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OCT16 | JAN17

ENVIRONMENT
‘Zero Waste’ in Quito

INTERVIEW

Mª Verónica Arias Cabanilla
Environmental Department of Quito

+ ARTICLES

ENAIRE puts SACTA at the forefront
Rolling stock supervision and validation
Modernisation of Chiclayo airport (Peru)
Airport pavement management
Renovation of Toledo station
Brand Spain: museums

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EDITORIAL
Environment

The environment, which takes centre stage on this autumn's cover, increasingly influences our projects and activities in Spain and around the world. With the support of Ineco, Ecuador's capital Quito has launched initiatives to reduce waste and foster a circular economy of resources; this will without a doubt translate into improved welfare and quality of life for the city's inhabitants.

Public policy is key in the move towards more sustainable cities. We are honoured with the opinion of María Verónica Arias Cabanilla, Environment secretary for the Municipality of Quito, the highest authority for environmental policy in the Ecuadorian capital. The city's environmental policy includes the 'Cero Basura' programme, based on the integrated management of resources; this is an ambitious project in which Ineco was responsible for the Master Plan for Comprehensive Waste Management and its legal framework. This coincides with Quito's selection by the UN to host the Habitat III Sustainable Cities Conference in October 2016. In addition to this, as Verónica Arias points out in her interview, Quito is Ecuador's most sustainable city and one of the 17 finalists for the World Wildlife Fund (WWF) award for the world's most sustainable city.

Optimal management of an environmental resource such as the sky is another area of interest that we will address in these pages. Specifically, we have a report dedicated to ENAIRE's significant technical efforts and investment to guarantee air safety with the highest levels of efficiency. The high concentration of flights in Europe requires a complex new automated air traffic control system: SACTA (so-called for its initials in Spanish) is a series of systems and equipment which ENAIRE is investing over 16 million euros to renovate. Ineco engineers, who are collaborating in the project, offer us a detailed description of the function of these services and what they bring us.

Also worth highlighting is Ineco's more than 20 years of experience in supervising the manufacture of trains. This issue features an in-depth article on rolling stock design validation, supervision and testing, particularly in Spain, Chile, Brazil and Colombia, where we have recently renewed our contract.

Finally, I am proud to present the new modernisation project at Chiclayo airport in Peru, where a new terminal is being designed. This large aeronautical project will complement our existing project at Lima's Jorge Chávez airport. These are big jobs and big challenges in a globalised world where we want to demonstrate the skills and capabilities of Spanish engineering. ■

"Public policy is key in the necessary move towards more sustainable cities"

JESÚS SILVA FERNÁNDEZ
President of Ineco

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on the map

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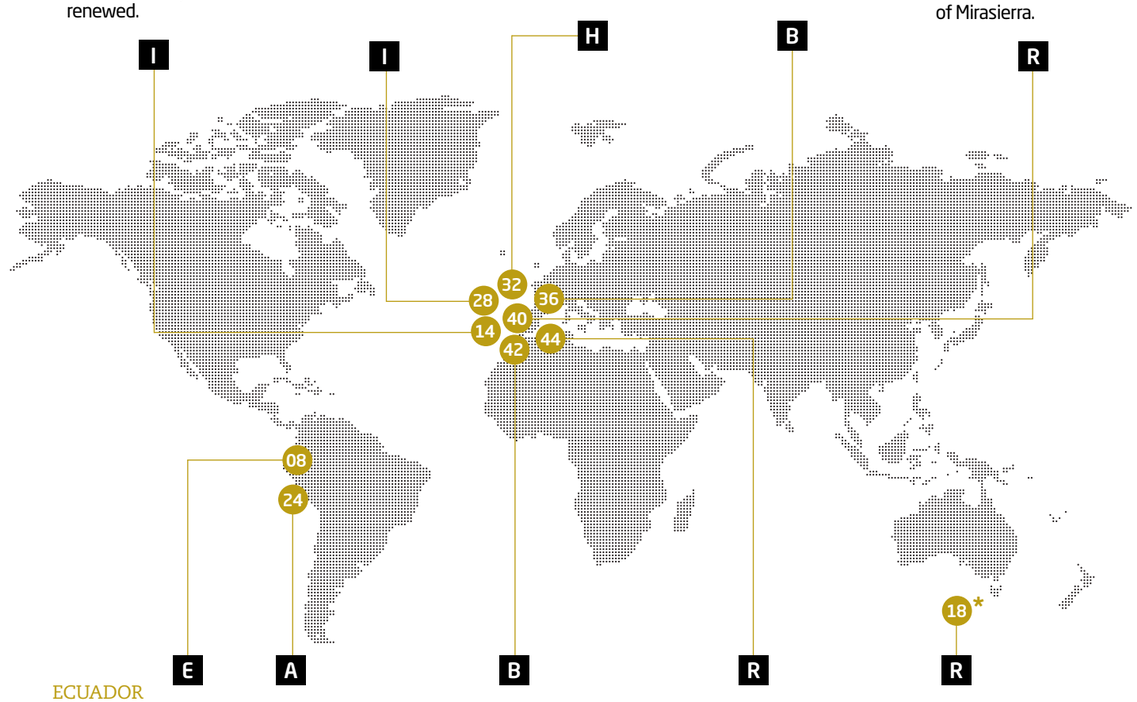
ENAIRE'S data communications system for air traffic control (SACTA) is renewed.

SPAIN
Innovation
Ineco has developed a pavement management tool, Gestrol.

SPAIN
Heritage
Renovation work on Toledo's railway station was completed this summer.

SPAIN
Buildings
Those who get on board will draw up better designs for their customers.

SPAIN
Railways
Ineco has collaborated in the design and construction of the new Commuter station of Mirasierra.



ECUADOR
Environment
Ineco has executed the Master Plan for Comprehensive Waste Management and the regulatory framework for Quito.

PERU
Aeronautical
Ineco and CESEL have been working on the preliminary studies for the modernisation of Chiclayo airport.

SPAIN
Buildings
A pedestrian walkway solving the challenging journey travelling between airport and the Instituto Feiral de Vigo.

SPAIN
Railways
Ineco carries out these complex calculations both for high-speed and for conventional lines, in national and international settings.

INTERNATIONAL
Railways
Throughout its history, Ineco has provided supervision for over 1,500 trains of all types and from all manufacturers.

* International article

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ADVANCED TECHNOLOGY FOR THE MEDITERRANEAN CORRIDOR

Implementation of the standard gauge continues on the Mediterranean Corridor. Ineco (in the image, a part of the team) currently provides construction management services and technical assistance on the railway line between Valencia and Castellón, where the so-called 'third line' is being installed: a third rail that allows trains to travel on either the Iberian gauge, the standard gauge or the "international gauge".

This is a state of the art, highly technical and complex track technology –seeing as the fact that the track includes three rails, as opposed to the usual two, affects the entire superstructure– in which the company has extensive experience (see *ITRANSPORTE 49)*. New developments are being installed on mixed gauge track apparatus, such as switches with through tracks and mixed, diverging tracks which will allow for speeds of 200 km/h on through routes with both gauges.

The main work includes connecting the Corridor to the high-speed line Madrid-Valencia with the standard gauge in the vicinity of Joaquín Sorolla station,

installing a mixed gauge track over the current track, updating the catenary and safety and communications installations, and implementing and commissioning the Level 1 ERTMS train protection system. All work is being performed without passenger or freight traffic service interruptions.

SPAIN

WORK ON THE MADRID, BARCELONA & MALAGA METROS

The company continues with several civil works projects, technical assistance work and design and feasibility studies for the Madrid, Barcelona and Malaga metros. Track inspection and monitoring work is being carried out on the Malaga metro; different unique and regulatory projects are underway on the Barcelona metro in addition to monitoring work. Aside from the Framework Agreement projects, Ineco has been hired to provide technical assistance during the inspection of track cars in the Madrid metro.

With regard to Light Rail West –which connects the towns of Pozuelo de Alarcón and Boadilla del Monte to Madrid–, work includes speed validation studies. In 2004, Ineco carried out the construction of Light Rail West infrastructure and facilities.

CAF FINANCES THE STUDY CONDUCTED BY INECO FOR QUITO CITY COUNCIL

Ineco has completed the Master Plan for Comprehensive Waste Management and the legal framework for the Municipality of Quito, the subject of this edition's cover story (see report on page 8). Quito City Council commissioned Ineco to conduct the study, financed by the Development Bank of Latin America (CAF), which aims to meet the local needs to manage the nearly 2,000 tonnes of waste produced daily in the city.

In the image, Juan del Campo (Ineco project manager), Verónica Arias (secretary of Environment for Quito City Council, interviewed on page 12) and Constanza Calderón (CAF sub representative in Ecuador).

SPAIN

COLLABORATION WITH DOWN MADRID

The Foundation Down Madrid, which Ineco collaborates with, has launched the exhibit Miradas sobre Madrid (Glimpses over Madrid), in which artists with Down Syndrome have participated along with renowned architects and photographers. The 36 works of art can be viewed from November to December at the CentroCentro Cibeles de Cultura y Ciudadanía space. Some of the participating architects include Rafael de la Hoz, Carlos Lamela, Teresa Sapey, Patricia Urquiola, Carlos Rubio Carvajal and Foster + Partners. The photographers that collaborated on the exhibit include Aitor Ortiz, Ouka Leele, Sacha Ormaechea, Mónica Sánchez Robles, Fernando Manso, Pablo Zuloaga, Jean Marc Manson and Dani Parra.

SPAIN

II GLOBAL FORUM ON ENGINEERING AND PUBLIC WORKS

The president of Ineco, Jesús Silva, and the Engineering Operations and Services managing director, Ana Rojo, participated in the II Global Forum on Engineering and Public Works held this past July in Santander (Spain). Organised by Foundation Caminos and the School of Civil Engineering (Colegio de Caminos, Canales y Puertos), this second edition brought together Spain's major construction firms and companies in addition to prestigious economists and journalists.

STUDIES FOR THE CENTRAL BI-OCEANIC RAILWAY CORRIDOR

The consortium formed by the companies Ineco and Incosa will carry out the pre-investment study for the Central Bi-Oceanic Railway Corridor, a project awarded by the Peruvian government's Ministry of Transport and Communications.

The project aims to commercially unify the Atlantic and Pacific ports via a massive, safe and sustainable international rail transport system that reduces operating costs and improves logistical operations between Peru, Bolivia and Brazil.

Taquile Island on Lake Titicaca.

The purpose of the pre-investment study awarded to Ineco and Incosa is to assess the implications, mainly in terms of economics finance, that the launch of this Corridor would have on Peru. Connecting Peru and Brazil through Bolivia would make it possible to transfer goods from Peruvian ports to the port of Santos, in Brazil, thanks to a rail network over 4,000 kilometres long.

GERMANY

INNOTRANS BREAKS RECORDS

The eleventh edition of the International Fair for Transport Technology InnoTrans, in Berlin, has beaten attendance record with 2,959 participants from 60 countries. Ineco has been back with the Spanish delegation –more than 50 companies– organized by the Spanish railway association MAFEX.

In the picture, State secretary for Infrastructure, Transport and Housing, Julio Gómez-Pomar -in the centre- with the ambassador of Spain in Germany, Pablo Garcia-Berdoy during his visit to the stand of Ineco, accompanied by its president Jesus Silva.

CAPE VERDE

MEETING WITH THE MINISTERS OF FINANCE, INFRASTRUCTURE & ECONOMY

In July, Jesús Silva, president of Ineco, met with Olavo Correia, minister of Finance; Eunice Silva, minister of Infrastructure; and José da Silva Gonçalves, minister of Economy and Employment in Cape Verde. Ineco has collaborated with Cape Verdean authorities since 2003 on projects such as the enlargement and modernisation of the international airports Boavista and Sal, and the renewal of the tread surface at Praia International Airport. The company has also worked on the master plans for Cape Verde's four international airports.

Additionally, in 2015 Ineco was awarded the tender for the inspection of passenger terminal enlargement work of Boavista and Sal, design of Global Navigation Satellite System (GNSS) procedures for Boavista and São Vicente airports, and the master plans for local aerodromes which will be used in planning how they will develop their airport network and in facilitating the development of tourism on other islands of this archipelago.

SPAIN

DELEGATION OF HIGH SPEED EXPERTS FROM INDIA (HSRC)

Ineco welcomed a delegation of experts from the High Speed Rail Corporation of India Limited (HSRC) at the headquarters in Madrid. In the image, the president of Ineco, Jesús Silva, next to batch officer Vijay Anand, director general of Rail Vikas Projects and member of the HSRC Management Board. The delegation visited Spain's high-speed lines (AVE) in Madrid, Alicante, Valencia, Barcelona, Seville and Malaga. Ineco is carrying out the new high-speed corridor project in India between Delhi and Kolkata together with the Indian consultancy ICT.

SPAIN

A DRONE FOR STRUCTURAL INSPECTIONS

Ineco technicians, certified by AESA, have demonstrated the applications of the company's drone at the Salobral viaduct on the Madrid Valladolid high-speed line. The presentation last summer served to introduce this new product offered by the company to complement and improve structural inspection works.

‘Zero Waste’

Ineco has executed the Master Plan for Comprehensive Waste Management and the regulatory framework for Quito. The study aims to meet the requirements of the ‘Cero Basura’ (‘Zero Waste’) programme, which is based on raising awareness and managing effectively the entire lifecycle of solid waste in the Ecuadorian capital. A circular economy strategy founded on effective models and solid contemporary regulation.

By **Miryam Sánchez,** biologist, **Emma Real,** chemist and **Juan del Campo,** environmental scientist

The study, commissioned by the Metropolitan Environment Secretary of the Mayoralty of Quito and financed by the Development Bank of Latin America (CAF), aims to meet the local needs to manage the approximately 2,000 tonnes a day of waste with a high level of organic material produced in the city. The Government and local authorities have taken various actions to ensure integrated waste management under the concept of ‘Zero Waste’, based on managing efficiently, effectively and innovatively the processes of generation, collection, use and final disposal.

