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BUILDING INFORMATION MODELING

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SMART CITIES

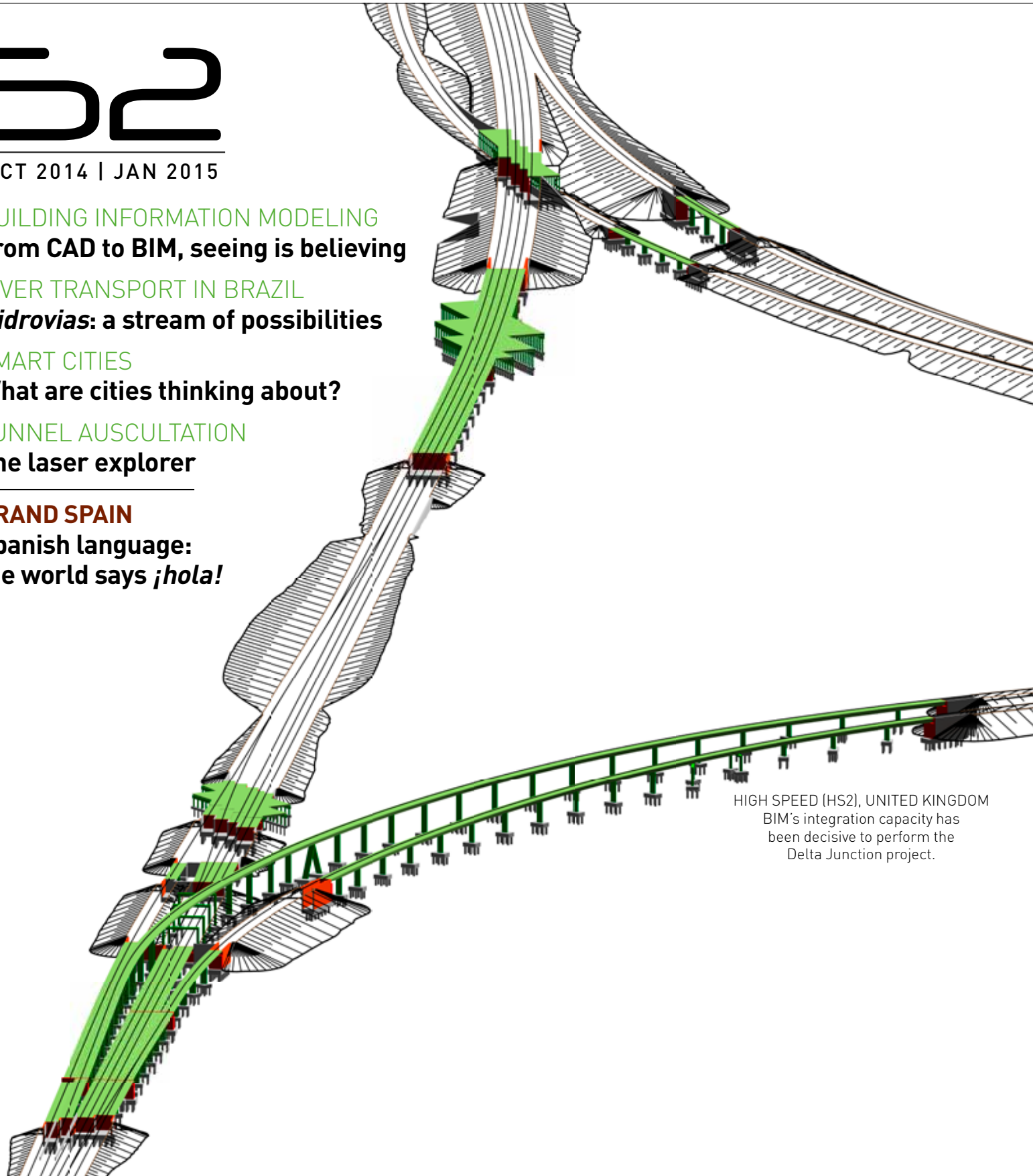
What are cities thinking about?

TUNNEL AUSCULTATION

The laser explorer

BRAND SPAIN

Spanish language: the world says *¡hola!*



HIGH SPEED (HS2), UNITED KINGDOM
BIM's integration capacity has been decisive to perform the Delta Junction project.

Editorial

Over the last few years, the advance of information technologies and communication is changing the way to tackle infrastructure planning throughout the world. If having the so-called TICs is nowadays an inescapable reality for any company, in engineering, TICs are already inherent to their DNA. Working methods considered unthinkable until a few years ago are now an everyday reality. For example, BIM technologies, which appear on the cover of this issue, make it possible to have collaborative environments which greatly streamline management and technical and economic-financial control processes of a project.

It has become increasingly more necessary to include all these communication tools in the planning and modernisation of our cities. In the article about smart cities we include in this issue, we assume that more than half of the world's population lives in urban areas. Having efficient, sustainable and well-organised transport systems requires using new and sophisticated equipment and data systems, and this is when "the Internet of Things", as well as the Big Data, come into play. Ineco has long been developing projects both in emerging cities and more mature populations from anywhere in the world, applying different planning strategies supported by TICs, a corporate and strategic decision which makes us gain as a consulting company and which allows us to offer the most advanced and comprehensive solutions.

Eventually, steps must be taken to make these technologies applied to mobility allow for sustainable development and life quality improvement of our citizens. Definitely, a bet which requires coming up with new outlines, making further progress in and collaborating with new disciplines and, above all, imagining and dreaming about the city we would like to live in.

Pablo Vázquez
President of Ineco

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COVER IMAGE: Delta Junction, high speed in the United Kingdom (HS2).

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News

Ecuador

A delegation from Ineco meets with Ecuador's Transport minister

Paola Carvajal, Transport and Public Works minister welcomed a delegation from Ineco last July. On the photo, from left to right, José Manuel Sáez, country manager of Ineco in Ecuador; Álex Pérez, Transport Management viceminister of Ecuador; José Manuel Tejera, managing director of Infraestructures and Transport of Ineco; Paola Carvajal, Transport and Public Works minister of Ecuador; Pablo Vázquez, president of Ineco; and Miguel Arregui, ministerial adviser and current Infrastructure viceminister of Ecuador.

United Kingdom

Ineco, supplier of railway design services

The company has successfully completed the registration as railway design service supplier in Achilles RISQS (Railway Industry Supplier Qualification Scheme). RISQS is a prequalification system which determines the suitability of suppliers to work with the main clients of the British railway sector such as Network Rail or Transport for London. Ineco is currently subscribed to the Pro Trans and DocuPLUS community, of the Achilles family.«

Abu Dhabi

AL AIN INTERNATIONAL AIRPORT

Studies for a new MSSR radar

As a consequence of the foreseen enlargement of Al Ain International Airport, airport managers, Abu Dhabi Airports, have entrusted Ineco's experts in air navigation the studies for the location of a new radar. Enlargement plans foresee refurbishment works and new buildings which would require a new surveillance system whose features are not affected by current and future infrastructure.
The Spanish company will perform the necessary studies for the correct location and operation of

an MSSR(Monopulse Secondary Surveillance Radar) radar, a generation of ATM/CNS systems in which Ineco has extensive experience.«

Al Ain airport, which opened in 1994, is Abu Dhabi's second international airport. Located 18 kilometres away from the city of Al Ain and close to the border with Oman, it will have a new cargo terminal and high-tech facilities for airline catering services.

Mexico /Costa Rica

SPANISH DELEGATION IN MEXICO
Spain's minister of Public Works, Ana Pastor, the State Secretary for Infrastructure, Transport and Housing, Rafael Catalá, Renfe's chairman, Julio Gómez-Pomar, and Ineco's chairman, Pablo Vázquez were part of the Spanish delegation.

COLLABORATION IN INFRASTRUCTURE PROJECTS

Minister of Public Works Ana Pastor chairs the Spanish delegation

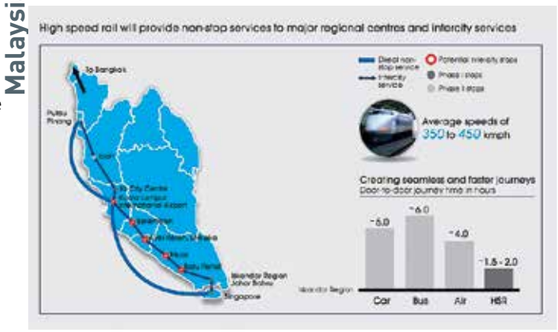
Spain's minister of Public Works, Ana Pastor, the State secretary for Infrastructure, Transport and Housing, Rafael Catalá, Julio Gómez-Pomar, Renfe's chairman, and Pablo Vázquez, president of Ineco, have become part of the Spanish delegation which has visited Costa Rica and Mexico last September to offer collaboration of the government and the Spanish companies in the future infrastructure projects of both countries. Ineco is closely working with the authorities of both countries in projects as relevant as Costa Rica's National Transport Plan or the construction of Guadalajara-Colima highway in Mexico, for which Ineco acts as supervising managing agent.«

Official opening of Galileo Service Centre

The meeting to launch the project for the definition of services and operations of the World Centre of User Services of the satellite navigation system Galileo was held at the offices of INTA (National Institute of Aerospace Technology) in the Spanish town of Torrejón de Ardoz, on 9 September this year. The centre, so-called Loyola de Palacio in tribute to former vicepresident of the European Commission and Transport Commissioner, will act as an interface between the system and the users of Galileo satellites.
Galileo is the first satellite navigation system for civilian purposes which will provide Europe technological independence with respect to current GPS systems (from USA) and GLONASS (from Russia), being at the same time supplementary and interoperable with them.
Its high performance will guarantee the service running even in the most severe circumstances and will inform the corresponding users of any anomaly within seconds, thus being suitable for critical applications.«

On the photo, members of the consortium, coordinated by Ineco and made up of INTA, Isdefe, ESSP and Ineco, together with representatives of the European Union, the European Space Agency (ESA) and the European GNSS Agency (GSA).

Malaysia



Informative graph of high speed railway in Malaysia.

New contract

Ineco has signed a contract with Malaysia's Public Transport Authority (SPAD) to perform a study of traffic demand for the future high speed line between Malaysia and Singapore. The so-called south high speed corridor is part of the improvement program launched by the Malaysian government in 2010 to boost the socio-economic development of the region.«

News

Madrid

Pablo Ramos, HS2 project manager in London, and Juan R. Hernández, Ineco's delegate for Europe, with the delegation at CEDEX.

