems consist of analysing the impact of new obstacles (buildings, power lines, cranes, etc.) in the surrounding area on the operation of this equipment. It is a 'veteran' discipline in which Ineco has been actively involved for 15 years. Nevertheless, it is worth reflecting on the new challenges and lines of action that the company needs to address in order to remain 'young' and at the forefront of knowledge:

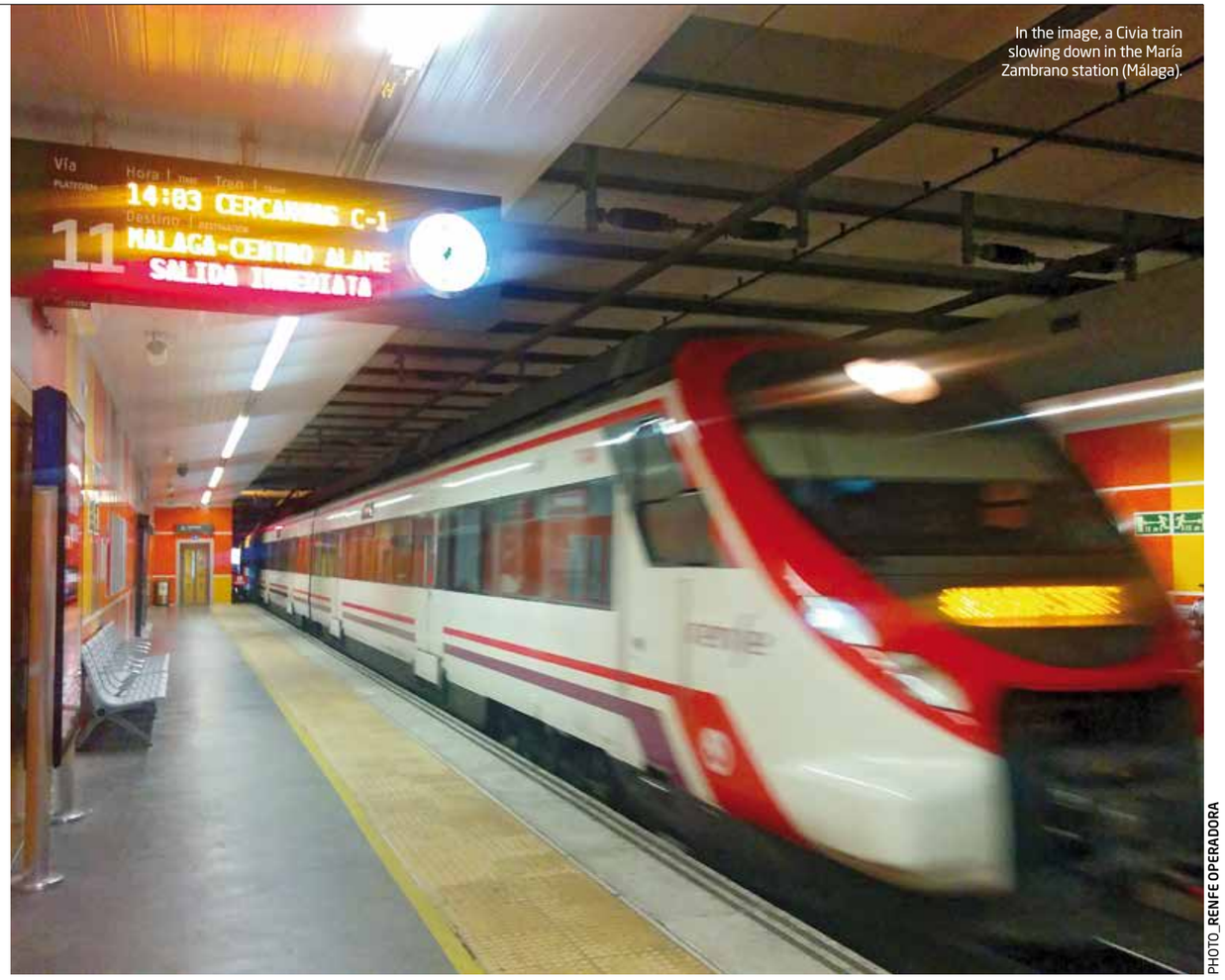
Process improvement: the experience gained over this time enables us to identify the activities that are capable of being updated, adapted or automated in order to improve efficiency and minimise human error. Simulation studies to assess impact on radio systems involve the performance of a large number of tasks, many of which, colloquially speaking, can be executed in '80 convenient steps.' It is, therefore, necessary to work on simplifying work routines by redefining them through the development or updating of internal tools, and seeking a greater degree of digitisation.

Applying Big Data methodologies to simulation studies: every time a simulation study is carried out, an enormous amount of data is generated and used (equipment operating parameters, obstacle geometry data, terrain topography, navigation signal structure, etc.). Once the study has been completed, however, very little is done with this data. Over the last 15 years, more than 2,000 simulation studies have been carried out, so the volume of information available is considerable. It is worth reflecting, therefore, on how to take advantage of all of this information and create behaviour patterns that allow the efficiency and quality of studies to be improved.

Analysis of new navigation systems: little by little, navigation systems based on GNSS technologies have been incorporated into the air navigation system, and in a few decades, they will be the main source of navigation information for aircraft, replacing the current terrestrial navigation systems. The simulation studies normally carried out to assess impact on radio systems essentially analyse the behaviour of the terrestrial systems (ILS, VOR, DME, NDB, radar), on which the current air navigation system is based. It is, therefore, necessary to start to focus on GNSS-based navigation systems to find out and understand how they are affected by their immediate environment (coverage, multipath, interference, etc.), and, in this way, begin to build a methodology for analysing them. In this regard, Ineco has already begun to work on the development of a software tool (CoverGBAS) to carry out studies on a particular type of GNSS-based navigation system, GBAS (Ground-Based Augmentation System).

"GNSS TECHNOLOGIES WILL BE THE MAIN SOURCE OF NAVIGATION INFORMATION FOR AIRCRAFT"

In addition to these, there are certainly more lines of action that will allow Ineco to remain at the forefront of simulations to assess impact on radio systems. The Ineco team that is doing this work combines experience and youth, and is ready to face the changes proposed by the future of air navigation.



In the image, a Civia train slowing down in the María Zambrano station (Málaga).

PHOTO_RENFE OPERADORA

THE INSTALLATION OF ENERGY RECUPERATORS ON SPAIN'S CONVENTIONAL NETWORK

Round-trip energy

The installation of energy recovery units in traction substations on the conventional network enables surplus regenerative braking energy to be recovered and returned to the electrical grid, preventing dissipation in the form of heat in the braking resistors of the trains. Since 2010, Ineco has been developing a number of engineering projects for Adif to define and implement these units.

By **Cristina Chicharro, Andrés Estévez** and **Ernesto Labarta**, industrial engineers, and **Juan Carlos Ramiro**, aeronautical engineer

Energy recovery improves the energy efficiency of the electric power supply installation for traction on conventional rail networks and reduces emissions into the atmosphere. Ineco's first task was to draft the construction project for the installation of a regenerative braking energy recovery unit in the traction substation of La Comba in the province of Málaga, which was put into service in 2014. This is the only installation of its type in service on the conventional network (see *ITRANSPORTE 44*). The recuperator has made it possible to return more than 1 GWh/year to the power grid, representing an annual savings of more than 12.5% on the energy consumption of the Málaga-Fuengirola line, reducing CO_2 emissions by around 230 tons/year (based on a conversion factor of 0.23127 kg of CO_2 per kWh). The investment is expected to be recouped within a less than 10 years.