With this programme, Quito wishes to transform the management of the waste generated by the more than 2.5 million inhabitants of its Metropolitan District (DMQ), which is the most populated area in the country. For this, the Environment Secretary has drawn up a strategy to reduce the total amount of waste currently taken to the city’s landfill site by 10% by 2025. This landfill site, referred to as ‘El Inga’, is approaching its capacity limit and will soon no longer be able to hold all the waste produced, hence the need for an imminent solution to the problem. Among the plans laid out are ‘containerisation’ of waste (a technique consisting in mechanisation and automation achieved using containers), construction of sorting and treatment plants, and the implementation of citizen-oriented awareness-raising campaigns on recycling and waste reduction.

> THE CITY GOVERNMENT HAS ENTRUSTED INECO WITH LEADING THE DRAWING UP OF THE MASTER PLAN

To deliver these plans, the municipal government has commissioned Ineco to lead the Master Plan for Comprehensive Waste Management for Quito for 2016-2025, which it has carried out in collaboration with Tragsatec, also a Spanish company. The main aim of this environmental consultancy has been to set out a realistic, economically sustainable waste management system that is flexible in its organisation and supported by a new, stronger legislative framework. The plan is a comprehensive update of that developed in 2012. Some of its main targets are: to increase mechanised collection by 40%, to boost new alternative models for handling waste by 60% by 2019, and to reduce production of solid waste per capita by 5% by 2025, the target date set for the plan.

The document defines management models for different types of waste: domestic, special (including demolition and construction), dangerous (including sanitary) and industrial. It also includes an economic and financial analysis, a proposal for organisational remodelling and a proposal for the legislative framework that regulates the provision of public ‘containerisation’, transport, and waste treatment and disposal services, as well as the activity of private agents.

DIAGNOSIS OF THE CURRENT SITUATION

The city of Quito’s current waste management system is insufficient to cope with current demand, therefore it is necessary to expand services and facilities for proper waste collection and treatment. Such is the case of containers, mobile means or specific treatment centres. Regarding waste from construction and demolition (debris), citizens do not have enough disposal sites for debris arising from small projects or domestic refurbishment.

Additionally, the use of illegal tips persists, and current tips do not have sufficient capacity in the medium term. To the practical aspects such as the lack of freight lorries and sorting containers we might add citizens’ lack of awareness

PHOTO_ SIMON MARZINGER (FLICKR)

PLANS SET OUT
These include waste ‘containerisation’, construction of sorting and treatment plants, and implementation of citizen awareness-raising waste management campaigns.

TEAMWORK
Ineco teams have cooperated closely with the Quito Municipality Environmental Department. Ineco has had permanent offices in the Ecuadorian capital since 2012, currently made up of engineers and technicians, both Spanish and Ecuadorian, who manage the various environment and infrastructure projects all over the country.

of how to sort waste at the source: with the lack of a recycling culture, citizens and companies dispose of waste in unsuitable places or give it over to unauthorised agents.

Local authorities are aware that, in order to make the necessary means available to citizens, it is vital to establish in parallel a new organisational and legislative system that protects the most disadvantaged, defines land use and establishes the obligations and functions of the agents involved.

THE AIM IS TO BE ABLE TO SERVE 98% OF THE POPULATION WITH WASTE COLLECTION SERVICES BY 2025

ENVIRONMENTAL REGENERATION IN QUITO

The plan put together is an ambitious environmental project spanning several aspects of great importance: from citizens' education and awareness raising –a fundamental aspect in any initiative towards sustainability– through acquisition of plants and recycling systems or the construction of an incinerator for deceased urban wildlife, to the elimination of all illegal tips and construction of new clean points and treatment centres.

Among the 48 action lines planned are included: building a treatment plant for organic matter to obtain compost, an anaerobic digestion plant for organic matter to obtain biogas, and four manual plants for the sorting and classification of recyclables for their subsequent treatment; and all adhering to social inclusion principles.

Achieving the 'Zero Waste' targets also means changing the culture, which will require active participation from politicians, public sector workers, public and private employers, and all citizens. In drawing up the comprehensive management model, Ineco's experts have taken into account current and future types of waste, so as to determine their components and establish the policies to pursue with each of them. The aim is to be able to serve 98% of the population with waste collection services by 2025.

For the plan to succeed, the Metropolitan District of Quito (DMQ)'s recruitment policy will include standards promoting the use of products manufactured using recycled and/or reused materials, such that there will be new legislation in 2018. The economic sustainability of the waste management system will require a system of taxes and cost allocation that pays heed to the various strata of buying power. ■

THE IMPORTANT FIGURES OF THE PLAN:

2.4 million inhabitants in the metropolitan district.

2,000 tonnes of waste per day (2015).

40% increase in mechanised collections.

5% decrease in the amount of waste per capita in 2025.

Developing awareness-raising programmes that reach **5% of the adult population** and **33% of students every year.**

Working towards **recycling comprising 25%** of generated waste by 2025.

Treating **100% of all recyclable waste** collected in 2022.

Committing at least **2% of the waste management** budget to R&D&I by 2025.

...AND THE KEY POINTS:

▶ Set targets until 2025 for waste generation, recycling and reduction.

▶ Establish rates for waste generation in public spaces: quantity and density of waste generated by type and, if possible, by area.

▶ Offer a system of waste collection, exploitation, treatment and final disposal. This system takes into account:

- Type of waste (domestic, construction and demolition waste, sanitary, special and dangerous).
- Current collection system for each type of waste.
- Current system for recovering recyclables and quantities recovered in recent years by type of material.
- Current systems for recovering energy from waste and quantities generated in recent years.
- Treatment centres for each current type of solid urban waste: capacity, dimensions, technology available, costs of treatment and labour employed.
- Waste storage facilities available for different types of waste: construction features, dimensions, current filling status and remaining useful life, exploitation of biogas, storage cost and labour employed.
- Current contracts for management of solid urban waste treatment in the District of the Municipality of Quito, scope and cost per year.
- Geographical information: current location of containers, container type and capacity; level of occupancy of homes; track centres; collection flow; distribution of shops and businesses.

▶ Establish an effective organisational model, in which functions and responsibilities are set within a municipal institutional structure.

▶ Perform a financial analysis of the situation and its evolution over recent years. For this, the weighing data of transfer stations and the 'El Inga' landfill site are analysed.

▶ Establish a legislative framework that brings clarity, definition of responsibilities and safety to the activities and actors involved.

Mª VERÓNICA ARIAS CABANILLA

“Waste reduction is based on a circular economy of resources”

María Verónica Arias Cabanilla is currently the head of environmental conservation in the city of Quito, an issue to which she has devoted her entire professional career.

ALWAYS PROTECTING THE NATURAL ENVIRONMENT
She is a lawyer with a Master’s Degree in International Environmental Law from the University of Washington, and a professor and tutor at the University of the Americas. She has been the Ecuadorian representative for the NGO The Nature Conservancy (TNC); member of the official Ecuadorian delegation for negotiations on the Convention of Biological Diversity; and President of the Ecuadorian Centre for Environmental Law.

How did the ‘Cero Basura’ programme arise?
Climate change, greenhouse gas emissions, excessive exploitation of resources, growth in consumption and waste generation demanded that we think about new avenues to explore.

The project comprises an ensemble of simple actions to ensure that the negative impact on the environment of our day-to-day activities is reduced. The end goal is the reduction and exploitation of resources based on a circular economy for resources: waste generation is reduced and waste is exploited to the maximum in the form of materials and energy.

How have companies and industries reacted to the plan?
The aforementioned unceasing changes are our driving force to promote and integrate environmental action into companies, which can make them more competitive and derive many advantages. Environmental policies, such as this expanded responsibility to which companies must adapt, will boost product sustainability at all stages of the production chain in a positive way. It is also important to note that companies, education institutions and other representatives of the public-private sector have taken part in the construction of the Master Plan, contributing a great deal and getting involved in meeting this target.

Recently you promoted the recovery of recyclable waste at the wholesale market in Quito. How was this experience?
The Environmental Department of Quito’s commitment was to involve traders, zonal administration and recyclers in a joint project that is enjoying success thanks to the participation of everyone. At the moment, 2.1 tonnes a month are recovered from the wholesale market. This is a goal and commitment for everyone to reactivate the economy of many families exploiting waste and looking after the planet using environmental best practices.

With the new plan, will the 2,000 tonnes of waste a day increase, decrease or remain the same?
The Master Plan for Comprehensive Waste Management coincides with the Metropolitan Plan for Development and Land Management 2015-2025, which plans for waste in production to be reduced by 5% per capita as a minimum by 2025 as compared with the production per capita for 2014. This figure, when compared and calculated alongside the annual growth rate of the metropolitan district, suggests that waste generation will increase over the upcoming years from 2,040 tonnes to 2,340 tonnes.

Comprehensive Management in the DMQ seeks for waste disposal to transition towards the circular economy or management of resources, in which waste is exploited to the maximum in the form of materials or energy for non-recoverable materials. Recyclable products and common waste are collected selectively in modern treatment facilities, sorted and exploited.

Recyclable waste will go from 12% in 2014 to 22% in 2025, including recovery of recyclable material from the ET-Sur sorting plant. 19 neighbourhoods of Quito and 300 environmental agents will benefit from this increase.

Apart from laws, what is needed for citizens to collaborate in waste management?
Our waste management policy is to ensure integrated waste management under the ‘Cero Basura’ concept and the circular economy, with the focus on participation, co-responsibility of citizens and environmental and social responsibility. But above and beyond citizen obligations and ordinances, we have got directly involved in the community, neighbourhoods, companies, education institutions and other actors in society to raise their awareness and create environmental best practices. Fundamental to this process have been our education campaigns, whose protagonist is anyone who recycles and sorts their waste.

You have initiated several awareness raising campaigns and even a “tour of waste”. Is the public welcoming these initiatives?
More and more, comprehensive waste management requires tools in the value chain (generation prevention, sorting at source and collection, exploitation and treatment, until eventual disposal). The “tour of waste” was a pilot project to include and demonstrate all these processes. We have provided added value including mechanised collection, cutting-edge technology and open days for the media and the general public to visit the Quito landfill site.

We are delighted by the approval the tour has enjoyed in the press and especially among university students, who are surprised that in this city waste can end up as water and be a new source of energy. This motivates us to keep working and help other municipalities in the country in the same way.

It started years ago with work on projects in marginal neighbourhoods of Quito. Have you planned any special actions to reduce and manage waste in the most deprived and vulnerable areas?
The DMQ currently has 96.5% cover for waste collection. We are working every day to achieve our target, which is to reach all neighbourhoods in Quito.

The UN has chosen Quito to host the Conference on Housing and Sustainable Urban Development (Habitat III) in October 2016. What agreements would you like to see there for sustainable urban development?
On those dates –17th to 20th October 2016– the city will bear witness to renewed vigour behind the global commitment to sustainable development and the setting out of a New Urban Agenda, which it is hoped will have a direct impact on urban policy on national, state and municipal levels. Quito has been chosen as the backdrop for numerous activities regarding the various central topics of the conference, in which all will be able to share experiences and responsible proposals aimed at creating safe, resilient, sustainable cities. This leads us to think about a city with integrated solid waste management, with new concepts such as that of ‘Cero Basura’, a commitment that should be extended to all other cities.

Isn’t reducing consumption in consumer societies a contradiction in terms?
It is a great challenge, which cannot be overcome overnight. Changing the consumer’s mindset and consumer culture will help to compare and choose products that are the greatest friends of the environment. Choosing by their origin, suitable packaging and sustainable manufacture will bring industrial change to companies, focusing on eco-designs, secondary resources and clean production.

Education is the key to sustainability. This is why we work daily to ensure more people find out somehow about our work, with consistent campaigns to care for the planet.

It has been said that there is healthy competition among large cities to be the first to be named among the most sustainable. Is this the case?
Clearly there is competition among major cities in terms of their local sustainability activities, and this can be seen not only from official recognition of various initiatives (such as the WWF City Challenge, the C40 City Climate Awards or the Siemens Green City Index), but also from the benefits this brings to their local governments and, most importantly, to their citizens. Recognition as a sustainable city can gain a city more attention from external investors, as well as providing international standing or cooperation on sustainability; it can generate opportunities for the city as a tourist destination as well as leadership and international positioning that open various doors for integration and exchange of experience.

Quito has not only been recognised as the most sustainable city in Ecuador, but was also selected as one of the 17 world finalists for the most sustainable city in the world award, conferred by the World Wide Fund for Nature (WWF).

Close your eyes. How do you envision the Quito city you hope to achieve with this project?
I dream of – and believe it is possible to achieve – an environmentally responsible city, a time when its growth is in keeping with the natural, rational limit of its ecosystems on land and in the water; a city that thinks about and plans its territory keeping in mind its environmental assets and, as such, minimises the negative impacts of pollution; which preserves and uses in a sustainable way its natural resources and biodiversity, reducing risk; and is resilient to the effects of climate change. Its functioning is based on alternative energies and its mobility motivates citizens to use public spaces, generating collective wellbeing and quality of life for its citizens. ■

> “Quito has been chosen as the backdrop for numerous activities, in which all will be able to share experiences and responsible proposals aimed at creating safe, resilient, sustainable cities”

ENAIRE puts SACTA at the forefront

ENAIRE will invest €12.3 million in renovating the data communication system for air traffic control in Spain, and €4.1 million in new equipment for Valencia airport's terminal control centre. Big investments for big improvements that Ineco has been collaborating on for over two decades.

By **Javier de Andrés**, computer engineer and **Javier del Pino**, aeronautical engineer

ENAIRE's automatic air traffic control system (SACTA for its acronym in Spanish), is a complex system of local machines and servers, installed in control centres and towers, that share information in real time. SACTA makes it possible to automate the acquisition, processing, distribution and presentation of the data required to carry out air traffic control tasks that form part of the air traffic management (ATM) system. The main objective of ATM is to regulate traffic in a secure and orderly fashion, as well as to ensure that air navigation system capacity can meet the demand. SACTA began providing service in 1990 at Palma de Mallorca's control centre; nowadays it is the only traffic control system in all of Spain's airports.