Visit of HS2 delegation

Representatives of HS2, United Kingdom's high speed, accompanied by Ineco's, Adif's and Cedex's professionals visited several facilities in Madrid on 8 and 9 September this year. The appointment took place as a result of Ineco's and Capita's invitation to get to know Spanish infrastructure. Both companies have been awarded a contract for the preliminary design of the Country North section of HS2 high speed line.

Ecuador

ATTENDANTS TO THE SEMINAR together with professors Marcelo Burgos and Ignacio Berenguer and Miguel Blanco (bottom right), project manager at Ineco.

Seminar on port engineering

Ineco has organised a seminar on port infrastructure design for Ecuador's Ministry of Transport and Public Works. During the two weeks the course held in Quito last July lasted, more than 50 Ecuadorian engineers and architects from the public and private sector have attended a programme that deals in depth with port engineering, from port planning to port building and management. To perform this training, Ineco has been aided by Fundación Valencia Port, an institution with wide national and international experience in port training.«

Refurbishment of Ministry of Economy and Competitiveness' office

The Ministry of Economy and Competitiveness has entrusted Ineco the project management and safety and health coordination services of the overall refurbishment works of the Ministry's headquarters. The job includes the refurbishment of 18 floors and the communications room of this iconic building located at Cuzco ministerial estate in Madrid. The company has wide experience in building, participating in the design and management of several unique structures and buildings in transport projects.«

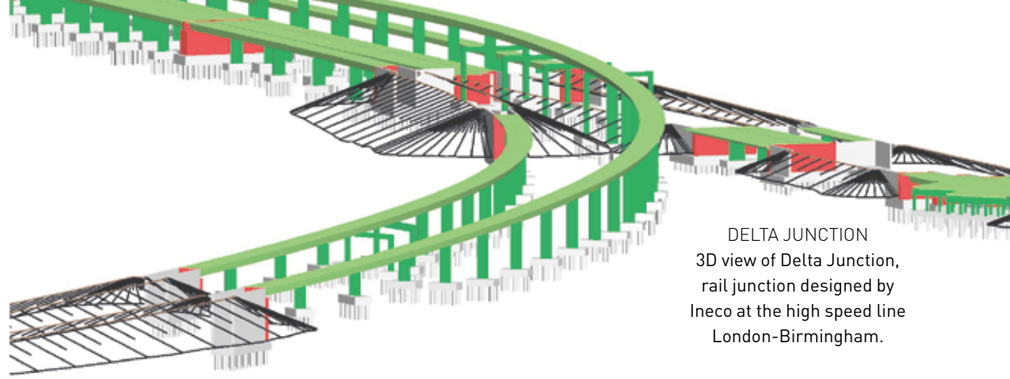
Ineco's in-house training school

The new in-house training school of Ineco has launched its first course addressed to works managers this summer. Over 50 professionals of the company have attended a thorough programme on work administrative management, safety and health, quality and environment, delivered by 10 professionals of the company with vast knowledge in these subjects. Furthermore, for this first course, one of the lecturers was Antonio Gutiérrez, Adif's Building and Operation general manager and Adif-High Speed general manager. **On the image**, Pablo Vázquez, president of Ineco and Berta Barrero, Corporate general manager, in the back, together with some lecturers and works managers of the first student class.«

From CAD to BIM, seeing is believing

Ineco's engineers speak about their experience with Building Information Modeling*

With the collaboration of **Luis Miguel F. Ferragut**, civil engineer and **Farah Baroudi**, aeronautical engineer



DELTA JUNCTION
3D view of Delta Junction, rail junction designed by Ineco at the high speed line London-Birmingham.

From left to right: **Luis Miguel F. Ferragut** (civil engineer), **Farah Baroudi** (aeronautical engineer), **Cristina Palmero** (architect), **Amelia Díaz** (architect), **Jorge Viñas** (BSc in Architecture), **Antonio Rúa** (BSc in Architecture), **Carlos Navas** (BSc in Mechanical Engineering), **Juan Carlos Alonso** (civil engineer), **Esther de la Montaña** (industrial engineer), **Raquel Veneros** (BSc in Architecture), **Carlos Loma,** (CAD manager), **José Manuel Blanco** (industrial engineer).

A MULTIDISCIPLINARY TEAM

Ineco has been betting on this technology for years and has a team of professionals dealing in design, modelling and development of BIM projects made up of engineers, architects and draghtsmen from all the areas of architecture, structures and installations, assisted by project and business and commercial development managers with the purpose of facing and overcoming the challenge involved in this new system. With this purpose in mind, the company works with state-of-the-art equipment and mainly with Bentley and Autodesk software.

BIM is not only an overall tridimensional image of a project. The AutoCAD substitute is also a summary of all the physical, functional and economic data needed for the design, building, exploitation and maintenance of works. In this interview, Ineco's engineers go over their experience in jobs performed with this tool which is changing the working system for the construction of buildings and civil works.

As in the Buggles' song *Video killed the radio star*, a world hit in 1979 in which the video killed the radio, the new digital management and 3D modeling system BIM is gradually displacing the bi-dimensional AutoCAD with which millions of engineers and architects in the world studied. The transition from one technology to the other leaves little doubt about the many advantages of the new competitor: with BIM, draughtsmen, engineers, architects, providers, constructors and clients, among many other professionals who are working on a project may virtually access and modify its development with thorough details and an immediate notification to all the parties involved which allows always working on the last version of the existing model.

In addition, governments are gradually implementing BIM in the regulatory requirements of their projects. For example, United Kingdom's decision to make it compulsory for level-2 readiness (3D) in all the projects of the public sector for 2016 implies these systems are being adopted little by little. Ineco is already willing to offer this readiness level based on how to pass from a lower to a higher data integration level, from level 0 (2D) to 3 (4D, 5D and 6D).

According to **Luis Miguel Fernández Ferragut**, civil engineer, "working with BIM allows obtaining better-quality design than through a traditional process, as the use of a single model for all disciplines benefits the coherence and coordination of all the project. On the other hand, concentrating greater efforts in early stages allows for better economic control."

Rather than a software, BIM is an information representation and modeling system of all the disciplines comprised in a building or civil engineering project.

BIM is an information representation and modeling system of all the disciplines comprised in a building project

Using this system, a large database is created, allowing managing the elements included throughout the whole life cycle of the project in real time, thereby enhancing the process and generating all the necessary documentation. **Antonio Rúa**, BSc in Architecture, states that "it allows developing several design alternatives which can be viewed in real time and relatively easily. The model positions itself with its geographical coordinates and based on real climatological data, it allows making a preliminary energy analysis: simulating the different alternatives

From 2016 onwards, all public sector projects in the United Kingdom will be carried out with BIM level 2 (3D), which means these systems are going to be gradually implemented; Ineco is ready for that

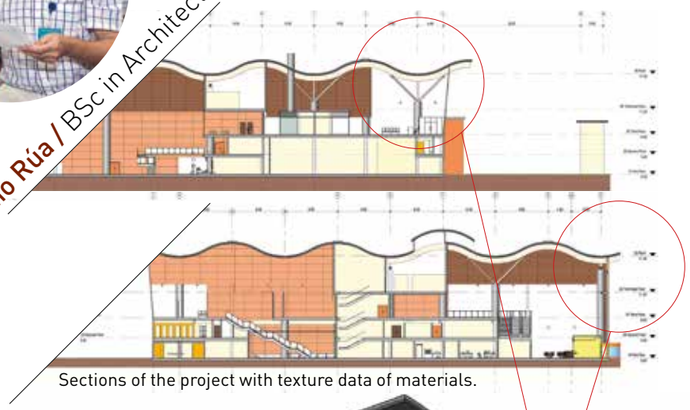
or modifying façade typologies, location and size of doors and windows, building orientation, etc." and adds "with this new working method, all the features (physical, mechanical, thermal, etc.) of all the elements and materials comprised in the project and required by the client are added to the project from the beginning . Also, the model allows having a real-time calculation of the costs as the project is being developed."

When the client requires substantial changes, BIM allows making them without extending deadlines

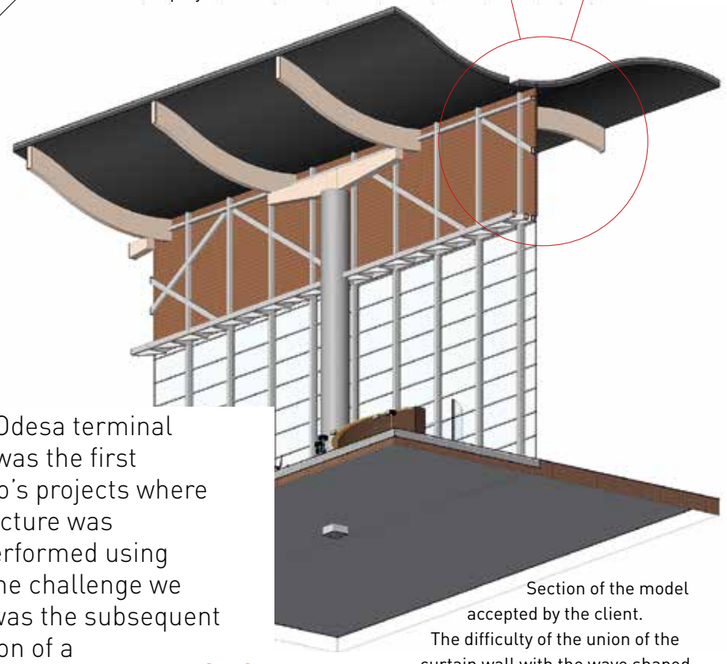
According to **Jorge Viñas**, BSc in Architecture and civil engineer, who has participated in the design of the enlargement of Boavista international airport terminal in Cape Verde, there are multiple advantages, "real building elements of different manufacturers can be incorporated and changed or modified based on the client's needs. This substantially speeds up and benefits communication with the client."

Indeed, when the client requires making substantial design changes in a short period of time, working with BIM allows facing these changes without major delays in the development of the project. **Farah Baroudi**, aeronautical engineer, makes specific reference to the major design changes required by the client during the execution of the project for the Odesa terminal building project (which included not only new areas but also new floors) as well as to the difficulties in the process »

Antonio Rúa / BSc in Architecture



Sections of the project with texture data of materials.