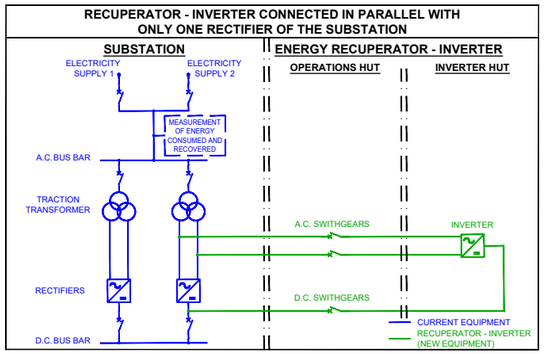
The success of this first energy recuperator prompted Adif to install recovery units in other substations. Since 2015, simulations on national gauge have been carried out to identify substations with the greatest capacity for energy recovery. Railway installations have been modelled taking into consideration data relating to rolling stock, traffic grids, geometric railway platform profiles, electrification installation characteristics, driving modes, etc.

The recovery of regenerative braking energy on the conventional network is one of the measures included in Adif and Adif HS's Energy Saving and Efficiency Master Plans. It is also one of the energy efficiency actions included in the *Programme of Subsidies for Energy Efficiency Initiatives in the Rail Sector* (Resolution of 30 November 2015, BOE-A-2015-13117) offered by the Institute for Energy Diversification and Savings (IDAE). The funding provided by this body for the exploitation of braking energy covers 30% of the investment. Adif plans to have 12 new energy recuperators in service between 2019 and 2020, and is considering extending the installation of these units across its network, mainly on commuter lines.

PUTTING 12 NEW RECOVERY UNITS INTO SERVICE

The first simulations carried out by Adif in 2015 and 2016 on several conventional railway lines identified the substations of Alcorcón, Getafe, Guarnizo, Olabeaga, Martorell and Arenys de Mar as the ones with the greatest capacity for recovering energy and, therefore, the ideal candidates for the installation of recovery units. For these six installations, Ineco prepared the documentation for submitting subsidy applications to the IDAE (successfully awarded in January 2017), drafted the construction projects for the installation of the recovery units and is currently providing the works management and technical assistance. In 2017, Adif carried out a second series of simulations and selected the substations in Tres Cantos, Alcalá de Henares, Pinto, Leganés, Granollers and Castellbisbal. For these, Ineco also prepared the subsidy applications (successfully awarded in February 2018), drafted the construction project and will be providing the works management and technical assistance. It is expected that the first group of substations will be in service by mid-2019, and the second group by 2020.

These 12 recuperators are expected to save some 18.5 GWh/year, which represents a reduction in CO_2 emissions of close to 4,300 t/year and a financial savings of over 1.3M/year. With IDAE's 30% funding, it is expected that the investment of more than 8M will be recouped in approximately 6 years. New simulations will continue to be carried out in the hope of further extending the installation of recovery units across the entire conventional railway network.



In the photo above, the first regenerative braking energy installation in the traction substation in La Comba has made it possible to return 1 GWh/year to the power grid.
The figure below it shows the general schematic for the energy recovery installation in the La Comba substation.

THEORETICAL BASIS

When trains use rheostatic or regenerative electric brakes, they transform the train's kinetic energy into electrical energy. Their engines act as generators, slowing down the wheels and performing the energy conversion. Some of this energy is used to supply the train's auxiliary services, and the rest, in the case of regenerative brakes, is transferred to the overhead line, increasing its voltage.

Part of the energy fed to the overhead line is used by other trains that require it at the moment that it is regenerated, and the surplus is either sent back to the electrical grid if the traction substations are reversible (enabling a two-way transfer of energy: from the grid to the overhead line and vice versa) or it dissipates in the form of heat in the braking resistors installed on board the trains if the substations are not reversible.

Traction substations on high-speed lines use alternating current (AC), which means that they are reversible. However, substations in direct current (DC) electrification systems, such as metros, trams, conventional railway lines, etc., are not reversible because the change to DC requires rectifiers that only allow energy to flow in one direction, from the electrical grid to the overhead line.

In order to make conventional substations reversible, a current inverter (DC/AC converter) must be installed in the substation, along with certain interface elements, such as DC and AC huts, wiring, electrical panels, control and remote control systems, etc. Together, all of these elements make up the braking energy recuperator.

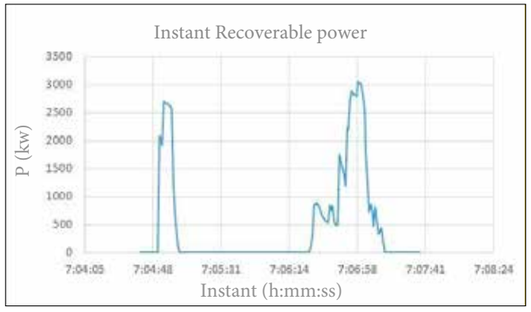
The energy recuperator detects when there is a surplus of braking energy in the overhead line and allows the inverter to operate so that it can convert this electrical energy, in the form of DC present in the overhead line, into AC and feed it into the power grid.

THE INVERTER LOAD CYCLE

Ineco has collaborated with Adif on the selection of the load cycle of the inverters to be installed on its conventional network. Similar to other units installed in traction substations, such as rectifiers and transformers, the inverter must be a standard unit that can be installed in different substations on the conventional network, and not specifically designed for individual facilities.

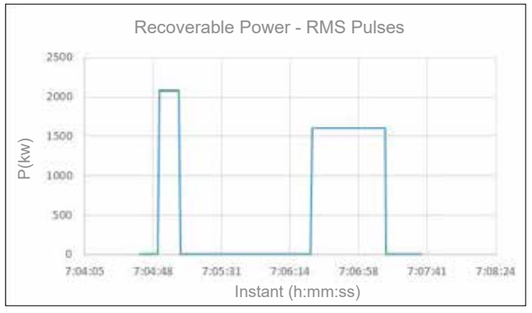
Following the electrical simulations that resulted in the selection of the Alcorcón, Guarnizo and Olabeaga substations, information was made available to characterise the recoverable power.

The graph below shows a typical recoverable power profile. The peaks represent pulses caused by train braking whose amplitude, as well as duration and separation in time, is variable.



The parameters that characterise the pulses are: **amplitude**, **duration of the pulses** and **time between braking**.

To determine the load cycle of the inverter, defined as indicated below, the profile of dischargeable power was aligned with a sequence of pulses of constant amplitude, whose value is the RMS (Root Mean Square) of the instantaneous power values.



The inverter's load cycle is defined based on the following parameters: maximum power **(P_{MAX}),** maximum power pulse duration **(T_1)** and cooling time **(T_2).**

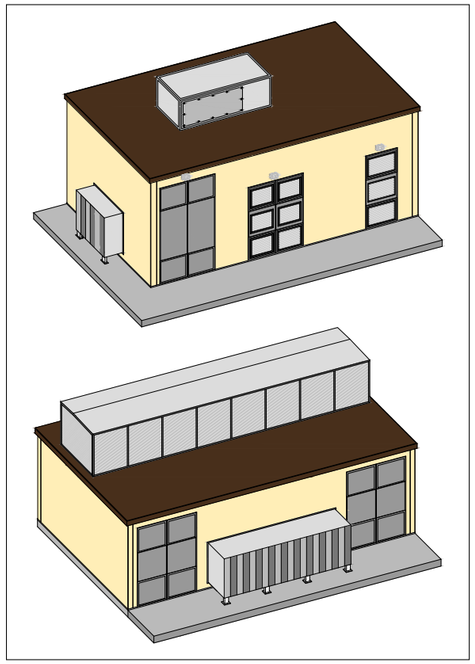
An inverter with the specified load cycle must be able to permanently transfer every T_1+T_2 seconds a power pulse with the value P_{MAX} and duration T_1 seconds. To recoup 100% of the energy discharged by trains in the substation environment, the envelope of the inverter's load cycle should contain all recoverable power profiles. However, the optimisation of the ratio of investment cost/recovered energy, that is, the maximum energy recovered for economically reasonable inverter dimensions, determined that the load cycle of the selected inverter will be determined by the following values: P_{MAX}= 2.5 MW, T_1= 40 s and T_2= 120 s.