This system carries out the integration, automation and improvement of processes which allow for the control of aircraft that are en route, approaching and near the tower. In this way, information can be coherently processed and the associated air traffic control and management services have the support they need to meet security and service objectives. It is an ever-evolving system, meaning that ENAIRE is constantly perfecting and modernising it.

Ineco has collaborated with ENAIRE since 1998 on the evolution of SACTA, as well as on the automatic system for flight plan, aeronautical and meteorological information (ICARO), by participating in the specifications, design, testing and commissioning of new functionalities. Ineco's experts are part of system evolution and development in almost all areas, from the design of both functional and hardware architecture requirements, to maintenance and assistance to different ENAIRE users. A broad range of ATM system knowledge is obtained this way, proving extremely useful to the company and facilitating its national and international expansion.

Broadly speaking, the SACTA system makes it possible:

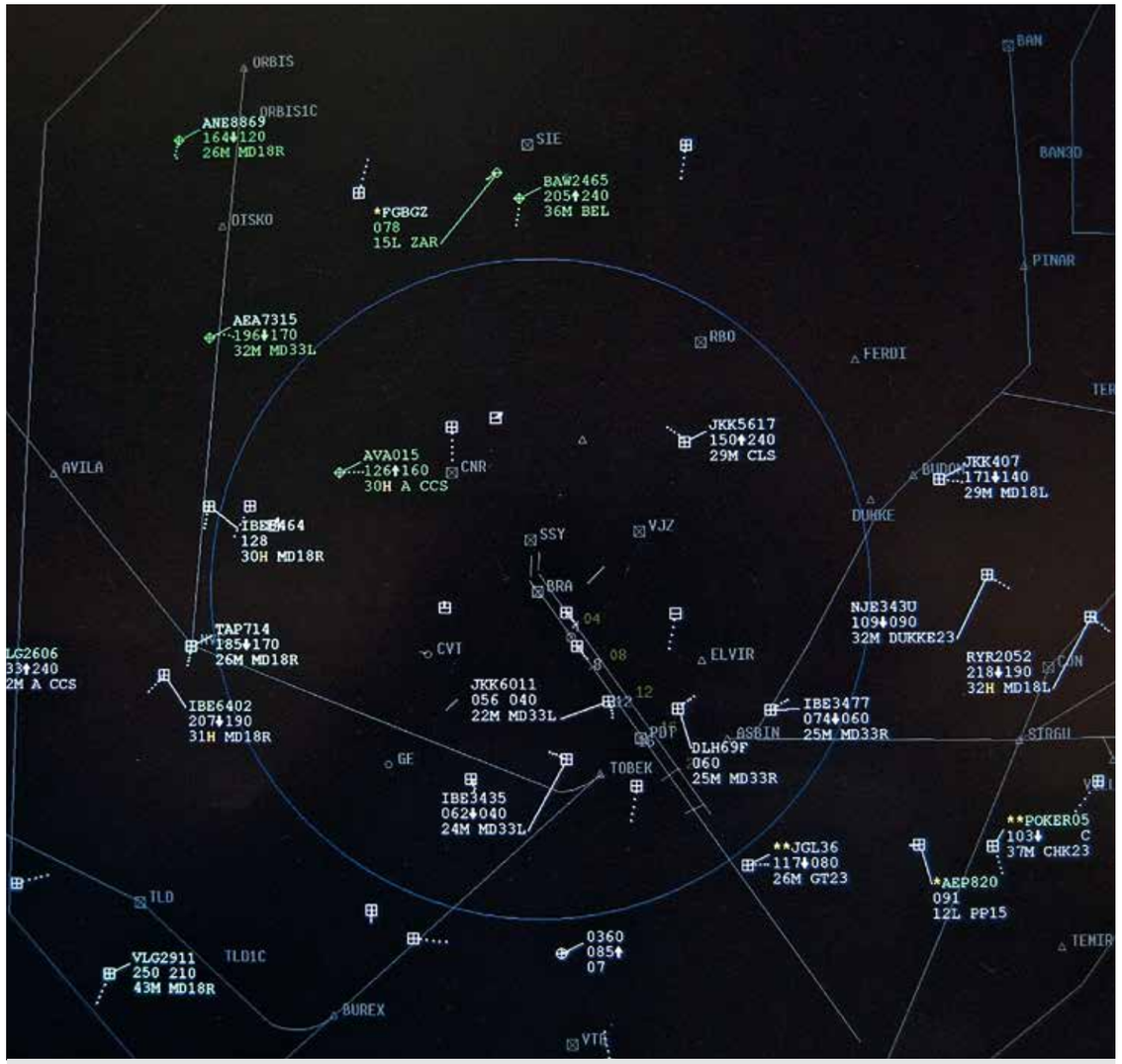
▶ To provide the controller with all relevant, updated air traffic data, thus facilitating interoperability between control facilities, collateral installations in Spain and abroad, and the CFMU.

▶ For controllers and technicians to receive training in a dynamic simulation environment.

A modular, redundant design was chosen to deal with such a complex system, thus allowing it to evolve with the least possible disruption to the operation. ■

PHOTO_**INECO. PABLO NEUSTADT 2011**

AUTOMATIC AIR TRAFFIC CONTROL SYSTEM
The complex, advanced technology of the SACTA air traffic control system allows for controlling and ensuring the movement of en route, approaching and near the tower aircraft. In the image, the T4 tower at Madrid Barajas-Adolfo Suárez airport.



SACTA SCREEN. The SACTA system determines routes and flight profiles, identifies the position of aircraft and ensures their separation in airspace.

INFORMATION THAT IS ALWAYS AVAILABLE TO AIR TRAFFIC

The SACTA system, via its subsystems, integrates and provides the following information which is available to air traffic controller at all times:

▶**Flight plan information:** the system is in charge of processing the flight plans received, determining routes and flight profiles. It also guarantees the interoperability of control facilities and foreign agents, making them fully compatible with flight plans that have origins and/or destinations beyond Spain's borders.

▶**Flight monitoring:** the system makes it possible to identify and obtain the position and information regarding aircraft trajectories in controlled airspace, as well as the capacity to ensure the separation and controlled flow of flights. This information is obtained by integrating data from the radar and sensor network for position within national territory, with the data provided by each aircraft in real time.

▶**Aeronautical and meteorological information:** the system receives and processes meteorological and aeronautical messages (such as SMI, QNH and NOTAM).

▶**Supervision:** the purpose of the system is to monitor, control and configure the HW/SW subsystems, which make up the SACTA system, thus promoting its reliability and integrity.

▶**Recording and operations:** these allow for the analysis and study of operational and technical information.

NEW FUNCTIONALITIES

Greater capacity, precision, savings and efficiency

The main purpose of SACTA, as an ATM system in service, is traffic security in all airspace sectors, thus the reason why it is constantly evolving. The automation of processes which are increasingly complex due to the high concentration of flights in European skies is organised, developed and tested alongside ATC personnel. This makes the information received by air traffic controllers through their HMI (Human Machine Interface) accurate and relevant, thus improving and strengthening communication flows with aircraft and different subsystems. The latest SACTA development included a series of functionalities which noticeably improve efficiency in route control, TMA and TWR. Below are the details concerning the most important changes currently being implemented:

▶Paperless Operations (OSF for its acronym in Spanish)

The flight progress strip is a fundamental tool for air traffic controllers. This little slip of paper contains the essential information about the route or itinerary for each controlled flight. With the use of 'paperless operations', aerodrome control management is possible with electronic flight strips. These strips appear on the screen in the same order as the old strips which were organised in bays. This system did not simply replace paper, but it had to be adapted to the different roles performed by tower controllers.

Management of traffic in the tower is divided into three different areas of responsibility: Clearance (ATC authorisation and start-up), taxi track (taxi clearance) and Local control (clearance for takeoff and landing); these areas of responsibility can be assigned individually, or several can be integrated into a control position. Accordingly, for each case the electronic flight strip presented will follow its functional cycle in line with the areas of responsibility assigned to each control position.

Implementation of paperless operations (OSF), presently at Palma de Mallorca and Malaga airports, immediately resulted in increased efficiency and capacity.

▶Air Ground DataLink (AGDL)

AGDL implements land-air point-to-point digital communication, allowing for the exchange of information between the aircraft and the Control Centre regarding two different technologies: ATN and FANS. Among other amenities, it provides ADS-C and CPDLC services.

Implementation of ADS-C (Automatic Dependent Surveillance-Contract), only in the FANS network, represents significant progress in surveillance. It generates periodic reports or variables on request such as aircraft position and speed, using available aviation information as the source, including GPS data.

CPDLC technology (Controller-Pilot Data Link Communication) consists in exchanging a series of pre-defined text messages based on a common phraseology between the air traffic controller and the pilot. This technology makes it possible, among other benefits, to accelerate operating instructions and prevent confusion caused by voice dialogues, thus a complementary tool to this technology.

▶Collaborative Decision Making (CDM)

The CDM project is an operational efficiency improvement tool whose approach is the process of aircraft rotation, based on the philosophy of sharing information that affects flights, among the different actors involved (handling, control, airlines and airport). This information is processed, thus increasing its accuracy and completeness. Reduced wait times and increased efficiency are achieved with this tool. The CDM process involves adapting the procedures that the airport operates with.

▶Arrival Manager (AMAN)

The Arrival Manager implements calculation of the optimal airport arrival sequence by utilising efficiency criteria to reduce wait times, thus facilitating flight transfer between APP and TWR.

▶eCOS/eVEREST

Although it is almost at the end of the list, it represents the most important change in the evolution of system hardware and software in recent years. It involves a redistribution of the system's core information nodes, thus affecting the overall architecture of the system. It goes from a configuration where the Seville and Palma servers are integrated, in a centralised manner, in Madrid and Barcelona respectively, together with their affected TWR facilities. The impact on the distribution of flight plan, radar, aeronautical and meteorological information is global, but the costs for implementation, commissioning, maintenance and development are reduced. Although it is a big change to the infrastructure, it is not a big change for normal control operations, meaning that it is transparent.

▶Phase 2 Configuration (CF2 for its acronym in Spanish)

CF2 affords easier operations, based on the aircraft tag that the air traffic controller sees on the screen. This tag displays colour changes or blinking on a global level or in certain fields, some of which are new, depending on the status of the flight plan, transfers between sectors, restrictions and alerts.

PHOTO_**PABLO NEUSTADT**

The main purpose of SACTA, as an ATM system in service, is to provide the tools which make it possible to guarantee the separation of traffic in all airspace sectors.

Trains made to measure

Throughout its history, Ineco has provided supervision for over 1,500 trains of all types and from all manufacturers, both in Spain and abroad. A high level of specialisation and technical knowledge are required in order to ensure that everything is functional and meets the operator's exact requirements.

By ***ITRANSPORTE***, with the collaboration of **Jon Aizkorbe**, industrial engineer

CAF TRAIN FOR COLOMBIA
A train is loaded at the port of Tarragona for the Medellín Metro, which is renewing its fleet with new CAF units.

Although some elements and processes of rolling stock manufacturing involve mass production, no two orders are the same: each design, operator and railway network has its own individual characteristics, even if the supplier is the same. In addition to this, there is the fact that the many components and systems a train is equipped with, from the air conditioning to the brakes or the traction, are produced by different companies. These must be integrated into the design produced by the manufacturer, who delivers the rolling stock to the operators who will put it into circulation.

A high speed train has very different features and characteristics than a tram, a commuter train or a freight train. Even so, what they all have in common is that they require experts to validate the design and to supervise the different tests (static and dynamic) that are carried out, both at the factory and on tracks, up until the train's entry into service. The supervisors must assure from the very beginning that the rolling stock being assembled meets technical specifications and is adapted to the needs of the end client. This is the reason for the fundamental importance of validating the initial design.

They must also have detailed knowledge of international railway regulations, as well as those of the particular countries concerned. Supervisors must also be familiar with standards that apply to the main and auxiliary elements, both structural elements (body, axles, wheels, etc.) and equipment and systems (traction, brakes, train safety system, passenger information system, conduction system, emergency system, etc.). The supervision process must guarantee the reliability and technical compatibility of all these elements.

Ineco has extensive experience in this field, with professionals whose specific knowledge of each component make it possible for trains to be functional, safe and comfortable for users. This experience covers all types of rolling stock from all suppliers: CAF, Alstom, Siemens, Bombardier, etc. In the case of new railway projects, clients may also require technical assistance prior to the purchase of rolling stock. In 2012, Ineco collaborated with the Santiago de Chile Metro in preparing technical specifications for public tenders and in assessing bids for the modernisation of its fleet.

In Spain, the company has over 20 years' experience in this area, having supervised over 200 high speed and over 750 conventional trains, 290 locomotives and around 75 metro trains and trams, as well as 1,400 freight wagons. Noteworthy projects abroad include numerous works carried out in Brazil for CAF and Alstom (suppliers to the Compañía Paulista de Trenes Metropolitanos, CPTM), in Colombia, where the Medellín Metro is renewing its fleet with new CAF units, and in Ecuador, which has purchased rolling stock from the old Feve or Euskotren for its railway network, for which it launched renovation works in 2008.

The tasks of design validation, review and supervision are applicable not only to new rolling stock, but also when updating operational units that require modernisation. This is the case with the

ALL TYPES OF TRAINS REQUIRE EXPERTS TO VALIDATE THE DESIGNS AND SUPERVISE THE DIFFERENT TESTS CARRIED OUT UP UNTIL THEIR ENTRY INTO SERVICE

EGO LOCOMOTIVE FOR ECUADOR
Ecuador has purchased rolling stock from the old Feve or Euskotren for its railway network, for which it launched renovation works in 2008.

ALSTOM TRAINS FOR CHILE
Alstom manufactured 49 NS74 trains for the Santiago de Chile Metro in the 1970s. Now, Ineco is providing technical assistance for detailed engineering and designs for the process of modernising the fleet, working in conjunction with Alstom engineers in Spain.