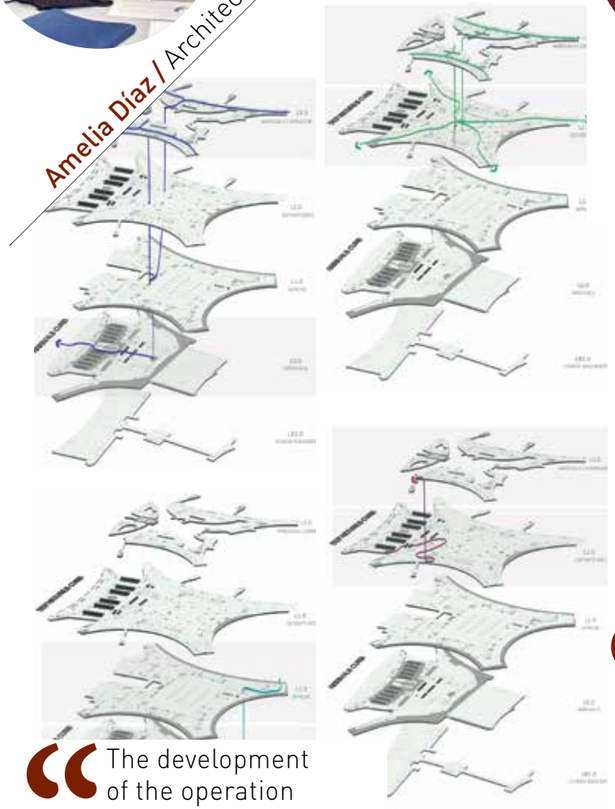


Section of the model accepted by the client. The difficulty of the union of the curtain wall with the wave shaped roof required different proposals.

> "Odesa terminal was the first of Ineco's projects where architecture was fully performed using BIM. The challenge we faced was the subsequent inclusion of a new 4,200-m² intermediate floor."

ODESA AIRPORT, UKRAINE

Amelia Díaz / Architect



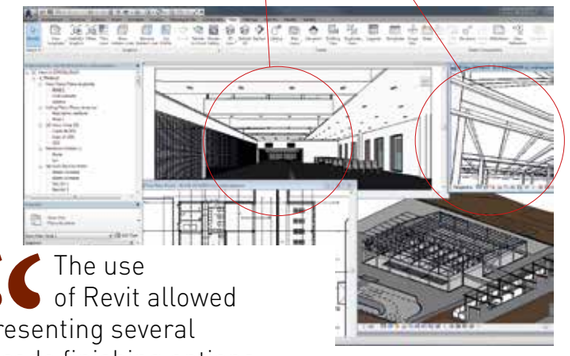
Passenger flows according to origin.

> "The development of the operation concept (CONOPS) of the future terminal in BIM was essential to obtain a graphic base according to which it was possible to clearly explain the passenger flow interference points."

ABU DHABI AIRPORT

Cristina Palmero / Architect

Indoor hall.



> "The use of Revit allowed presenting several façade finishing options, so the client was able to make a quick decision being aware of the design, cost, quality of materials and building methods."

ELCHE STATION, SPAIN

The roof solution allowed for natural lighting. Graphic representation made it possible to present several solutions and choose the most suitable one.

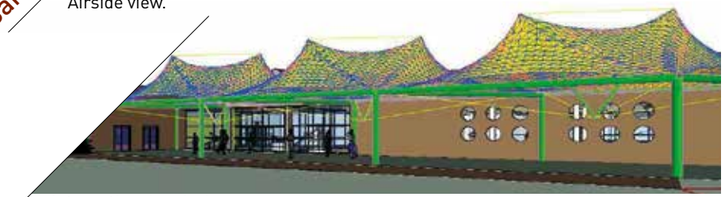
Façade solution.

With BIM, draughtsmen, engineers, architects, providers, constructors and clients may virtually access and modify its development working on the last existing version

to define the union of structural elements (beams) with architectural elements (curtain walls). BIM model allowed for the implementation of the changes required by the client leaving deadlines unchanged. This would have never occurred with traditional systems. Furthermore, sections and overviews obtained with BIM allowed viewing the union of the structure with the rest of the elements, so that the client was able to see the different solutions and take the most suitable decision from the technical and economic point of view."

Farah Baroudi / Aeronautical engineer

Airside view.



International arrivals.

BIM's integration capacity has been decisive to build the Delta Junction in the United Kingdom

According to **Pablo Ramos**, country manager of Ineco in the United Kingdom and in charge of the North section of HS2 –high speed between London and Birmingham– BIM's, integration capacity has been decisive to perform the Delta Junction project, a highly complex railway triangle. "Thanks to BIM we have been able to integrate and share information with all the members of the project team, working from London, Madrid and Seville. Its participatory and unifying nature has made decision-making, collaboration and cost reduction easier, which is highly appreciated by the client." This project received the Be Inspired Award 2013 from Bentley Systems.

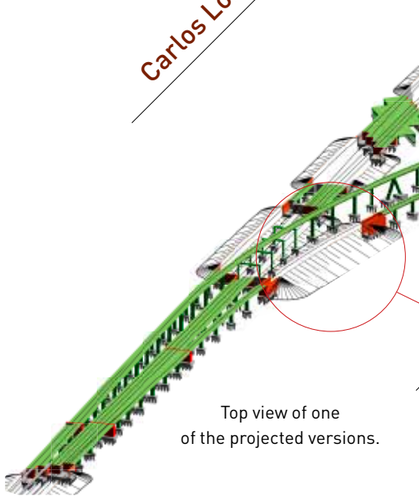
During the bidding process of the contract to perform the operational readiness and »

Retail area at Departures hall in Sal airport.

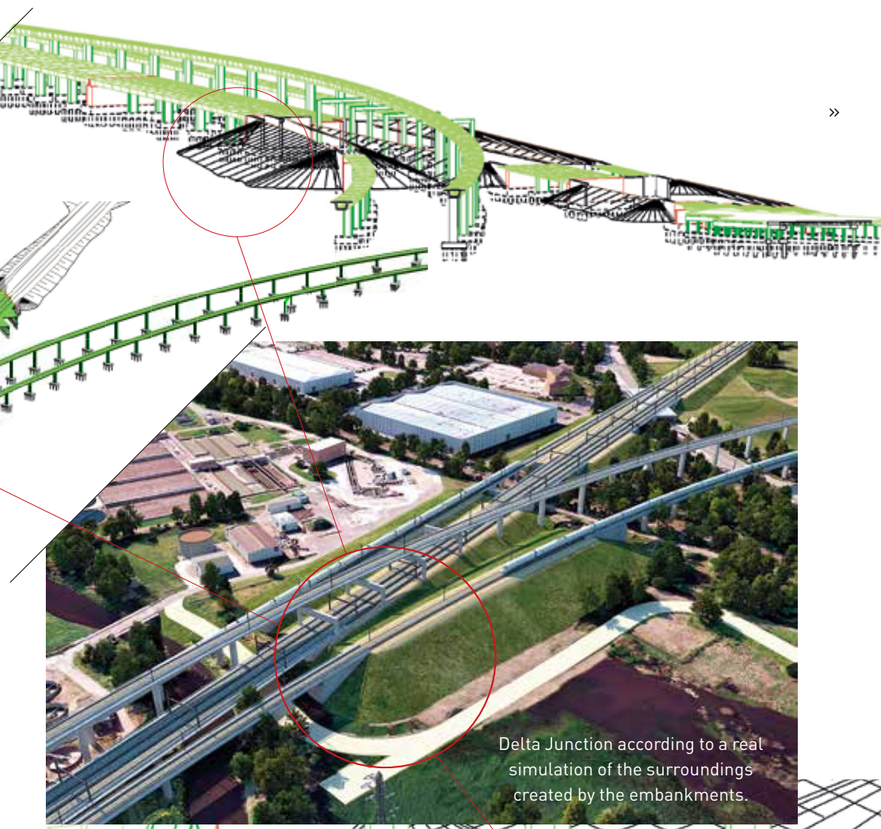
> "The challenge consisted in achieving the ideal combination of traditional concrete roof structures with the canopies of the patios. Working with BIM allowed choosing the most suitable solution from an aesthetic and structural point of view."
>
> SAL AIRPORT, CAPE VERDE

3D counter design.

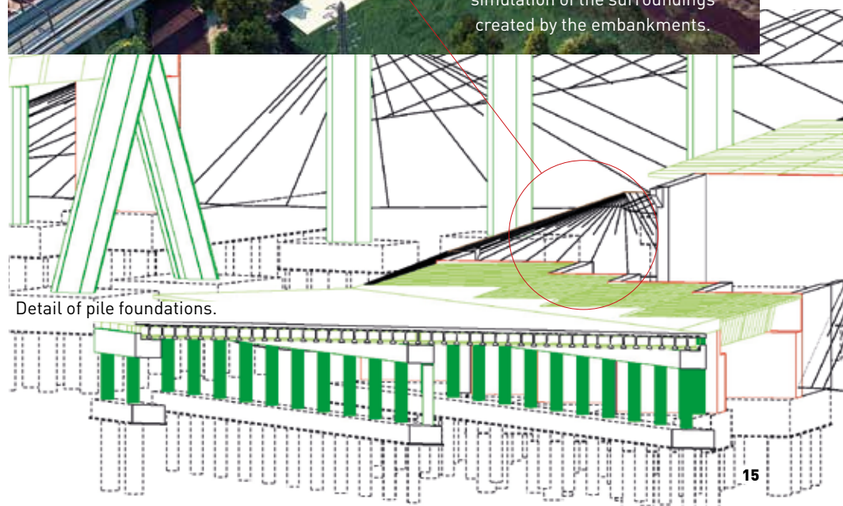
Carlos Loma / CAD manager



Top view of one of the projected versions.



Delta Junction according to a real simulation of the surroundings created by the embankments.

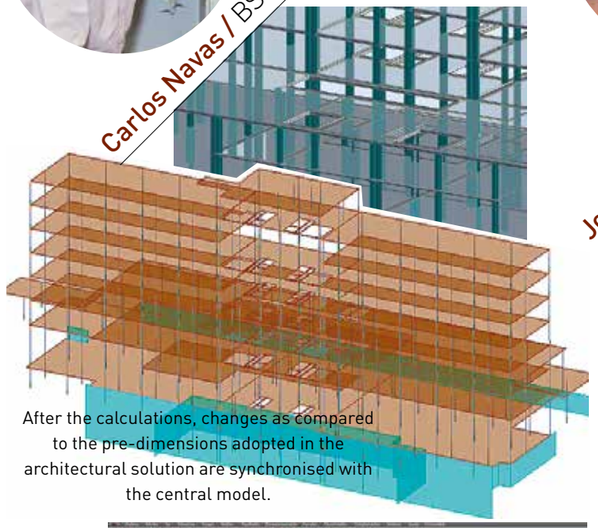


Detail of pile foundations.

