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APR | JUL 20

RAILWAYS

RECOLETOS TUNNEL

Rejuvenating the main artery of Madrid

+ ARTICLES

EDITORIAL
Innovation for safer infrastructure

As of the closing of this issue, we are immersed in the greatest health crisis in recent history. An unprecedented event that is forcing us to adapt, change how we work and bring out the best in ourselves. I want to express my solidarity and appreciation to everyone with the firm conviction that together, we will overcome it.

Nevertheless, our dedication and commitment to the improvement of mobility and safety of infrastructure, spurs us on to continue carrying out our activity. One example of this is **the comprehensive renovation of the Recoletos tunnel,** which traverses Madrid from north to south and is a key element in improving the comfort and safety of this infrastructure, which carries the most rail traffic of the entire Spanish network. Designed and managed by Ineco on behalf of Adif, our technicians have played a crucial role in tackling one of the most important railway mobility projects in little more than five months, given that several commuter lines run through this tunnel, serving more than 250 million passengers a year.

Knowledge and input for improving urban mobility and promoting its sustainable development were combined at the recent World Urban Forum in Abu Dhabi. With the objective of facing the future with more sustainable and inclusive transportation, the companies of the Group of the Ministry of Transport, Mobility and Urban Agenda presented their innovative projects at this international meeting convened by UN-Habitat.

Experience in the modernisation of railway lines, and in particular in the development and deployment of the ERTMS system, together with more than 14 years of collaboration in European innovation projects, led to Ineco's participation in ERSAT GGC, an ambitious project financed by the European Satellite Navigation Agency which will make it possible **to implement satellite technology in the European rail traffic management system** ERTMS by means of virtual balises.

This same **dedication to innovation to improve air and land safety** is also behind the efforts by our experts to develop the 'Factor Humano' methodology, which has received several different awards, including the Canso 'Global Safety Achievement Award 2019'.

Ineco's international activity also prompted its involvement in the supervision of new trains for Quito's first metro, and in the aeronautical field, to the design of the Master Plans for 12 airports of the Pacific Airport Group, a client to whom we are grateful for the comments made by its Network and Regulated Business Director, Jose Ángel Martínez.

As for Spain, in this issue we cover two road projects recently opened by the Ministry of Transport, which will reduce travel times and increase safety levels: the complex stretch of the A-23 highway as it passes through the Monrepós mountain pass, and the new Gaznata bridge over the Burguillo reservoir in Ávila.

Lastly, we highlight the launch of Ineco's new Equality Plan, which includes important initiatives aimed at achieving real and effective equality, and which will have a Monitoring Committee to measure its degree of implementation and impact. ■

"Our dedication to improving the safety of transport and mobility has led us to participate in important studies and projects with major social benefits"

CARMEN LIBRERO
President of Ineco

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SPAIN

REMODELLING OF THE MARITIME STATION IN THE PORT OF CEUTA

Ineco is planning a complete remodelling of the maritime station in the port of Ceuta, through which 2 million passengers pass every year. The Port Authority has commissioned Ineco to draft the preliminary design (including a study of alternatives) and the construction project for the rearrangement and enlargement of the terminal spaces, which were last renovated in the 1990s. The objective is to increase the functionality and safety of the facilities, by separating passenger flows. It also includes the remodelling of car parks, and the complete renovation of one of the city's most emblematic buildings. The drafting of the project started at the end of 2019 and has an execution period of ten and a half months.

GREECE

INECO TO DESIGN THE NEW HERAKLION AIRPORT IN KASTELI, CRETE

The company will prepare the detailed design of the new airport to be built in Kasteli, on the Greek island of Crete, with a capacity for 15 million passengers. It will be located some 35 kilometres from the existing Nikos Kazantzakis airport, which was opened in 1937 in Heraklion, the island's capital and currently serves as the country's second international airport.

The construction and operation of the new airport have been awarded to the international consortium Ariadne Group, comprising the Indian company GMR Airports and the Greek holding company GEK TERNA. By 2015, Ineco had already completed the tender project for TERNA, which included the Master Plan and the complete conceptual design, both on the ground and in the air: a airfield with a 3,200 metre runway, parking apron for 41 aircraft (commercial, general aviation and helicopters), ground access, a passenger terminal building with approximately 75,000 m² of floorspace, the control tower and auxiliary buildings: SEI, police, power plant, water supply, water treatment plant, maintenance building, buildings for handling operators and fuel plant.

The new airport is expected to be operational by 2025.

SAUDI ARABIA

BAGGAGE HANDLING AT DAMMAM AIRPORT

IMAGE_DACO

The Dammam Airports Company (DACO) has awarded Ineco the consultancy contract for the integral management of the implementation of the automatic baggage handling system at Dammam King Fahd International Airport, in Saudi Arabia. The project aims to improve and renovate this system and the security inspection equipment, so that the airport can meet growing demand with high standards of quality.

The work includes a design review; a structural analysis of the building to accommodate the new equipment and project management and supervision tasks. In addition, DACO will provide assistance in the testing and commissioning process of the entire system, support in the training of DACO staff and advice during the Operational Trial Period (OTP).

Since 2009, Dammam Airport, Saudi Arabia's third largest airport in terms of passengers, has increased by 10.5% to 10.8 million passengers in 2018.

EXPANSION OF TRUJILLO INTERNATIONAL AIRPORT

Aeropuertos de Perú (AdP) has entrusted the Ineco-CEMOSA consortium with the construction project and monitoring in the bidding phase of the expansion of the Capitán FAP Carlos Martínez de Pinillos International Airport, located in the district of Huanchaco, 10 kilometres from the city of Trujillo, on the northern coast of Peru. The objective is to respond to the expected growth in traffic volume, which according to AdP has increased by an annual average of 13% since the beginning of the concession in 2006.

The project includes the construction of new passenger and cargo terminals, the extension of the apron and taxiways, and new auxiliary facilities (fire brigade, sewage treatment plant, service block, etc.). Trujillo, with nearly one million inhabitants, is the third largest city in the country and has a rich cultural and archaeological heritage of the pre-Inca cultures of Peru.

PERU

PHOTO_GUILLERMO VICH (INECO)

COLOMBIA

Ineco also designed and outfitted the current tower (see *IT46*).

APRON MANAGEMENT SERVICES FOR ELDORADO

Aeronáutica Civil de Colombia (Aerocivil) has contracted a consortium made up of Ineco and Colombian engineering firm Integral to carry out research for the implementation of Apron Management Services (AMS) at the Eldorado International Airport in Bogotá. The AMS service is operated from the airport control tower, and its function is to manage aircraft traffic on the ground.

The research includes a detailed study of all the requirements for the optimum performance of the AMS, including an analysis of Colombian aeronautical regulations, safety requirements, professional profiles, equipment, installations, radio aids, software, hardware, communications and procedures.

The company, which implemented and provided this service from 2011 to 2017 at Barajas airport, will define the strategies and action plan for Aerocivil to determine the best technical-economic alternative to be implemented in 2021.

MASTER PLAN FOR THE SANTA MARTA AIRPORT

Ineco is leading the consortium with Spanish engineering firm Ivicsa that will carry out the updating of the Master Plan for Simón Bolívar Airport in Santa Marta, on the country's Caribbean coast, for Aerocivil. The plan will include the analysis of alternatives for extending the runway and associated surfaces (feasibility and cost-benefit studies), which include a possible extension of some 400 metres up to a total length of between 2,400 and 2,700 metres, claiming some 8 hectares of land from the sea.

According to the groundside concessionaire, Aeropuertos de Oriente S.A.S., in 2019, Simón Bolívar airport handled nearly 2.4 million passengers, almost 17% more than the previous year.

UNITED KINGDOM

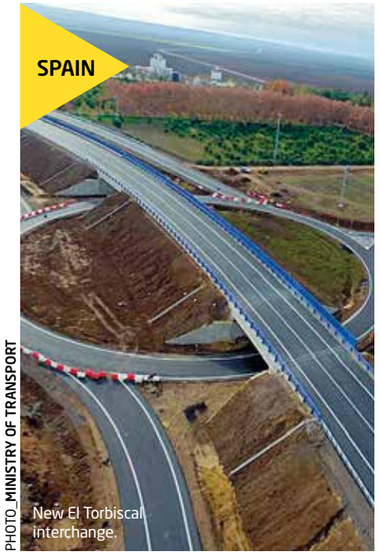
TECHNICAL CONSULTANCY FOR THE SILVERTOWN TUNNEL

MAP_TfL

Map of the Silvertown Tunnel.

Cintra, the Spanish company that, as part of the RiverLinx consortium, has been selected by Transport for London (TfL) to manage the Silvertown Tunnel, has contracted the Ineco and RPS consortium as an independent certifier throughout the design and construction process. The new tunnel will be the first piece of infrastructure to be built to cross the Thames since 1991, and will increase the transport supply in this area of the river sixfold.

RiverLinx, formed by Aberdeen Standard, BAM PPP, Cintra, Macquarie Capital and SK E&C will manage the design, construction, financing, operation and maintenance of the tunnel. The £1 billion contract includes the design of two 1.4 kilometre long twin road tunnels under the Thames and 0.6 kilometres of access ramps.



PHOTO_MINISTRY OF TRANSPORT

New El Torbiscal interchange.

NEW SECTION OF THE SE-40 AND EL TORBISCAL INTERCHANGE

Last December the Minister of Transport, Mobility and Urban Agenda, José Luis Ábalos, opened an 8.1 kilometre stretch of Seville's ring road, the SE-40, between the A-376 in Alcalá de Guadaíra and the A-4 in Dos Hermanas, which will be 77.6 kilometres long in total. Also in December, the El Torbiscal interchange (Utrera, Seville) became operational, at the crossroad of the N-4 road with the A-471, a point that produced congestion, especially in summer.

Ineco participated in both projects: for the SE-40 section, it supervised the construction projects; it carried out health and safety coordination and road safety audits and environmental monitoring, as it also did for the new El Torbiscal Interchange, for which it also drafted the project and provided support for mandatory purchases. Some of the more important environmental integration measures required in this project included the replacement of the Cañada Real de la Armada cattle route, the installation of acoustic screens and archaeological monitoring: two Roman necropolises with 63 burial sites were found.

SPAIN

RAILWAY MODERNISATION PROJECTS FOR THE PORT OF HUELVA

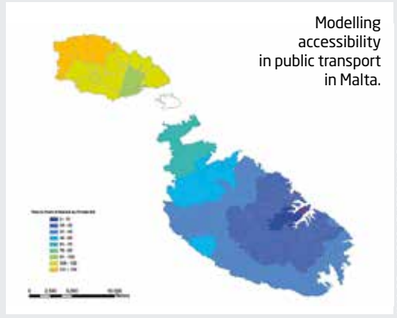
Ineco has drafted two projects for the Huelva Port Authority to modernise railway access to the port: one of them, at the Majarabique logistics complex, to remodel the track bundle at the north end of the station's commercial depot to enable the operation of trains of up to 550 metres.

In addition, another project has been drawn up to renovate all the track devices in the station. The works will be carried out on the general tracks of the Seville-Cadiz line. Majarabique is a large 250-hectare logistics area connected to the ports of Huelva and Seville, which the Andalusian government is promoting as an extension of the already congested area of La Negrilla.

MALTA

UPDATING OF THE NATIONAL TRANSPORT MODEL

Ineco, together with Italian engineering firm Systematica, will provide consulting and technical assistance services for two years to update and improve Malta's National Transport Model, as well as to develop a complete technical framework for the next five years. This consortium was already designated by Transport Malta in 2014 to develop the National Transport Master Plan to be finished in 2025 and the National Transport Strategy 2050. The works included the preparation of the Strategic Environmental Assessment (SEA).

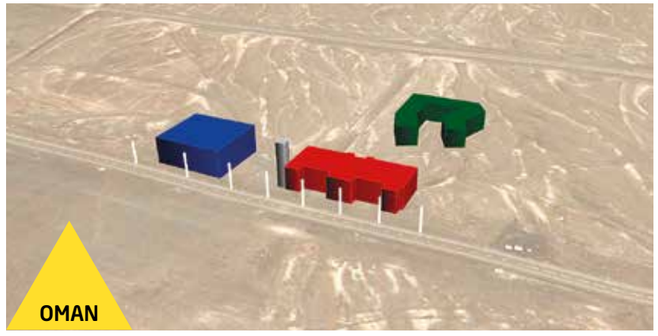


Modelling accessibility in public transport in Malta.

IMAGE_INECO/SYSTEMATICA

RESEARCH AT SOHAR AIRPORT FOR THE OMAN AVIATION ACADEMY

Ineco has carried out various radio equipment and navigation easement studies for the Oman Aviation Academy at Sohar Airport in the Sultanate of Oman. The aim is to ensure that the new infrastructure of the flight school (academic building, student residence, hangars, aircraft apron, etc.) does not interfere with the safety and regularity of operations. The work carried out included a study of possible violation of the BRA (Building Restricted Areas) of the CNS installations, as well as detailed studies and simulation of the signals of the ILS/DME, DVOR/DME equipment. The company is also carrying out other similar studies at the same airport in Sohar and at the airport in the capital, Muscat.



CSR CONFERENCE

ASSESSMENT OF THE AGENDA 2030 PLAN

PHOTOS_ELVIRA VILA (INECO)

The president of Ineco, Carmen Librero, stated that the initiatives of the Agenda 2030 Plan allow "progress towards a fairer and more egalitarian social model".

The conference, held on 26 February, was closed by the Secretary General of the Urban Agenda and Housing of the Ministry of Transport, David Lucas.

David Lucas stressed that the Ministry's "Urban Agenda policies" must serve to "improve people's lives".

A round table moderated by Celestino Rodríguez, Director of the Office of the President, took place during the day, with the participation of representatives from each of the Plan's five pillars: Jorge de San José, Director of People; Luis Janeiro, Deputy Director of Administration, Labour Relations and Safety; Ainhoa Zubieta, Deputy Director of Economy, Planning and MA; Bertrán Visedo, Deputy Director of Management Systems; África Jiménez, Deputy Director of Institutional Relations and CR; and Carlos Moro, Director of Legal & Compliance.