WORKS FOR THE MEDELLÍN METRO

With a population of 2.4 million, Medellín is Colombia's second city. In 2004, it pioneered the use of cable cars as a means of public transport, and now other cities have followed its lead: São Paulo in Brazil, capitals such as Bogotá (Colombia) and Quito (Ecuador), for which Ineco is producing a feasibility study, La Paz in Bolivia, etc.
A dynamic city with difficult orography (it sits in a narrow valley, 1,300 metres above sea level), Medellín has invested in public transport as another element of social integration (the 'metrocable' lines serve the city's least privileged neighbourhoods, or comunas) and sustainability: buses run on natural gas, all metros and trams use electric traction and a public bicycle system has been installed at stations.
Mobility in the city and its metropolitan area is in constant growth, increasing road congestion and the use of public transport in its various forms: buses (MetroPlús, large-capacity buses that run on natural gas, the SIT or Integrated Transport System, and minibuses), trams, the cable car or metrocable, free public bicycles (EnCicla) and the over ground metro. Metro de Medellín, a public company owned by Medellín city hall and the regional government of the department of Antioquia, is responsible for managing the network, which comprises two conventional metro lines, two metrocable lines (with two more to be added soon) and the Ayacucho tram line, opened in October 2015.
Having been in operation for 20 years, the company is now renewing its fleet; this has involved the purchase of new trains from the Spanish company CAF. In 2011, Ineco was commissioned to supervise the design and manufacturing of the trains, as well as their testing in the factory and on tracks and the subsequent entry into service of the initial batch of 13 three-car trains, equipped with the latest technology. In 2015, the company supervised a second batch of another 3 units as well as the on-board signalling equipment (ATC) for 26 drivers' cabs.
With the new CAF trains (20 in total), Metro de Medellín plans to increase transport capacity by 36 %, which will translate into reduced congestion at peak times.
In addition to this work, Ineco has carried out other projects for Metro de Medellín, such as feasibility studies for the recovery of the old Antioquia railway (see *IT39*), renamed the 'Valle de Aburrá Multi-purpose Railway System'. The project consists in renovating 80 kilometres of disused track for the transport of passengers and urban waste through the Aburrá Valley.
The valley, created by the basin of the river Medellín, is a narrow stretch of land in the centre of the region of Antioquia and has seen intense urban development.
In addition to the city of Medellín there are a further 10 municipalities, constituting an urban area with a population of over 3.3 million. For that reason, Medellín's public transport system is designed as a multimodal network named the Valle de Aburrá Integrated Transport System (SITVA, for its Spanish initials) with stations that allow passenger to change mode of transport (for example, from tram to cable car, bus to metro or metro to bicycle). In 2010, Metro de Medellín implemented a metro and metrocable traffic control system based on Adif's Da Vinci platform, developed by Indra. Two years later, it also incorporated Metroplús buses, Ineco took responsibility in this in the supervision and technical management of the extension of the system, which enables any incidents in the service to be managed and handled in real time.

forty-nine NS74 trains manufactured by Alstom for the Santiago de Chile Metro in the 1970s. Ineco is providing technical assistance for the detailed engineering and design for the process of modernising the fleet, working in conjunction with Alstom engineers in Spain.

The same is true with second-hand or surplus rolling stock which is sold on to another operator (generally abroad) and needs to be adapted. This was the case with the three new TD 2000 series locomotives manufactured in Spain in 2006 by the company Ingeteam, which were surplus to the requirements of the Basque operator Euskotren. The machines, accompanied by fifteen 3,500 series trailer cars (with no additional costs), were acquired by Ecuador's railway network for its star product, the Tren Crucero ('Cruise Train') tourist line between Durán and Quito. Ineco, which also carried out the original testing for Euskotren, supervised the tune-up of the units for their new function, which is very different than their original intended use in a freight project.

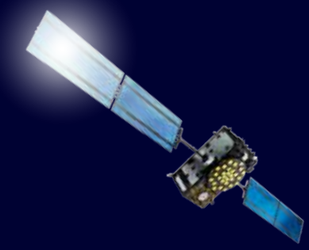
For that reason, the machines have a powerful electro-diesel dual-mode traction system, large loading capacity and efficient braking systems. Their sturdiness and power make them very suitable for their new destination, as the 'Cruise Train' is a 450 kilometres of unelectrified line running through a mountainous region known as the 'Avenue of Volcanoes', where it reaches altitudes of over 3,600 metres. For that reason, the locomotives will only use diesel traction. In addition, the units required modification to travel on the Ecuadorian network, where the gauge is 1,067 millimetres, compared to the 1,000 millimetre gauge for which they were originally designed. ■

For Metrô SP, Ineco oversaw in 2015 the manufacture and operation of 26 new trains for Line 5-Lilas, and for commuter trains (below, De la Luz station, in São Paulo), nine power units of eight cars each for the Line 11-Coral.

SÃO PAULO METRO AND COMMUTER NETWORK

The Metropolitan Region of São Paulo (RMSP for its Portuguese initials) is one of the world's largest urban areas, with a population of more than 18 million, unevenly distributed across 8,000 square kilometres. 11 million of these inhabitants live in the city of São Paulo, and the rest in 39 other municipalities. However, its urban and inter-city transport network, comprising buses, metro and commuter trains, is limited in size compared to the area of land and the population it serves: six railway lines with a total length of 261 kilometres, managed by the CPTM (Companhia Paulista de Trens Metropolitanos), and five suburban lines totalling 68.4 kilometres, operated by the São Paulo Metro company (Metrô SP). For that reason, the city government has in recent years been implementing enlargement and improvement plans, including both the construction and extension of existing lines and the renovation of equipment and rolling stock, as well as intermodal connections between the bus, train and metro networks. In 2015, Ineco and its local partners carried out two projects, supervising the manufacturing and commissioning of new rolling stock. The objective in both cases is to ensure that the client receives the final product according to schedule and with the required quality standards. For the commuter train network, the company completed its work supervising the purchase of nine electric units of eight cars each, for Line 11-Coral, which measures 50.8 kilometres and has 16 stations, and which is being enlarged with financing from the International Bank for Reconstruction and Development (IBRD). The new trains, which have already been delivered, have a capacity of 2,600 passengers and are compatible with the rest of the CPTM fleet. Working for Metrô SP, Ineco also supervised in 2015 the manufacturing and commissioning of 26 new trains for line 5-Lilas, which is to be extended by 11.4 kilometres with 11 new stations. The new trains have five cars each, with a capacity for up to 1,500 passengers. The works, with financing from the World Bank, started in 2013 and are expected to be completed in 2016. Ineco's services include analysing the construction documents, providing assistance during conformance testing and inspecting and monitoring the manufacturing process.

European
GNSS
Agency



European GNSS Agency

Ensuring the success and security of the European Satellite Navigation Systems, Galileo and EGNOS

ROAD: The European Global Navigation Satellite System, is key to design new ITS services requiring precise and secure positioning, without increasing the road side infrastructure. Precise and secure positioning enables smart mobility applications, connected vehicles, and new forms of liability and payment applications.

RAIL: Satellite-based positioning is set to have a substantial impact on the rail industry. Precise and secure positioning provided by Galileo and EGNOS will contribute to the evolution of the European Rail Traffic Management System (ERTMS) through the virtual balise functionality that will help to improve efficiency of European railway infrastructure.

AVIATION: EGNOS provides safety and economic benefits to the aviation sector, including for business and helicopter operators who can enjoy enhanced accessibility to less equipped airfields also in poor weather conditions.

EGNOS

EGNOS, the European Geostationary Navigation Overlay Service, increases the accuracy and reliability of existing satellite positioning signals while providing a crucial 'integrity message', informing users in the event of GNSS signal problems. It also transmits an extremely accurate universal time signal.

GALILEO Galileo is the European Global Navigation Satellite System (GNSS), together with other GNSS programmes, it will provide increased accuracy, enhanced robustness and reduced time to first fix.

www.gsa.europa.eu

JOSÉ ABELARDO QUIÑONES GONZALES INTERNATIONAL AIRPORT
As one of the alternatives to Jorge Chávez airport in Lima, it is important to expand and improve it. For the architectural design of the new terminal, we enlisted the help of Efebearquitectura, a Spanish architectural firm with longstanding experience in building design of airport architecture.

The gateway to the treasure of Sipán

IMAGE_EFEBEARQUITECTURA

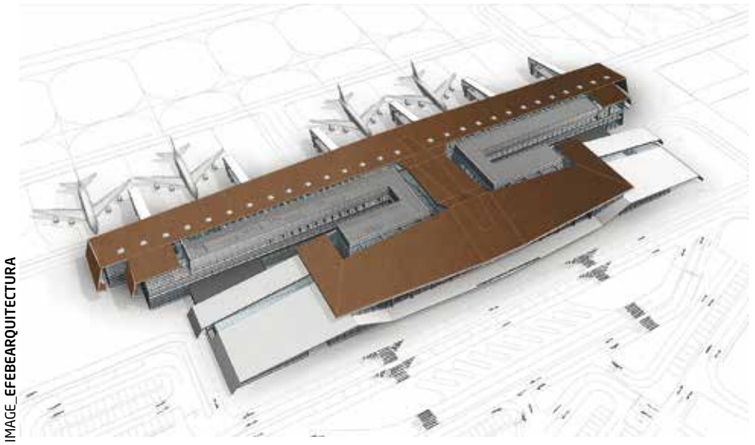
Since late 2014, together with its partner CESEL, Ineco has been working on the preliminary studies for the modernisation of Chiclayo airport. Chiclayo is the fourth largest city in Peru. These analyses will enable us to determine and plan the improvement and enlargement work that aim to turn Chiclayo into the air transport hub of northern Peru and drive trade and the tourist sector built around the huge archaeological richness of the area.

By ***ITRANSPORTE***, with the collaboration of **Roberto Serrano**, aeronautical engineer and head of the project

In spring 1987, Peruvian architect Walter Alva attended a local police call. The police had discovered looting activities at an archaeological site from the 2nd century in Sipán, 35 kilometres from the city of Chiclayo, in the department of Lambayeque in northern Peru. The remains they found, which include the first intact tomb and grave goods of a Moche leader with his entourage, known today as 'the Lord of Sipán', were subsequently compared with discoveries such as Tutankhamen's tomb in Egypt or even the Machu Picchu complex in the south of the country. Later on in the excavations, another 15 burials were discovered, as well as around 2,000 articles made of gold and silver, valued in some estimates at more than $16 million. Today, they are exhibited in the modern Museum of the Royal Tombs of Sipán, which was opened in 2002 under the directive of Alva himself, and attracts 160,000 visitors a year.

Sipán and its treasure, which is one of the jewels of Peruvian and global cultural heritage, transformed Chiclayo's demographic and socioeconomic reality. Chiclayo, unlike other Peruvian cities, is not of Hispanic but indigenous origin, and was the epicentre of the pre-His-

CHICLAYO TERMINAL
In 2015, according to figures from the General Directorate for Civil Aviation (DGAC in Spanish), there were 7,813 operations and 431,840 passengers recorded.



IMAGE_EFEBEARQUITECTURA

CHICLAYO INTERNATIONAL AIRPORT
AdP aims to boost Chiclayo as the air transport hub for the whole region of northern Peru. The goal is to increase passenger traffic fivefold to 2.1 million by 2031.

MODULAR GROWTH
Modular growth is envisioned that will enable demand to be met. We have researched how to make sure access is fast and well connected to the surrounding area.

panic Lambayeque and Moche cultures. With almost 600,000 inhabitants, it is the country's fourth most populated city, after Lima, Arequipa and Trujillo. Within a distance of under 35 kilometres from the urban centre, there are also other significant archaeological enclaves, like the Valley of the Pyramids in Túcume, which is a World Heritage Site, and museums such as that of Sicán in Ferreñafe or the Brüning Museum in Lambayeque, the oldest in the area, also dedicated to the local pre-Hispanic cultures.

To the range of local tourist attractions we can add the beaches in the region, such as San José, Pimentel and Santa Rosa, although this 'sun, sea and sand' tourism is far from having the same impact as the more cultural attractions. Despite this, in recent years, the flow of tourists in the country has reoriented: before the 1990s it was mostly directed towards the centre and the capital, Lima, 770 kilometres away on the roads, and towards the south, with the Machu Picchu complex and the plains of Nazca being the main magnets for domestic and international tourists.

The central and local governments, as well as the private sector, are aware that the potential for tourist development in Lambayeque and its capital, Chiclayo, has great development margins. The modernisation and enlargement of its airport, which is named after aviator and national hero José Quiñónez Gonzales, is an essential step in boosting tourism. The task is in the hands of the manager of the airport, the company Aeropuertos de Perú, AdP (Airports of Peru), which in 2006 was granted the project by the government of Peru, along with another 11 aerodromes.

Chiclayo airport opened in 1956 and, though it has been classed as international since 1994, the first regular operations of this type began on 28th June 2016 with the introduction of two weekly Copa Airlines flights to Tocumen Airport in Panama. In 2015, according to figures from the General Directorate for Civil Aviation (DGAC in Spanish), there were 7,813 operations, 431,840 passengers and 731,120 kilograms of air freight recorded.

AdP aims to increase these figures and boost Chiclayo as the air transport hub for the whole region of northern Peru. The goal is to increase passenger traffic fivefold to 2.1 million by 2031. To this end it has put in place a process of modernisation that comprises overlaying the runway (2,520 metres long and 45 metres wide) and, once feasibility studies are complete, building a new terminal building, as well as remodelling access ways and other improvement works, including a new control tower, firefighting services, hangars, fuel area, freight terminal, etc.

As this is a co-funded award, it is a legal obligation to plan lines of action as well as the necessary investment, and to have the approval of the Peruvian Government before beginning the work. In December 2014, AdP entrusted the consortium set up by Ineco and Peruvian engineering company CESEL –who are also working on overseeing the enlargement work at Jorge Chávez Airport in Lima– with the task of drawing up these pre-investment and feasibility studies.