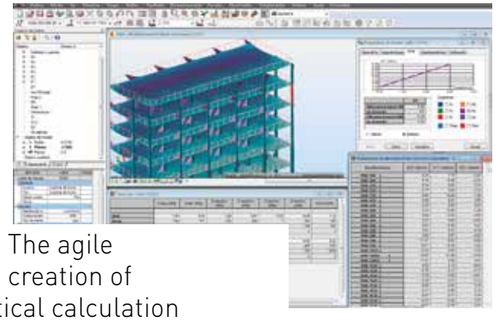
> "Besides Bentley's Power Rail Track –within Microstation– Projectwise documentation management tool was fundamental as it made work easier for the teams in Spain and United Kingdom."
>
> HIGH SPEED HS2 / UNITED KINGDOM

The BIM model allows changes to be introduced, viewed and quoted, and decisions can be taken based on them without delaying deadlines

Carlos Navas / BSc in Mechanical Engineering



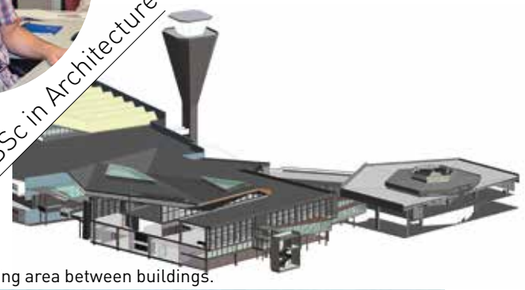
After the calculations, changes as compared to the pre-dimensions adopted in the architectural solution are synchronised with the central model.



> The agile creation of analytical calculation models as well as the improved bidirectional communication between architecture and engineering help enhance the final quality of projects.

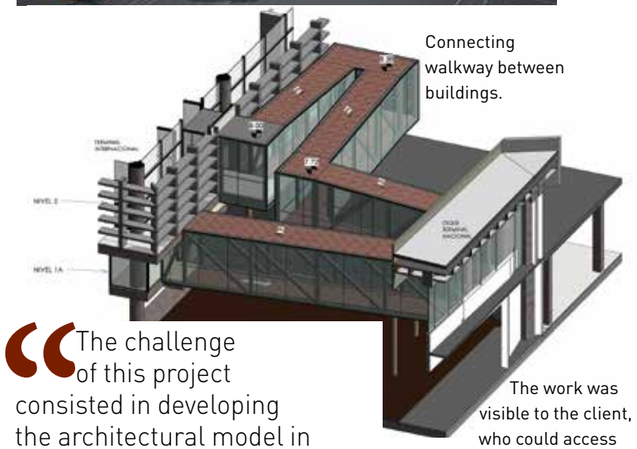
BUILDING STRUCTURE

Jorge Viñas / BSc in Architecture



Connecting area between buildings.

Recreation of Cali airport.



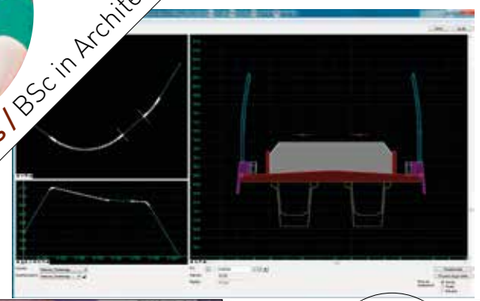
Connecting walkway between buildings.

The work was visible to the client, who could access the project and view advances in real time.

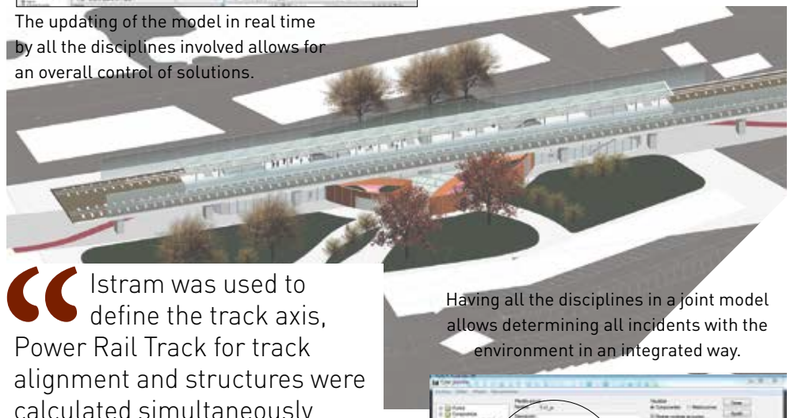
> The challenge of this project consisted in developing the architectural model in Revit for Aerocali, the company holding the concession of Alfonso Bonilla Aragón airport, in conjunction with the local architectural firm

CALI INTERNATIONAL AIRPORT, COLOMBIA

Raquel Veneros / BSc in Architecture



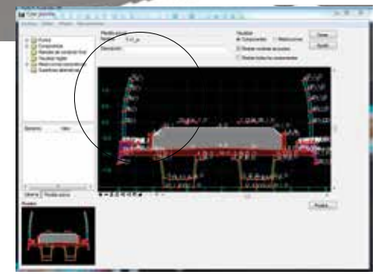
The updating of the model in real time by all the disciplines involved allows for an overall control of solutions.



Having all the disciplines in a joint model allows determining all incidents with the environment in an integrated way.

> Istram was used to define the track axis, Power Rail Track for track alignment and structures were calculated simultaneously to the development of station options by the architectural team in Revit Autodesk, keeping the model updated in real time at every moment.

TORRELAVEGA STATION, SPAIN



transfer of the future MTC terminal of Abu Dhabi airport, a BIM model was developed to present the client, in an easily recognisable way, with the flashpoints which could occur during passenger traffic flows "an advantage which –according to the director of the project **Ignacio Alejandre**– made the client rely more on Ineco's capabilities."

The main advantage of BIM is that it comprises the whole life cycle of the building: design, construction, exploitation and demolition

Raquel Veneros, BSc in Architecture, points out that "the advantages of BIM are not only related to the design process but they continue in the whole life cycle of the building: from the building phase to its subsequent exploitation, even reaching its demolition , as it makes up the database of the building including all the information comprised within the model".

Finally, engineer **José Manuel Blanco**, highlights that "the possibility of foreseeing and solving during the design stage interferences between elements of the different disciplines (architecture, structures and installations) and between the different installations of any building project (air conditioning and ventilation, electricity, plumbing, sanitation, etc.) gives the project an added value as it adjusts design, execution and maintenance. The space necessary for installations, specially in utility ducts, false ceilings and raised floors is easily appreciated.«

Stop, train coming

Improved safety in 562 level crossings

By ***itransporte***, with the collaboration of **Juan Manuel Rodríguez**, BSc in Industrial Engineering (project manager)

Ineco has worked in the signalling of more than five hundred crossings in the two main sections of Ecuador's railway network, which together amount to more than 500 kilometres. In short, the country has renovated its railway network mainly focusing on tourism.

In 2007, Ecuador's government began the renovation and recovery of railway lines, after four decades of decadence, to change its focus completely. Instead of focusing on standard passenger and cargo transport, it was declared national heritage in 2008 and was reconverted to be used for tourism. The come-back of the train allowed for a reactivation of the local economies of about thirty towns throughout the country; another goal declared by the Government was to recover cultural heritage and to preserve local traditions, which have been included in the tourist railway offer. With this change in business approach, the improvement and modernisation of management was also started, with the creation in 2010 of a new entity, the state-owned railway company Ferrocarriles de Ecuador (FEEP).

Reconstruction works

In parallel, the reconstruction of the old railway infrastructure which had been invaded, dismantled or damaged has been started. There are 480 out of 965 kilometres of the network currently operating and modern standards of quality and safety are being applied: the alignment, built more than a century ago, crosses several urban areas and the tracks cross paths, streets and roads, making it necessary to signal the crossings. Within this framework, a team of Ineco's professionals has worked for one year and a half for the Ministry of Transport and Public Works (MTOP) in the installation of signalling equipment in 562 intersections in several sections of the journey, Durán-Quito, reopened in 2013, and Otavalo-Salinas, to the north.«

There are 480 out of 965 kilometres of the network currently operating, and modern standards of quality and safety are being applied

Railway tourism and economy

Seventy five per cent of the almost one thousand kilometres of Ecuador's railway lines run across mountain areas of the Andes ranges, crossing the large natural area known as 'Avenida de los Volcanes', where Cotopaxi or Chimborazo volcanoes stand out. The railway tourism offer -mainly aimed at foreign tourists or domestic tourists with high purchasing power– is made up of 11 different journeys. According to FEEP data, in 2012, a total of 124,231 tourists was recorded, three times the figure of 2008. The star product is the so-called 'Tren Crucero' (Cruise Train), which offers a scenic rail ride between Quito and Durán, with cars manufactured by the Spanish company FEVE and an old national steam locomotive, all of which fully refurbished. It runs across 450 kilometres in four days and goes up to 3,607 metres high.

PHOTO: DAVID GRIJALVA (FEEP)

View of 'Nariz del Diablo' from the 'Tren Crucero'.

With meaningful names such as 'Tren de la Libertad' (Freedom Train), 'Nariz del Diablo' (Devil's Nose), 'Avenida de los Volcanes' (Volcanoes' Avenue) or 'Sendero de los Ancestros' (Ancestors' Path), the journeys last several days and include hotel, excursions, multi-language guides and cultural and gastronomic activities. Stations have been renovated and provided with local retail and cultural equipment, managed by local groups or communities such as 'Cafés del Tren' (Train Coffeeshops), 15 in all, or 13 'Plazas Artesanales' (Handicrafts Squares), besides nine 'Tiendas del Tren' (Train Stores) and half a dozen 'Museos del Tren' (Train Museums).