Ineco presented its 2020 roadmap with 40 actions to help achieve the Sustainable Development Goals (SDGs) of Agenda 2030, while at the same time taking stock of what was achieved during 2019, with more than 30 initiatives in five areas: equality, conciliation, sustainability, solidarity and compliance.

The company took stock of its commitment to the United Nations' Agenda 2030 by holding a conference on 26 February at its headquarters on Paseo de la Habana in Madrid, which was closed by the Secretary General of the Urban Agenda and Housing of the Ministry of Transport, Mobility and the Urban Agenda (MITMA), David Lucas. During the meeting, Ineco's president, Carmen Librero, presented the main results of the company's Agenda 2030 Plan over the past year, and highlighted "the enormous commitment" of all participants.

The President explained that the Agenda 2030 Plan is integrated into Atenea, the company's strategic plan, and reviewed the five action programmes around which it is structured: equality, conciliation, sustainability, solidarity and compliance. In total, and as certified by an external body, 34 'concrete' actions were carried out in 2019, with a total of 3,435 volunteer hours that have impacted the lives of more than 200,000 people.

Carmen Librero stated that, as a whole, the initiatives included in the five programmes represent "progress towards a fairer and more egalitarian social model". In addition to reviewing the balance sheet for 2019, the 40 actions planned for 2020 were presented, including the first Equality Week and the second edition of the Mujeres IN programme, Ineco's carbon footprint offset project, as well as ongoing actions such as collaboration with different NGOs, compliance training for the company's business partners, the implementation of Plan Concilia, etc.

The Secretary General of the Urban Agenda and Housing of MITMA, David Lucas, highlighted that Ineco's commitment as a public enterprise to sustainable development in the area of mobility and smart cities is part of "the policies of the Urban Agenda" of the Ministry which should serve, above all, to "improve people's lives".

Rejuvenating the main artery of Madrid

After 52 years in service, the Recoletos tunnel in Madrid, the backbone of the Madrid railway system and the busiest tunnel in Spain, is undergoing a complete renovation designed and managed by Ineco. Its 7.3 kilometres connect the two major stations of Atocha and Chamartín along the city's most important urban axis.

With the collaboration of **Ignacio Garrido**, **Mª Victoria Parejo** and **Alfonso Parra,** civil engineers; **Miguel Ramos,** architect; and **Miguel Solana,** head of the technical assistance unit.
Photos: **Elvira Vila (Ineco)**

The development of modern Madrid is closely linked to that of its railway infrastructure. The increase in population forced the city to expand northwards at the beginning of the 20th century, and the construction of new stations, lines and railway connections were planned and implemented at the same time. Today, the capital's main urban axis runs between the two major stations, Chamartín in the north and Atocha in the south, connected on the surface by the Prado, Recoletos and Castellana promenades and underground by three tunnels: two for commuter trains and one for high-speed trains, which has not yet opened.

Of the three tunnels, Recoletos was the first to be opened, in 1967, at the same time that the city was growing along the new urban corridor. With the opening of the subway, which had two stops –Recoletos and Nuevos Ministerios– development began on what starting the 80s would be Madrid's commuter rail network, the largest in the country, which today carries more than 900,000 passengers every day.

Recoletos is still the busiest railway tunnel in the country today: 470 trains and 200,000 passengers pass through it every work day, for a total of almost 3,300 journeys each week. 98% of this traffic corresponds to the Madrid commuter rail lines C-1, C-2, C-7, C-8 and C-10 –the rest runs through the Sol tunnel– along with some twenty medium- and long-distance trains per day.

Although improvement works were carried out in 2008, 2009 and 2012, the intensive use of this infrastructure after more than half a century in service made it necessary to undertake a more thorough renovation of the underground system. On behalf of Adif, Ineco provided the project and management of the works, as well as technical assistance, which required the closure of the tunnel between June and November 2019; on 17 November, the 7.3 kilometres tunnel was reopened to traffic.

The works were carried out against the clock in order to minimise the impact on Madrid's railway network, which began operations in the mid-19th century. The first railway line in the capital, initially for the exclusive use of the Royal Family, linked Madrid with the Royal Palace of Aranjuez and was opened in 1851. It started from a stop (or 'boarding platform' as it was known at the time) that would later become the Mediodía station, today's Atocha station.

The development of the railway parallels the growth of the city, which until the end of the 18th century was enclosed within walls with their corresponding puertas or 'gates', with the Puerta de Alcalá and Puerta de Toledo, for example, surviving up to the present day. The last wall, built by King Felipe IV, was demolished in 1868, making it possible to expand the city.

LA CASTELLANA FROM THE TORRE ESPACIO
View of the Paseo de la Castellana from the 31st floor of the Torre Espacio building, the fourth tallest skyscraper in Spain, facing south, with the Plaza de Castilla, the Calatrava obelisk and Torre Picasso in the background.

THE RECOLETOS TUNNEL IS STILL THE BUSIEST IN THE COUNTRY TODAY: 470 TRAINS AND 200,000 PASSENGERS PASS THROUGH IT EACH WORK DAY

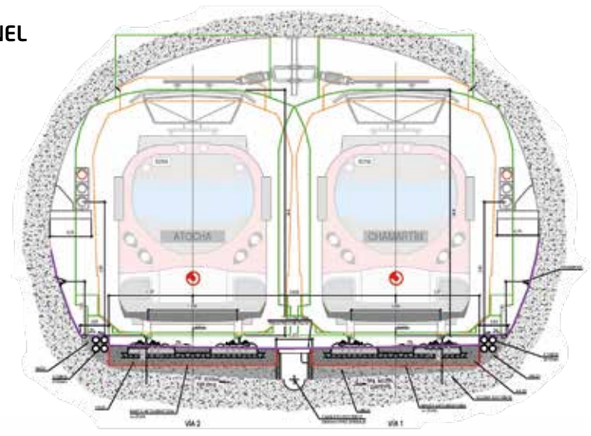
The first urban development plans, at the end of the 1920s, proposed growth along a large new north-south avenue that would structure the city, the Paseo de la Castellana. This planning included, among other installations, a new railway network of which the Recoletos tunnel was a part, which was designed and planned in 1933 following the same alignment of the future Paseo de la Castellana. The outbreak of the Spanish Civil War (1936-1939) and the economic difficulties of the post-war period paralysed these and many other projects for years, including the underground, which finally opened four decades later.

At the beginning of the new millennium, the growth in the demand for transport drove the expansion of the commuter rail network: In 2008, a second tunnel, Atocha-Sol-Nuevos Ministerios-Chamartín, was opened. A third tunnel, also between Atocha and Chamartín, which has already been completed, will be dedicated exclusively to high-speed trains, connecting all of the lines in the network. ■

HOW TO REJUVENATE A HALF-CENTURY OLD TUNNEL

The renovation required completely removing all of the tracks, with ballast and wooden sleepers, and replacing them with slab track, which requires less maintenance. In addition, flexible overhead lines were replaced with a rigid catenary system, which is more robust and reliable: this type of catenary on DC electric lines shows less wear and tear, and if any of its elements need to be replaced, this can be done automatically with specialised machinery, reducing the possibility of incidents. The signalling systems were also modernised.

For the above reasons, it was necessary to close the tunnel and work continuously, 24 hours a day, for six months, in order to reopen the infrastructure as soon as possible. In this project, the most important one in the Madrid Commuter Plan, Ineco participated by preparing the construction project for the most important action, track and overhead line renovation, for Adif, and by managing and providing technical assistance for works on the entire line.



NUEVOS MINISTERIOS STATION

RECOLETOS STATION: IMPROVEMENTS IN SAFETY, ACCESSIBILITY AND INTERIOR

At the same time, Ineco also drafted several projects for Adif and managed the work on various remodelling projects in the Recoletos station, which will be completed by the end of 2020:

▶ Safety and evacuation improvements, with the reopening and conditioning of two existing exits to outside, in addition to the two that were operational; the installation of the compartmentalisation elements (such as doors, gates, etc.) and ventilation to make the platform cavern independent from the station lobby and to configure all the evacuation routes as continuous protected enclosures, and all the additional actions required: lighting, signposting, fire detection and extinguishing installations, protection of structures, etc. The structural reinforcement of three cross galleries above the tracks was also carried out. The project also includes the design and installation of a new surface transformer station for the supply of electricity.

▶ In terms of accessibility, two projects were drafted, one to adapt the height of the platform to current regulations by minimizing the horizontal separation, and another for the installation of three lifts to connect the platforms to each other and to street level, which are expected to be ready by the end of 2020. The access corridors to Prim and Villanueva streets were also remodelled and are now completely enclosed in glass.

▶ Renovation of the platform vault: elimination of the suspended ceiling, improvement of ventilation, replacement of the floor and wall coverings and installation of new benches and ischiatic supports.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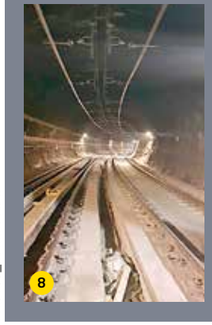
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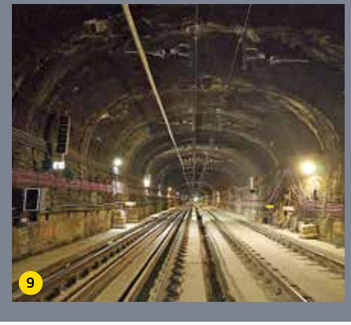
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PHOTOS_INECO / ADIF

TRACK AND OVERHEAD LINE RENOVATION: THE MAKING-OF STEP BY STEP

1. To renovate the track, first the old ballast was removed (stripped) and collected on a conveyor train. In total, 15 km were cleared.

2. The ballasted track was lifted and replaced by slab track. The picture shows the new bi-block sleepers, type BP-SO, ready for the pouring of the slab track.

3. The concrete was poured directly in order to create the slab. In total, 23,000 m3 of reinforced concrete was used.

4. Machinery for the correct positioning of the track. Throughout the tunnel, 29,400 m of rails were installed in 288-metre long bars.

5. Pouring of track 2 from track 1, already completed, with a three-tank train.

6. Additional work carried out included the installation of 25 new track devices: 7 turnouts, 8 crossovers and 1 bretelle. In the image, at the entrance of Nuevos Ministerios, one of the turnouts that has already been assembled; in the tunnel vault, supports for the new rigid overhead line.

7. Assembly of part of the 1,300 rigid catenary bars installed in the tunnel.

8. The completed track, with the rigid overhead line already installed.

9. Running of new signals, wiring and signalling elements.

10. Electronic signalling control points were installed in the Recoletos and Nuevos Ministerios stations, upgrading the existing technology to a safer system.

94.5M PASSENGERS PER YEAR*

ATOCHA

Built on the former Mediodía station, the existing railway complex, the largest in Spain, was opened in 1992 along with the Madrid-Seville high-speed line. It consists of two stations, the commuter station and the high-speed station. It is located in the Glorieta del Emperador Carlos V, where the Paseo del Prado begins and continues north to the Plaza de Colón. The three major national museums are located in this area: the Prado, the Museo Nacional Centro de Arte Reina Sofía and the Thyssen Museum.

9.3M PASSENGERS PER YEAR*

RECOLETOS

In the 16th and 17th centuries, this was an area with orchards known as Prado de Recoletos, in reference to the convent of Augustinian friars, located on the site now occupied by the National Library and the Archaeological Museum. The Paseo de Recoletos begins at the Plaza de Cibeles – with its famous fountain, a symbol of Madrid, and which houses, among others, the Palacio de Telecomunicaciones and headquarters of the City Council – and ends at Colón. In the 1960s and 1970s many old palaces and buildings were demolished and replaced by modern buildings.

35.1M PASSENGERS PER YEAR*

NUEVOS MINISTERIOS

In the 1930s the city's growth towards the north was first planned, along a large avenue, the Paseo de la Castellana, which opened to traffic in 1952, and Azca, a new residential, commercial and entertainment area. The Nuevos Ministerios complex was built alongside it and the first underground suburban station was opened here in 1967, located under the central courtyard. After several extensions, it has now become a large interchange, connecting to three metro lines and seven suburban lines.

THE TUNNEL LAYOUT FOLLOWS THE MAIN URBAN CORRIDOR OF MADRID, FROM ATOCHA TO CHAMARTÍN, UNDER THE GREAT BOULEVARDS OF THE CAPITAL

CHAMARTÍN

The route of the tunnel is separated from the axis of the Paseo de la Castellana until it reaches this station, which gets its name from the former village of Chamartín de la Rosa on which it is located. The first station was opened in 1967, and eight years later the new railway terminal was designed by the architects Alonso, Corrales and Molezún, along with the engineer Rafael Olaquiaga. In 2008, it was renovated to adapt to high-speed trains and connect to the new Sol tunnel. The next major remodelling has already begun with a view to the commissioning of the third exclusive high-speed tunnel between Atocha and Chamartín.

24.2M PASSENGERS PER YEAR*

SOURCE: Spanish Railway Yearbook. FFE (2019)

Spain's Urban Agenda travels to Abu Dhabi

Adif, Puertos del Estado, Renfe and Ineco presented their proposals for more sustainable, inclusive, safe and resilient cities at the United Nations World Urban Forum. The event, which attracted 18,000 delegates from close to 170 countries, was held in Abu Dhabi from 8 to 13 February.

By **Irene Thomas,** graduate in Audiovisual Communications

PHOTO_INECO / LUMIERE ADVERTISERS

Apps that predict the location of traffic jams; optimised street lighting and irrigation for green spaces; train stations that communicate with taxi and bike operators; smart airports that recognise passengers; and digitalised ports that connect ships to the power grid to reduce their engine emissions... The functionalities provided by artificial intelligence, *Big Data* and robotics are already a reality that is transforming the mobility of our cities, which, according to the UN, are home to 55% of the world's population. The goal is to exploit all of our technological resources to make them more efficient and, above all, more sustainable and environmentally-friendly.

With this in mind, the UN Human Settlements Programme (UN-Habitat) convened the tenth session of the World Urban Forum, which was hosted by the emirate of Abu Dhabi from the 8 to 13 February 2020. A group of businesses backed by the Ministry for Transport, Mobility and Urban Agenda together operated a 100m^2 stand at the event: Adif, Aena, Puertos del Estado, Renfe and Ineco were among those in attendance to present their proposals for more sustainable, inclusive, safe and resilient cities.