FIRST STAGE

The first stage studies revolve around identifying investment alternatives and assessing the technical, economic, social and environmental aspects of the modernisation project. During this stage, both the general conceptual design of the project and the specific conceptual design of the terminal building and other buildings were developed. The aim of these studies is to demarcate the key aspects of the project –what is needed and how it will be financed– to be approved by the concessionaire AdP, as well as the Ministry of Transport and Communications.

The tasks undertaken include an analysis of capacity and demand, studying navigation easements and the general conceptual design, which enables certain basic standards to be defined for the whole project. Thus, regarding airside, we investigated what length of runway would be the most suitable considering type of aircrafts used at the airport, what would be the most effective design for the rapid exit taxiways; how to distribute the parking positions over the apron, how passengers will reach aircraft on foot to reduce turnaround times, etc.

Regarding on the land side, we analysed how to achieve the shortest and most comfortable distances and passenger flows between key points (check-in –security– boarding gates) so as to avoid queues. Modular growth is envisioned that will enable demand to be met. We have researched how to make sure access is fast and well connected to the surrounding area. We also seek to ensure that basic services such as a coffee shop and parking facilities are provided in balance with the other functional requirements.

In addition to drawing up the specific conceptual design for the terminal building, analysing the architectural aspects, placement, shape and size, materials and design of spaces, analysis was also undertaken of the investment necessary and alternatives were compared, and a study was conducted on the environmental impact, permissions management and general coordination of the project.

SECOND STAGE

The second stage of studies is feasibility, which goes deeper into the fundamental technical aspects of the first stage, such as positioning and size of the new infrastructure, the technology to be implemented, the timescale of the work and management of finances. Thus, in terms of airside, the geometric design of the runway will be performed, as well as overlaying designs and designs of traffic signing and road marking and guiding lights, of drainage works and of air navigation equipment and systems. ■

UNDERGROUND TREASURES

The studies conducted by Ineco also took into account the physical and socioeconomic environment of the airport, indicated by tourist potential and agroindustrial activity. According to AdP, the airport's development will aid in boosting both activities, tourism and exportation of agricultural products. Notable among the latter is asparagus, of which Peru is the world's largest exporter of this fresh vegetable and the second in preserved form; more than half is cultivated on the northern coast. The department (region) of Lambayeque, of which Chiclayo is the capital, is the fifth highest producer of this vegetable in the country. It is exported fresh, preserved or frozen to Europe, the United States and other countries in South America. For this purpose, the concessionaire has announced that the airport will have refrigerated storage units for this kind of air freight.

As regards tourism, the city of Chiclayo is located on the 'Moche Route' promoted by the Peruvian government, an itinerary which connects several points of cultural and archaeological interest around the axle of Chiclayo-Trujillo. According to the Peruvian Ministry of Foreign Trade and Tourism, more than 923,000 tourists went to Lambayeque in 2015, up 7.4% from the previous year. 77% of foreign visitors came by aircraft, making Chiclayo airport the gateway for international tourism in the region.

Long live your airport's pavement

When the pavement of a new airport or enlargement is designed, it is usually with a view to a 20 year life cycle. However, weathering, overloading and variations to the forecasted level of traffic will all shorten its life cycle. Ineco has developed a pavement management tool, Gestrol, which monitors and forecasts the evolution of the pavement.

By **Jorge Martín**, graduate in Physical Sciences

In recent decades, the constant worldwide increase in air traffic has led to the development of large-fuselage aircraft such as the Airbus A380 and the Boeing B777 and B747-8. These are all large-capacity aircraft with the autonomy to fly long haul, and are therefore much larger and heavier than previous models. This has led to changes in the management, design and maintenance of airport infrastructure, both landside and airside. Airports have had to enlarge their terminals and access road in order to be able to accommodate more passengers, and have also had to increase the dimensions of their runways, taxiways and aircraft parking aprons.

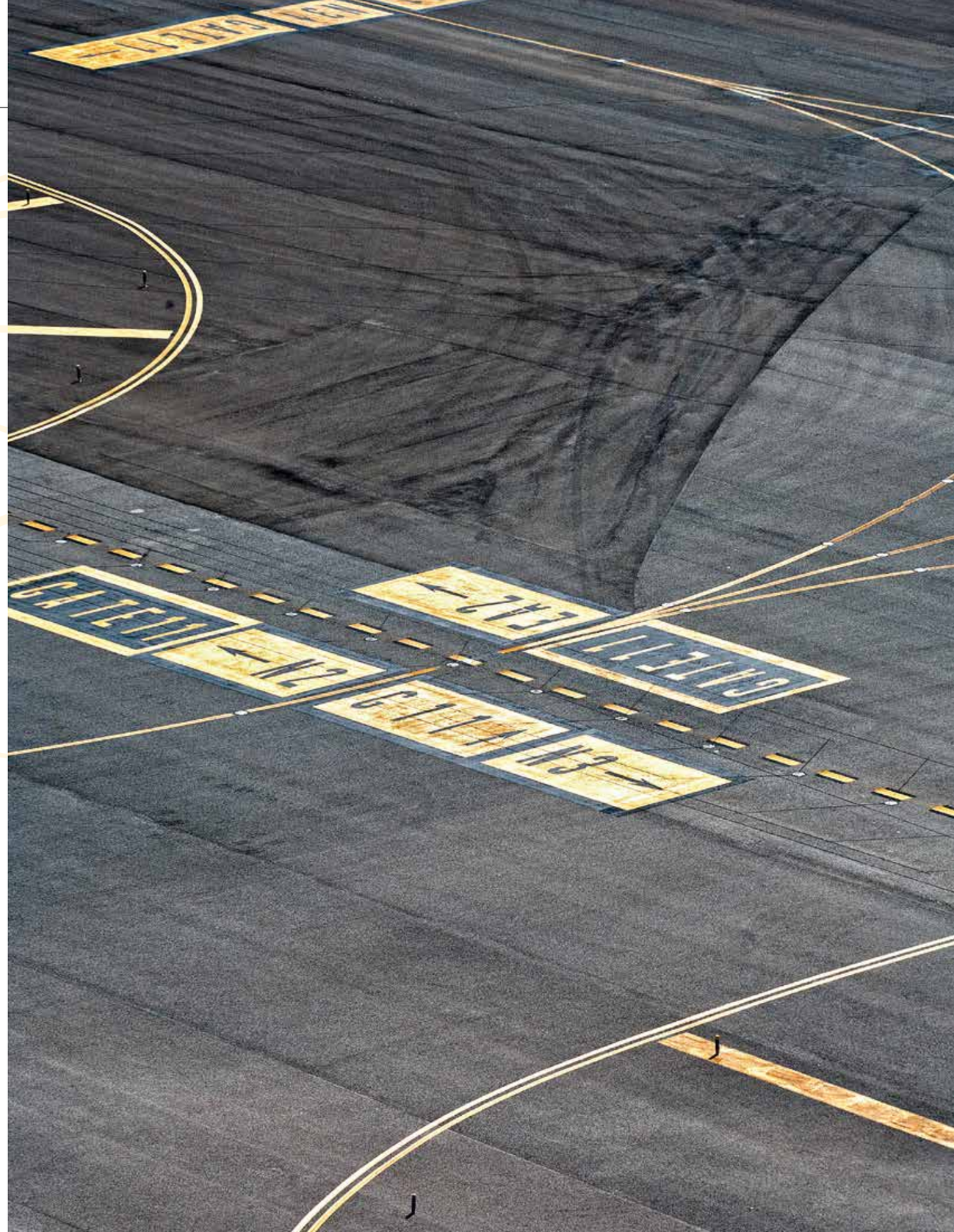
Of all airport installations, the airfield is of critical importance, as it is where aircraft continuously taxi, take off, land and park. In many cases, they are in use 24 hours a day. For this reason, the International Civil Aviation Organization (ICAO) considers preventive maintenance to be of great importance, as the failure to correctly undertake these actions incurs additional costs, such as traffic restrictions or closures in order to carry out the necessary works, in addition to the cost of the repair works themselves.

Currently, the majority of airports find themselves handle more intense levels of traffic than they were designed for. As a result, the pavement deteriorates due to the loads produced by aircraft. This is then further exaggerated by exposure to the elements. In order to maintain operational safety, managers have to double their maintenance efforts.

In any case, airfield pavements are dynamic in nature: their properties will change with the passage of time and the amount of airport traffic. Therefore, once it has reached the end of its useful life, usually around 20 years, new design, works and exploitation will be necessary. This cycle will not need to be applied to the entire pavement, rather only in the areas where it is necessary.

> INECO HAS DESIGNED GESTROL, AN APPLICATION THAT PROVIDES THE AIRPORT MANAGEMENT WITH ALL THE NECESSARY INFORMATION ABOUT THE CONDITION AND EVOLUTION OF THE PAVEMENT

Airport managements are not usually aware of the overall conditions of the airfield pavement. For this reason, when a problem is detected, an immediate solution is required, generating unforeseen costs. Ineco has designed Gestrol, an application that provides the airport management with all the necessary



information about the condition and evolution of the pavement, in such a way that they can anticipate future problems and possible solutions.

In addition to maintaining the minimum levels demanded by the international civil aviation regulations, the tool applies the quality levels that each manager chooses to implement. The application directly connects the manager to an engineer over the Internet, so that any issue may be resolved practically in real time.

When aviation was in its infancy, planes used to take off and land on earth or grass airfields. With the increase in size and weight of planes, airfield pavements also evolved and became more specialised in order to be able to bear growing loads and ever-intensifying usage. Currently, there are two main types of airport pavement: rigid and flexible. Both are made up of various layers. In rigid pavement, the top layer is made up of concrete slabs, while in flexible ones, asphalt materials are used. The lower layers absorb loads, reinforcing the earth's load bearing capacity, and sometimes also help drainage. They are made up of different materials and may include the addition of a stabilising or binding ingredient to increase resistance.

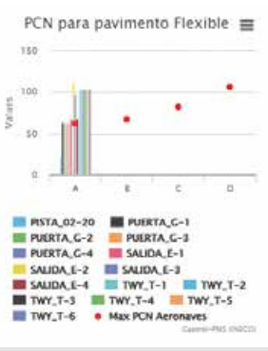
AIRFIELD PAVEMENTS ARE DESIGNED TO WITHSTAND ANY WEATHER CONDITIONS IN ACCORDANCE WITH DETERMINED LOADS

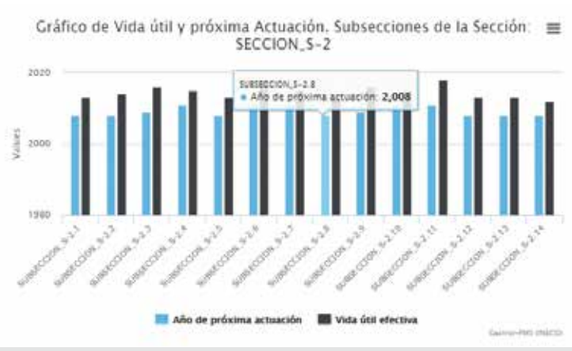
Pavements are designed to withstand any weather conditions, in accordance with the loads determined in structural calculations. If loads or usage levels (or both) are greater than those for which it was designed, larger deformations will be produced, affecting the different layers and thus shortening the lifespan of the pavement. When measuring the deformations, an indicator called PCN (Pavement Classification Number) is obtained; this indicates the resistance to unrestricted use. This indicator is linked with another value known as ACN (Aircraft Classification Number) which indicates the relative effect of an aircraft on the pavement for a particular category of terrain. If this second value is less than or equal to the PCN, the pavement will be able to withstand operations without restriction.

As well as the load bearing capacity, other factors that determine the conditions of the pavement are the coefficient of friction and the surface texture. Friction between the surface of the runway and the tyres of the landing gear should be sufficient to ensure the maximum braking effectiveness, making this a factor which directly affects safety. According to the ICAO's Airport Services Manual, the frequency of measurements must increase with the number of landings that occur: for less than 150 daily landings, once a year; between 150 and 210 landings, twice a year; and for more than 210 landings, three times annually.

The texture of the runway is crucial when it is wet, given that if the tyres lose contact with the surface of the runway, hydroplaning can occur; this in turn leads to the loss of control of braking and the steering of the aircraft. Slippery textures can be caused by the accumulation of rubber from the tyres of the landing gear or by wear from traffic. There are various measurement methods to determine whether the texture is suitable and what actions should be taken (clean-up of the rubber, screeding, etc.) if this is not the case.

All of these factors are reviewed and monitored through a Maintenance Plan. The information gathered through the various tests and studies is collected in a database, which is updated with the results of periodic assessments and any preventive or corrective work, as well as any possible change to traffic levels. ■





ADVANTAGES OF THE GESTROL TOOL FOR THE AIRPORT MANAGER

1. A powerful database which records measurements for various parameters of the pavement: construction dates, dates when work was carried out, pavement sections, number of operations and aircraft models, etc., as well as the results of studies undertaken for each of the assessments.

2. Historical information regarding the overall condition of the pavement.

3. The recommended procedures to maximise the lifespan of the pavement at minimal cost.

4. Analysis of the evolution of the lifespan of the pavement according to its conditions, and any work that may be necessary in the future, as well as any variation in aircraft operations.

5. Studies into the overloading of the pavement, as well as possible screeds that may meet future requirements.

PHOTO_ **PABLO NEUSTADT**

There exist different types of periodic assessment:

▶ Assessment of the coefficient of friction and the surface texture of the runway: this consists in determining the resistance of the pavement surface to the movement of aircraft, and whether it provides the optimum level of braking effectiveness.

▶ Assessment of load bearing capacity: determines the level of resistance of the different layers making up the pavement. The PCN (Pavement Classification Number) is obtained from this study.

▶ Assessment of the PCI (Pavement Condition Index): this is a numerical indicator that evaluates the quality of the surface and catalogues the different types of deterioration present in both flexible and rigid pavements and reveals superficial or structural defects.

▶ Assessment of surface regularity: this determines the comfort level of rolling aircraft, avoiding any possible ricochets, wobbles or vibrations that could make manoeuvring the aircraft on the ground more difficult.