DETAILS OF SIGNALLING ELEMENTS AT LEVEL CROSSINGS

Ineco has been in charge of signalling 562 crossings of Ecuador's railway network.
1_barrier
2_traffic lights
3_stop signal
4_passing warning signal 100 metres away

Ineco has signalled 562 crossings of Ecuador's railway network in two sections: Quito-Durán and Otavalo-Salinas, which together are over 500 kilometres long

Sections under work

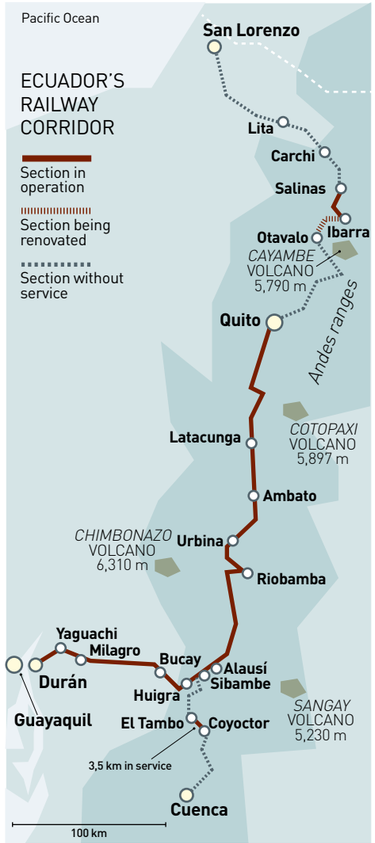
Works have been performed in the two main sections of the railway network.

SECTION: QUITO-DURÁN

The longest section, 446.8 kilometres, connects the capital city Quito with the city of Durán, and reopened in 2013. Builders in the beginning of the 20th century intended it to go as far as Guayaquil port, Ecuador's second most important city, but the connection was never built. The line connects the towns of Yaguachi, Naranjito, Milagro, Bucay, Huigra, Alausí, Guamote, Colta, Riobamba, Ceballos, Salcedo, Ambato, Latacunga, Laso, El Boliche, Tambillo and Mejía.

SECTION: OTAVALO-SALINAS

The second section were works were performed, Otavalo-Ibarra-Salinas, is 56.5 km long, 30 of which are already in operation and another 26.5 are being renovated. Thus, more than 55% of the railway network is in operation, except for 147 km between Quito and Otavalo, and 170 between Salinas and San Lorenzo. In the line Sibambe-Cuenca, 145 km long, only 3.5 km are in operation between Tambo and Baños del Inca (Coyoctor).




Rail transport has generated more than 2,700 direct jobs.

PHOTO: FERROCARRILES DE ECUADOR

How to protect a level crossing

■ **The heavier the traffic at an intersection, the higher the protection required. Besides road markings, the following equipment has been installed:**

- ☐ **Acoustic and light signalling for around 500 level crossings.**
- ☐ **Automatic semibarriers for around 400 level crossings.**
- ☐ **Magnetic obstacle sensors: they send a signal when they detect train wheels.**
- ☐ **Mixed controllers for road and railway traffic: this is a mixed system for road and railway traffic fully designed in Ecuador. They have been installed in all towns.**

INECO'S WORKS

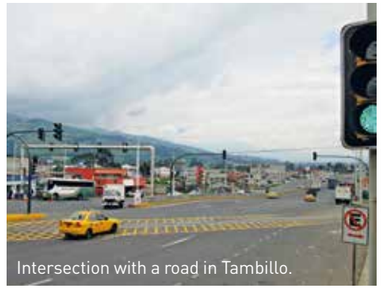
Ineco has over 15 year's experience in level crossings in Spain, where it has provided technical assistance to Adif (Spain's railway infrastructure administrator), in more than 70 signalling projects. For the MTOP, it has carried out the following jobs:

- → Revision of project design
- → Modification of design and improvement of equipment features
- → Setting out of all intersections (level crossings)
- → Assembly quality control
- → Control and follow-up of expenses of the works (audit)
- → Factory tests
- → Coming-into-service tests


Road markings at an intersection opposite Ibarra station (bottom left).


'Autoferro' (bus adapted to circulate on rail tracks) in Riobamba.


Road traffic and pedestrians in Ibarra-Salinas subsection.


Intersection with a road in Tambillo.


Crossing with all signalling elements.


In the back, Riobamba station.

Volunteers on the move

■ **In August and September 2013, a group of four Ineco's volunteers rendered technical collaboration services to the company Ferrocarriles del Ecuador in the section Ibarra-Salinas, which performs the tourist ride known as 'Tren de la Libertad' (Freedom Train).**
This job was the result of a cooperation agreement between Ineco and CODESPA foundation, which is working on the development of railway tourism in this rural area of the province of Ibambura to support 169 low-income families.


From left to right, Marta Leal, Joaquín Muñoz, Diego Andrés and Rosa Gutiérrez, of the volunteers' team, with Juan Manuel Rodríguez Cordovilla, signalling project manager.

■ **Volunteers of the project, called 'Ineco en ruta' (Ineco on the move) studied the line on the ground and drafted a document with improvement proposals for physical infrastructure –mainly in terms of safety–, rolling stock and internal organisation.**
They also provided several training courses to personnel from Ferrocarriles de Ecuador Empresa Pública (FEEP) on the improvements proposed, which include subjects ranging from new signalling to drafting of an Emergency Plan in case of accidents, among others.

AERONAUTICAL | **SINGAPORE** | Air navigation

Going for the most award-winning airport

CAAS entrusts Ineco with the revision of flight procedures at Changi

With the collaboration of **Jorge Blanco** and **Alberto Fernández**, aeronautical engineers

PHOTO: CHANGI AIRPORT GROUP (CAG)

Changi received several awards since it opened in 1981 –more than 400–, among them, the award of the magazine *Business Traveller* to the world's best airport in 2013.

The Civil Aviation Authority of Singapore (CAAS) has entrusted Ineco with the revision and design of instrumental flight procedures at Changi international airport, one of Asia's most important ones.

With these implementation jobs, the air space of this vital Asian financial centre is up-to-date with ICAO's recommendations in terms of putting into practice instrumental flight procedures based on the *Performance Based Navigation* (PBN) concept which provides for basic requirements in terms of navigation performances, which aircraft must observe in a specific air space, regardless the type of navigation sensor available on board.

Changi, considered one of the world's best airports, is one of the main entrance gates in Asia for international passengers travelling to Singapore or making a stopover there. This airport, located around 20 kilometres to the northeast of the city of Singapore and with a total of 52 million passengers per year, will increase its traffic capacity by 25% with the construction of its fourth terminal, to be completed by 2017, and is also planning a new one, a fifth terminal that will increase traffic to over 100 million passengers per year. Changi has received several awards since it opened in 1981 –more than 400– among them, in 2013 the *Business Traveller award* to the world's best airport.

Ineco's works consisted in the revision of RNAV1-based instrumental procedures for departures and arrivals and the design of new RNP-APCH instrumental landing procedures for Changi airport. In particular, landing procedures for two of the three runways, 2C/20C and 02L/20R, have been designed for this airport, together with their corresponding approach charts. On the other hand, experts of the company have provided support to validation flights.

Today, Changi has an annual traffic of 52 million passengers, and this figure is expected to double in the next few years

Ineco consolidates its presence in Singapore

With this second contract, Ineco consolidates its position in Singapore, where it also extends advice to other departments of CAAS together with other consultants, in regulatory and financial matters. In 2013, the company opened an office in the capital city from where it coordinates its activity in the Asian continent.

Ineco has developed flight procedures and airport certifications in Norway, Panama, Egypt, Costa Rica, Nepal, Brazil, Oman, Algeria, Luanda and, mainly, in Spain, where it has been collaborating for over a decade with Aena, the world's first airport operator, –with 46 airports in Spain and 15 in the rest of the world– and Europe's fourth provider of air navigation services.«

On the photo, Ineco's aeronautical engineers who have worked on the revision of flight procedures in Singapore. From left to right: José Mª Colás, Jorge Blanco –project manager– and Manuel Santos, at Ineco's offices in Madrid.

Op-ed

José María Colás Pulido

BSc in Aeronautical Engineering, senior expert in flight procedure design

Designing under PBN (Performance Base Navigation) criteria

Air navigation has gone through several major evolutions over the last few years. Many of them have entailed important changes in the way of travelling through the sky depending on the facilities they are based on and on how aircraft establish their position.

At the beginning, standard instrumental navigation obliged aircraft to fly over radio aids located on the ground to go, point by point, from a facility to the next one. It was with the development of air navigation (RNAV) that it was possible to design paths which did not depend on location of radio aids the flight was supported on.

There was another problem to solve: the new RNAV paths were still dependent on the type of sensor/radio aid they were designed for. This forced air companies to certify according to the different sensors chosen by the States where they were going to fly (sensor-based navigation). Therefore, investment in updating on-board equipment was very expensive and, sometimes, there was no guarantee that said investment was going to be profitable.

The new PBN (Performance Base Navigation) concept allows aircraft to fly in certain air space with specific features if they comply with minimum requirements, regardless of the type of sensor available.

States are in the process of developing or adjusting their flight procedures to this new concept, and Ineco has already set out on this road, designing PBN procedures for its clients in Spain, Egypt, Oman,Tunisia, Brazil or Singapore, for example.

Ineco's flight procedure design team is ready to face these new challenges and continues to adapt its processes to take on the rest of the changes necessary such as the processing of data received or generated, ensuring its veracity, accuracy, integrity and traceability. This becomes a decisive factor when it is considered that provided data allow for aircraft automated navigation, without any manipulation of said data by the pilot.

Hidrovias: a stream of possibilities

Ineco designs a cost simulator for river transport in Brazil

With the collaboration of **Jorge Pérez**, civil engineer and **José Andrés Maroto**, economist

The tool will help to better plan the development of the large network of waterways in Brazil, which offers a wide growth margin. The country intends to multiply its use over the next few years.

Brazil, the world's fifth largest country, has one of the greatest river networks on the planet, with around 63,000 kilometres, approximately 42,700 considered navigable. Together with China and USA, it tops the list of countries for which rivers represent a highly relevant means of transport.

Within this context, Ineco is developing for Empresa de Planejamento e Logística (EPL), under Brazil's Ministry of Transport, a cost calculation model for the transport of goods through the *hidrovias* network (navigable), considered vital for the planning of a country with continental dimensions. In large areas which would otherwise be inaccessible by air –such as Amazonia– rivers are the main transport and communication routes for people and, above all, for merchandise.

The main advantage of river transport lies in its great load capacity and in the major scale economies generated when moving large volumes in long distances, with lower power consumption and environmental impact than railway or road transport. According to a detailed study conducted by ANTAQ (Agência Nacional de Transportes Aquaviários) in 2012, Brazil currently only uses 49.9% of its navigable river network, that is 20,956 kilometres, 19,764 out of which were used for cargo transport and 6,360 kilometres for passengers. These data show the great development potential of waterway corridors that the country intends to boost in the next few years.