An inverter with this power characteristic was able to recover the following percentages of dischargeable energy for the three simulations carried out for the load cycle determination study: Alcorcón substation > 73.15%, Olabeaga substation > 92.11% and Guarnizo substation > 99.97%.

A larger inverter would have made it possible to recover all of the available energy, but its cost would have made the investment unviable.

Another step in standardising the installation of energy recuperators was identifying the equipment that could be specified with precision, regardless of the specific design of the inverter by the technology company, in order to reduce the scope of supply of this company. This made it possible for energy recovery installations in different substations to differ only in the inverter and the equipment directly linked to its design, mainly DC and AC switchgears and filters, and transformers at the inverter output.

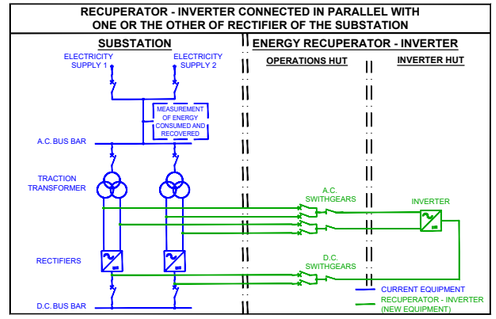
THE DESIGN OF ENERGY RECOVERY INSTALLATIONS IN CONVENTIONAL SUBSTATIONS



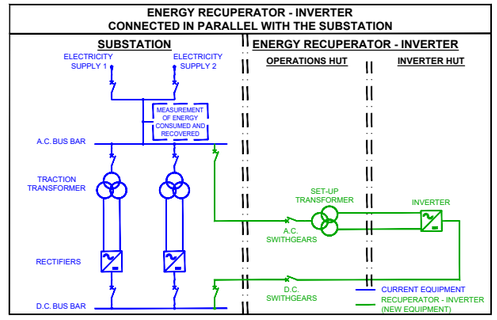
At the top, an operations hut; at the bottom, an inverter hut.

Because there is a lack of free space inside substation control buildings, energy recuperators need to be installed in two separate buildings designated as the operations hut and the inverter hut. The operations hut houses the substation interface equipment and the inverter hut, the inverter itself.

GENERAL SCHEMATIC OF AN ENERGY RECOVERY INSTALLATION



The general schematic of the energy recuperators to be installed in the substations of Alcorcón, Getafe, Guarnizo, Olabeaga, Martorell and Arenys de Mar (pictured) is different from the one implemented in the La Comba substation because the inverter can be connected in parallel to either one of the substation's two rectifiers. This means that energy will always be recovered regardless of the mode of operation of the substation. In order to reduce the interface between the recuperator and substation, the recuperator's connection to the substation has been modified. The new solution consists of connecting the recuperator between the substation's DC busbar and general AC busbar downstream of the fiscal measurement equipment to allow reading of the energy returned to the grid. For this connection, a step-up transformer must be installed in series with the inverter to adjust the recuperator's output voltage to that of the substation's connection.



In the image, the schematic designed for the substations of Tres Cantos, Alcalá de Henares, Pinto, Leganés, Granollers and Castellbisbal and, if there are no new modifications, the one that will be adopted for future energy recovery installations in substations on the conventional network. ■

A monument to iron architecture

Almería's old station is a fine example of 19th century iron architecture, listed as a Site of Cultural Interest. Over the last two years, Ineco has drafted two projects for the renovation of the building, including restoration of the façades, roofs and concourse.

By **Raquel Alonso** and **Ángel Ranz**, architects

PHOTO: ADIF

In the 19th century, engineers designed stations with concourses made of glass and iron, creating spacious, airy and bright structures, with Almería station serving as a fine example. In the photo, the main façade.

The station's concourse is illuminated by a large glass window featuring a large clock by Garnier of Paris, typical of the railway stations of the nineteenth century.

With the opening of Almería's new intermodal station in June 2000, the city's old historic station fell into disuse, housing only a number of railway offices. Since then, the Almería City Council has been calling for the station building to be renovated and put to use for the city. With this in mind, Adif commissioned Ineco to draft projects for the restoration of the building (façades, roofs and concourse) as a step prior to transferring ownership of the station to the City Council to determine its final use.

One of the key characteristics of the building is its consideration as a historic 'monument' after being listed as a Site of Cultural Interest by the Ministry of Culture, Education and Sport in 1985. This fact means that the building's exterior appearance and construction systems have to be conserved, and all restoration proposals had to be extremely respectful in order to be approved by the Office of the Deputy Director of Historical Heritage, limiting the renovation options available.

Over the last two years, Ineco has drafted two projects for the renovation of the building, one of which has already been executed and the other in its construction phase. The first project involved executing restoration works and consolidating the ornamental elements of the roof of the station with the aim of replacing the perimeter balustrade of the lateral sections, which was significantly deteriorated, and restoring its ornamental elements, in addition to repairing the entrance canopy.

The second is the construction project, which involves restoring the façades, including metal and woodwork and the glass curtain wall of the central section, repairing the roofs (lateral and central sections), water drainage systems and the slabs of the lateral sections that support it and renovating the original platform canopy, and restoring and enhancing the concourse in the central section, including the lighting, for its future use.

THE HISTORY OF THE STATION

The building dates back to 1893 and is believed to be the work of French architect L. Fargue. It was built by the French company Fives-Lille, which was highly regarded throughout Europe for its iron-framed buildings. As Adif explains in its description of the station, the aspect that particularly stands out about the building is the special way that it merges traditional architecture with new techniques and materials. The development of the railways in the second half of the nineteenth century required new spaces and functions in stations. To address this, engineering and architecture successfully worked together to combine ornamental buildings in the classical style with functional structures of the modern era. Together with engineers, architects gained prominence by designing concourses and platforms with glass and iron, creating spacious, airy and bright structures of which Almería station is a fine example. Other examples of Andalusian station buildings from this period are the historic stations of Córdoba, Cádiz, Málaga, Seville-San Bernardo, Granada, Jaén and Huelva-Zafra.

The building was completed in 1893 and was put into use in 1895, when the Almería-Guadix section was opened. Its entry into service, along with the development of the port of Almería, helped to solve the communication difficulties of a province enjoying a full economic and demographic boom due to mining, agriculture and commerce. A number of decades later, during the Spanish Civil War, part of the premises were destroyed and, in 1940, it was closed due to a serious danger of collapse. In the 1970s, a major renovation project began, involving the construction of, among other aspects, a balustrade with slight variations with respect to the original one. In 1974, a refurbishment was carried out on the upper floor and, in 1975, a general renovation of tracks and platforms was done.

In the 1990s, thanks to the Station Modernisation and Equipment Plan, the almost 600 square metres of surface area was restored. The works were supervised by the architects José Antonio Pruneda and Antonio Morales, who managed to restore much of the station's charm.