1
Pavement at Malaga airport.

2
Pavement at Alicante airport.

3
Rubber clean-up equipment.

An architectural gem shines again

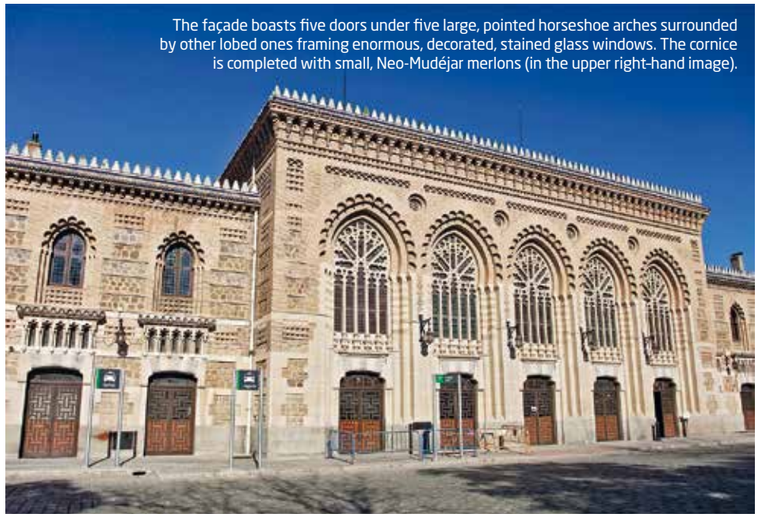
Renovation work on Toledo's historic railway station undertaken by Adif in 2015 was completed this summer. Ineco drafted the project and was responsible for managing the construction management, including refurbishment of the roof, façades and the tower, among other elements.

With the collaboration of **Javier Méndez**, architect and **Javier García**, BSc in Architecture, from Adif; y **Antonio Asenjo**, architect, and **Gema Lanzas**, BSc in Architecture, from Ineco

Constructed with brick, stone, iron and cement, the station is a symmetrical, rectangular structure consisting of a single level central building with one double storey building attached to each side. The outside of the station is furnished with an iron canopy.

PHOTO: **FMA BOAL / FLICKR**

The entire building is crowned with a four sided, glazed tile rooftop, work of local ceramicist Ángel Pedraza, the artist who is also responsible for the coffered ceilings. In the image, after renovation work.



The façade boasts five doors under five large, pointed horseshoe arches surrounded by other lobed ones framing enormous, decorated, stained glass windows. The cornice is completed with small, Neo-Mudéjar merlons (in the upper right-hand image).

As it corresponds to the monumental city it is located in, Toledo's railway station exudes art and history: it was designed by the architect Narciso Clavería from Madrid and inaugurated in 1917. Ceramic from Toledo, stained glass, coffered ceilings and wrought iron elements, such as the exterior fence, decorate this Neo-Mudéjar building characterised by the use of brick on its exterior and ornamentation reminiscent of Arab architecture: polylobed arches, crestings, geometric designs…

An unusual clock tower –whose use at that time was restricted to other types of official buildings to symbolise their importance– stands over the station; the passage of time has left its mark on this building, declared Heritage of Cultural Interest in 1991.

For this reason, Adif began renovation work in 2015 on the rooftop, façades and the tower, in addition to other buildings. In 2013, Ineco drafted the construction project and provided its construction management services to the railway infrastructure administrator; the project required quality artisan interventions in order to recover extremely delicate elements such as the glazed ceramic tiles and merlons, the work of ceramicist Ángel Pedraza, a native of Toledo.

In another, independent project awarded in July, Adif completed this work with the renovation of the station's large iron lamps: the lamps were waterproofed and repaired and the lighting system was updated with LED technology.

Adif had formerly carried out, also in collaboration with Ineco, another remodelling process, finalised in 2005, to implement a high-speed line. ■

REPAIRS CARRIED OUT

▶ **Repair of the passenger building roof:** replacement of Arab-style tiles, white and blue-coloured glazed tiles on false overhangs and ceramic elements on crestings; replacement of gutters, drains and downspouts. Repair of the underground rainwater drainage system which connects the downspouts to the sewage pipes located under the station's main platform.

▶ **Refurbishment of the left side of the building-first floor (formerly houses) and the ground floor, except for the travel centre:** sanitation work on partitioning and walls including elimination of dampness and repair of exterior carpentry to keep spaces in the façade watertight.

▶ **General restoration of the tower:** general clean-up including bird excrements caused by their entry into the tower, sanitation work on the interior of the façade (walls and ceilings), repair of carpentry and replacement of broken glass to prevent the entry of birds.

▶ **Façades:** repair of cracks and elimination of efflorescence; restoration of decorative stained glass carried out by specialists on the side of the building.

The tower-minaret of five levels holds the original clock which was restored in 2005.

THE PASSAGE OF TIME HAS LEFT ITS MARK ON THIS BUILDING, DECLARED HERITAGE OF CULTURAL INTEREST IN 1991. THE RENOVATION WORK REQUIRED QUALITY ARTISAN INTERVENTIONS

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*Source: Aena, based on ACI-Mundo.

All about BIM... your imagination's the limit

The time has come for the world of construction to make the same leap that the world of engineering experienced in the industrial revolution. BIM proposes the method of achieving this. Those who get on board will draw up better designs for their customers and keep their place in this evolving trade. Those who don't will condemn their clients to higher overall building costs. Evidently, there is a limit to the number of times they can do this.

By **Antonio Manuel Reyes**, PhD. industrial engineer, director of the *Spanish Journal of BIM*

It has become very common to hear talk of BIM in technical forums, but what exactly is it? Do we know all its applications in our work? Who works with BIM in Spain, and who are they working for? BIM stands for Building Information Modelling, which brings us to the first clarification we should make: as well as buildings, BIM can also be used in infrastructure and any kind of construction in general.

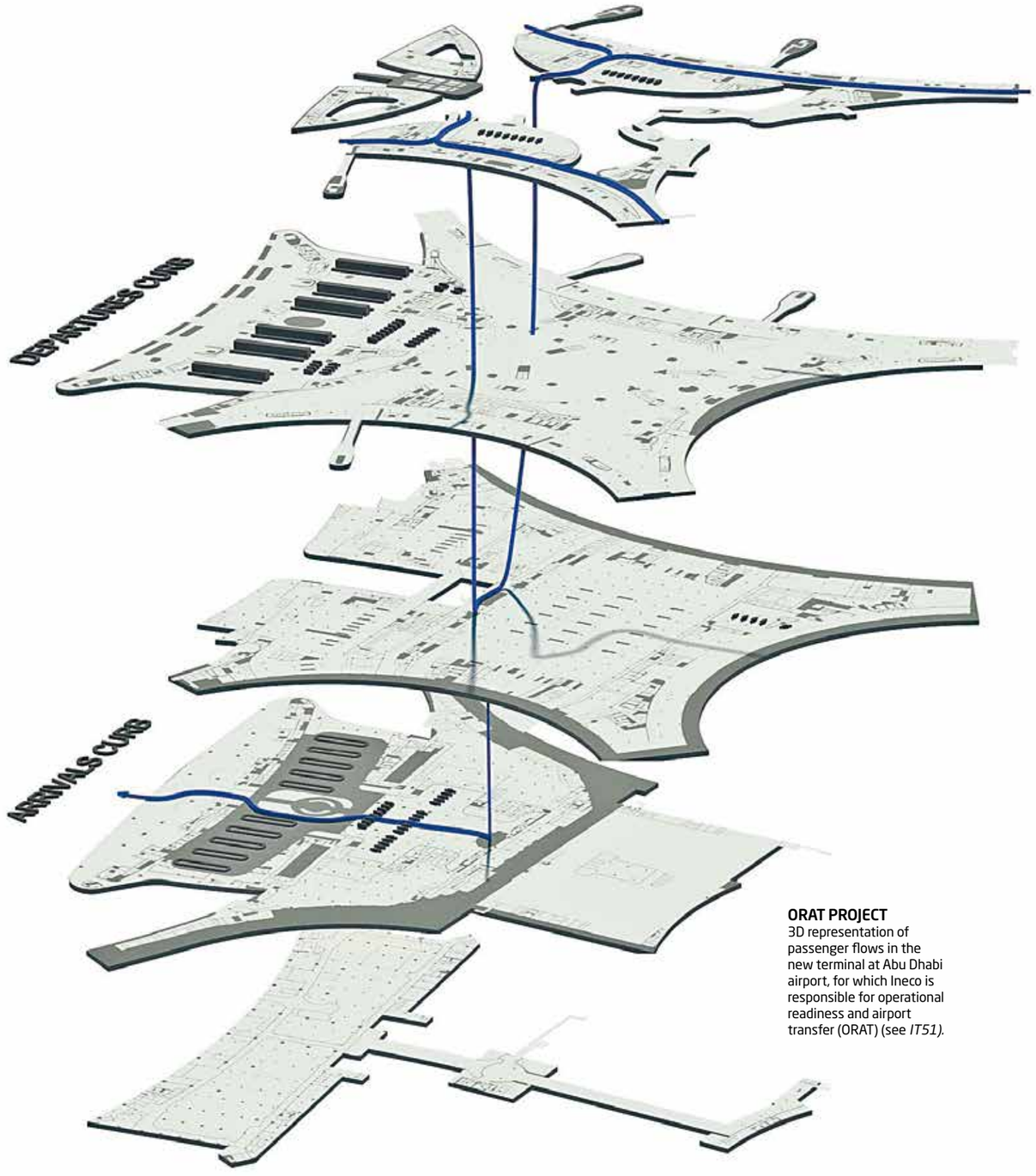
Beyond these precisions, the concept of BIM is to use a graphical interface to document all the details that we want to gather about each building. Programs that work with BIM will show us the building elements of our work, and we will feed the program all the associated documentation. Once we finish this process, we will have a striking virtual model of the building and, more importantly, a large, perfectly-organised database for the design.

This is evidently a much more complete way of designing than using a CAD program; greater effort is required in the design phase for this reason. With all this information, the design is ostensibly superior and far more descriptive, coherent and complete. Using computers, we have resolved the problems that would usually arise on site, avoiding expenses for materials, distributing installations in the most suitable way, reducing completion times, minimising errors and making gains in safety and sustainability, among a great many other advantages. If we are ingenious in managing the data we feed into our model, the limit to these advantages is our imagination.

We can use BIM by searching for any of its known capabilities, but also for any other task we can imagine. All we need is to know and properly manage the parameters of the different building elements in our virtual model, or the parameters we have assigned them. To be more specific, let's focus on the parameter of dimensions in BIM. One of BIM's functions is the 3D modelling and visualisation. It is now possible to create precision designs thanks to powerful programs on the market. This allows us to offer to our customers any manner of technical drawings, which will be perfectly coherent with one another and fully parameterised.

WITH BIM, OUR PROJECT IS OSTENSIBLY SUPERIOR AND FAR MORE DESCRIPTIVE, COHERENT AND COMPLETE

We can also generate the most photorealistic images and impressive videos of our virtual models. However, when we incorporate 4D information, other uses become possible. The concept of time allows us to create work schedules, reducing completion times and integrating work from each discipline into each stage of the work. All this is done using the parameters of our virtual model. 5D information refers to the costs of different building elements and consignments, making it possible to generate estimates and project certifications as works develop. We can also link the different building elements to our favourite cost database and manage parametric measurements with our preferred estimating software. 6D information refers to the building's sustainability. The software makes powerful energy use calculations, accounting for the building's



ORAT PROJECT
3D representation of passenger flows in the new terminal at Abu Dhabi airport, for which Ineco is responsible for operational readiness and airport transfer (ORAT) (see *IT51*).

BIM makes it possible to incorporate all kinds of information, from cost estimates to energy calculations or the cost of maintaining buildings. (In the image, Tikrit airport, Iraq).

exposure to the sun and countless other criteria that directly influence the building's sustainability throughout its life cycle. Finally, 7D information is dedicated to the operation and maintenance of the property, the costs of which reach several times the original cost of the work.

The BIM methodology can integrate the Lean methodology (cutting waste and inefficiency) and the concept of Integrated Project Delivery (IPD), a new trend in construction where the architect, engineers, contractor and even the administration work in conjunction in drawing up projects. This makes it possible to solve problems from the very beginning, when the cost of addressing them is negligible compared to rectifying errors of coordination once work is underway.

Whether we like it or not, BIM has arrived and it's here to stay. The governments of many countries are promoting the use of BIM and making it a requirement of its biddings. There is no turning back. We do not have money to improvise prototypes for every work. With BIM, we create the prototype virtually and begin production once it is optimised, as if it were a ship or a plane.

THE GOVERNMENTS OF AN EVER-INCREASING NUMBER OF COUNTRIES ARE PROMOTING THE USE OF BIM

BIM is not new by any means; what is new is the capacity of our personal computers to handle this enormous amount of information, and the ability to use telecommunications to send that information anywhere in the world. These new capabilities have made BIM a reality in the offices of small technical firms around the world, rather than only in large, elite centres. Spain is characterised by having a great number of these smaller offices and very few huge work centres. But let's not forget the potential of Spain's large engineering and construction firms. They are currently working more on large works in the rest of the world than in Spain. However, all the important work being done will gradually begin to require the use of the best available technology: BIM.

PRO-BIM ORGANISATIONS

All this movement led to the creation in late 2011 of the buildingSMART Spanish Chapter *(www.buildingsmart.es)* of BuildingSMART International, the agency that works with the ISO and the CEN in developing international standards for BIM. When it was founded, there were few more than 20 member companies, institutions and private individuals. Today, the group has over 140 members from all parts of the sector: engineering and construction firms, architects, building products manufacturers, software developers, project developers, research centres, universities, etc. Sergio Muñoz has been the organisation's president since it was founded. If we examine the association's website, we can see that its objectives are the following:

▶ To develop and maintain international, open, neutral BIM standards (Open BIM).

▶ To accelerate interoperability in the construction sector through success stories.

▶ To provide specifications, documentation and reference guides.

▶ To identify and solve problems interfering with the exchange of information.