Ineco is currently developing for EPL a cost calculation model for cargo transport through the waterway network

Planning instruments

As a result, several planning instruments have been created, which Ineco has taken as a reference for the cost calculation tool it is developing. Among them is the Strategic Waterway Plan designed by the Ministry of Transport for the 2013-2031 term, the National Logistics and Transport Plan, the river transport national policy Guidelines 2010-2013, etc. In parallel, the Federal government has recently announced that investments in the transport sector of the third phase of the Growth Speeding-up Plan (PAC 3), foreseen as from 2015, will give priority to railway and river transport modes.«

The "green gold" country

Only in 2012, 80.9 million tons of merchandise travelled along Brazil's "liquid roads". They transport any kind of products, but in terms of volume, iron ore (bauxite), oil and by-products, fertilizers and agricultural bulks, such as corn, wheat, cotton or sugar cane, and also soy, the agricultural product with the world's largest growth in demand in the last decade, 28%, stand out. In 2015, with a projection of more than 90 million tons, Brazil expects to oust USA from

the top position in world production of this legume, which is used for human feeding, for manufacture of animal feed and biofuels. Only the Brazilian region of Mato Grosso, the world's largest soy production and export centre, will exceed 25 million tons according to official forecasts. In 2013, Brazilian waterways transported 6.7 million tons of soy (in grain, flour or oil), a volume that is equivalent to almost five times the annual production of this vegetable in Spain, which shows an idea of the economic relevance of this trade.

PHOTO: ANTAQ (AGÊNCIA NACIONAL DE TRANSPORTES AQUAVIÁRIOS)

TRANSPORT IN DIFFERENT TYPES OF VESSELS

River transport is vital in a country like Brazil, which has one of the largest river networks on the planet, specifically a total of 63,000 kilometres. Only in 2012, 80.9 million tons of merchandise travelled along Brazil's "liquid roads". Top left, a grain vessel with pusher craft, to the right, a vessel transporting minerals and below, a self-propelled vessel.

Ineco's study will allow for a better integration of the river system in the cargo transport network, improving its efficiency. To achieve this, it is necessary to evaluate the costs of all the elements comprised in it

BRAZIL
Hydrological region map

The rivers which make up the different hydrological regions into which the Brazilian river network is divided are shown in the following table, including navigable and potentially navigable rivers.

Regions Hydrological	Rivers	Length (km)
AMAZON	Amazonas, Solimões, Negro, Branco, Madeira, Tapajós, Teles Pires and Guaporé	19,024
TOCANTINS ARAGUAIA	Tocantins, Araguaia, das Mortes and Capim	3,500
ATLANTIC NE WEST	Mearim, Pindaré and Itapicurú	2,100
PARANAÍBA	Paranaíba and Balsas	2,520
SÃO FRANCISCO	São Francisco, Grande and Corrente	4,100
ATLANTIC EAST	Paranaíba do Sul, Doce and Jequitinhonha	1,094
PARANÁ	Tietê, Piracicaba, Paranaíba, Grande, Ivaí and Ivinheima	4,800
PARAGUAY	Paraguay, Cuiabá, Miranda, São Lourenço, Taquari and Jaurú	3,095
URUGUAY	Uruguay and Ibicuí	1,200
ATLANTIC SOUTH	Jacuí, Taquari, Lagoa dos Patos and Lagoa Mirim	1,309
TOTAL		**42,742**

SOURCE: BRAZIL'S MINISTRY OF TRANSPORT

PARANÁ-TIETÊ WATERWAY
It is a river navigation route for cargo and passenger transport located among the south, southeast and central west regions of Brazil.

Why a cost calculation model?

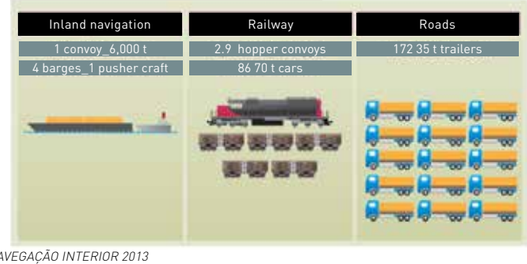
■ The river system, with its triple function of being an axis of social and economic life and as key element of the territory, requires a global analysis to develop without neglecting sustainability. Therefore, a cost model that is suitable, consistent and that contributes to achieving logistic development global objectives will make decision-making by the managing entity of the transport system and its infrastructure easier.

■ Ineco's study will allow for a better integration of the river system in the cargo transport network, improving its efficiency. To achieve this, it is necessary to evaluate the costs of all the elements comprised in it, from those derived from the implementation of port infrastructure and navigation channels, throughout maintenance and exploitation elements –which guarantee their functionality and service level– to those related to transport services and line operation.

■ The simulation tool will be integrated into the logistic and cargo transport models being drafted by Empresa de Planejamento y Logística (EPL).

FUEL CONSUMPTION (1)

LOAD CAPACITY (2)



1_For the transport of 1 t in a 1,000 km distance
2_ Comparison among load capacities of the different modes

SOURCE: CONFEDERAÇÃO NACIONAL DO TRANSPORTE: *PESQUISA CNT DA NAVEGAÇÃO INTERIOR 2013*

MAIN RIVER CORRIDOR

SOLIMÕES-AMAZONAS_This is the giant of the network by volume and length, with 18,300 navigable kilometres; it transports three thirds of the goods of the Brazilian river system, above all organic chemical products, soy, corn, fuels, containers going to sea ports and bauxite.
MADEIRA_It is the second in terms of load, and grew 30% from 2011 to 2013. It has 1,056 navigable kilometres. The main goods are soy and corn.
TOCANTINS-ARAGUAIA_Connected with the two previous ones; among the products it transports in long distances, aluminium and kaolin can be mentioned, destined to be exported.
PARAGUAY_In fourth position is this corridor where other products, among them minerals such as iron and manganese, are transported. In 2013, its load volume grew 37% as compared to the previous year.
PARANÁ-TIETÊ_Together, both rivers have 1,585 navigable kilometres; this corridor is strategic for transport flows of agricultural solid bulk products from Central-Western Brazil. In 2013, more than one fourth of the soy and one third of the corn transported through inland waterways arrived at Santos port to be exported. Other products worth highlighting are sand and sugar cane.
HIDROVIAS DO SUL_They are characterised by the high load volume in short sections (292 km on average). It has 900 navigable kilometres and mainly transports fertilizers, soy and soy flour.
SÃO FRANCISCO_With 1,371 kilometres, in 2013 the transport of ginned cotton and soy stood out.

SOURCE: ANTAQ (AGÊNCIA NACIONAL DE TRANSPORTES AQUAVIÁRIOS)

BABYLON

Saul Espinosa, the author of this urban futuristic skyline, is a conceptual artist specialised in Matte Painting, one of the most complex areas in visual effects (VFX), allowing creating movie *sets* thanks to digital imaging tools and 3D software. **www.ArtofSaul.com**.

What are cities thinking about?

Technology applied to urban development results in the so-called 'smart cities', which are linked by transport systems that need to be efficient, sustainable and well-organised. Ineco has experience both in Spain and abroad in products and services related to smart mobility.

With the collaboration of **Emilio Miralles**, civil engineer, **Ignacio Martínez**, IT specialist and civil engineer, and **Jesús Vázquez**, technical IT engineer

Over 50% of world population, i.e. 3.5 billion people, lives in cities, as reported by the United Nations. The trend to growing urban population will be consolidated over the next few decades, as certified by the UNO, the OECD and other international agencies. Since the late portion of the 20th century, the application of new information technologies to the urban environment has been incorporated into the 'smart city' concept which refers to the enhancement of resources to achieve cities that are better managed, friendlier for their inhabitants and more sustainable from an energy and environmental point of view. In this context, having efficient transport systems guaranteeing the citizens' mobility is critically important.

This is because as from the Industrial Revolution, the urban environment has grown in complexity as social and economic development generated an increase in population due to a fall in mortality and the mass movement of rural population to the cities, a phenomenon that is still taking place in countries with strong development such as China. It is a proven fact that population growth gives way to a simultaneous expansion in mobility demand while environmental impact and energy consumption increase. In fact, the UNO stated that even though cities occupy 2% of world territory, they consume 60% to 80% of energy and generate 75% of carbon emissions.«

The 'smart city' concept intends to achieve cities that are well-managed, friendly and sustainable

Ineco and smart mobility

SMART PRODUCTS AND SERVICES

In addition to extensive experience in Spain and abroad in all the phases of the implementation of sustainable interurban and urban transport infrastructures, as well as trams, underground or train commuter lines, over the past few years, Ineco has developed new products and services related to information technologies and smart mobility. Some of them include urban and inter-urban transport plans, demand analyses and models, studies and tools to improve power efficiency and characterise the environmental impact of transport. Information and Communications Technologies (ICT) are not a panacea or magic potion but they contribute to improving the quality of life in our cities through multiple applications that Ineco has been incorporating into its urban transport studies and plans. Thus, the Operations Assistance Systems (OAS) of bus networks allow following up on and controlling the fleets and interactive communication with users. Exploitation data are »

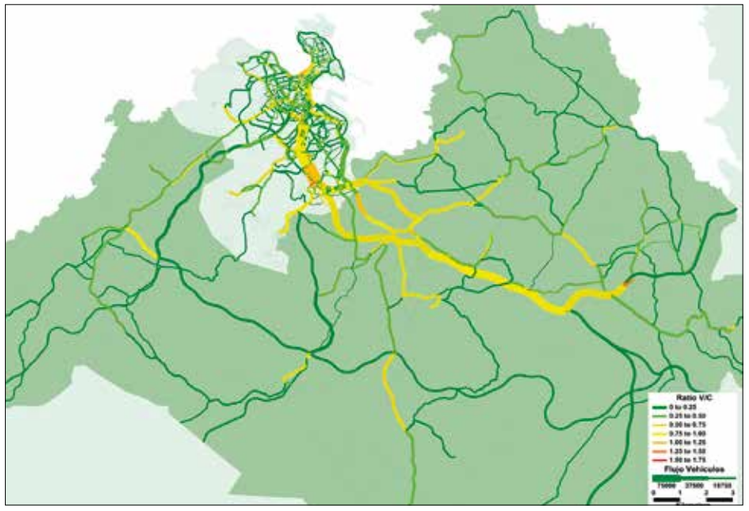
Experts committee

■ **With this knowledge, in 2014, the company was incorporated to the Smart Cities Committee of AENOR (Spanish Association of Standardization and Certification). The entity's goal is contributing to deploying what is defined as "the holistic vision of a city applying ITCs to improve the quality of life and accessibility of its inhabitants and it ensures a sustainable environmental, social and economic development subject to ongoing improvement." Ineco's experts contribute their knowledge on infrastructure, consulting, governance and mobility to the preparation of the development of standards and certifications helping "to favour interoperability" among the multiple systems operating in the city, which is vital to leverage the resources properly, constituting a part of the foundations of the concept of 'smart city'.**

Based both on capacity and the environment, collective transport systems are the alternative to private transport, which has proven inefficient in the urban context

SUSTAINABLE URBAN MOBILITY PLAN IN A CORUÑA

Model of vehicle flows prepared by Ineco for the Sustainable Urban Mobility Plan (SUMP) of A Coruña (Spain) in progress through 2024.



obtained and they are used as support by other systems supplementing it and improving the quality of the services. On the other hand, Passenger Information Systems (PIS) provide users with information on transport services, real time bus and train wait times or any other type of information through information panels, mobile phones or other channels.