The building has a rectangular footprint and consists of three sections: a central one featuring the iron architecture and two symmetrical, side sections with traditional architecture. In the centre, there is a large clock by Garnier of Paris, typical of the railway stations of the nineteenth century. As a whole, the station is a highly representative example of the work of Compañía de los Caminos de Hierro del Sur de España, featuring ornamental elements such as acanthus capitals, entablatures, cornices, etc., characteristics that appear with classical shapes and proportions although made of iron, among which the large glass window in the central section stands out. The side façades are notable for their exposed brickwork and polychrome ceramics on wall lamps, signs, branches, etc.

In Ineco's project designs, the principles adopted were aimed at acknowledging the building as a heritage monument, documentation and interpretation of its history according to the Xi'an *Declaration on the Conservation of the Setting of Heritage Structures, Sites and Areas, adopted in Xi'an, China. 21 October 2005*. The restoration of the different elements must be distinguished from the architectural ensemble, and must bear the stamp of our era. The current configuration of the monument building will be respected, regardless of which era its annexes, attachments or extensions belong, given that unity of style is not the purpose of the restoration.

Elements intended to replace missing parts must be integrated harmoniously into the whole, but, at the same time, differentiated from the original parts, so that the restoration does not falsify the monument, in terms of its artistic and historical aspects. The structural, functional and perceptive function of these new elements will, however, seek the original meaning of the monument and always strive not to highlight the inherently historical, following the doctrine of the Council of Europe in relation to cultural heritage, according to the principles of the *European Charter of Architectural Heritage*. The starting point for this is studying the planimetrics of the building, examining information obtained from historical research and carrying out analyses (petrographic and petrophysical) of the materials. ■

TECHNICAL CRITERIA FOR THE RESTORATION

The project focuses on the consolidation, restoration and conservation of all façade walls, including original metal and woodwork.

▶**Removal of foreign deposits,** for which, in the case of brick, dry systems will preferably be used to avoid bringing possible salts to the surface.

▶**Systems that project glass microspheres** at very low pressure will be used for the removal of paint from stone or rendering.

▶**Consolidation treatments will be applied where needed,** after testing by petrophysical analysis, with application on laboratory control samples.

▶**Choice of replacement stone, where necessary,** with similar characteristics to the existing stone in terms of appearance, colour, texture, etc., but also with appropriate petrophysical characteristics, based on the tests to be carried out or facilitated by the quarry.

▶**Where necessary, replacement of mortar:** always salt free (no use of Portland cement), with lime binder (good quality) and selected limestone and/or siliceous aggregate. Additives in order to achieve the appropriate properties of porosity, shrinkage, mechanical strength, setting, etc.

▶**Missing elements** will be replaced by moulding the solid negative.

▶**Replacement stones,** as well as restoration mortar used in re-integrations of missing volumes may be subsequently enlivened with patinas of inorganic-based components.

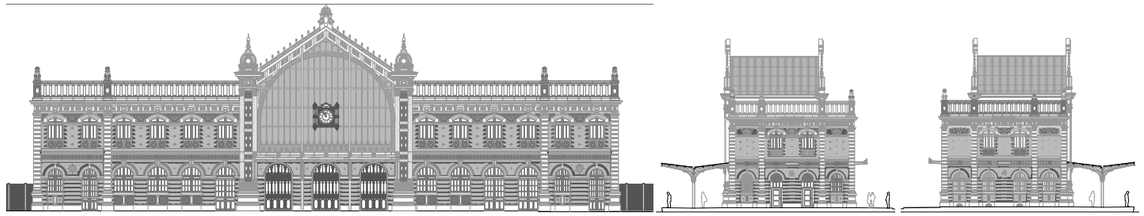
▶**All replacement elements,** whether stone or mortar, will be carved.

▶**Final pointing mortar** for ashlar stones with base of hydraulic lime.

▶**Waterproofing** of all existing or replacement ashlar stone elements.

▶**All renewed elements** must be inspected and dated after the work.

ADIF REQUESTED THAT INECO DRAFT PROJECTS FOR THE RESTORATION OF THE BUILDING AS A STEP PRIOR TO CEDING THE STATION TO ALMERÍA CITY COUNCIL



SOUTH FAÇADE

EAST AND WEST FAÇADES

AN EXAMPLE OF THE REFINEMENT OF THE 19TH CENTURY

As a whole, the station is a highly representative example of the work of Compañía de los Caminos de Hierro del Sur de España, featuring ornamental elements such as acanthus capitals, entablatures, cornices, etc. Particularly notable are the exposed brickwork and polychrome ceramics on wall lamps, signs, branches, etc.

Digitisation, the information of all, for all

The incorporation of new technologies to improve the delivery of value –through new forms of digital relationships– is generating a wide variety of opportunities in both internal and external services. The aim of Ineco's Digital Transformation Plan 2018-2020 is to take a major step forward in the implementation of a new culture centred around collaborative work and the 'digital first' philosophy.

By **Ignacio Martínez,** PhD in Civil Engineering and computer science engineer

Ineco is recognised as a leading engineering firm in the transport sector with highly specialised and highly valued human resources, and in recent years, it has developed a set of innovative initiatives in the IT area, including new digital services for its customers (smart cities, IoT, artificial intelligence, blockchain, virtual/augmented reality, etc.). This process is now to be given a decisive boost with the launch of its Digital Transformation Plan 2018-2020, an initiative that will be applied not only to services provided to customers, but also to the company's own operations.

Digital transformation makes it possible to unify Ineco's vision and enable it to move forward, with everyone interconnected, moving in the same direction, making use of the company's intangible assets and taking advantage of digital tools. In this new stage, information no longer belongs to a single area and becomes part of the entire company.