▶ To extend the use of this technology and its associated processes throughout the life cycle of the building, incorporating all actors involved.

Despite its short history and the fact that its members work without remuneration, it has made very significant achievements. The following are particularly noteworthy:

▶ uBIM guides, produced with the voluntary participation of 80 technicians led by Manuel Bouzas. These guides are for users of BIM in Spanish and are analogous to the guides available in other countries and languages. The guides, comprising 13 documents, organise according to discipline the tasks of design, planning, construction and operation of buildings using BIM technology. The guides can be downloaded free at: *www.buildingsmart.es/bim/gu%C3%ADas-ubim/*.

▶ The *Spanish Journal of BIM* is a dissemination and research journal, published in Spanish. Directed by Antonio Manuel Reyes, the journal has a science committee made up of a group of professionals in the sector from Spain, Portugal, Argentina and Chile. It has been published biannually since mid-2014, both digitally and in print. The journal is free and available for download at: *www.buildingsmart.es/journal-sjbim/historial/*.

▶ esFAB, the Spanish BIM Academic Forum *(www.buidingsmart.es/esfab/)*, is organised by Norena Martín and Óscar Liébana. The goal of the project is to create an academic network to develop and promote training, learning and research in the field of BIM through close collaboration and cooperation between members and other organisations and bodies whose ultimate aim includes improving the productive model of construction.

In addition to these achievements, members of this active organisation participate in one way or another in all conferences in the sector and all commissions that meet on the subject. Noteworthy examples are the AEN/CT 41/SC13 Committee, which when it concludes will draw up an UNE standard on standardisation in BIM projects, and the recently formed CEN/442 Committee, which fulfils the same role at the European level.

But if anything can be expected to give the definitive push towards the use of BIM in Spain, it would be esBIM *(www.esbim.es)*, the BIM Commission set up by the Ministry of Public Works and organised by Ineco. The purpose of the commission comprises the following points:

1. To promote the implementation of BIM in the Spanish construction industry through the creation of a working group open to participation from the sector as a whole, both public and private.

2. To foster the use of BIM throughout infrastructure life cycles.

3. To raise awareness among public administrations about establishing BIM requirements in infrastructure public tenders with the aim of reducing costs.

4. To establish a schedule for adapting regulations for the generalised use of BIM.

5. To develop national standards allowing for a uniform application of BIM.

6. To produce the academic roadmap for BIM training in Spain and to promote its inclusion in curricula.

7. To promote the digitalisation of derivative work of infrastructure development, abandoning physical formats and consequently making economic and environmental savings.

8. To foster the application of Open BIM, wherein all BIM-related operations are based on open, universal, mutually interoperable standards.

9. To offer support in increasing and improving the position of Spanish industry in the world through the use of BIM methodology.

10. To secure Spain's participation in all international decision-making forums.

As a final comment: one idea that came out of this commission, and hence also out of the Ministry of Public Works, is for designs for public buildings submitted from 2018 to support BIM, and for linear works designs to support it from early 2019. The BIM train has pulled into the station, are you getting on board? ■

NATIONAL AND EUROPEAN SUPPORT
Ineco supports the Ministry of Public Works in the BIM Commission, which seeks to promote the implementation of the methodology in Spain. The image shows Ineco's president Jesús Silva presenting the programme for 2016. The EU has urged member states to address the modernisation of contracting and public tender regulations.

Roofs of the terminal building at Boavista airport in Cape Verde, designed by Ineco and opened in 2007.

Mirasierra looks at Madrid

With the new Commuter station at Mirasierra, located between the Pitis and Ramón y Cajal stations, residents of Fuencarral–El Pardo will have an integrated service on line 9 of the Madrid Metro. Ineco collaborated in its design and construction.

By **Marisa Guillamot** and **Antonio Asenjo,** architects

This simple and comfortable infrastructure brings residents of the district of Mirasierra in Madrid closer to the city centre in a matter of minutes. The new facility makes use of the Commuter line passing between Pitis and Ramón y Cajal stations, such that the station –with estimated traffic of almost 10,000 passengers– will be connected to Commuter lines C-7 and C-8. The area around the station comprises a series of residential buildings, green areas and sports facilities. The halt will service the district of Fuencarral-El Pardo with over 220,000 inhabitants and will improve links with the southeast thanks to its connection with line 9 of the metro.

THIS SIMPLE AND COMFORTABLE INFRASTRUCTURE BRINGS RESIDENTS OF THE MIRASIERRA DISTRICT CLOSER TO THE CENTRE OF MADRID IN A MATTER OF MINUTES

The spaces between the Metro and the Commuter train areas are connected via a main lobby that is the main entrance or exit to the station. On the upper floor there is a waiting room for passengers. The floor underneath the railway lines contains a hall with access control, a customer service office, public toilets, platform access by stairs and escalator, and lifts, as well as rooms for cleaning services. In the station itself, Renfe and Adif also have several rooms for their facilities.

The station has two new passenger buildings on both sides of the platform, connected by an inner walkway. It also has special facilities including the execution of a new processing plant.

PLATFORMS
The platforms are 210 metres long and five metres wide with ramps at the end. A marquee is placed on each platform using pieces covering a total length of 84 metres.

GARDENS
Around the station there are paved and garden areas and a children's playground, as well as pedestrian walkways between Montecarmelo and Mirasierra.

ENTRANCES AND EXITS
The station has a limited use access for maintenance and emergency vehicles on the southern road in the Montecarmelo district, and a pedestrian access, also on the Montecarmelo side, with stairs and a ramp, complying with accessibility standards. ■

GARDENS
Around the station there are paved and garden areas and a children's playground, as well as pedestrian walkways between Montecarmelo and Mirasierra.

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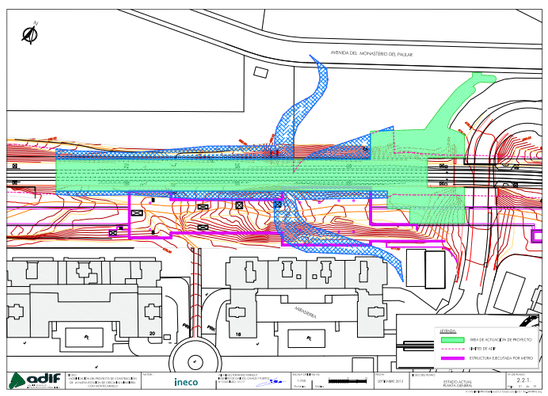

2

1. Halt.
2. General floor plan.

INECO'S EXPERIENCE WITH COMMUTER STATIONS

▶ **Jardines de Hércules, Seville.** Drawing up the construction project, construction management and coordinating health and safety. 2015.

▶ **Soto del Henares, Madrid.** Architectural, structural and facilities design and construction management. 2015.

▶ **Bogotá, Colombia.** Project for eight modern stations on the Western Corridor of Bogotá. 2011.

▶ **Rodalíes, Barcelona.** New station on the Sagrera-Meridiana Commuter line. Technical assistance in the work for the new station, the largest interchange in northern Barcelona. 2010.

▶ **Malaga.** Excavation project and two new Commuter stations for Malaga airport. Ineco drew up for Aena the blueprint and the construction project of the overall civil work (the bypass into dual tracks, the tunnel and the two stations). 2010.

▶ **Alboraya, Valencia.** Construction management and technical assistance on two new underground stations in Alboraya, line 3 of Valencia Regional Railway (Ferrocarriles de la Generalitat Valenciana, FGV). 2010.

▶ **Galicia.** Project of homogenisation of architectural elements of nine stations, as well as new passenger buildings for two of these (Arcade and Vilagarcía de Arousa), 2010.

▶ **Buenavista-Cuautitlán, Mexico.** Overall technical assistance until the commissioning of the line. 2009.

▶ **Miribilla, Bilbao.** New station Miribilla on Bilbao line C3. Project planning, management and technical support. With its platforms almost 50 metres underground, it is the deepest station on the entire Spanish railway network. 2009.

▶ **Commuter trains in Catalonia.** Several alterations –including a project for three new passenger buildings– on 20 of the 50 historic Commuter stations in Catalonia, which Adif remodelled in 2009.

▶ **São Paulo, Brazil.** Feasibility study on the modernisation plan for the São Paulo Commuter railway lines (CPTM), including building new stations and remodelling another 65. 2008.

▶ **Aranjuez, Madrid.** Restoring the station: prior investigations and overall project. (2007-2008). Works completed in two stages.

An effective connection

A pedestrian walkway, almost 300 metres in length, has been designed to connect Vigo-Peinador airport and the Instituto Feiral de Vigo (IFEVI), solving the challenging journey for pedestrians travelling between the two places.

By **Bárbara Canle**, civil engineer and **Cristina Palmero**, architect

Vigo-Peinador airport has undergone a number of works in recent years, for example the construction of a new public car park with over 2,500 spaces and the enlargement of the southern terminal building. The Instituto Feiral de Vigo (IFEVI), which is very near to the airport, hosts more than half the international events held in Galicia. A large proportion of attendees arrive by air. The large capacity of the new terminal car park also makes it possible to expand the parking offered by the exhibition centre itself. Given the short distance separating the airport and the exhibition centre, visitors used to travel between the two across the roundabout by which both places are accessed by road. The considerable traffic, the dimensions of the roundabout and the high number of roads connected to it made the walk a long, tortuous journey, where road crossings were challenging and pedestrians were not protected from poor weather conditions. The pedestrian walkway connecting Vigo-Peinador airport with the Instituto Feiral de Vigo has two purposes. Firstly, there is the intention of exploiting the airport terminal car park to serve the exhibition centre. Secondly, the walkway facilitates the connection between the terminal and the exhibition centre for visitors arriving by air. It establishes a path that connects both places, and on another level avoids the different roads between the terminal car park and the IFEVI centre.

The walkway begins at car park P-1 and ends beside the heavy vehicle parking basins at the exhibition centre. The walkway has a total length of 281 m, with 10 spans of a maximum length of 40 m. The walkway's roof is designed with geometrical surfaces whose orientation follows a logical sequence spanning the length of the walkway. The play between different dimensions, densities and angles of the different segments brings the ensemble a dynamic, three-dimensional character. ■

Priority measures

Defining railway gauges is not only a crucial safety consideration; it also allows for interoperability in international traffic and can mean significant cost savings in infrastructure construction. Ineco carries out these complex calculations both for high-speed and for conventional lines, in national and international settings (Saudi Arabia and United Kingdom).

By **Carmen Vecino**, civil engineer

Gauge calculation is a complex process to check whether there is sufficient space between rolling stock and the infrastructure on which it operates. Gauges need to be defined for the construction of vehicles, the installation of equipment near the track and for loading open freight wagons, in order to guarantee rail traffic safety and to avoid interference between vehicles and between vehicles and track infrastructure. The implementation of these standards thus guarantees safety, preventing impacts between trains travelling on adjacent tracks or with the infrastructure itself, and always providing for a minimum margin of protection.

All gauges based on the kinematic calculation method, are based on a combination of the specific reference profile and its kinematic associated rules, that form an agreement between the rolling stock and the infrastructure.

As defined in the EN 15273:2013 a 'gauge is a set of rules including a reference profile and its associated calculation rules allowing definition of the outer dimensions of the rolling stock and the space to be cleared by the infrastructure'.

The conclusions of the gauge study are of great importance, as in addition to guaranteeing traffic safety, they can also have financial implications: in specific points such as structures or tunnels, the study may find that it is possible to reduce the size of rolling stock or

GAUGE CALCULATIONS
The definition of gauges is a complex process that ensures traffic safety, preventing interference between vehicles and these with the infrastructure.

that infrastructure requires enlargement. The following gauges are used in railway activities:

▶ **Rolling stock gauge:** the maximum construction profile for rolling stock to operate, whether on straight sections or on curves.

▶ **Structure gauge:** defines the space relative to the track, not to be encroached upon at any time by objects or structures neither by traffic on adjacent tracks, in order to permit safe operation. There are three types defined in *ORDER FOM 1630/2015:*

• **Limit gauge:** is the space not to be encroached upon at any time to ensure completely safe passage of traffic.

• **Nominal gauge:** defines the space to be cleared of any obstacle in order to enable train operations and track maintenance by incorporating allowances for safety, maintenance as well as additional allowances defined by the infrastructure manager.

• **Uniform gauge:** defined for a line. It is a nominal gauge derived from the least favourable set of circumstances which do not occur simultaneously on any stretch of track.

▶ **Loading gauge:** the space that must not be obstructed in static conditions by a wagon's load.

GAUGE STUDIES FOR DIFFERENT TRACK TYPES CAN REDUCE TUNNEL CROSS-SECTIONS, IMPLYING SIGNIFICANT SAVINGS

REGULATIONS IN A UNITED EUROPE

There are different regulations for gauges, in Spain and in Europe. The European Union Agency for Railways (ERA) was set up in April 2004 to develop procedures within the framework of interoperability and railway safety. This implies the implementation and development of Technical Specifications (TSI) for Interoperability and a common approach to questions concerning railway safety.

To achieve this, the ERA contributes technically to the implementation of the EU legislation aiming at improving the competitive position of the railway sector by: enhancing the level of interoperability of rail systems; developing a common approach to safety on the European railway system; contributing to creating a Single European Railway Area without frontiers guaranteeing a high level of safety.

The aims of interoperability are to allow the safe and uninterrupted movement of trains and reconciling the various national railway systems of the EU countries, suppressing or reducing technical barriers.

To improve the level of interoperability, ERA establishes and manages the development and updating of the TSIs.