Simulations and models are used to prepare forecasts when designing a transport plan

SIMULATION AND MODELS

Transport models and simulations are used upon designing transport plans. Such models and simulations are fed by numerous data allowing them to reproduce the present situation as well as prepare estimates for the future. Models, which are fed by multiple data sources –from residential surveys or others performed using mobile devices to information obtained from traffic cameras–, represent reality from a simplified standpoint and allow analysing issues and proposing solutions. Therefore, Ineco's professionals engaged in transport modelling and simulation have been engaged in many Smart Mobility projects, such as the increasing microsimulation of the study of accesses in the Madrid Hub City complex. These projects cover from mobility plans to pedestrian flow simulations, all of which play a fundamental part in sustainable mobility.

INTEGRATED ANALYSES

Ineco has taken one step further in its bet on a unified vision of ICTs and transport models. This integrated vision allows planning the interaction of the city's systems and the mobility of its population in a unified environment, that is to say, modelling the smartest part of an intelligent city. This allows analysing the impact on future mobility of the dynamic automation of an intersection regulated by street lights on the basis of data sensors, simulating the improvement of a surface parking system with real time information for users, or estimating how a city will work in the future with and independently-driven vehicle fleet.«

THE CITY OF THE FUTURE IN THE MOVIES: "I HAVE SEEN THINGS YOU WOULDN'T BELIEVE"

The movies have recurrently used cities as narrative support both in film noir, comedy or science fiction, and the latter has often done so providing a dark and apocalyptic picture with major references to comics. Motion pictures such as *Metropolis* (Fritz Lang, 1926), *Alphaville* (Jean-Luc Godard, 1965) *Blade Runner* (Ridley Scott, 1982), *Total Recall* (Paul Verhoeven, 1990), *Demolition Man* (Marco Brambilla, 1993), *The Fifth Element* (Luc Besson, 1997), *Minority Report* (Steven Spielberg, 2002) or *Elysium* (Neill Blomkamp, 2013) evidence the most overwhelming imagination. The latter was inspired in a space colony project (on the right) designed by NASA in the 1970s which could house 10,000 people.

Basic concepts

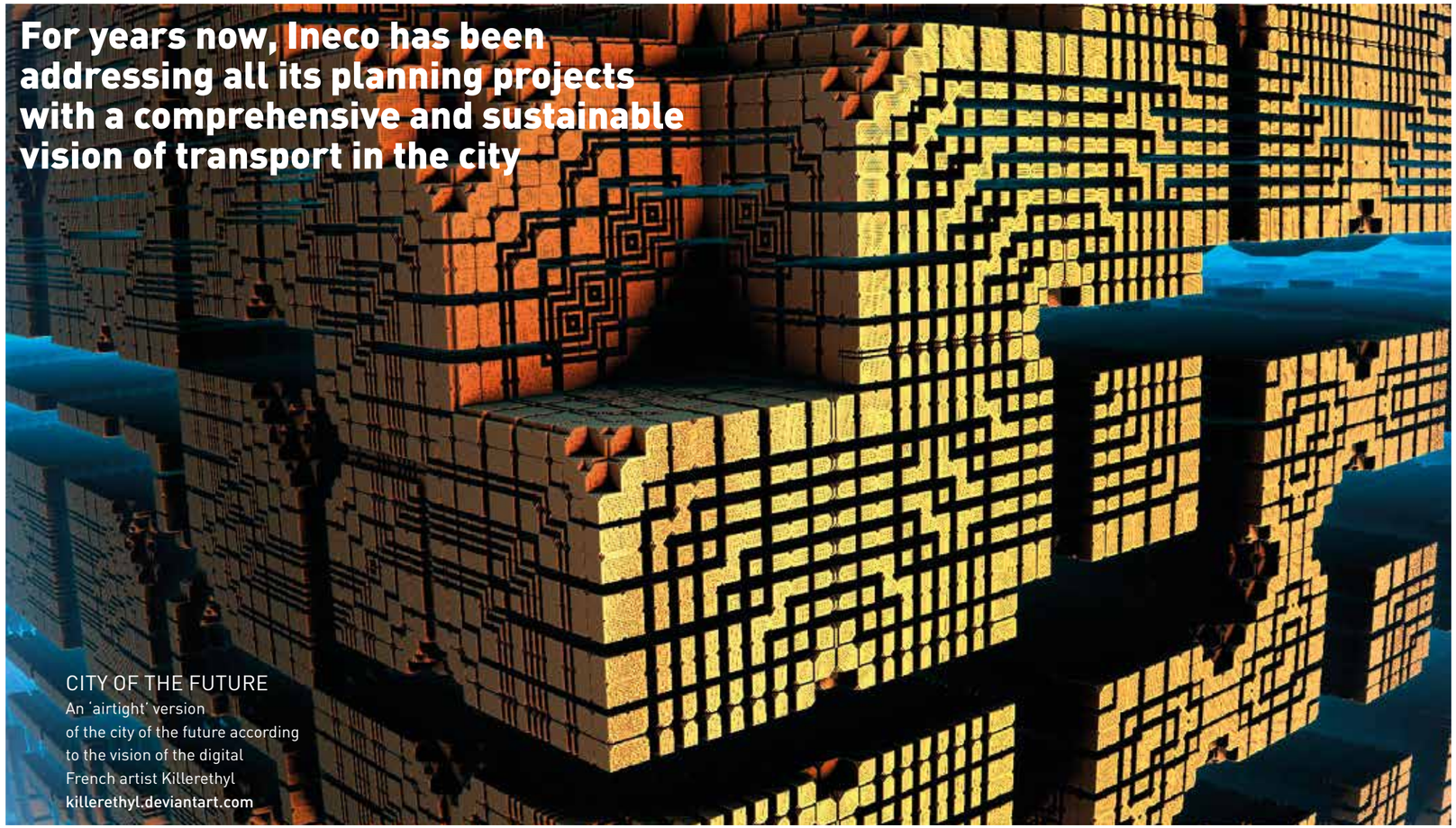
■ **Some of the contributions made by ICTs include compiling and processing data, which is enabled by the use of sensors. These devices, which are connected to data networks, gather and send in real time all sorts of data, including that related to the way they work. This is what is known as "the Internet of Things".**

■ **Within the realm of transport and mobility, this information spans from data on free parking spots, to traffic camera images to air and acoustic pollution measurements, among others. Even users may be a part of this information networks by using applications and social networks from their mobile devices.**
As cities get larger sensor networks, huge data volumes are generated in real time, which may be stored, analysed or compared. And to do so, high-performance equipment and systems with superb capacity and processing speed are required. This is what is known as Big Data.

■ **However, a smart city vision also requires that these data be shared among the different networks –transport, health, energy, etc.– as well as with city managers, and by city managers with the citizens: this is the Open Data concept. It is a 360° mindset change in the light of the deeply rooted information planning in silos, a metaphor that reflects the extended concept of proprietary information organised vertically and not shared.**

■ **In short, the future is about creating 'smart city platforms' which will centralise all the information so that services may be optimised and management may be improved thanks to the integration of all the data gathered in the city in real time.**

For years now, Ineco has been addressing all its planning projects with a comprehensive and sustainable vision of transport in the city



CITY OF THE FUTURE
An 'airtight' version of the city of the future according to the vision of the digital French artist Killerethyl **killerethyl.deviantart.com**

On the way to sustainable urban transport

A RECENT CONCEPT

The term 'sustainability' was first used in the 1970s when, owing to the petroleum crisis, a global concern started in connection with energy and environmental issues and balanced development. The term 'sustainable development' is thus coined to describe a development that meets present needs without endangering the quality of life or environment of future generations, without increasing the use of natural resources beyond the capacity of nature to produce them.

Over the last few decades, global social and economic changes have had substantial impact on urban transport. Mobility in current cities arises from patterns that are becoming vaguer with longer travel distances and ongoing growth in motorisation levels. Urban transport adversely affects this balance, impacting on the environment, the health and safety of its citizens, the economy, society and, in general, the quality of life of the population. In order to address and correct these trends, most cities promote Sustainable Urban Mobility Plans (SUDP) in which actions are analysed and proposed to channel mobility within the city into more sustainable commuting forms (public transportation and non-motorised means such as walking or biking). Some examples of these plans developed by Ineco over the past few years in Spanish cities include Hospitalet de Llobregat, the Barcelona metro area; Logroño, the capital city of La Rioja; and, more recently, A Coruña, the capital of Galicia and the Galician city with the largest population, where we stressed citizen participation programmes in selecting and proposing actions.

Over the last few decades, global social and economic changes have had a substantial impact on urban transportation

CLEAN FUELS

To ensure the environmental quality and sustainability of our cities, transport vehicles need to increase clean fuel use. And this is an ever-growing concern around the world. Ineco prepared a study on the development and implementation of alternative powering systems to reduce the pollution in the São Paulo metro area which, with a population of 24 million, is among the 5 largest metropolitan areas in the world and presents extremely high pollution levels.

The study, which was financed by the World Bank, is carried out for the metropolitan urban transport company of the State of São Paulo managing over 800 lines with a fleet of over 5,000 vehicles and includes the contrastive analysis of the different fuels used (or at a development phase) in buses: »

SÃO PAULO METRO AREA

Ineco was engaged to prepare a study on the development and implementation of alternative powering systems to reduce the pollution of the buses covering the São Paulo metro areas. On the picture, traffic at Marginal Tietê.