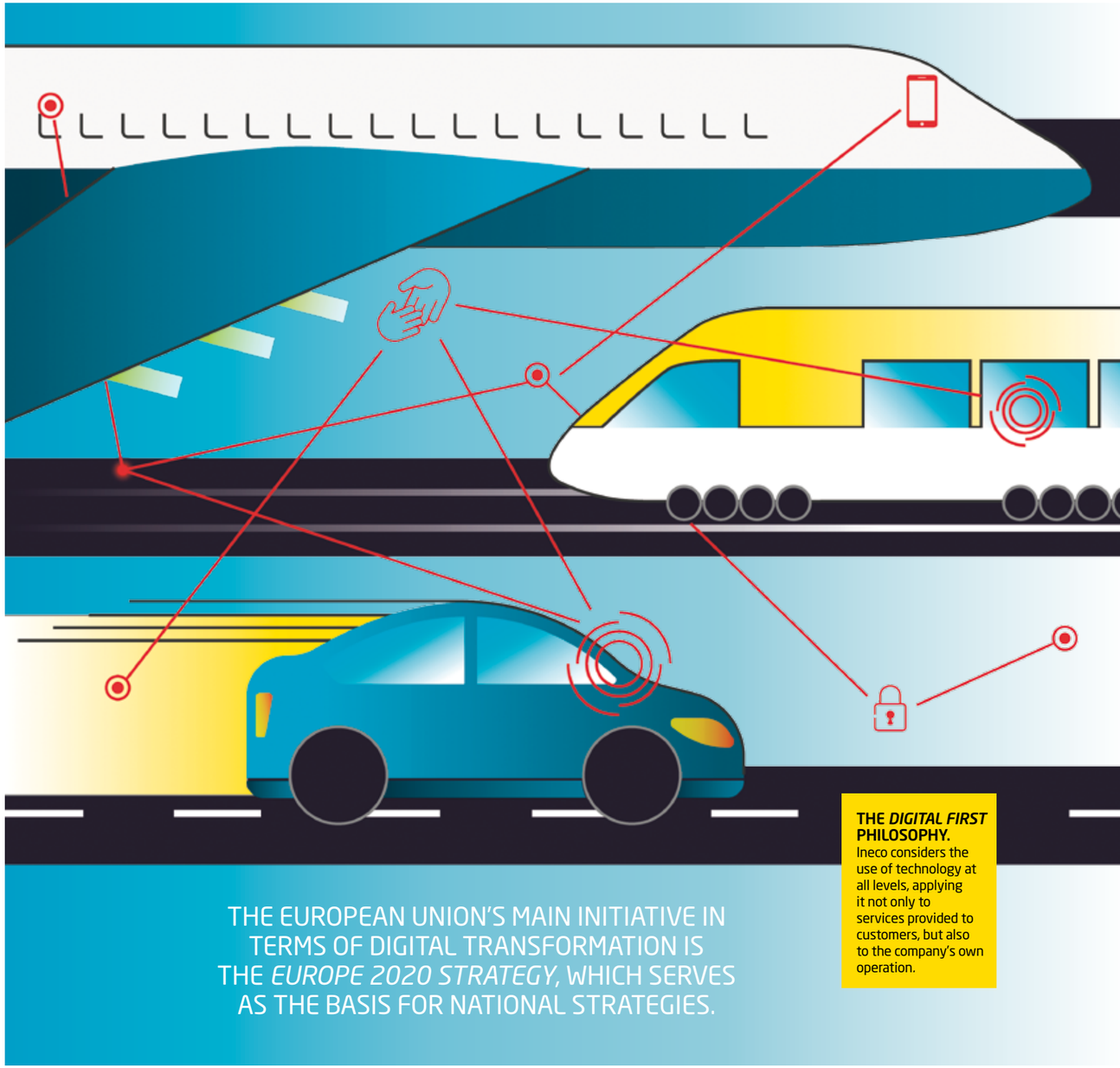
TECHNOLOGICAL CONVERGENCE

Today, the modernisation of companies in the field of transport and government is inextricably linked to the intensive use of new technologies. Technologies such as cloud computing, big data and artificial intelligence are fundamental elements for addressing the current challenges. They also have a mutual multiplier effect, making it possible, for example, to have big data and artificial intelligence cloud computing applications, which would not be possible otherwise.

The use of cloud services in transport management systems, gives companies the potential for lower costs, greater agility and flexibility, improved response to unpredictable events and changes in customer behaviour, reduced risk levels, availability of globally accessible services and easier and faster implementation.

The use of artificial intelligence and big data in the transport sector makes it possible to identify trends, verify phenomena and predict behaviours. With these tools, decision-making will be easier, faster and, above all, more efficient, meaning that this data becomes an element of great value. In fact, this kind of analysis is already underway and is being used by public authorities in areas that affect passenger transport in cities and on the roads. For example, sensors that count the number of vehicles passing a certain point are already being installed on traffic lights to optimise changing times and improve flow.

This enormous amount of data for analysis provides numerous advantages such as enabling better planning and management, reducing environmental impact and optimising the performance of vehicles



ILLUSTRATION_**IRENE LIÉBANA**

THE EUROPEAN UNION'S MAIN INITIATIVE IN TERMS OF DIGITAL TRANSFORMATION IS THE *EUROPE 2020 STRATEGY*, WHICH SERVES AS THE BASIS FOR NATIONAL STRATEGIES.

THE *DIGITAL FIRST* PHILOSOPHY. Ineco considers the use of technology at all levels, applying it not only to services provided to customers, but also to the company's own operation.

THE INTERNET OF THINGS (IOT) HAS THE POTENTIAL TO RADICALLY TRANSFORM THE TRANSPORT SECTOR, CREATING NEW SERVICES WITH HIGH LEVELS OF INTELLIGENCE

and drivers. Artificial intelligence is also used in most areas of the transport sector, especially in autonomous driving. In this field, which has been widely developed in the aviation sector, autonomous road vehicles and smart drones are now making their presence felt.

New generations of technologies and mobile devices help improve efficiency and reduce the costs of passenger transport companies, while users can enjoy faster, safer and more reliable journeys that they can plan, manage and easily pay for from their phones. And both agents and users benefit from the potential of analysing the large volumes of real-time data generated as a result of these transactions.

In the case of employees, the use of mobile technologies enables business processes to be transformed and carried out from any location. Employees will have access to all of the information and tools they need to perform their work on the mobile device of their choice, thereby improving productivity and customer relationships.

The Internet of things (IoT), the basis of an environment in which people and objects are interconnected, has the potential to radically transform the transport sector, creating new services with high levels of intelligence. This is the case with air transport and the optimisation of routes with the consequent reduction in travelling times and increased safety; simplification of procedures; and availability to passengers of self-service and seamless processes, both at airports and on the aircraft themselves.

Another major field of application for the IoT is vehicles and driving. Taking cars as an example, the current starting point is the connected car, in which both the driver and car have a high degree of connectivity with the outside and services necessary for journeys are available. The growing adoption of vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) technologies, together with the development of smart cities and smart roads, will positively influence driving, thanks to direct communication between cars and interaction with traffic lights, signs and even the mobile devices of pedestrians.

This will result is transport systems in which all elements of the environment can communicate and cooperate to create safer and more efficient driving within the framework of smart mobility. The next step is the autonomous car and the concept of car as a service (CaaS): no longer is it necessary to buy a car to travel from one place to another, it can be available as a service only when needed. In this environment, interaction with customers through social media and the collaborative economy provide many advantages, among them, brand loyalty and positioning.

Agile methodologies enable working methods to adapt to the circumstances of a project at any time. The two most widely used today by developers are Scrum and Kanban, the first of which is characterised by its incremental development strategy, with projects coded in increments through iterations called sprints. Conversely, Kanban is a more visual methodology, where tasks, defined according to established rules, progress through different phases (*to do, in progress, done, etc.*).

In the current IT environment, the term DevOps is one of the most frequently mentioned. Its concept can be defined as a software-creation methodology based on integration between software developers and system administrators. DevOps makes it possible to manufacture software more quickly, with higher quality, lower cost and very frequent releases. Another advantage is the automation of basic hardware and software management through a specialised kind of scripting language, reducing administration costs and generating more homogeneous and efficient systems. DevOps is not a culture in itself, but it does require major cultural and organisational change. A cultural change towards collaboration, communication and, ultimately, complete integration between the old (usually stagnant) development and systems areas.

New approaches to new architectures based on microservices and software containers also generate benefits. Unlike the traditional approach in which everything is created in a single piece, microservices are separate and work together to carry out the same tasks. Each of these components, or processes, are microservices whose ultimate goal is to deliver high-quality software faster.

As for software containers, these are packages of elements that allow a particular application to run in isolation from the operating system that supports it. If software is developed and needs to be moved from a server installed in a data centre to a virtual machine running on a public cloud, the code may not work well in its new environment. However, if this software is inside a container, it can be transferred to the system that best suits it.

New 5G technology needs to play a fundamental role when supporting the vast amount of data that is expected to be handled on the network.

ILLUSTRATION_FREEPICK

Blockchain is a technological paradigm whose application is being explored by all sectors due to its ability to radically change current business models. Blockchain is precisely the technology that enables the functioning of Bitcoin, the world's main cryptocurrency and clear blockchain success story, but it is a paradigm that can be used in other very different areas.

Blockchain technology allows collaboration, guaranteeing the security of transactions with a high level of transparency. A blockchain network is a collection of computers, called nodes, connected to each other using a common protocol for the purpose of validating and storing the same information in a P2P (peer-to-peer) network. This information is interpreted as a common ledger, hence the acronym DLT (distributed ledger technology) associated with this type of architecture. The ledger records all transactions between nodes that have occurred since the creation of the aforementioned blockchain network. It provides an incorruptible technology whose processes are secure, error and intermediary-free and fast.