At the forum, the Spanish government also presented Spain's Urban Agenda, the result of its commitment to the UN's Sustainable Development Goals. The Agenda, approved in 2019, is a roadmap that aims to guide all of Spain's towns and cities, regardless of their size, towards a more economically, socially and environmentally equitable, integrated and sustainable future by the year 2030. The Agenda offers a Decalogue of Strategic Goals, which, in turn, feature a total of 30 specific goals and 291 lines of action.

> THE FORUM, UNDER THE MOTTO OF *CITIES OF OPPORTUNITIES: CONNECTING CULTURE AND INNOVATION,* IS THE PRINCIPAL INTERNATIONAL STAGE FOR DEBATING AND SHARING EXPERIENCES RELATED TO URBAN ISSUES

The forum, under the motto of 'Cities of Opportunities: Connecting Culture and Innovation', is the principal international stage for debating and sharing experiences related to urban issues The event was attended by more than 18,000 delegates from approximately 170 countries, representing mostly institutions, ranging from national and local governments, non-governmental organisations, the private sector and the academic world.

One of the organisations in attendance was Spanish railway operator Renfe. The rail operator, which presented the Haramain project at the stand, is working on its new 'mobility as a service', 'Renfe as a Service (RaaS)' platform back in Spain. The platform aims to integrate different modes of both public and private transport into one single application.

In addition, Puertos del Estado, which comprises and coordinates the 28 port authorities in charge of Spain's 46 ports, presented its Ports 4.0 project. The Ports 4.0 project establishes an equity fund to finance innovative projects in new technologies and business models based on the 4.0 economy, via a public requests for tenders.

In the aviation sector, Spanish airport operator Aena is focusing on the concept of smart airports: its lines of action include a pilot project for biometric technology and digital identity (facial recognition) at its Adolfo Suárez Madrid-Barajas airport and its airport in Menorca, as well as testing drones for different uses within the airport environment.

Adif, Spain's railway infrastructure administrator, has activated a plan to digitalise its network of long-distance and AVE train stations, aiming to convert them into 'intelligent stations' that will connect to other transport systems and different city services. ■

SPAIN'S URBAN AGENDA

The Directorate-General for Architecture, Housing and Land under the Ministry of Transport, Mobility and Urban Agenda organised two events at the forum. The first, on 10 February, was a networking session entitled 'Governance: a key element in the implementation of national urban policies: Spain's Urban Agenda experience', which was attended by Ineco's Director of Business for Roads and Intermodal, José Ángel Higueras. The event was also attended by, among others, the Ministry of Transport's Deputy Director of Urban Policy, Ángela de la Cruz, who presented the book *Ciudad productiva y ciudad circular. Conversaciones alrededor de la Agenda Urbana (The Productive and Circular City: Discussing the Urban Agenda),* on Tuesday the 11th.

SMART PROJECTS FROM INECO

PHOTOS_INECO / LUMIERE ADVERTISERS

Above, the Director of Ineco, José Ángel Higueras, (first from the right) presents the Cityneco model to the Ministry of Transport's Deputy Director of Urban Policy, Ángela de la Cruz (centre). On the left, a visitor tests virtual reality glasses.

CITYNECO: LAUNCHED IN GRANADA

Ineco demonstrated its Cityneco Mobility model at the stand. The model city, constructed from Lego pieces, allowed delegates to observe the functions of its Cityneco platform through its augmented reality application. The company developed the technology platform for the smart management of different urban services in 2016, as part of an innovation project in which it partnered with the Granada City Council to pilot the platform in the city. The platform has since been updated to a new version 2.0.

Specifically designed to facilitate mobility, the model's modular architecture and layered structure make it easily scalable and interoperable. A Software-as-a-Service (SaaS) version makes Cityneco available to medium-sized cities without their own infrastructure.

The platform features several vertical modules, one for each of a local council or organisation's management areas. Its modular architecture facilitates the incorporation of new vertical levels to adapt to new requirements. Its IoT functionality (the Internet of Things), allows it to connect to sensors located throughout the city while simultaneously integrating and processing multiple sources of information, from social networks to video feed.

The information is displayed simply and intuitively through dashboards, based on both real-time data and management indicators, and in the case of mobility, with a GIS viewer (Geographical Information System).

WHAT DOES CITYNECO OFFER?

1. COMPATIBILITY WITH SIMULATION MODELS. The platform is compatible with existing versions of microsimulation software. This compatibility allows Cityneco to analyse information from simulations in precisely the same way it would do with real-time sensors, which means the scenarios can be merged with other information contained on the platform.

2. TRAFFIC VOLUME PREDICTIONS. By analysing historical data and real-time data obtained from the citywide sensors, the platform is capable of predicting traffic conditions in 15, 30, 45, and 60 minutes.

3. MOBILITY OPTIMISATION. Cityneco can carry out mobility simulations in accelerated time, taking current information as a starting point. The platform runs a finite series of simulations, with varying mobility control parameters, to obtain the optimal configuration for each of the available elements of control.

4. POLLUTION CALCULATIONS. Data is obtained by cross-checking the simulation model's road network with traffic information provided by the different sensors. The traffic-sensor information and the simulation can be used to calculate emissions, enabling the platform to estimate contamination levels in places without sensors.

A CONNECTED CAMPUS FOR THE UNIVERSITY OF ALMERÍA

The University of Almería (UAL), founded in 1993, is not the first Spanish university to introduce smart-management projects for its services and infrastructure, but it is the first to have a Master Plan for their implementation, which it asked Ineco to design. With a few methodological adjustments, the document incorporates smart-management proposals similar to those that would be applied to a small city.

The work, which was carried out over the course of 2019, includes a model for a smart campus, a diagnosis of the University's current state of technological or smart development, the objective to be achieved and a roadmap of necessary actions.

At just over five kilometres east of the city of Almería and a few meters from the sea, the UAL is a small to medium-sized public university situated very close to the Natural Park of Cabo de Gata-Níjar. Despite being located in a water-deficient province, the university benefits from abundant sunshine and regular winds that it can use to obtain clean energy. The plan, therefore, concentrates on environmental initiatives to create a green smart-campus with particular emphasis placed on optimising its water and energy consumption. Given its location outside of the city centre, which makes access on foot difficult and generates high levels of private vehicle use, another priority is to improve the university's mobility framework.

In total, the plan covers 21 services, grouped in nine sub-areas: urban environment (maintenance and irrigation of gardens, air quality, noise and light pollution), waste management (cleaning roads and buildings, and waste collection), energy (electricity and gas consumption in buildings, public lighting, clean energy generation), water (water consumption and quality, sanitation and sewage network management), parking (car park management), traffic control (vehicle influx, internal bicycle and scooter traffic, charging points for electric vehicles, information on modes of transport), accessibility, public infrastructure and urban equipment, (management and maintenance, incident detection) and an innovation ecosystem.

PHOTO_UAL

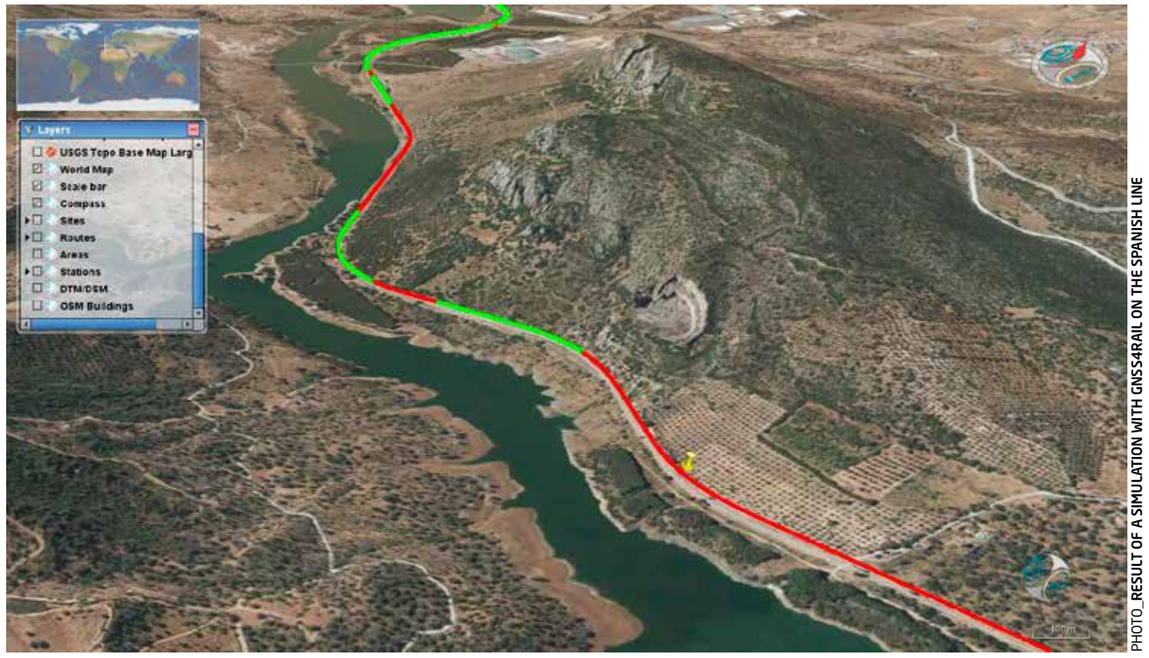
Above: view of the UAL campus. Below: bicycles parked in front of lecture theatre IV; promoting sustainable mobility is a cornerstone of the plan.

THE UAL IS THE FIRST SPANISH UNIVERSITY TO HAVE A MASTER PLAN FOR THE IMPLEMENTATION OF SMART-MANAGEMENT INITIATIVES THANKS TO INECO

In order to establish the current technological advancement of the services, six levels were defined: basic, initiation (UAL's current level) intermediate, advanced, very advanced and connected. The objective is to reach the 'connected' level, which specifies that at least 80% of the services must be interconnected.

The Master Plan includes indicators to measure UAL's smart progress and establishes a Steering and Coordination Committee and a Monitoring Committee, as well as suggesting a two-yearly revision of the document to keep it up to date.

For the test period in Spain, Adif selected the Conventional Network line between Almorchón (Badajoz) and La Alhondiguilla (Córdoba) a low-density, non-electrified line 94 kilometres long. Coordination between Adif, Ineco, CEDEX, IFSTTAR and DLR was key to the success of the campaign.



PHOTO_RESULT OF A SIMULATION WITH GNSS4RAIL ON THE SPANISH LINE

Virtual balises for European trains

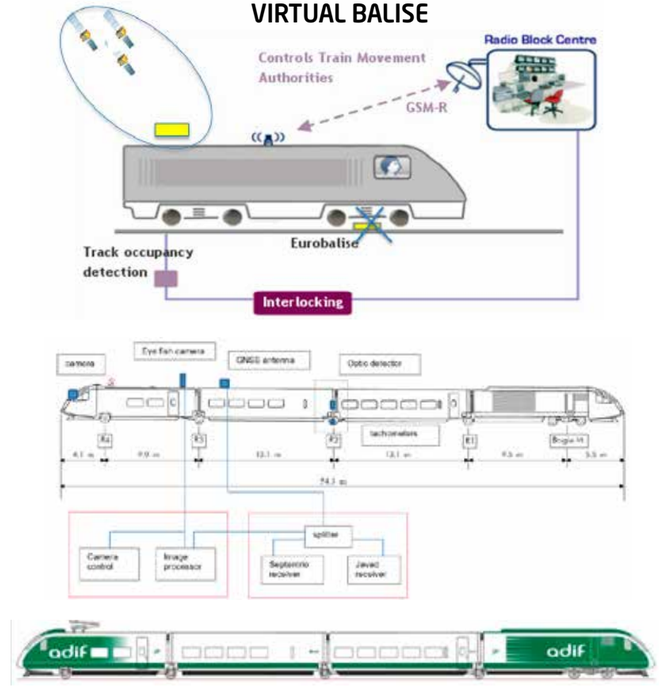
14 companies from five EU countries participated in ERSAT GGC, an ambitious European project financed by the European Global Navigation Satellite Systems Agency (GSA) that will allow the implementation of satellite technology in the European Rail Traffic Management System (ERTMS) through virtual balises.

By **Antonio Águila,** BSc in Telecommunication Engineering

In December 2017, this European project, financed by the GSA (European Global Navigation Satellite Systems Agency) as part of the H2020 Programme, began with a set duration of 24 months. The 14 European companies from five EU countries that participated in the ERSAT GGC project are RFI (project coordinator), Hitachi STS (formerly Ansaldo, technical coordinator), RINA, Trenitalia, Radiolabs, Italcertified and Bureau Veritas for Italy; Adif, CEDEX and Ineco for Spain; IFSTTAR and SNCF for France and UNIFE for Belgium.

The final objective is to contribute to the standardisation of the certification process for the adoption of satellite navigation systems (GNSS) in the European Rail Traffic Management System (ERTMS) standard. The scope of the project was very ambitious, working towards the consolidation of an improved ERTMS functional architecture that includes GNSS, safety studies, definition of a procedure for the classification of railway lines in relation to the 'virtual balise', development of a set of tools to assist in this classification, measurement campaigns in three countries (France, Spain and Italy), analysis of the data in the laboratories, evaluation of the architecture, procedure and tools by independent NoBos (Notified Bodies) and, finally, dissemination of the results and activities of the project in different national and international forums.

The 'virtual balise' concept has been under development for several years in previous projects launched by GSA, ESA and Shift2Rail, and consists of providing positioning information to the train by means of GNSS signals, instead of the physical balises required by ERTMS.



MEASUREMENTS MADE ABOARD A TALGO LABORATORY TRAIN

For this purpose, the onboard equipment will consist of a new module called Virtual Balise Reader (VBR), which will process the GNSS signals and compare the GNSS coordinates with the list of coordinates onboard, reporting the corresponding virtual balise to the Eurocab when the coordinates stored for it are reached. This will make it possible to reduce the number of physical balises installed on the tracks, with the resulting savings for infrastructure managers, (Adif in the case of Spain) in terms of installation tasks, maintenance, theft, etc. This requires adequate reception of the GNSS signal at the points where the physical balises are to be installed, and therefore requires the classification of the

On the left, Ineco's team in the Spanish campaign; from left to right: Víctor Quiñones, María Pedauyé, Alejandro Mendoza and Antonio Águila. On the right, GNSS measurements in the Talgo BT-02 laboratory train.

railway lines according to the 'quality' of the GNSS signal received in each section.