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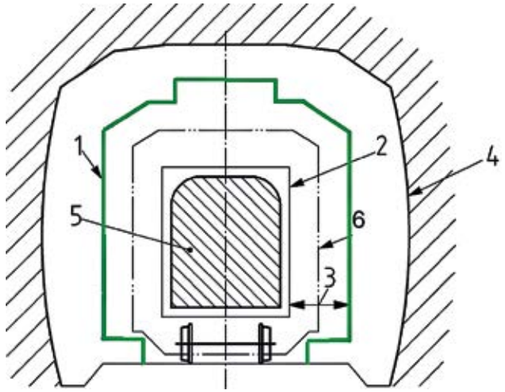

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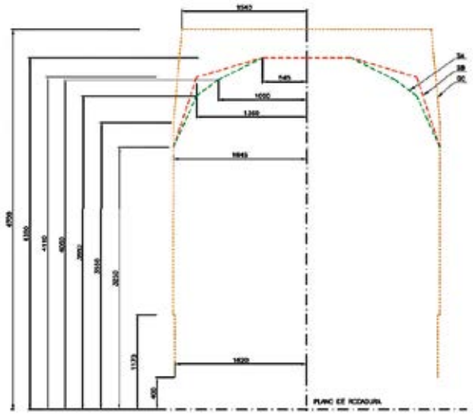
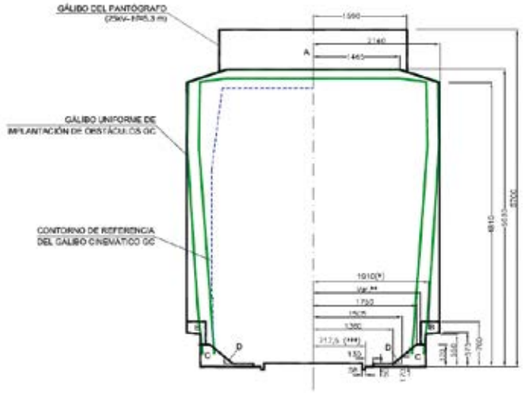


TSIs are intended to foster the development of a single European railway system ensuring the essential requirements of *Directive 2008/57/EC* on the interoperability of the rail system within the Community.

The TSI for the European Union infrastructure subsytem (Regulation nº1299/2014), in sections *4.2.3.1 Structure gauge*, *4.2.3.2 Distance between track centres* and *4.2.9.3 Platform offset*, defines the gauge, the space between track centres and the platforms installation, according to *Standard EN 15273:2013 Railway Applications. Gauges*. In addition to this, gauge assessments are established in sections *6.2.4.1 assessment of structure gauge*, *6.2.4.2 assessment of distance between track centres* and *6.2.4.11 assessment of platform offset*.

In Spain, *Order FOM/1630/2015*, of 14 July, has been drafted. The Order, published in Spanish Official Gazette (BOE) of 04/08/2015, approves the *Railways Instruction on Gauges*, which defines the gauges to be considered in the construction of vehicles, the installation of equipment near the track and the loading of open freight wagons.

3



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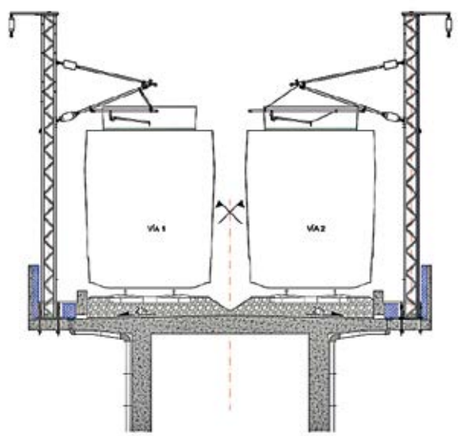

The Instruction was drafted to be consistent with *Standard EN 15273:2003* on gauges, and respects the TSIs for the infrastructure, rolling stock and energy subsystems of trans-European conventional and high speed railway systems.

INECO'S EXPERIENCE WITH GAUGES

Ineco has participated in drafting both European *Standard EN 15273:2013* and *Order FOM/1630/2015*, as an expert representative for the part concerning infrastructure (structure gauge). The company periodically attended meetings of the WG 32 working group of Technical Committee CEN TC256 for Railway Applications, and meetings of the National Mirror Group for Gauges (WG32 mirror group) *AEN/CTN 25/SC04/GT 03 GÁLIBOS*. Spanish and European railway sector experts (Adif, Renfe, Talgo, CAF, Infrabel, SNCF, Alstom, RSSB, RATP, ÖBB, etc.) have collaborated at these meetings. *Order FOM 1630/2015* is applicable to the definition of the structure gauge and takes into consideration the planning of new railway lines and the adaptation of existing ones. The Order covers lines in the public railway network of Iberian, European standard or metric gauge tracks (excluding the Cercedilla-Cotos line in the province of Madrid).

The company has over 30 years' experience working with gauges and more than five conducting studies for structure gauges and determining pantograph gauges, distance between track centres and installation of platform offset. This work has been done both for the planning of new railway lines and for the adaptation of existing ones in the public railway network of Iberian, European standard and metric track gauges. This process involves analysing track parameters (horizontal radius, vertical alignment radius, track type and condition, top speed, maximum cant and cant deficiency, etc.), making calculations according to European and/or Spanish regulations, creating diagrams and delivering reports describing the methodology used and the main conclusions. When the calculation process is completed, width and height values are obtained for each point studied.

This experience has allowed Ineco to calculate gauges in all areas of Spain, including stretches of the Mediterranean Corridor and the Basque "Y", among other lines. Internationally, the company has carried out studies for the Haramain high speed project in Saudi Arabia and the United Kingdom's HS2 (High Speed 2) project, which will connect London and Birmingham. Recently, in June 2016, Ineco staff spoke at a training event on gauges held by the Spanish Railways Foundation (FFE, for its Spanish initials). The event offered an introduction to structure gauges and the practical application of calculating them. ■

1. Structure gauge.
(1) Structure gauge
(2) Rolling stock maximum construction profile
(3) Sum of vehicle movement and infrastructure interaction phenomena
(4) Infrastructure
(5) Vehicle
(6) Reference profile

2. GA, GB and GC kinematic gauge reference contour. The upper parts of the reference contours (the contour drawn on coordinate axes, in order to define the vehicle gauge and the structure gauge using the kinematic gauge method) of the upper parts of the European standard track gauge (1,435 mm) kinematic gauges GA (in green), GB (in red) and GC (in yellow).

3. GC uniform gauge. The diagram shows the uniform gauge, which is a nominal gauge for a set of sufficiently unfavourable parameters (radius, cant etc.) that would not be exceeded in the majority of the line. This enables the use of a single gauge for the entire line. The diagram also shows the pantograph gauge, the calculation of which is influenced by the type of pantograph, the type of overhead line, the contact wire height and track parameters. The data used for the calculation were:
- Minimum radius of the track alignment: 250 m
- Minimum vertical alignment radius: 2,000 m
- Maximum cant: 160 mm
- Maximum cant deficiency: 150 mm
- Ballasted track in poor conditions
- 1,950 mm pantograph with non-insulated horns
- EAC-350 catenary

4. GC uniform gauge on viaduct section. The diagram shows the GC gauge and the pantograph electrical gauge, calculated for a viaduct section.

All about my art

From the anonymous prehistoric artists of Altamira to Velázquez's *Meninas* at the Prado, Picasso's *Guernica* at the Reina Sofía, to avant-garde centres such as the Guggenheim in Bilbao or the MUSAC in León, you can trace Spain's history through its museums.

By ***ITRANSPORTE***

FROM ALTAMIRA TO GOYA

The Caves of Altamira in Cantabria –named a World Heritage Site by UNESCO in 1985– keeps the traces of the earliest settlers in cave painting form, between 35,000 and 13,000 BC. There is also a reproduction at the National Archaeological Museum in Madrid, which was recently refurbished. This museum, together with the Museum of Roman Art in Mérida, among others, displays pieces by Phoenician, Greek, Carthaginian, Roman and Visigoth artists.

RELIGIOUS ART


03

Cathedrals and monasteries across Spain are home to almost two hundred religious art museums, containing everything from altarpieces and religious ornaments to religious imagery, from the Middle Ages to the Baroque period, for instance the Museum of Holy Week in Valladolid (03), Museum of Zamora or the museums of the great Spanish gothic cathedrals like Burgos, León, Seville or Segovia.

FROM EL GRECO TO SOROLLA

Toledo is home to the El Greco Museum. El Greco was one of the great masters of the Spanish renaissance. The museum's creation in 1911 was the initiative of the Marquis of the Vega-Inclán, who also founded the Museum of Romanticism in Madrid.

The Thyssen-Bornemisza Museum has a noteworthy collection of Spanish impressionists such as Mariano Fortuny, Darío de Regoyos, Ignacio Zuloaga and Joaquín Sorolla, as well as a monographic museum in Madrid.

FROM PICASSO TO DALÍ


04

The great geniuses of the 20th century, like Pablo Picasso (04) (Cubism), Salvador Dalí and Joan Miró (Surrealism) are well represented in Spanish museums: the famous Guernica by Picasso, a piece in protest against the Civil War of Spain (1936-39) is the flagship piece of the Reina Sofía Art Centre in Madrid, although his extensive oeuvre is also exhibited at the Picasso Museums of Barcelona and Malaga. Dalí's creations can be found in Catalonia (Figueres Theatre and Museum, in Girona, Púbol and Portlligat Museum-Houses, Perrot-Moore Art Centre in Cadaqués, the Museum of Montserrat and the Regional Museum of Maresme), but also in the Thyssen and Reina Sofía in Madrid, and the Juan March Foundation Museum of Contemporary Art in Palma de Mallorca. The Foundation also directs the Spanish Abstract Art Museum, located in the Casas Colgadas (Hanging Houses) of Cuenca, with paintings and sculptures of Millares, Tàpies, Torner, Rueda, Saura or the founder Fernando Zóbel, among other.

The Prado Museum (02) was visited by 2.7 million people in 2015, more than the entire population of Paris. Along with the Reina Sofía Art Centre and the Thyssen-Bornemisza, all in Madrid, it is the star of Spain's museum offerings. Although it is far from receiving the number of visitors that the number one in the world, the Louvre, can boast, it is one of the best in terms of the relevance of its permanent collection, which includes the main works by universal Spanish artists such as Francisco de Goya and Diego Velázquez.

The extraordinary wealth of its collections includes four centuries of Spanish, Italian and flamenco art, among others: Tiziano, Tiépolo, Rafael, Rubens, Rembrandt, El Greco and El Bosco (01), through to Mengs, Correggio and many more. ■


02


05

BUILDING AS ART

Special mention is owed to the museums of contemporary art in which the separation between vessel and content is blurred, forming a whole in which the building is conceived as one more work of art. This is the case of the Guggenheim in Bilbao, by Frank O. Gehry, which is home to works by artists such as Chillida, Tàpies, Andy Warhol and Jeff Koons (05); the MUSAC in León (Mies van der Rohe Award) or the ARTIUM in Vitoria, which exhibits works by artists such as Miquel Barceló, Antonio Saura and Jorge Oteiza, as well as pieces by Dalí, Miró and Rafael Canogar.

It is also worth mentioning the Valencia Institute of Modern Art (IVAM in Spanish), which has a considerable space set aside for photography and graphic design, with works by Constantin Brancusi, Man Ray and Robert Capa.

Experience, competitiveness and technology at the service of society

Ineco has extensive experience in transport engineering:
over 45 years planning, designing, managing, operating and maintaining airports, railways, roads, ports and urban transport systems throughout the world.

Ineco is a global leader in infrastructure engineering and consultancy. With a presence in more than 50 countries, it has an expert team of 2,500 professionals and has for more than 45 years contributed to the development of projects in all areas of transport: planning, airports, air navigation, railways, urban transport and ports. Its activities extend to the environmental sector, architecture and construction.

Ineco offers comprehensive solutions in all phases of a project, from preliminary feasibility studies to commissioning, including making improvements to management, operation and maintenance processes.

Its high level of technical capability allows it to bring the most advanced ad innovative developments, both for the public and the private sector, anywhere in the world. ■

MODES

Aviation

Railways

Roads

Urban Transport

Ports

PROJECTS

- ▶ Airport's ORAT. **Abu Dabi**
- ▶ Airport Expansion Project Management. **Kuwait**
- ▶ Modernisation of the airport network and reorganisation of airspace. **Spain**
- ▶ Spanish High-Speed network. **Spain**
- ▶ HS2 high speed. **United Kingdom**
- ▶ High Speed Makkah-Madinah. **Saudi Arabia**
- ▶ CPTM lines, São Paulo. **Brazil**
- ▶ Supervising Agent Guadalajara-Colima highway. **Mexico**
- ▶ Strategic Mobility Plan **Ecuador**
- ▶ Lima international airport expansion. **Peru**
- ▶ ERTMS deployment in **Europe**
- ▶ Muscat's Public Transport Plan. **Oman**
- ▶ National Collection and Treatment of Waste Plan 2016-2026. **Panama**
- ▶ Irrigation and Drainage National Plan. **Ecuador**
- ▶ Modernisation of the Samsun-Kalin railway line. **Turkey**
- ▶ Expansion and improvement of the Spanish railway stations. **Spain**
- ▶ Transport Infrastructure Programme Management and National Transport Plan. **Costa Rica**
- ▶ Technical supervision of the new trains at Medellin Metro. **Colombia**
- ▶ Tram line 4 in Tallinn. **Estonia**
- ▶ Coordinating works on the Mário Covas bypass in São Paulo. **Brazil**

INECO IN THE WORLD

AFRICA
Angola
Algeria
Cape Verde
Egypt
Ethiopia
Kenya
Mali
Morocco
Mauritania
Namibia
Uganda

AMERICA
Argentina
Bolivia
Brazil
Chile
Colombia
Costa Rica
Ecuador
El Salvador
Jamaica
Mexico
Nicaragua
Panama
Peru
Venezuela

ASIA
China
India
Iraq
Jordan
Kazakhstan
Kuwait
Malaysia
Nepal
Oman
Philippines
Qatar
Saudi Arabia
Singapore
Taiwan
UAE

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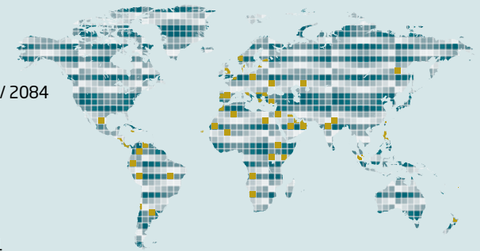

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