The use of virtual/augmented reality in transport is becoming increasingly significant. Among the main advantages is the creation of immersive virtual environments that allow you to move freely through interactive simulations; physical teleworking, through the use of haptic devices and automated systems; the commercialisation of products and services without the need to have a physical environment for sales; and its great utility for supporting education and training.

WITH A VAST AMOUNT OF DATA, IT IS POSSIBLE TO PLAN AND MANAGE BETTER, BUT ALSO REDUCE ENVIRONMENTAL IMPACT AND OPTIMISE THE PERFORMANCE OF VEHICLES AND DRIVERS.

5G WILL REACH TECHNOLOGICAL AND CULTURAL MATURITY BY 2020, GREATLY INCREASING TRAFFIC ON MOBILE NETWORKS AND MASSIVELY EXPANDING THE NUMBER OF INTERCONNECTED DEVICES

5G NETWORKS, THE NEW PARADIGM

5G technology addresses the next (fifth) generation of data transmission for mobile networks, constituting not only a new wireless communications paradigm, but also an essential technological component in digital transformation in the most advanced countries over the next decade.

The main solutions that are driving this digital transformation, the Internet of Things and Big Data, robotics, virtual reality and ultra high definition, will be supported by 5G technology. For its introduction to be successful, it is necessary not only for infrastructures and telecommunications networks to evolve, but also for an entire ecosystem of platforms, services and 5G content to be developed.

5G is expected to reach technological and commercial maturity in the 2020 time horizon with a large increase of traffic on mobile networks, and massively expanding the number of interconnected devices (the number of interconnected devices is expected to increase from 15 billion in 2015 to more than 75 billion in 2025). New technology will play a fundamental role when supporting the vast amount of data that is expected to be handled on the network. It will also significantly reduce file download times. In specific terms, 5G networks will provide very fast, high-capacity mobile broadband with speeds in excess of 100 Mbit/s with peaks of 1 Gbit/s, which will enable, for example, ultra high definition content or virtual reality experiences to be offered. It will provide ultra reliable communications, with low latency of around 1 millisecond (ms) compared to 20/30 ms typical of 4G networks. This could make them appropriate for applications that have specific requirements in this area, such as connected or autonomous vehicles, telemedicine services, real-time security and control systems and others, such as smart manufacturing. They will also make mass machine-to-machine (M2M) communications possible. The capacity to manage a large number of simultaneous connections will be increased, which will allow, among other things, the mass deployment of sensors, the Internet of things (IoT) and the growth of big data services.

Any user connected to the Internet through any device is a potential target for a cyberattack, hence the vital importance of cybersecurity, a discipline in constant evolution which focuses on offering the best protection to systems in the face of a changing landscape of threats in which attackers have been professionalising in recent years and now boast significant infrastructures and organisations that can jeopardise the security of almost any institution or company.

PLAN OBJECTIVES

Digital transformation is an extremely powerful lever of change and innovation for companies. It is not, however, an ultimate objective in and of itself; it needs to be a catalyst that enables the achievement of the goals derived from the aspects analysed above:

1. **Total digitisation of processes:** ensuring that all of the organisation's processes are managed digitally, thereby improving efficiency, sustainability and relations with customers.
2. **Improved competitiveness based on the intelligent management of data:** transforming the analysis and exploitation of the company's data to improve decision-making and make management smarter.
3. **Strengthened collaboration and communication between areas of the organisation:** promoting as much as possible collaboration and teamwork among Ineco's staff to take advantage of all knowledge that exists in the company.
4. **Comprehensive digital commercial management:** comprehensive management of customer relations, from the generation of opportunities to the execution and closure of projects, involving all Ineco staff who participate in every phase of identifying new business opportunities. Creation of new digital channels for developing relations with customers (e.g. social selling).
5. **Permeability of technology at all levels:** taking advantage of new technologies to continue contributing value to current products and services, as well as enabling the generation of new solutions to support the growth of the future business.
6. **Facilitation of digital transformation:** piloting new ideas to generate a disruptive transformation. ■

LINES OF ACTION

Finally, to achieve the established objectives, work needs to be carried out on various lines of action, which, in this plan, have been classified into six different areas:

▶ DIGITAL TRANSFORMATION LAB

This is a laboratory for testing all kinds of digital transformation ideas, especially those that are disruptive, applying the fail fast paradigm of 'fail fast'. In other words, quickly discarding any initiatives that are considered to have failed and scaling up those that work.

It is also about internally disseminating innovative technologies that have the potential to transform the organisation: Big data, artificial intelligence, RPA, etc.

▶ FAST EXECUTION

This area includes actions and initiatives that aim to improve the execution speed of the company's processes and productivity of employees, with the resultant increase in efficiency at all levels.

Actions in this category can be considered from two perspectives: the user and systems. From the perspective of the user, actions aimed at improving application usability and user experience are incorporated, resulting in improved agility and greater speed in the adoption of new tools thanks to a reduced learning curve.

From the perspective of systems, improvements are sought in the 'raw' speed of applications and agility in their development and modification thanks to changes in system architecture, less customisation/use of out-of-the-box solutions, reduced number of tools through the merging of functionalities and the 'mobilisation' of processes in smartphones.

▶ CYBERSECURITY

Cybersecurity initiatives are aimed at safeguarding the security of information and systems. The actions included here involve considering the implementation of guidelines, actions, training, best practices and technologies that can be used to protect the assets of the organisation and users within the computing environment in which they work.

The approach focuses on system users at all times, seeking to ensure levels of cybersecurity with the least possible intrusiveness in the daily work of people and understanding that an excellent level of digital security can be achieved through the use of the latest technologies (AI, passive monitoring, etc.) without harming productivity.

▶ PAPERLESS

The ultimate goal of the initiatives in this area is to totally eliminate paper from the organisation's processes in order to gain major benefits such as improving efficiency, increasing sustainability, facilitating network working and analysing and optimising processes.

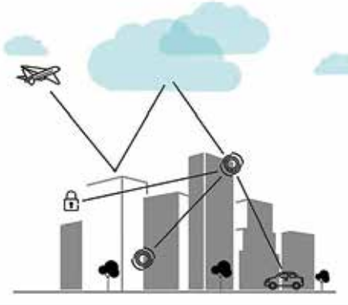
▶ DATA-DRIVEN COMPANY

Data-driven companies are organisations that are characterised by taking advantage of and exploiting data generated by their daily activities, with the ultimate goal of improving their value proposition, processes and decision-making.

To achieve this, the data must be properly incorporated in a digital format, transversally available, 'unique' and high quality. The initiatives are therefore aimed at identifying non-digitised data with value for the organisation, including it in tools and solutions from which it is easily accessible, creating new data channels and exploiting all of the available information in an advanced manner through BI/business discovery, AI or similar techniques.

▶ CO-CREATION/COLLABORATION

This line includes actions focused on promoting agility, collaboration and co-creation options among the different areas of the company. The underlying objective is to maximise the productivity and utilisation of the knowledge of all employees, taking advantage of multidisciplinary capabilities and promoting teamwork, regardless of the geographical or organisational location of each employee.