The procedure will identify the sections/points where it is feasible to deploy a virtual balise so that the performance of the GNSS signal in terms of availability and accuracy meets the requirements.

The participation of Spanish companies in ERSAT GGC was distributed in such a way that CEDEX collaborated on the measurement campaign, integrating the tools in its laboratory and analysing the results of the different campaigns, contributing significantly to the customer's last Demo. For its part, Adif purchased the necessary equipment for the campaign and provided a line and a laboratory train to carry out the measurements to be analysed at a later date.

Lastly, Ineco played a key role by participating in almost all of the work packages, contributing its knowledge in the areas of GNSS and ERTMS given its experience in previous projects such as GRAIL, GRAIL 2, NGTC and STARS. In particular, the company contributed to the consolidation of the functional architecture of ERTMS, the definition of several tools for the toolset, the participation in the Spanish measurement campaign, the analysis of the data from the Italian and Spanish campaigns, and lastly, contributing to the demonstration with the customer and the dissemination activities.

MEASUREMENT CAMPAIGN IN SPAIN

For the test campaign in Spain, Adif selected a line equipped with a Telephone Blocking (TB) system and with low traffic density. Specifically, line No 528 of the Conventional Network between Almorchón (Badajoz)-Mirabueno (Córdoba), which is of type E, with a total length of 130.1 kilometres and which is not electrified, although the runs were made on the section between the Almorchón and La Alhondiguilla stations, which is 94 kilometres long and has a maximum speed of 60 km/h.

Coordination between Adif, Ineco, CEDEX, IFSTTAR and DLR was key to the success of the hours and 20 runs were carried Spanish campaign. A static calibration test lasting 12 hours with 20 runs was carried out over 10 days of the campaign, at different times, in order to cover the various satellite positions of both the GPS and Galileo constellations. With all the data collected (GNSS signals, images and odometry), we moved on to an analysis phase, where the set of tools also developed in the project would make it possible to classify the line regards to the main local hazards to the GNSS signal on railway lines: interference, multipath, NLOS (Non-line-of-sight) and degraded performance.

Main GNSS local feared events on railways. Source: ERSAT GGC project.

All measurements were made on a Talgo laboratory train (BT-02), which was equipped with:

- GNSS Antenna: AntCom G8-PN
- GNSS Receiver: Javad Delta3
- GNSS Receiver: Septentrio AsteRx2e
- Splitter
- Laptops
- UPS
- Video camera
- Fisheye system

THE 'VIRTUAL BALISE' CONCEPT HAS BEEN UNDER DEVELOPMENT FOR SEVERAL YEARS AND CONSISTS OF PROVIDING POSITIONING INFORMATION TO THE TRAIN BY MEANS OF GNSS SIGNALS, INSTEAD OF PHYSICAL BALISES

ERSAT GGC technical team during the measurement campaign at Almorchón station, Badajoz.

TOOL DEVELOPMENT (DEGRADED PERFORMANCE INDICATOR)

Ineco contributed to the development of different tools used to classify the areas of the train lines as green, yellow or red, for the placement of the virtual balise. In particular, two tools were developed to be integrated into the project:

1. SBAS_Health_Monitoring_tool (SHMT): assigns a health status to each GPS satellite by analysing the message received from EGNOS (European Geostationary Navigation Overlay Service).

2. GNSS4Rail: a simulation tool that makes it possible to manage a highly accurate 3D model of the railway line environment (both in rural and urban environments) based on a surface model and the ability to launch point or time simulations along the entire line with different GNSS constellations (GPS and/or Galileo) and for any time frame.

The inclusion of the Galileo constellation was an added value to the project and enabled multiconstellation simulations (use of several GNSS constellations), following the path traced by safety market applications. Moreover, the prognosis capability provides a clear advantage over other applications that only analyse real, static data from the past.

GNSS TECHNOLOGY IN ERTMS

In the future, ERTMS will be the only signalling standard not only in Europe, but worldwide, with a maximum safety level (SIL4) and multiple suppliers. Cost reduction is the main challenge in the deployment of ERTMS, which is why the integration of GNSS technology into the system:

- Reduces the cost of the signalling system and maintenance costs (reduction of trackside equipment).
- Is an option for the migration of conventional lines to ERTMS with GNSS.
- Will improve performance due to improved odometry, increased availability and system reliability.
- Capacity increase, ERTMS level 3.

The use of satellite positioning with ERTMS will allow more economical deployment on regional lines, contributing to its expansion into the European rail network. Lastly, it should be noted that important synergies and collaborations are being done with other Shift2Rail projects (e.g. TD (IP2-TD2.4) to implement satellite technology in ERTMS), which reveal the potential of satellite positioning technologies in the next generation of ERTMS, and in different GSA, EC and ESA projects.

The success of this project is the result of the efforts of a team from different areas of Ineco (Francisco J. Fernández de Líger, Beatriz Sierra, María Pedauyé, Ilie Cordero, Javier Espinosa, Víctor Quiñones, María Eva Ramírez and Antonio Águila) and the collaboration and understanding with other companies from Mitma (CEDEX and Adif). For more information, please visit *http://www.ersat-ggc.eu/*.

The GNSS4RAIL tool provides the following advantages in the deployment phase:

- Support for feasibility analysis and planning of the deployment of virtual balises on the line.
- Preliminary identification of feasible sections for deployment.
- Analysis both along the railway line (spatial domain) and for a time interval (time domain).
- Minimises the data acquisition campaigns with an auscultation train mainly thanks to the temporal analysis.

Advantages in the operation phase:

- Support as a performance predictor of deployed virtual balises.
- Provides pre-tactical information to the management of GNSS-based railway operations.

The possible uses of the tool are not limited to the specific application of the virtual balise; it can also be used to determine in advance the 'coverage' of the GNSS signal at any point on a line and at any given time, and these results can be used for other applications such as operations planning, fleet control, passenger information, ticketing, maintenance, etc. It can also be applied in other sectors such as road transport, maritime operations in ports and VLL drones/aircraft air operations in U-Space. ■

A NEW HIGHWAY NOW CROSSES THE MONREPÓS MOUNTAIN PASS WHICH, AT 1,262 METRES ABOVE SEA LEVEL, IS THE HIGHEST IN THE HUESCA PYRENEES

The highway that tamed the mountain

At the foot of the Aragón Pyrenees, this complicated, 3-kilometre downward-sloping stretch required many years of work. The reason: its route through the Monrepós pass is the highest in the Huesca Pyrenees, with gradients of up to 7%.

By **Miguel Vila,** road engineer

ARGUIS INTERCHANGE.
The section includes the Arguis trumpet interchange, which provides access to the new Monrepós Tunnel Control Centre, the town of Arguis and the Nocito Valley located within the Parque Natural de la Sierra y los Cañones de Guara.

The Ministry of Public Works opened the Huesca A-23 (E-07 for Europe) stretch of the Mudéjar highway in October 2019. Ineco provided technical assistance and supervised the project's environmental monitoring programme. Thanks to this and other works, the full length of the Monrepós mountain pass can now be traversed on a highway, reducing travel times and increasing safety levels.

Construction of the A-23 to connect the Mediterranean coast to the French border began in 1999. The road starts in Sagunto, Valencia, and runs for 435 kilometres (413 of which are now in service), to Jaca in Huesca. Partially new construction and also taking advantage of the existing alignment, the A-23 follows the corridors cut by the N-234 (to Retascón, Zaragoza) and the N-330, which crosses Aragón and connects to the Somport tunnel (Huesca) to pass through the Pyrenees.

In the year 2000, the A-23 was extended to the capital of Huesca. Due to the challenging geology of the terrain and, in particular, the Monrepós mountain pass which, at 1,262 metres above sea level is the highest in the Huesca Pyrenees, the final stretch to Jaca was the last to be completed. For this stretch, in 2019, the Ministry of Public Works in conjunction with the Aragón State Highways Division, opened three new sections of road, which means it is now possible to travel the entire 39-kilometre stretch between Huesca and the Monrepós pass on a highway.

The sections in service are: Alto de Monrepós-Caldearenas, Caldearenas-Lanave, and also, since October 2019, the 3.3 kilometres between Congosto de Isuel and Arguis. The contract to build this last section was awarded to FCC, and work began in May 2007. Since April 2016, Ineco has been providing technical assistance to FCC's construction management

team, for the supervision and monitoring of the works. The works posed considerable technical difficulties for several reasons, not the least of which was the geotechnical complexity of the geography, which, among other things, gives the entire route a downward gradient of between 4% and 7%.

Now that the new sections of the A-23 are operational, only the 30.4 kilometres of the Lanave-Sabiñánigo section and the Sabiñánigo and Jaca bypasses remain uncompleted. The Ministry of Public Works has stressed the significance of the new road axis which, together with the A-21 (Pamplona-Jaca) and A-22 (Huesca-Lleida) highways, gives traffic travelling between the Cantabrian coast and Catalonia an alternative to the Ebro valley. When the work is finished, the travel time between Castellón and the Atlantic coast will be about six hours.

The new section of the Congosto de Isuela-Arguis highway was constructed with new infrastructure, including a tunnel more than 900 metres long on the ascending carriageway (direction Huesca-Jaca). However, whenever possible, the descent takes advantage of the existing corridor (the N-330). The cross-section of the highway consists of two carriageways with two 3.5-metre lanes, separated by a narrow median strip measuring between 1.2 and 2 metres in the sections with parallel carriageways, a 1-metre inner hard-shoulder, a 2.5-metre outer hard-shoulder, and 0.75-metre lateral berms.

VIADUCTS AND OTHER STRUCTURES

The difficult alignment required the construction of numerous structures: six viaducts, two walkways, a reinforced concrete wall and six reinforced soil walls.

PRINCIPAL WORKS: THE ARGUIS TUNNEL

The most significant feature of the section is the 920-metre long Arguis tunnel. The carriageway comprises two 3.5-metre lanes, a 1-metre inner hard-shoulder, a 2.5-metre outer hard-shoulder and two 0.75-metre walkways. In addition, given the steep downward gradient of the area, an additional 2-metre safety area was added to the outer hard-shoulder as a supplementary measure.

The tunnel was built using the new Austrian tunnelling method. The method consists of excavation (in this case using blasting and mechanical means) immediately followed by the construction of a flexible support. Depending on the geomechanical characteristics of the terrain, four types of support sections were constructed using anchor bolts, gunite (shotcrete reinforced with fibres to increase its load capacity), trusses and a systematic concrete tunnel invert.

The tunnel has three evacuation galleries (measuring 171, 146 and 153 metres, respectively) which provide access for ambulances and small emergency vehicles. In addition, all the of the facilities required for the proper functioning of the tunnel were installed: lighting, ventilation, fire detection and protection systems, electrical connection, signalling, traffic lights, variable information panels, a video monitoring and surveillance system, public address system, SOS posts, height clearance control and a collection system for hazardous spills.

The Arguis tunnel is a dual carriageway single-tube tunnel with a safety area and three emergency evacuation galleries. Work on the almost 1-kilometre tunnel was completed in 2019. The photos show the different phases of the construction.

The photos above show the response to one of the biggest challenges of stabilising the embankments using retaining walls and metal netting to prevent landslides and falling debris.

The photo on the left shows the construction of Monrepós Tunnel Control Centre in the background.

In addition, three bridges of the N-330 built over the Isuela River in 1982 were repaired and adapted. They showed a significant degree of deterioration due to several different causes, but mainly due to a combination of poor drainage and exposure to salt used as a melting agent.

EMBANKMENT REINFORCEMENT

Another notable aspect of the new section's construction was the reinforcement of slopes and embankments with stability issues resulting in fractures and frequent occurrences of falling debris (stones and metre-sized blocks). The problem was addressed with more than 60,500 m² of triple-twisted wire mesh netting anchored with bolts and Californian drains (drainage pipes inserted into the rock). Additionally, the project required more than 7,600 metres of soil walls, the reinforcement of unstable soil with a total of 53 buttresses formed by 265 piles, and static and dynamic barriers three and four metres high, respectively.

> THE NEW ROAD AXIS, TOGETHER WITH THE A-21 (PAMPLONA-JACA) AND A-22 (HUESCA-LLEIDA) HIGHWAYS, GIVES TRAFFIC TRAVELLING BETWEEN THE CANTABRIAN COAST AND CATALONIA AN ALTERNATIVE TO THE EBRO VALLEY

DOUBLE DRAINAGE SYSTEM

In sections where the highway runs almost parallel to the Isuela river, the Environmental Impact Statement (EIS) dictated that waters should be handled differently depending on their origin. For this reason, a double longitudinal drainage system was installed. Clean run-off from the embankments is diverted into a ditch in a clearing and drains directly into the river; dirty water that accumulates on the carriageway flows into a curb collector, central ditch and lateral gutter between the roads, with degreasing and settling tanks to prevent pollutants from reaching the river. ■

A MODERN PUBLIC TRANSPORT SYSTEM
With just a few months to go until its opening, Line 1 of Quito's publicly-owned Empresa Metropolitana de Metro de Quito will be completely underground, with 22 kilometres of track built with cutting-edge technology and equipped with modern trains manufactured by the Spanish company CAF.

Trains to make better citizens

The commissioning of Metro de Quito's first subway line is fast approaching. Ineco has supervised the construction of the 18 new trains built by Spanish company CAF, that in just a few short months will be providing service to the most ambitious and significant infrastructure project in the history of the city and will be helping to create a "place to be better citizens".

By **Jon Aizkorbe**, industrial engineer, and **José Antonio Pernas**, civil engineer

PHOTOS_**INECO**

For Dr. Jorge Yunda, Mayor of Quito, the city's first metro line is more than just emblematic infrastructure; it's "an excellent opportunity for people to change the way they relate to each other". The city's authorities hope the new mass transport system will consolidate 'Metro culture'. They also believe it will improve quality of life by saving time for residents, enabling them to be more supportive of one another, and allowing them to breathe cleaner air by reducing the thousands of tons of CO_2 they currently release into the atmosphere.

With just a few months to go until its opening, Line 1 of Quito's publicly-owned Empresa Metropolitana de Metro de Quito will be completely underground, have 22 kilometres of track built with cutting-edge technology and will be equipped with modern trains manufactured by the Spanish company CAF in the north of Spain. The line will have 15 stations stretching from the El Labrador station at the south terminal station of the old airport to the Quitumbe station south of the city, and a total travel time of 34 minutes. Four hundred thousand people are expected to use the new infrastructure every day.

MORE THAN 400,000 PEOPLE WILL BENEFIT FROM THE NEW SUSTAINABLE TRANSPORT SYSTEM EVERY DAY

The success of the Medellín Metro prompted representatives of Metro de Quito to sign a rail transport cooperation agreement with the Empresa de Transporte Masivo del Valle de Aburrá Limitada-Metro de Medellín (the Valle de Aburrá Limited-Medellín Metro Mass Transit Company). The agreement provides a framework for joint contribution, knowledge transfer and work in different areas related to the metro's operation. Similarly, in August 2019, a cooperation agreement was also signed between the Central University of Ecuador and Metro de Quito. The ambitious construction project is supported by the World Bank, the Inter-American Development Bank, the CAF-Development Bank of Latin America and the European Investment Bank.

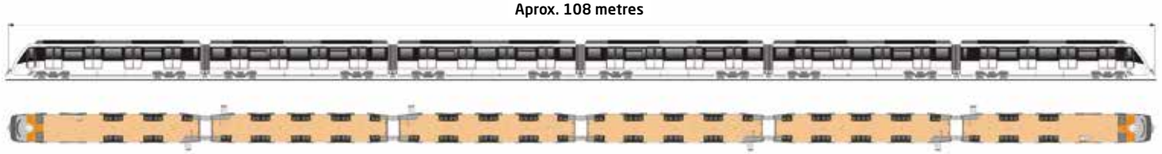
INECO INSPECTORS SUPERVISED TRAIN MANUFACTURE AND ASSEMBLY AT CAF'S MANUFACTURING PLANTS

THIRTY YEARS OF EXPERIENCE

Just as it did with the trains built by CAF for Metro de Medellín Metro, at the start of 2017 Ineco began supervising the complete rolling stock acquisition process for the Empresa Pública Metropolitana Metro de Quito (EPMMQ - the Quito Metro Metropolitan Public Enterprise). The order included 18 trains with six cars each, plus auxiliary vehicles, equipment and tools for the depot, and spare parts. The railway experts from the Spanish engineering firm provided technical supervision and management of the design, build and tune-up of the trains, a task that involves monitoring compliance with production deadlines, the issuing of deliveries in running order, and ensuring maximum consistency throughout the design, manufacturing and factory testing processes.

The company's extensive experience in supervising the design, manufacture and commissioning of all types of rolling stock, comes from its work dating back to the 90s in Spain, as well as its contributions to metro and commuter

Aprox. 108 metres

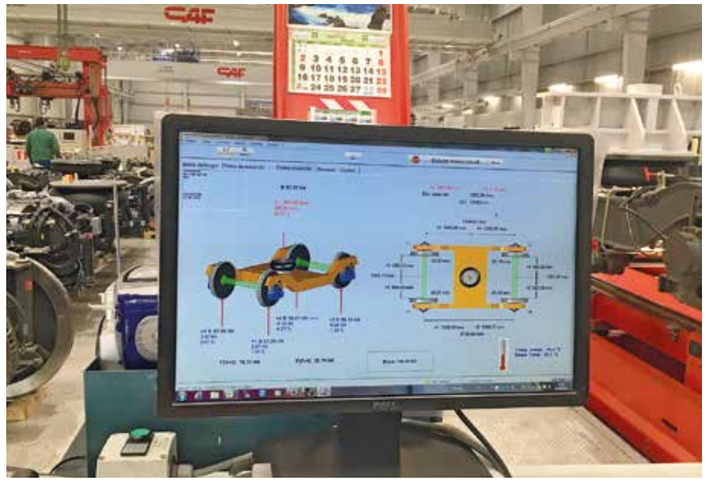


SUPPLYING THE TRAIN UNITS

Ineco has experience in provisioning many different types of large equipment projects, such as the construction of new EMUs, DMUs and locomotives, overhauling rail stock, freight cars, auxiliary equipment such as draisines, specialised infrastructure maintenance vehicles and on-board equipment.

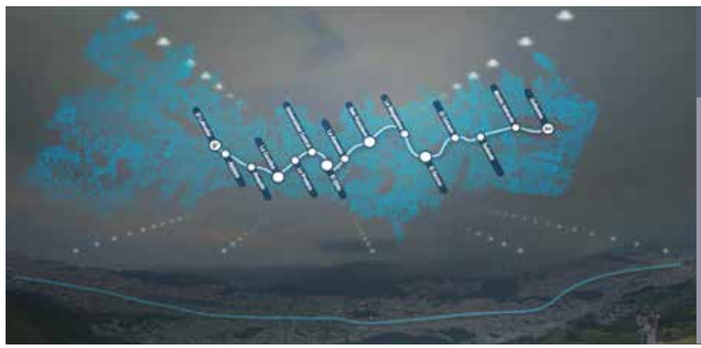
BUILD SUPERVISION AT CAF'S BEASAIN PLANT

The images show different stages of the design, manufacture, assembly, adjustment and trial/testing processes. Ineco's experts must be able to guarantee the compatibility of the equipment and the electrical, electronic, wireless, electromechanical and mechanical systems on-board, with the trackside equipment and systems.



COMPREHENSIVE BUILD SUPERVISION

Metro de Quito commissioned Ineco, as a company specialised in subway-type rail transport systems, to supervise, evaluate and ensure full contract compliance throughout the stages of design, manufacture, transport and at tune-up at the final destination.



QUANTITY	TYPE OF TRAIN	POWER SUPPLY	CAR TYPES
- 18 trains - 6 cars/train - 108 cars	- Continuous trains - Aluminium alloy	- Rigid overhead line - Overhead line voltage: 1,500 Vdc - Gauge: 1,435 mm - Max. speed: 100 km/h	- Four locomotive cars (middle) - Two towing cars (at the ends)

TESTING TRENASA/CASTEJÓN

Compliance with the respective technical and operational specifications and applicable standards and regulations was monitored at every stage of the process: throughout the design, manufacture and assembly of the units, as well as during the provision and installation of auxiliary vehicles, spare parts and depot equipment and tools. Special attention was given to any systems that could influence operational safety.

trains abroad, in the cities of São Paulo, Medellín and Santiago de Chile. Ineco's qualified personnel and exhaustive knowledge of regulatory issues have made the company a household name in the world of railway rolling stock.

A LONG AND PAINSTAKING PROCESS

The Ineco division responsible for the supervision of the design of the rolling-stock, which has an operating life span of 35 years, oversaw the process from the company's Madrid office. Meanwhile, specialists from the company's leading teams were present for approval tests carried out on-site at the installations of each of the main train equipment suppliers (in South Korea, China, Switzerland, Germany, Austria, Finland, Portugal and Spain).

Build supervision, train unit assembly and factory tests were completed in the presence of inspectors at CAF's manufacturing plants in Irún, Beasain and Castejón. The acceptance phase for the trains, auxiliary vehicles, depot equipment and spare parts took place at EPMMQ's installations in Quito.

Ineco also provided technical assistance to FEEP (the Ecuadorian Public Railway Company) by inspecting three TD2000BB locomotives supplied by Euskotren, to verify their suitability to the track and traction conditions of the country's lines. ■

COLLABORATION BETWEEN RAIL SPECIALISTS

New rolling stock depots were built in Quitumbe, south of Quito, at the bottom and front of the picture 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) and David Polo (Ineco-Ecuador). Rail experts from the Spanish engineering firm Ineco directed the supervision and technical management of the design, manufacture and adjustment of the trains.

TRANSPORT AND DELIVERY OF THE ROLLING STOCK

Part of the job included the review of the packing and dispatch logistics for the trains and auxiliary vehicles, to guarantee their safe and efficient transport throughout the journey. The images show a train leaving the Trenasa plant -part of the CAF group- and later, arriving at Metro de Quito's depot at the Labrador Station.

AN EXCITING PROJECT

As this report goes to print, Ecuador's most important mobility project to date is also one of the most exciting for Quito's residents. With just a few months to go before its opening, Metro de Quito is keeping them updated on its progress by sharing step-by-step pictures of the testing and completion of the work. *https://www.metrodequito.gob.ec/el-proyecto/.*

Plans for 12 Mexican airports

Ineco has updated the Master Development Plans for the period 2020-2034 for 12 airports belonging to the Pacific Airport Group (GAP), which is partly owned by Aena Internacional. Against a background of strong growth in the Mexican aviation market, these plans will allow airports, including Guadalajara, sufficient capacity to meet increased demand.

By **Pablo Fuente, Rodrigo López, Marta Martínez** and **Sandra Velasco,** aeronautical engineers

GAP PASSENGER GROWTH 2019 vs 2018			
1	Guadalajara	14,846,329	3.4%
2	Tijuana	8,925,873	13.9%
3	Los Cabos	5,609,122	6.9%
4	Puerto Vallarta	5,051,855	6.0%
Montego Bay (Jamaica)		4,707,745	5.0%
5	Guanajuato	2,755,807	17.8%
6	Hermosillo	1,874,059	7.5%
7	Mexicali	1,198,808	5.3%
8	La Paz	1,008,136	8.8%
9	Morelia	897,754	23.0%
10	Aguascalientes	858,433	-1.2%
Kingston (Jamaica)		408,702	15.4%
11	Los Mochis	391,300	13.5%
12	Manzanillo	174,718	1.3%
TOTAL		**48,708,641**	**8.4%**

SOURCE_ **GAP FORECASTS AS OF JANUARY 2020**

Air traffic at GAP airports has grown over the last five years by 12%, more than the country's average of 8%. In the image, the Puerto Vallarta airport.

PHOTO_ **INECO/GAP**

The Mexican airports of Guadalajara, Tijuana, Los Cabos, Puerto Vallarta, Guanajuato, Hermosillo, La Paz, Mexicali, Morelia, Aguascalientes, Los Mochis and Manzanillo, all operated by GAP (the Pacific Airport Group), have just updated their Master Plans to 2034. Ineco first began preparing these plans, which are structured in three five-year phases, in 2003, for the periods 2005-2019, 2010-2024 and 2015-2029.

GROWING AVIATION MARKET

In an aviation market as dynamic as that of Mexico, it is essential to adjust plans to anticipated levels of demand.

In the last five years alone, Mexican air traffic has skyrocketed –with year-on-year growth of more than 10% until 2019, when it grew by 8.4%– due to several factors: the 35% drop in ticket prices due to the trade war between airlines, the drop in fuel prices, the signing of 23 bilateral transport agreements in just four years and the strength of tourism. Within this context, GAP operates five of the 10 busiest airports in the country, with the list topped by Mexico City, with 50.3 million passengers in 2019, and Cancun, with 25.5 million. The Guadalajara airport, with 14.8 million passengers, is in third place.

Air traffic growth at all GAP airports over the past five years, at 12%, is higher than the national average (8%), which is attributable to several factors: the saturation of the international airport in the capital, Mexico City (AICM), which has benefited Guadalajara airport, the *cross-border* effect at Tijuana airport, and the increase in tourism at the Rivera Nayarit and La Paz airports, which has benefited the Puerto Vallarta and La Paz airports. ■

GAP, MEXICO'S LEADING OPERATOR

GAP was created in 1998 when the Mexican government privatised the administration of 35 of the 58 airports in the national network. The Group was awarded a 50-year concession for 12 of them. That same year, Aena Internacional was established, which has a 33.33% stake in GAP via the company Aeropuertos Mexicanos del Pacífico (AMP), one of GAP's strategic partners. At present, the 12 Mexican airports have been joined by two more in Jamaica: the Sangster in Montego Bay, since 2015, and the Norman Manley in Kingston, since 2019. GAP has been listed on the Mexican and New York stock exchanges since 2006 and is one of the largest private airport groups in the Americas and the largest in Mexico, with a market share of 26.3% of total traffic. In total, in 2019 it processed 48.7 million passengers, 8.4% more than the previous year.

1 GUADALAJARA
The Guadalajara International Airport is the third most important in the country and is located in the state of Jalisco. Guadalajara is an important commercial, industrial and tourist centre. In line with the Master Plan, the main actions to be carried out in the coming years will be the construction of a second runway and a new terminal with its associated commercial apron. An increase in the capacity of the general aviation apron and the parking and access facilities is also proposed.

2 TIJUANA
General Abelardo L. Rodríguez International Airport is located in Baja California, adjacent to the US border. Passengers departing from San Diego (USA) use the Cross Border Xpress (CBX), which allows them to cross the border without leaving the airport. The Tijuana Plan is currently underway, which includes the construction of a new processing building and the joining of the Alfa and Eco taxiways. The Master Plan aims, within the first five years, to reconfigure and expand the aircraft stands, as well as the security control area in the terminal building, and to reserve an area for cargo, in particular for CBX-Cargo. For the second five-year period, the construction of Dock C and a new control tower.

3 LOS CABOS
The airport serves the Los Cabos area -comprised of the municipalities of San Jose del Cabo and Cabo San Lucas- currently one of the most important tourist destinations in the country. 70% of the traffic is international. Among the key actions, the Master Plan proposes, in the short term, to expand the commercial and general aprons, as well as the terminal buildings. For the second five-year period, land is being reserved in the medium term for the construction of a future second runway.

4 PUERTO VALLARTA
Located in the state of Jalisco, 7.5 kilometres northwest of the city of Puerto Vallarta. The main proposal of the Master Plan is the construction of a new terminal building with an associated apron, parking lots and roads, as well as a reform of the current terminal building.