ILLUSTRATION_**IRENE LIÉBANA**

PHOTO_ANDALUCÍA FILM COMISSION (AFC)

PHOTO_CANARIAS FILM COMISSION/UNIVERSAL

PHOTO_GOYI BENÍTEZ / FACEBOOK

PHOTO_RAFAEL GARCÍA / R. CATERING

PHOTO_AFC

A country of film

Films and series with worldwide popularity and big budgets like *Star Wars* and *Game of Thrones* have showcased Spain's monuments, landscapes and beaches to the world. Thanks to a combination of extraordinary landscapes and an attractive tax regime, the Canary Islands have become a highly sought-after filming location for international productions.

By ***ITRANSPORTE***

In 2019, audiences from all over the world will again see the Israeli actress Gal Gadot play *Wonder Woman*, this time cavorting around the beaches of Fuerteventura and Tenerife; and the *Terminator* (in the sixth film of the saga) doing his thing in the Madrid neighbourhoods of Lavapiés and Pueblo Nuevo, transformed into the streets of a Mexican village, and in Almería, Murcia and Salamanca, where other scenes were shot. These are just two of the big international film shoots that were under way in Spain at the time of closing this edition, not counting advertisements and documentaries.

Over the last three seasons, fans of *Game of Thrones* have enjoyed scenes filmed in 2014, 2015 and 2016 throughout Spain: Castellón, Navarra, Guipúzcoa, Cáceres and Seville, which was also visited by the stars of *Star Wars: Episode II - Attack of the Clones* (2002) for a scene in which the city's Plaza de España –one of the most sought-after locations for international producers– fleetingly became a palace on the planet of Naboo.

Since the great epics of Samuel Bronston, 'Spaghetti Westerns' and 'Roman' films of the 1950s and 60s, Spain has developed a vibrant film industry boasting highly qualified professionals –film studios, photography, sound and editing technicians, stunt performers and body doubles, transport and catering companies, sets, extras, etc.– who support a business capable of generating millions of euros of income and representing a first-class international tourism showcase.

As was the case with other industries, such as automobiles, during the 1960s and 70s, Hollywood found that Spain offered highly diverse locations - from desert landscapes to authentic medieval castles thanks to its rich cultural and artistic heritage –at a much lower cost than in the US. The development of tourism in Spain, which also started around this time, led to the construction of modern hotel and transport infrastructure, which, together with an exceptional climate– especially in the south, on the Mediterranean coast and islands –made the country an enticing location for international film productions, which were experiencing their golden age. Recent tax breaks approved in 2017– which return up to 20% of the total investment of a production (with a limit of 3 million euros) nationally, 40% in the Canary Islands and 30% in Andalusia –have boosted business, amid calls by the sector to increase tax breaks even more to compete with other European countries.

At the end of the 1950s and in the 1960s, the main filming locations were Madrid, Barcelona and Almería, which was much in demand –as it still is today– because of its desert landscapes, for films such as *Lawrence of Arabia*, directed by David Lean (1962), which was also shot in Seville (Plaza de España, Reales Alcázares, Casa de Pilatos, Palacio de Miguel de Mañara and Hotel Alfonso XIII). This period also stood out for the epic films of Samuel Bronston, such as the biblical classic *King of Kings*, directed by Nicholas Ray in 1961 and filmed entirely in Spain, in locations including Chinchón and Manzanares el Real (Madrid), El Fresno (Ávila) and Añover del Tajo (Toledo). *El Cid*, starring Charlton Heston and Sophia Loren (1961), was filmed in Ampudia (Palencia), Burgos, Calahorra and Colmenar Viejo. The film's director, Anthony Mann, also used Spanish filming locations (Madrid, Segovia and Valencia) for *The Fall of the Roman Empire* (1964).

SPANISH STILLS

01. Castle of Almodóvar del Río (Córdoba).
02. Matt Damon in Tenerife in 2015.
03. Brad Pitt in Las Palmas de Gran Canaria.
04. The Madrid neighbourhoods of Lavapiés and Pueblo Nuevo played host to the filming of the sixth instalment of *Terminator* in 2018.
05. Clint Eastwood with Rafael García and Francine Roy, owners of Rafael Catering, a ground-breaking Spanish company which has provided its services to international film shoots since 1954, including practically all of the ones mentioned in this article.
06/07. Reales Alcázares and Plaza de España in Seville.
08. *Conan the Barbarian* was filmed almost entirely in Spain.

Colmenar Viejo, located north of Madrid, came to have its own studios and played host to hundreds of film shoots, including 55 *Days at Peking* (1963) and the famous battle scene from *Spartacus* (1960), where 8,500 soldiers from the Spanish army took part as extras, as well as numerous European Westerns, for which an Old West-style town was built as a set for the almost 200 films of the genre shot there.

In the 1980s, *Conan the Barbarian*, from 1982, which launched Arnold Schwarzenegger to stardom, was filmed almost entirely in Spain, with locations in Colmenar Viejo and Ciudad Encantada near Cuenca. The scene in *Indiana Jones and the Last Crusade* (1989) in which Sean Connery scares the seagulls with an umbrella was shot on the beach of Mónsul in Cabo de Gata (Almería). The director Ridley Scott chose the spectacular Romanesque castle of Loarre in Huesca for *Kingdom of Heaven* (2005), which was also shot in Córdoba, Segovia, Seville and Ávila. The 18th century France of *Perfume: The Story of a Murderer* (2006) was actually Catalonia: it was filmed in Barcelona and in the towns of Besalú, Figueras and Cantallops (Girona), Tortosa and Tamarit (Tarragona). The new century saw the arrival of major movie franchises such as James Bond *(The World Is Not Enough*, 1999; *Die Another Day*, 2002; and *Quantum of Solace*, 2008) and *Star Wars (Episode II - Attack of the Clones*, 2002).

THE CANARY ISLANDS ON THE BIG SCREEN

Thanks to tax breaks that return up to 40% of the total investment of a production –with a limit of 4.5 million euros and a minimum investment in the islands of one million euros– in recent years, the Canary Islands have become a much sought-after natural filming location for international cinema. Its varied landscapes, climate, with 3,000 hours of sunshine a year, range of hotels and the good air and sea communications that have made them one of the most visited tourist destinations in the world complete their appeal as a film set.

This is demonstrated by films such as *Fast and Furious 6* (2013), and *Exodus: Gods and Kings* (2014), filmed in Almería and the island of Tenerife, generating an estimated 7 million euros during the two month shoot. The locations for the action adventure fantasy film *Clash of the Titans* (2010) included Timanfaya National Park, the islands of Lanzarote and Gran Canaria and Teide National Park in Tenerife, which also appeared in the sequel *Wrath of the Titans* (2010), along with other spectacular places on Tenerife, such as the Los Gigantes cliffs.

In 2015, the streets and airport of Santa Cruz de Tenerife were transformed into Athens, Beirut and Reykjavik for *Jason Bourne*, the fifth instalment of the series. Las Palmas de Gran Canaria appears as a North African city in *Allied*, directed by Robert Zemeckis and starring Brad Pitt (2016). In 2017, the beaches and sand dunes of Fuerteventura served as the birthplace of the main character in *Solo: A Star Wars Story*. ■

FILM TOURISM

The Spain Film Commission, a non-profit organisation founded in 2001 with regional offices in the country's 17 regional communities and dedicated to promoting international film shoots, cites the case of New Zealand, which gained worldwide renown and experienced increased visitor numbers after *The Lord of the Rings* (2001-2003) and *The Hobbit* (2012-2014) trilogies were filmed there.