5 GUANAJUATO
Located in the municipality of Silao (Guanajuato). With 2.7 million passengers in 2019, Guanajuato is the fifth largest city within GAP. In the last five years, average growth has been spectacular, at 15.5%, above the average of 12.1% for GAP. Commercial traffic is mostly domestic. The proposed development includes an expansion in several phases of different areas of the terminal building (departures, arrivals, baggage claim, new boarding gates), as well as the parking aprons (commercial and general aviation).

6 HERMOSILLO
The airport is located in the municipality of Hermosillo, in the state of Sonora. It serves as an alternate airport to Tijuana. The main development proposals include the enlargement and reconfiguration, over several phases, of the stands on the general aviation apron and, in the short term, of the passenger and baggage claim areas. Also, the control tower is to be renovated, although it does not need to be relocated.

7 LA PAZ
The General Manuel Márquez de León International Airport is located in the state of Baja California Sur. Almost 100% of passenger traffic and commercial operations are domestic. The Master Plan recommends, among other actions, the enlargement of customs, phytosanitary and documentation controls, in the short term; or, in the medium term, of the terminal building, the final waiting room and baggage claim.

GUADALAJARA IS THE LARGEST AIRPORT, PUERTO VALLARTA, LOS CABOS THE MOST TOURISTIC AND TIJUANA IS THE MAIN GATEWAY TO THE US

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PHOTOS_INECO / GAP

8 MEXICALI
The General Rodolfo Sánchez Taboada International Airport is located in the state of Baja California, about 6.5 kilometres from the US border. Short-term development proposals include increasing the number of documentation counters, installing an X-ray machine and remodelling the general aviation building.

9 MORELIA
The airport is located 30 kilometres from the city of Morelia, in the north of the state of Michoacán. Following an analysis of demand, it was concluded that the airfield has sufficient capacity for the entire reference period. In the short term, proposed actions include, among others, the expansion of the general aviation apron, as well as the areas for document control, boarding and baggage claim rooms.

10 AGUASCALIENTES
The Licenciado Jesús Terán Peredo International Airport is located 24 kilometres south of the city of Aguascalientes. Over the last five years, the average annual growth rate of commercial passengers has been 13.9%, well above the figures reported for the entire group. Among the actions of the Master Plan, it is worth highlighting that during the first five years, the commercial and general aprons were enlarged and remodelled, as well as the passenger area, in particular for baggage claim and document control, and some repairs were made to the beacon in the control tower.

11 LOS MOCHIS
The Valle del Fuerte International Airport, or Los Mochis, is located in the state of Sinaloa. Its traffic is almost 100% domestic. The proximity of the airports of Hermosillo and Culiacán -both state capitals- results in competition that affects primarily the development of international traffic. As for the Master Plan, it proposes the remodeling and expansion of the south-west and south-east facades of the existing terminal building, the expansion of the general aviation apron and the reconfiguration of the current seating arrangements.

12 MANZANILLO
Also known as Playa de Oro, it is located in the west of the state of Colima. The distribution of commercial passengers is very balanced: 55% of the traffic is domestic and 45% international. No need to increase the capacity of the runway and the commercial aviation apron over the entire time frame of the study was identified. For the terminal building, the expansion and remodeling of the medical clinics, security controls, waiting room and baggage claim area are proposed.

WHAT IS A MASTER PLAN?

A Master Plan is the document that constitutes the main planning tool for the development of an airport and governs its development over different time frames. It takes into account its geographical and socio-economic environment, based on the current situation. Since traffic and expected demand are constantly evolving due to multiple factors, they need to be updated regularly. Master Plans involve two distinct planning figures:

▶ 'Proposed development', which includes the necessary works to adapt airport capacity to foreseeable demand in the short, medium and long term. Works are planned so that they are ready when needed, and are distributed over three five-year periods between 2020 and 2034 (five-year periods).

▶ From the final year, 2034, the 'maximum possible development', considers a longer time frame, with the aim of defining a 'reserve area' for the future development of the airport.

Within the 'proposed development', all plans include an aeronautical easement study, a section on environmental measures, the noise footprint of each airport, a preventive maintenance plan for the facilities, an accessibility study in accordance with Mexican legislation, and a proposal for tariffs calculated on the traffic units.

JOSE ÁNGEL MARTÍNEZ

“Going from 23 to 46 million passengers in seven years requires enormous amounts of planning”

The head of the GAP network outlines the challenges of keeping airport infrastructure up-to-date, the key to achieving economic efficiency and passenger service quality.

It has been more than 20 years since the Pacific Airport Group (GAP) was created –have the challenges changed much since then?
The industry has evolved a lot over the past 20 years, and so has GAP, which I think has adapted very well to these developments. In the first years of the concession, the majority shareholder of the group was the Mexican government, until 85% of the company’s capital went public in 2006 and the management model changed. Then came the crisis and along with the arrival of low-cost airlines in Mexico, there was a sustained annual increase in demand, which made GAP focus its management on improving and adapting airport infrastructure. Today, the group continues to strive to build quality infrastructure, applying an efficient management model. In addition, there is a growing vision for the internationalisation of the company which is demonstrated by the recent acquisition of the concession of Kingston Airport in Jamaica.

Traffic at GAP airports has increased significantly in recent years. What challenges has the increase in traffic posed and what does it mean for the future?
When GAP was awarded the concession for the 12 airports in Mexico in 1999, the total traffic of the Group was around 16 million passengers. By 2020, excluding the Kingston and Montego Bay airports, we will reach 46 million passengers. This growth has been particularly marked in the last seven years, in which traffic has doubled –from 23 to 46 million– with growth rates close to or above double digits each year. Situations such as this are not easy to foresee and require enormous efforts to bring existing infrastructure up to speed with demand. The process of designing, building and operating new infrastructure takes several years, and this must be taken into account during planning.

> “Among the most significant actions of the Master Plans, I would highlight the second runway in Guadalajara, the new terminal buildings in Guadalajara, Puerto Vallarta and Tijuana, and the acquisition of state-of-the-art equipment to process passengers and luggage”

What are GAP’s forecasts for the next few years in terms of opening up new routes and markets?
Over the next five years, GAP should pursue connectivity objectives such as positioning Guadalajara as an alternate hub to Mexico City, seeking long-haul routes to Europe (primarily), Latin America and Asia; positioning Tijuana as a facilitator of trade between Asia and Latin America, and enhancing the market from Northern and Southern California to Mexico and other destinations, exploiting the advantages of the *Cross Border Express*, and diversifying international markets to GAP’s beach destinations (Los Cabos, Puertos Vallarta, etc.).

What do you think has been the main challenge in preparing the Master Development Plans for the 12 GAP airports for the period 2020-2034?
There have been several important challenges, one of which is to predict demand in a scenario of uncertainty such as the one we are experiencing, not only in Mexico but also internationally. With regard to the development proposals, I would like to highlight the solution for the second runway in Guadalajara, an option that does not require additional land outside the scope of the current concession, and which solves the capacity problems of the airfield for the next five years. In general terms it is always a challenge, especially in this fiscal year, to meet the expansion requirements of airports with a limited amount of investment.

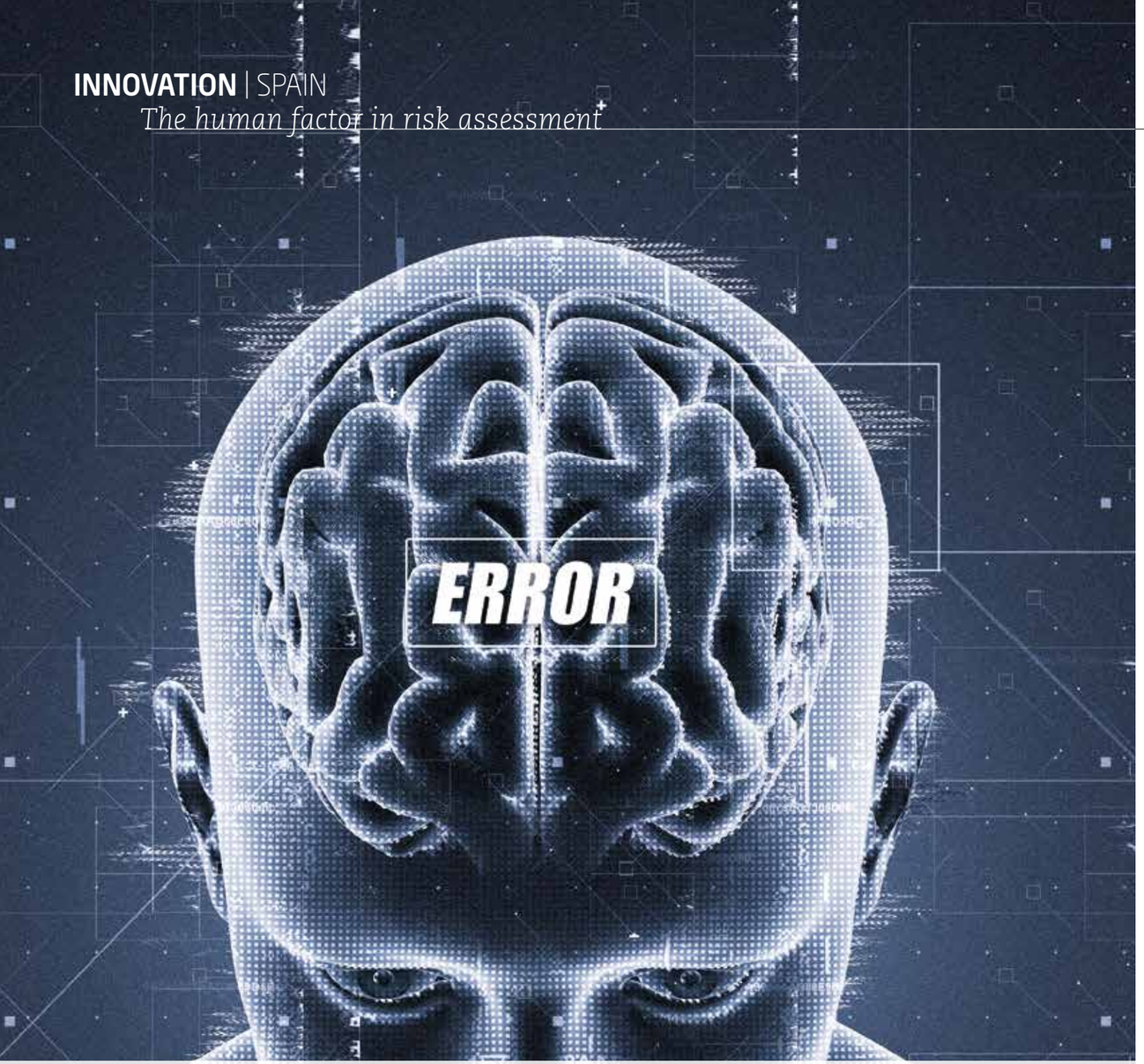
Which actions would you highlight from the Master Development Plans as a whole? Not only by volume but by any other measure: environmental, social, technological, innovation...
As a result of the recent revision of the Master Development Plans, GAP will invest more than 1.2 billion dollars over the next five years, which exceeds the investment made over the last 20 years. Among the most significant actions, I would highlight the second runway in Guadalajara, the new terminal buildings in Guadalajara, Puerto Vallarta and Tijuana, and the acquisition of state-of-the-art equipment and infrastructure to monitor, improve and facilitate the different processes through which our passengers and their baggage must pass: tomography equipment for baggage inspection, body scanners, biometrics and facial recognition, construction and technological equipment for Airport Management Centres, among others.

PHOTO_GAP

Environmental issues are becoming increasingly important in general and in the world of transport and aviation in particular. How is GAP dealing with these?
We are confronting these issues with enormous responsibility and commitment, as demonstrated by the fact that we are the only Mexican operator with an airport registered in the ACA (Airport Carbon Accreditation), plan of the ACI (Airport Council International); today we have nine and by the end of this year we will have all 12 airports in our network in Mexico. We also have, other significant projects in progress, such as the installation of solar panels in parking areas and the construction of solar farms, which will allow GAP to be self-sufficient in terms of energy in approximately five years.

AIR TRANSPORT SPECIALIST
With almost 20 years of experience in the sector, aeronautical engineer José Ángel Martínez, who joined GAP in 2016, is currently responsible for the Network and Regulated Business Management of the Group, which manages 12 airports in Mexico and two in Jamaica. Specialising in air transport, he has a Master’s degree in Infrastructure Management from the UPM, and an MBA from the CEREM International Business School. At Aena Internacional, José Ángel Martínez was technical operational manager in Colombia for five years –handling the airports of Cartagena de Indias, Cali and Barranquilla– and manager responsible for the takeover of the London-Luton airport. He has held various positions of responsibility at Aena, Ineco and the construction company ACS.

Ineco has been collaborating with GAP for more than 15 years, on the Master Development Plans and other projects at its airports. How do you value this collaboration and what would you highlight?
Ineco has become GAP’s best partner in planning the growth of its airports, due to its experience, the capacity of its technicians, its cultural proximity and, mainly, its knowledge of the airports in the network and the regulatory peculiarities of Mexican concessions. ■



To err is human... but so is to prevent

Ineco has developed its own method of analysing human error, which, according to safety studies, accounts for 80% of all accidents and mistakes. The innovation project won the 2019 CANSO Global Safety Achievement Award and Ineco's 2019 Innova Awards.

By **Tatiana Rueda,** graduate in Physical Sciences and **Miguel Capote,** aeronautical engineer

PHOTO_**FREEPIK**

Human error is the principal causal factor in approximately 80% of all recorded accidents, regardless of the industry involved. But despite the current trend towards automation, human beings are still the key element of all systems and an intrinsic part of their entire life cycle, hence the vital importance of studying the influence of human behaviour on safety. Regulations in some countries already demand analysis of the human factor in addition to conventional safety assessments.

However, in those cases where risk analysis does take the human factor into account, a market deficiency in regard to methods for performing more in-depth analysis means that it generally only does so on a superficial level. Under this premise, there is a definite need for safety studies that take a broader, more comprehensive view of the human factor, or in other words, the human interaction with systems and how it is influenced by different environmental elements, to come up with effective accident prevention strategies.

One of the reasons the human factor is typically absent from system studies is a lack of scientific knowledge regarding the subject, and also how to include it in risk assessments and safety studies. However, leading national and international organisations now demand increasingly safe and reliable systems, which means that taking the human factor into consideration when designing, producing, operating and maintaining a system has never been more important.

INECO'S PROJECT

Over the course of two years, the Ineco innovation project has been working to develop a more thorough and transparent method for handling the human element in safety analyses, which, in turn, will enable us to design systems that are more human friendly. The project analysed proven human-factor methodologies and techniques not generally applied to safety studies and managed to extract, simplify and integrate them into risk assessment processes, therefore, making them universally applicable to any sector of the transport industry. The method was selected as the winner of Ineco's 2019 Innova Awards and the 2019 CANSO Global Safety Achievement Award.

The company has spent years trying to gain a better understanding of how to account for the human factor in safety. Some of the lines of action include the innovation project, coordination between the rail and air navigation sectors, collaboration with universities such as Polytechnic University of Madrid and the University of Málaga, training in human factors and participation in different forums and conferences.

The project began with an exhaustive analysis of human-factor methodologies and science, which were used to begin to extract different tools and techniques and apply them to case studies, while simultaneously developing other methodologies of their own. Given that safety assessments typically concentrate on identifying threats to mitigate their risks, this time, the project team focused on identifying the human mistake or error.

By doing so, they were able to design a process that included an adapted HRA (Human Reliability Assessment), based on the HEART method(Human Error Assessment and Reduction Technique). The process can be run in conjunction with safety studies and can be tailored to each phase in an integrated and traceable manner. The result is that we now have a generic method for including the human factor in risk assessments.

The main goal of the project was to integrate accepted human-factor techniques into a standard safety study in a way that safety technicians will find easy to apply and, in doing so, to develop new techniques, like FARHRA. In addition, the method utilises and customises different tools such as HAZOP sessions, interviews and targeted surveys or questionnaires, to capitalise on expert knowledge, which is the primary source of information in this type of analysis. The next step now is to implement the knowledge and experience in this area in safety studies for aviation, railways or other sectors in order to verify its consistency and internal and external reliability.

The final results will represent an improvement in the design process of systems with a specific requirement for enhanced human output, increasing safety and adding value and recognition to the human role. ■

OBJECTIVE: TO REDUCE HUMAN ERROR

• The first step is to analyse the tasks to expand the description of the system, identifying all its relevant human operational interventions and any points where errors could occur. This is then cross-checked with the list of threats or risks for the operation, thus determining human failure modes through Human HAZOP-type techniques, in line with the customary methods of identifying safety hazards.

Task classification has been developed based on five parameters, rather than the generic task types used by the HEART method. This makes it possible to obtain an overview of the potential for human error in each task; in other words, how easy it is to make a mistake while performing the task in question.

• The overview is then linked back to safety, by carrying out a cause and effect analysis to explain the contribution of the identified human errors to the threats and their corresponding levels of risk or criticality.

• The contributing factors of the error are then determined. The generic lists of Error Production Conditions (EPC) of HEART have also been adapted to generate more usable lists of the factors or Performance Shaping Factors (PSF) that affect human performance.

• By combining the three aspects -task error potential, error criticality and PSFs- priorities can then be established for the final stage of the process: the reduction of human error. Error-reduction measures were initially determined using the NARA (Nuclear Action Reliability Assessment) approach. At a later stage of project maturity, Ineco's FARHRA (Feasible Action Rules for Human Reliability Assessment) method was developed, which provides a more comprehensive set of measures that are better aligned with the usual approach taken during risk analysis.

DESPITE THE CURRENT TREND TOWARDS AUTOMATION, HUMAN BEINGS ARE STILL THE KEY ELEMENT OF ALL SYSTEMS AND AN INTRINSIC PART OF THEIR ENTIRE LIFE CYCLE

New La Gaznata bridge on the N-403

IMPROVING MOBILITY
The new bridge (in the background) operational since November 2019, represents a significant improvement for daily users of this section of the N-403.

PHOTO_INECO / JOAQUÍN MUÑOZ

SPANNING THE RESERVOIR

Ineco, commissioned by the Ministry of Transport, Mobility and Urban Agenda, provided the supervision and monitoring of the works to construct the new La Gaznata bridge over the Burguillo reservoir in Ávila. The opening of the bridge means the end of the traffic bottleneck for users of the existing narrow arched bridge. The two structures represent 100 years of evolution in bridge design and construction.

With collaboration from **Joaquín Muñoz,** civil engineer

Floating on the waters of the Burguillo reservoir, and later hoisted into position to connect the two cantilevered end sections: this was how, last July, the central steel box girder section of the new La Gaznata bridge in Ávila province was installed. The bridge, now completed and opened on 28 November, 2019, represents a notable improvement in mobility and safety for the 5,000 road users whose daily travel takes them past kilometre 100 of the N-403 road, which spans the provinces of Toledo, Madrid, Ávila and Valladolid. Access to the bridge has also been improved by a new roundabout to smooth the horizontal alignment. In total, the works covered almost a kilometre.

Ineco provided technical assistance services for the supervision and monitoring of the works for the General Directorate of Roads and the Ministry for Transport, Mobility and Urban Agenda. At 11 metres wide and with one lane for each direction of travel, the new bridge replaces the narrow crossing offered by the old arched bridge, whose single carriageway measuring just 4.5 metres wide meant that users had to take turns crossing from each direction.

The structure, however, which was designed and constructed in the 1920s by engineer Eugenio Ribera, is of both historical and technical significance as one of the first bridges to be built in Spain using reinforced concrete, which was just coming into use in the country at that time. The bridge was later used as a construction model for other viaducts and is an excellent example of the construction techniques at that time. Its closure to traffic will therefore ensure its preservation. Alongside it, the new, partially prefabricated straight bridge made from prestressed concrete and steel epitomises the construction techniques of today, and the combination of the two structures, separated by a distance just a few metres but 100 years in time, perfectly illustrates the evolution of Spanish bridge design and construction over the course of the last century.

THE NEW BRIDGE

The deck of the bridge consists of a box girder measuring 11.3 metres wide to support the carriageway, hard shoulders and parapet walls. Both prestressed concrete and Corten steel were used with the incremental launching method from both piers towards the centre, building successive prestressed concrete segments.

The new bridge has three spans. The two ends, with spans of 40 and 50 metres (distance between the support points), support prestressed concrete box girder sections, built using falsework, with a thickness that varies between 2.4 metres at the ends and 5.5 metres above the 10-metre reinforced concrete piers. Each pier comprises two shielded shafts forming a 'V'. The shafts rest on footings which are in turn 'stitched' to the supporting rock with micropiles.

The central span measures 120-metres long and is divided into three sections of two types: two outer sections made from prestressed concrete with variable thickness beginning at each pier, built using the incremental launching method, and a 42-metre long middle stretch made from concrete and steel.

One of the highlights of the project was the floating transfer and subsequent lifting of the central metal stretch of this section, which took place in July 2019. The 115-tonne segment, which had to be entirely watertight for it to float, was manufactured in the workshop and then transported to the site in two pieces measuring 27 and 15 metres.

THE OLD BRIDGE

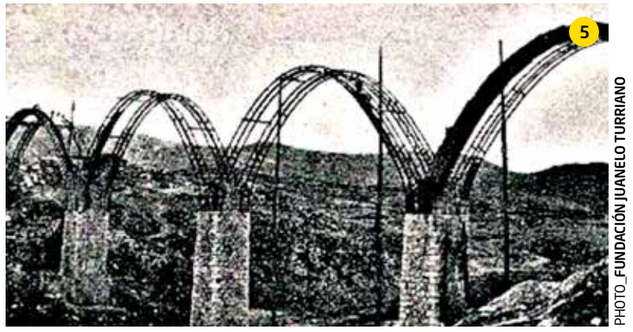
La Gaznata was an old stream that has today become one of the four tributaries of the El Burguillo reservoir. It was opened in 1913 to channel water from the Alberche river. The first bridge, designed by civil engineer, entrepreneur and professor José Eugenio Ribera, who pioneered the use of reinforced concrete in Spain, was opened in 1918.

It comprises four cambered arches spanning 25 metres each, followed by five 11.5 metre straight sections (four on one side and one on the other). It was built using a rigid truss for each span, which was raised by complete spans from the ground.

The bridge is one of the concrete road bridge models designed by Ribera for the Ministry of Public Works. The designer, who died in 1936, dedicated his career to promoting the novel idea of using reinforced concrete or cement in construction and, particularly, for building bridges and viaducts. The appearance of reinforced concrete in the last quarter of the nineteenth century revolutionised construction methods. It displaced both traditional materials like the stone and wood which had been used for centuries and also, thanks to the cost-effectiveness of concrete, the metal bridges that had become popular after the Industrial Revolution.

1/2. The metal structure of the central section was floated to the site and later lifted 20 metres into position. **3.** Ineco's works supervision and monitoring technical assistance team: from left to right: José Luis Domínguez, Joaquín Muñoz, Jesús González, Enrique Tristán and Manuel Martín.

4. The new bridge was constructed using the incremental launching method for the central section and falsework for the ends, while the old bridge **(5)** was constructed using rigid movable falsework.



PHOTO_FUNDACIÓN JUANELO TURRIANO

Construction using arched structures, a practise employed since ancient times, presents the the disadvantage that structures only become self-supporting once completed. This necessitated the construction of large temporary structures, the falsework, which were almost as expensive and complex as the bridge itself.

Eugenio Ribera's decision to build with spans measuring no more than 25 metres meant that he was able to forgo the falsework, significantly reducing costs: "*... If the spans of the arches do not exceed 25 metres, as was the case with the Gaznata viaduct, we assemble each of the trusses in a single piece and raise them using rigs fitted to a mast until they are in position. (...) The elimination of falsework almost always results in significant savings in the cost of the bridge.*" José Eugenio Ribera, "*Masonry Bridges and Reinforced Concrete - Volume IV (Puentes de fábrica y hormigón armado - Tomo IV)*", 1932.

After 1928, the appearance of prestressed concrete made it possible to construct non-arched straight structures for large bridges, as well as for the smaller spans built from concrete before then. It also facilitated the incremental launching construction method, which eliminated the need for falsework and made concrete bridge building even more economical.

After World War Two, the new technique spread rapidly, spurred by the need to reconstruct bridges after the conflict. Since then, straight bridges have practically made arched bridges redundant. Today, we use two systems: in situ concrete bridges (which allows for different forms, curved or forked decks, etc.) and bridges made from prefabricated beams for smaller spans. ■

	NEW BRIDGE	OLD BRIDGE
Type	Straight (girder bridge)	Concrete arches
No. of spans	Three: 40, 120 and 50 m	Four 25-metre long cambered arches + five straight stretches spanning 11.5 m (four on one side and one on the other)
Material	Mixed: prestressed concrete / steel / reinforced concrete (piers and deck slabs)	Reinforced concrete
Construction system	Incremental launching + floating transportation and lifting of the central stretch	Rigid movable falsework (raised from the ground for each span)
Length	212 m	167 m
Width of deck	11,3 m	4,5 m
Piers	Two concrete piers in a 'V', 18 m, on footings	Eight masonry piers
Accesses	Split roundabout that enables a change of direction and provides access to neighbouring roads and properties	Two curves with radii of 75 and 40 m and a change in elevation in the direction of Toledo

Talent has no gender...

... And neither should its financial reward. This is the powerful message conveyed by the recently introduced and updated Equality Plan. A message that Carmen Librero, the company's first female president in its more than 50 years of history, hopes will highlight Ineco's engagement and commitment to equal opportunities.

By **Marisa de Castro**, area manager for Training and Knowledge Management, in charge of Gender Equality at Ineco

Above, José Luis Ábalos, Minister for Transport, Mobility and Urban Agenda, beside Carmen Librero, President of Ineco, during the presentation of the Equality Plan. On the right, the Equality Committee, which works to safeguard the principle of equality between men and women, among other objectives.

On 4 December, José Luis Ábalos, Minister for Transport, Mobility and Urban Agenda, highlighted the realistic and ambitious nature of the Plan and announced the establishment of a monitoring committee to measure its degree of implementation and impact. The Equality Plan introduced by Ineco contains eight sections and includes important initiatives designed to achieve real and effective gender equality.

On several occasions, Ineco's president has outlined the critical role played by women in the mobility sector, along with her belief that equal opportunities for all genders should form part of the company's duty and commitment to society. "To believe is to create, and to believe in equality is to create plans and formulas that allow us to advance towards achieving it", she declared on presenting the initiatives. The Equality Plan will be given continuity within the framework of the company's commitment to the 2030 Agenda and, in particular, Sustainable Development Goal 'SDG 5 Gender Equality'.

The signing of the updated Equality Plan represents a milestone for the company. It is the result of work carried out within the Equality Committee, which is made up of both company representatives and legal representatives of the company's employees.

The Committee's priority was to continue safeguarding the principle of equal treatment and opportunities for men and women at Ineco, in line with the redrafting of Organic Law 3/2007, of 22 March, to include innovative and efficient updated measures for a continued commitment to effective equality between men and women. ■

THE EIGHT KEY ELEMENTS OF THE EQUALITY PLAN

1. Breaking through the 40% barrier.
Although the number of women working in the world of engineering is increasing, they account for just 25% of Spain's engineering and architecture undergraduates. At Ineco, women account for nearly 38% of the workforce, and in 2019 the number of women hired rose by 11%. The new Plan aims to eradicate any potential discrimination from our selection processes and encourage the hiring of women in areas where they currently have less presence, in order to break through the 40% barrier. Furthermore, and within the framework of these actions, efforts will be made to hire more victims of gender violence.

2. Encouraging communication.
Specific sections of the Ineco website and corporate employee mailbox have been dedicated to fostering a culture of communication and awareness around the subject of equality. These recently developed equality-focused channels will continue to set out general criteria for the use of non-sexist language. The Equality Plan has also been promoted on social networks and via Ineco's Youtube channel.