In Spain, the Andalucía Film Commission has just launched an initiative to promote film location tours: among others, in Almería, the Tabernas desert, a setting for *Lawrence of Arabia*, the spaghetti westerns of Sergio Leone (*A Fistful of Dollars, For a Few Dollars More* and *The Good, the Bad and the Ugly*) and, more recently, Ridley Scott's *Exodus: Gods and Kings*, standing in for ancient Egypt. In the province of Seville, in addition to the Plaza de España, film fans will recognise the spectacular Alcázares, Reales Atarazanas (13th-century shipyards), the bullring of Osuna and the Roman city of Italica as some of the locations of *Game of Thrones*, not to mention the Castle of Almodóvar del Río (Córdoba), among others. Other places in Spain have also played host to the filming of the hit series, such as Girona; Peñíscola, which has a long history as a film location since the 1960s; Bárdenas Reales Natural Park in Navarra; the Castle of Santa Florentina in Canet de Mar (Barcelona); the Castle of Zafra in Guadalajara; San Juan de Gastelugatxe (Bermeo); Zumaia (Guipúzcoa); and Malpartida in Cáceres. Navarra and Cantabria also offer tours of these and other places. Soria, where 80% of *Doctor Zhivago* (1965) was shot, also has tours of the filming locations of a film that, at the time, was a major economic boost for the province and immortalised its landscapes, turning them into the Russian steppes.

ALBERTO VÁSCONES

"Inecomex and Ineco share the same DNA: integrity, respect, rigour and commitment"

A civil engineer with expertise in land transport, he holds a degree from the Technical University of Madrid and is a graduate of the General Management Programme of the IESE Business School. He joined Ineco in 1994 and has spent most of his career working in international consulting. He previously held the position of Business Director for North and Central America.

PHOTO_MIGUEL BLANCO

NEW INFRASTRUCTURE

Madrid-born Alberto Váscones Díaz-Santos has been working for three years in Mexico as a representative of Ineco and general manager of Inecomex, the Spanish engineering company's Mexican subsidiary. His work involves managing a team of more than 50 people directly involved in a variety of projects ranging from Mexico City's Metro Line 12 and the Guadalajara-Colima highway, to supervision of the works on Mexico City's new airport.

Ineco has been operating in Mexico since 2006 when it opened an office to carry out work on the Buenavista-Cuautitlán commuter rail line. In 2011, the company created its subsidiary Inecomex. In addition to the projects mentioned here, it has also participated in the execution of the functional designs of terminals at the airports in Tijuana and Puerto Vallarta, as well as the drafting of master plans to develop the 12 airports of the Grupo Aeroportuario del Pacífico (GAP) in Mexico.

1 COMPLETE THE SENTENCE: IN A RANKING OF ENGINEERING CHALLENGES, ¿NAICM...?
...would certainly be near the top, because of the area's seismic activity, the type of terrain and the fact that it will be one of the world's largest airports: with a capacity of 125 million passengers.

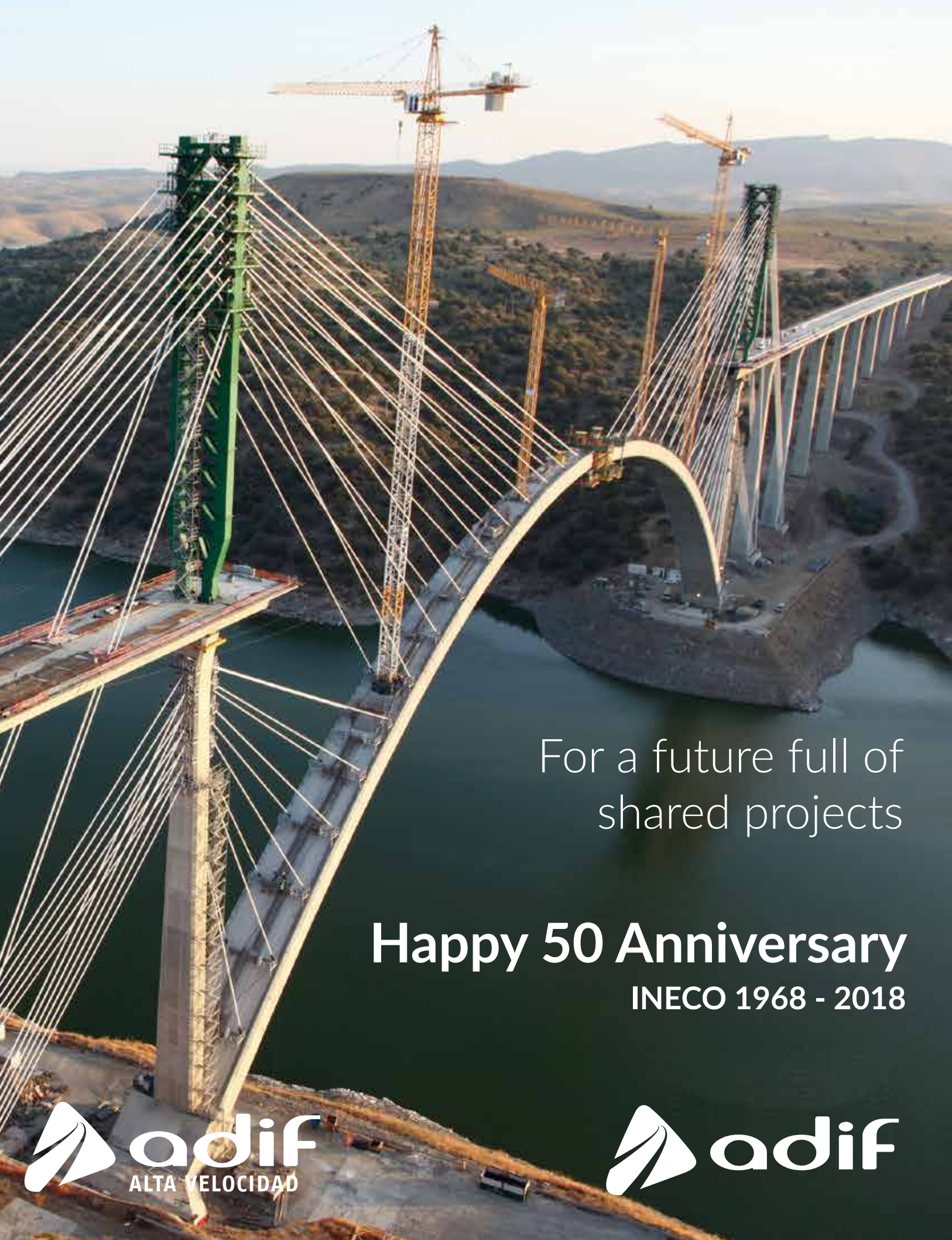
2 AND THE GUADALAJARA-COLIMA HIGHWAY?
Also, of course, because of the geography. In the mountain section, for which we are responsible for works management, seven special bridges are being built: the Atenquique bridge is 148 m high.

3 WHAT IS SPANISH ABOUT INECOMEX?
Inecomex and Ineco share the same DNA, the same integrity, respect, rigour and commitment that sustains our work all over the world.

4 AND WHAT HAS MEXICO CONTRIBUTED MOST?
The values of its people: manners, sense of humour, joy, their warmth... "my house is your house", solidarity after last year's earthquake... And, since it's not all about work, its rich gastronomy, which was listed as Intangible Cultural Heritage of Humanity in 2010 by UNESCO: tacos, tamales, tequila...

5 HOW DO YOU THINK SPANISH ENGINEERING IS PERCEIVED IN MEXICO?
It is generally highly respected and valued.

6 WHICH OF YOUR CURRENT PROJECTS IS MOST EXCITING?
All three –Mexico City's new international airport, Metro Line 12 and the Guadalajara-Colima highway– are equally exciting. Seeing them progress knowing that we have participated is a source of great pride. ■


For a future full of
shared projects
Happy 50 Anniversary
INECO 1968 - 2018
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