3. Equal training opportunities for men and women.
Our objective is to maintain an equal level of training for men and women, given that training –to which Ineco dedicates more than 150,000 hours a year– is one of the cornerstones of professional and personal development. This includes specific training in the areas of equality and reconciliation of work and family life, as well as on the reporting procedures for incidents of psychological or sexually motivated harassment. The Equality Plan seeks to definitively break through "glass ceilings" with specific projects like the IN Women's Mentoring Programme (see *IT66*). The IN programme supports the professional development of women with great potential at Ineco by providing them with a framework to develop valuable relationships, as well as the tools, resources and methods they need to progress in their careers.

4. Promoting equality in areas with less female representation.
We will continue to push for equality in professional development across the board, with particular emphasis placed on those areas with less female representation. To do this, we will ensure that an applicant's ability to meet the criteria set out by the jobs map is judged on equal terms based on their knowledge, experience and skills. Women will be given preference for promotions to jobs or professional groups in which they are currently under-represented.

5. Work-life balance rights.
The company will continue to implement measures that support joint responsibility and reconcile the personal, family and work lives of all personnel. Information on work-life balance rights will be reinforced, extending accessibility to these rights to the entire workforce and ensuring that those working under reconciliation measures have access to the same career opportunities as other employees. Similarly, we will continue to guarantee that those working under timetables that differ from the standard schedule are not at a disadvantage in terms of career development, opportunities for promotion and advancement, remuneration or access to training.

6. Equal pay.
Since talent has no gender, neither should salaries. Ineco's Equality Plan guarantees the principle of equal pay through its policies on fixed remuneration, variable remuneration and social benefit allocation, as well as by measuring its compliance with quantitative indicators. A progressive reduction of the overall wage gap, guaranteeing an annual decrease of at least half a point, is one of the Plan's objectives.

7. Zero harassment and better protection for victims.
Our aim is to guarantee an atmosphere of mutual respect preventing, and where necessary, eradicating, any behaviour that could be construed as harassment in the workplace. Moreover, we aim to offer protection to women who have been the victims of gender violence and to facilitate the prevention, mediation and abolition of harassment in the workplace, as well as to establish responsive and simplified internal procedures with all the necessary guarantees of protection and confidentiality.

8. Biannual monitoring and evaluation.
Monitoring is an essential tool for proper analysis of the Plan's progress. Evaluation procedures are necessary to gauge the level of satisfaction among employees and the impact of the Plan on company operations and the workforce. To this end, Ineco has set up the Equality Plan Monitoring Committee to assess and advise on the matter.

A toast to Spanish wine

Spain is the country with the most vineyards, is the third largest producer and the leading exporter of wines by volume... And despite the worldwide fame of sherry, cava or Rioja, a large part of its oenological richness, with 90 designations of origin, remains almost unknown.

Por ***ITRANSPORTE***

PHOTO_HTTPS://TURISMO.RIBEIRASACRA.ORG

In the Galician Ribeira Sacra region, 'heroic viticulture' is practised on the slopes of the valleys formed by the Sil and Miño rivers, between Lugo and Ourense. Galicia also has four other designations of origin: Rías Baixas, Valdeorras, Monterrei and Ribeiro.

A country like Spain, due to its size, geography and diverse climate, produces a wide variety of wines; it has 90 designations of origin, only a few of which are known to the international consumer. Spain is the country with the most land devoted to vineyards in the world: in 2019, according to data from the Ministry of Agriculture, a total of 952,829 hectares. It produces a quarter of all European wine, which in turn accounts for three out of every four bottles consumed in the world. The total turnover of the approximately 4,000 Spanish wineries –75% of which export abroad– amounts to over 7 billion euros and the sector contributes around 1% of GDP. Indeed, after Italy and France, it is the world's third largest producer of wine and the leading exporter by volume, mainly of bulk wines without a protected designation of origin or geographical indication (PDO/PGI). This type of wine accounts for more than half of the total production and approximately the same percentage of exports, of which only 30% to 40% are quality wines. Of the latter, Rioja and Cava are the most popular, and even more so, Cariñenas, Utiel-Requena, Almansa, Valdepeñas and Jerez are the most popular abroad by volume. The United Kingdom and Germany are the main consumers of Spanish wine, and outside the European Union, Mexico, the United States, China and Canada.

SPAIN PRODUCES A WIDE VARIETY OF WINES AND HAS 90 PROTECTED DESIGNATIONS OF ORIGIN

In Spain, some 120 native grape varieties are grown, some of which are associated with very specific areas or regions. On the Atlantic and Cantabrian coasts –what is known as 'green Spain'– varieties adapted to the moist climate are grown, giving rise to the Galician Albariños or the Basque Txakolís. In the vast central area of the country, with its dry continental climate, the varieties Garnacha and Tempranillo (above all) are used to produce outstanding reds such as the Castile and León wines of Ribera del Duero, La Rioja, or the wines of El Bierzo, in León, produced with the red Mencía grape and the white Godello grape. The designations of origin Toro, Rueda or Cigales are also from the Castile and León region. Catalonia produces 90% of Spanish cava –a sparkling wine with DO produced since the 19th century according to the French Champenoise method– mainly in the regions of Penedés, Costers del Segre and Alella, with the native varieties Parellada and Xarel·lo, although it is also produced in some areas of La Rioja, Extremadura or Navarra. In addition to cava, which is its most exported wine, Catalonia has more than half a dozen other designations of origin, including Priorat and Monsant.

Andalusia is the cradle of the most famous Spanish wines in the world: Jerez or Sherry (from the Arabic Sherish). They all share the same common denominator: they are produced in the province of Cadiz, with the Palomino grape variety (or Pedro Ximénez in the case of sweet wines) and in the territory of the nine municipalities known as 'el Marco de Jerez': Jerez de la Frontera, El Puerto de Santa María, Sanlúcar de Barrameda, Chiclana de la Frontera, Chipiona, Puerto Real, Rota, Trebujena and Lebrija, the latter belonging to the province of Seville. Different types of wines come from different winemaking processes: biological ageing or 'velo de flor' (yeasts that prevent oxidation), or oxidative (natural ageing in American oak barrels or 'botas'), sugar content (based on which, they are classified from dry to sweet), and final alcohol content after the process of adding wine spirits, called 'fortification'. ■

WINE TOURISM: MORE THAN WINE

In a country like Spain, the second largest tourist destination in the world which in 2019 once again broke its own record by receiving 83.7 million visitors, there is no shortage of wine tourism. According to the Spanish Association of Wine Cities (ACEVIN), in 2019 this sector generated 80 million euros and attracted three million visitors, a quarter of which were international. Spain has 30 'wine routes' to become acquainted with the different designations of origin.

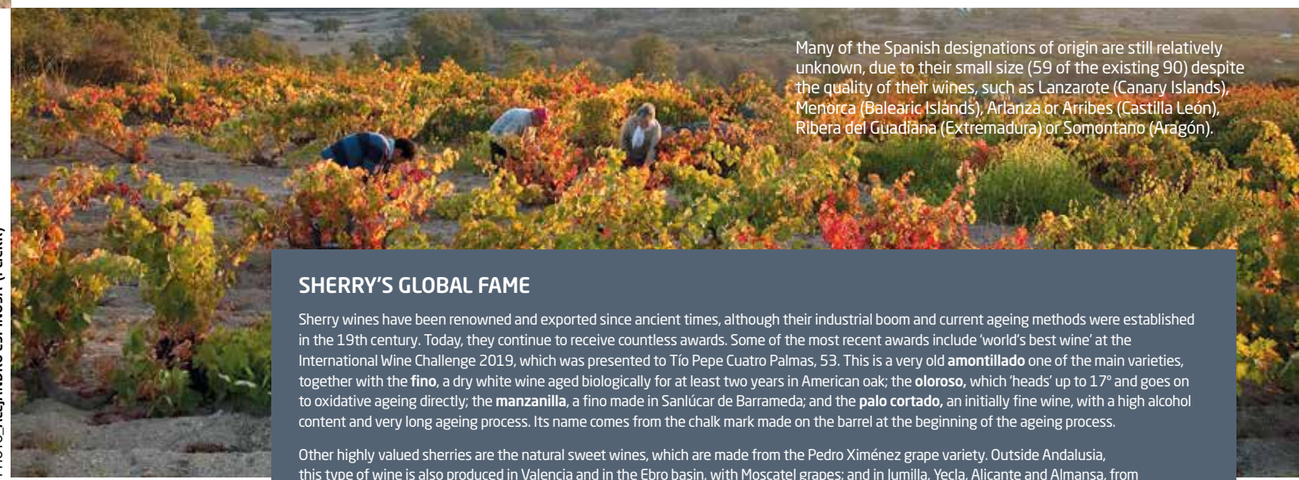
The major wineries are the wine tourism destinations par excellence. With more than half a million visits in 2019, those from Jerez top the list: Tío Pepe, from González Byass; Osborne, in El Puerto de Santa María or the Bodegas Hidalgo La Gitana, in Sanlúcar de Barrameda, to name but a few. After that, it is cava that arouses the most interest among wine tourists. In Catalonia, some of the most outstanding wineries are: Cordorníu, in San Sadurní d'Anoia (Barcelona), founded in 1551, the oldest winery in Spain; or the Castillo Perelada winery, with its spectacular monumental complex.

Of the Rioja D.O., the most visited and internationally recognised are Viña Tondonia, in Haro, where the Barrio de la Estación Tasting, one of the most popular wine and food events in the country, is also held every two years. Vivanco, in Briones, Ysios, in Laguardia (Álava), with its facilities designed by Santiago Calatrava, or the ultra-modern complex designed by Frank O. Gehry, for the Marqués de Riscal winery, in Elciego (Álava).

The 12th century Santa María de Retuerta Abbey in Sardón del Duero (Valladolid) has been converted into a winery with a five-star hotel and a Michelin-starred restaurant. In the Ribera del Duero D.O., Bodegas Portia, in Gumiel de Izán (Burgos), boasts its avant-garde headquarters designed by Norman Foster.

Another way of getting to know the world of Spanish wine is by attending the 'Radical Wines' Fair, which for the past six years has brought together winemakers from all over Spain in Madrid who strictly follow traditional methods of cultivation and production. With minimal production and often high prices, another option is 'garage wines' (made in very small quantities and of high quality) such as those from the Dominio de Pingus winery, in Quintanilla de Onésimo, Valladolid, which produces some of the most exclusive and award-winning wines in the country.

Map of protected wine designations of origin in Spain *(https://www.mapa.gob.es/es/cartografia-y-sig/publicaciones/alimentacion/mapa_dop_vinos.aspx).*



PHOTO_ALEJANDRO ESPINOSA (FLICKR)

Many of the Spanish designations of origin are still relatively unknown, due to their small size (59 of the existing 90) despite the quality of their wines, such as Lanzarote (Canary Islands), Menorca (Balearic Islands), Arlanza or Arribes (Castilla León), Ribera del Guadiana (Extremadura) or Somontano (Aragón).

SHERRY'S GLOBAL FAME

Sherry wines have been renowned and exported since ancient times, although their industrial boom and current ageing methods were established in the 19th century. Today, they continue to receive countless awards. Some of the most recent awards include 'world's best wine' at the International Wine Challenge 2019, which was presented to Tío Pepe Cuatro Palmas, 53. This is a very old **amontillado** one of the main varieties, together with the **fino**, a dry white wine aged biologically for at least two years in American oak; the **oloroso**, which 'heads' up to 17° and goes on to oxidative ageing directly; the **manzanilla**, a fino made in Sanlúcar de Barrameda; and the **palo cortado**, an initially fine wine, with a high alcohol content and very long ageing process. Its name comes from the chalk mark made on the barrel at the beginning of the ageing process.

Other highly valued sherries are the natural sweet wines, which are made from the Pedro Ximénez grape variety. Outside Andalusia, this type of wine is also produced in Valencia and in the Ebro basin, with Moscatel grapes; and in Jumilla, Yecla, Alicante and Almansa, from the Monastrell variety.

IRENE DONAIRE / JUAN DEL CAMPO

“At Ineco, we take the fight against climate change very seriously”

She’s an industrial engineer, and he’s a graduate in Environmental Sciences. Together they’re responsible for coordinating Ineco’s Technology Intelligence Group for the Environment and Climate Change (GIT), a small think tank that has already made 14 project recommendations to the company.

PHOTO_ELVIRA VILA

1 HOW DOES INECO CONTRIBUTE TO THE FIGHT AGAINST CLIMATE CHANGE?

IRENE: From a dual perspective: internally, with projects like the mobility plan, the Awards and Environment Week, and externally, through our work for Adif or Aena, for example.

JUAN: I think the company takes it very seriously. The GIT, which was set up by the sub-directorate for Economy, Planning and the Environment to suggest and develop ideas that Ineco can put into action quickly and practically, is proof of that.

2 WHAT PROJECTS IS THE GIT INVOLVED WITH?

I: A total of 14 projects have been identified, half of them deal with internal working improvements, and the others propose new lines of business.

J: The proposals include methodological improvements to air and noise pollution, as well as more innovative ideas like water footprint calculation.

3 AND YOUR PERSONAL CONTRIBUTIONS?

I: There needs to be a global push for improvement, but that starts with small individual gestures like reducing your energy consumption and avoiding single-use plastics or opting for sustainable modes of transport. Although it’s not always easy... Even I still struggle to decide whether to put a paper napkin in the “organic” or “paper and cardboard” bin!

J: (Laughter). If they’ve been used... organic! We have to understand that we can’t continue to poison the very thing that sustains us, our planet. We need to make vital lifestyle changes that conserve water and energy and generate less waste. ■

EXPERT ENVIRONMENTAL CONSULTANTS

Irene Donaire is an industrial engineer with more than 10 years of experience working in Environmental and Land management for Ineco. The last five years have seen her take the lead role in Aena’s Energy Efficiency and Savings Plan, the Sustainability Management Plan for Dammam airport in Saudi Arabia and, she’s currently in charge of Adif’s Environmental Sustainability Plan.

Juan del Campo is a graduate in Environmental Sciences who has also been with the company for more than a decade. During that time, he’s undertaken projects on environmental integration, water planning, socio-environmental integration, waste management and environmental site management. He’s also a university lecturer.

Both bring their experience to the Technology Intelligence Group, through which they hope to help Ineco tackle the climate emergency with “responsive and practical” initiatives.

IDEAS *“MADE IN INECO”*
in the photo, some of the contributors to the Technology Intelligence Group.