PICTURE: NDRÉ LEMES

PICTURE: ELVIRA VILÀ

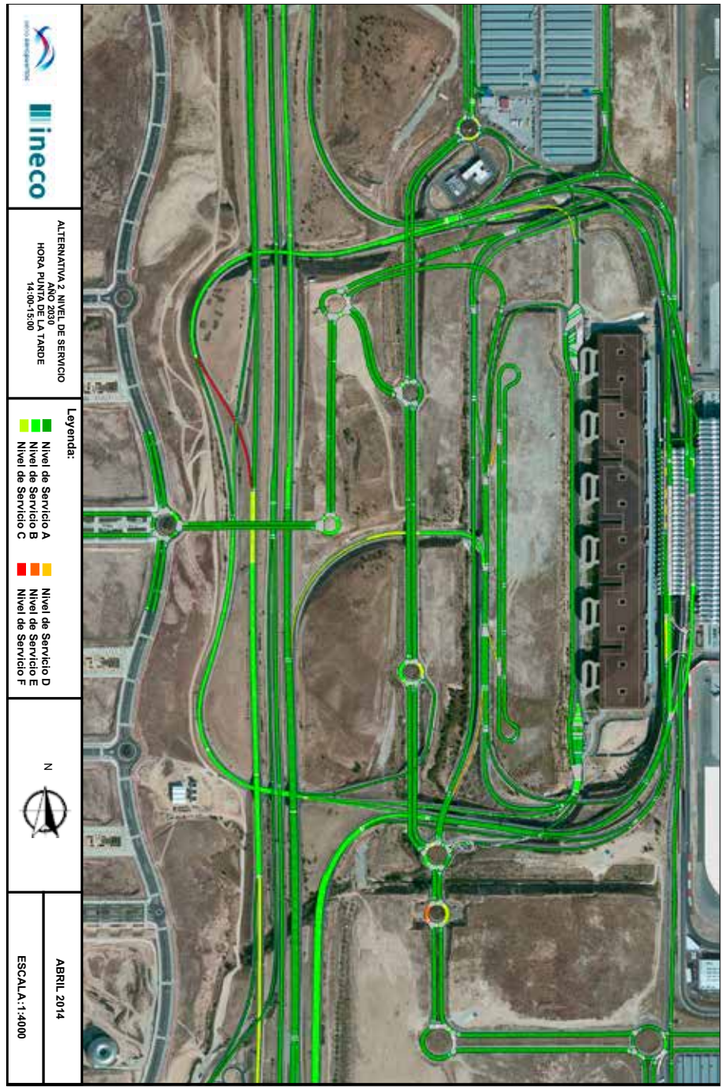
VALENCIA UNDERGROUND

Enrique Albelda, a civil engineer, at the Valencia underground in which Ineco has performed several works including the expansion of lines 1 and 2.

To ensure the environmental quality and sustainability of our cities, transport vehicles need to increase clean fuel use

MADRID HUB CITY

The image below shows a study performed recently by Ineco in the accesses to plot 2 of the Madrid Hub City location close to the T4 terminal of the airport Adolfo Suárez Madrid-Barajas.



diesel, biodiesel, ethanol, natural gas, hydrogen, electric power, hybrids, etc. The study is based on technical and operational, environmental, social and economic efficiency criteria. Proposals are made for the progressive substitution of buses by other less polluting ones.

For years now, the company has been addressing all its planning projects with this comprehensive and sustainable vision of transport in the city. Thus, at present, it is preparing the Master Plan for Public Transport of Muscat, the capital of Oman, which includes the creation of a metropolitan transport authority following the model used in other cities, the implementation of a public transport system with all its coordination, rating and information elements, bus network design, reshuffling of the existing taxi and microbus system, and a group of supplementary proposals to improve accessibility, the environment and urban quality of life.

MASTER PLANS

By 2007, Ineco had designed the Master Plan for Transport of the Conurbations of Rabat-Salé-Temara in Morocco, a metropolitan area with a population of 1.9 million with a projection of 2.6 million for 2020. The recent Mobility Plan of Ecuador 2013-2017 (PEM) and before that the National Transport Plans of Algeria and Costa Rica also consider urban transport in spite of having a country-wide scope.

Over the past few years, the company has engaged in all sorts of sustainable planning tasks both 'vertical' (based on a specific area) and 'horizontal' (integrating different modes). Also, this is the case of the study of the different transport systems –railway, metropolitan, roads and sea– in the Italian region of Forli (jointly with the Italian companies Sintagma, Metropolitana Milanese and Systematica). It incorporated this new vision of planning and it included proposals to enable circulation areas for bicycles and scooters and

Over the past few years, Ineco has engaged in all sorts of sustainable planning tasks both 'vertical' and 'horizontal'

it was even granted an award by the Italian Ministry of Public Works. Likewise, Ineco participated in the design of the Anillo Verde (green ring) in Madrid, a bike lane surrounding the capital.

Other major works in sustainable planning are the reorganisation of the Algiers urban buses networks, the Territorial Plans of the Tenerife railway (Canary Islands) or the flow models of high-speed stations in Seville and Córdoba or Atocha station in Madrid.«

Op-ed

Emilio Miralles
Civil engineer and economist

The city of the future

Urban transport planning in these first few decades of the 21st century has been adjusted to the requirements of the smart and sustainable city of the future. It is no longer about building or expanding infrastructures to address the growing demand in transport but about implementing and applying adequate and efficient mobility management models. At the time of enhancing the way cities work it is all about getting each means of transport to play the role which is most suited to play boosting inter-modal exchange and prioritizing environmental criteria, sustainability and quality of life.

In the realm of cities, it has been over 50 years since the time when Lewis Mumford contributed *The city in history* (1963) a radically innovative interpretation of the city. Instead of accepting that the fate of the city was the trend to metropolitan congestion, the out-of-control expansion of the suburbs and social disintegration, Mumford outlines an order integrating technical innovations with the needs of the citizens and social standards, and, as to the city, he asserts that "with language itself, it remains man's greatest work of art." Likewise, Colin Buchanan already anticipated the traffic problems related to congestions, pollution and accidents in his report *Traffic in Towns* (1963) , and stated that the city was not prepared to allow for a significant increase in cars and that, consequently, a huge effort would have to be made to replan and rebuild the cities.

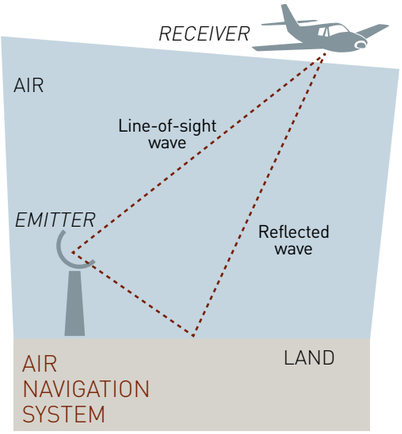
The path has been complex and challenging: after the disproportionate growth, at times uncontrolled, of many large cities, concepts, such as energy efficiency, mobility management, automated regulation, calm traffic, sustainable mobility, and geolocation, among others, are new tools and measures allowing discerning what smart cities will be like in the future. The model seeks to leverage new technologies as much as possible in order to achieve cities which are more respectful towards human beings and their environment.

Ineco has participated in this innovation process and in this new vision of planning which is more sensitive to sustainability and quality of life issues. Vast experience has been accumulated in planning urban transport with studies performed in Madrid and other Spanish cities as well as in many other countries including the largest megalopolis around the world, such as São Paulo, or cities such as Muscat, the capital of Oman, which are highly dependent upon private vehicles, but with the clear goal of being modernized and thus becoming part of the group of the smart cities of the 21st century.

Good waves

Analysis of obstacle incidents in CNS systems

By **Víctor Gordo** and **José Mª Berdoy**, aeronautical engineers



Ineco has engaged in more than one thousand radio electric simulation studies analysing the disturbances that may be caused by obstacles in radio wave transmissions, which are paramount to air navigation.

In current air navigation, within the context of ever growing traffic, controllers and pilots need to send and receive information that is accurate and reliable in order to operate safely. Communication, navigation and surveillance systems or CNS systems, are used for such purpose. They work transmitting and sending radio frequency signals, which are adequately modulated. These signals are propagated by spatial wave, that is to say, by a direct line of sight between the transmitter and the receiver. However, the obstacles are also reflected on the ground and they are combined with the direct signal; therefore, they may cause fading or amplification and, in general, overlapping or distortion of the information transmitted.

The effect of lateral reflections

The effect produced by lateral reflections is especially disturbing as many systems function with a space modulation. This means that the signal received is different based on the direction of the aircraft thus transmitting erroneous information from the signals reflected laterally, apart from the rest of the already mentioned effects. Radio electric easements may only determine which obstacles should be analysed in detail, but they do not allow identifying which of them should not be built.

Radio electric simulations

Detailed studies are necessary to determine accurately the obstacles incompatible with the correct operation of the systems; such studies are called radio electric simulations and they require deep knowledge of the CNS systems.

Ineco has wide experience in this area with over 1,000 studies carried out for Aena, but also for other countries such as Kuwait, Oman, Colombia or Cape Verde. Simulations reproduce in one model the signals emitted and received by the CNS systems so as to obtain:

→ A coverage assessment by line of sight and/or power density in order to determine the potential losses of signal in a single area as well as throughout the instrumental procedures and/or existing routes.

→ Analyses of errors in the guidance provided arising from the multi-direction of the emitted signals.

→ Analyses of reflections and time of arrival (TOA) of direct and reflected signals in the case of pulsed systems to identify any potential issues related to the corruption, overlapping or fading of the direct signal.

→ Assessment of reduction of the probability of detection in the case of radars.«

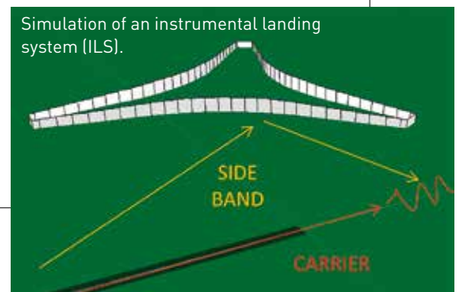
RADIO ELECTRIC EASEMENTS

To control the survey of obstacles, protection surfaces have been set in the areas close to the CNS systems. In many countries, constructions deemed hazardous for the safety of air operations are banned; in Spain, these surfaces are those called 'radio electric easements' described in Decree 584/1972 on aeronautical easements. Globally, the most salient example are the Building Restricted Areas defined by ICAO in the document EUR DOC 015, which although not being considered regulatory, have been included in the legislation of several countries.

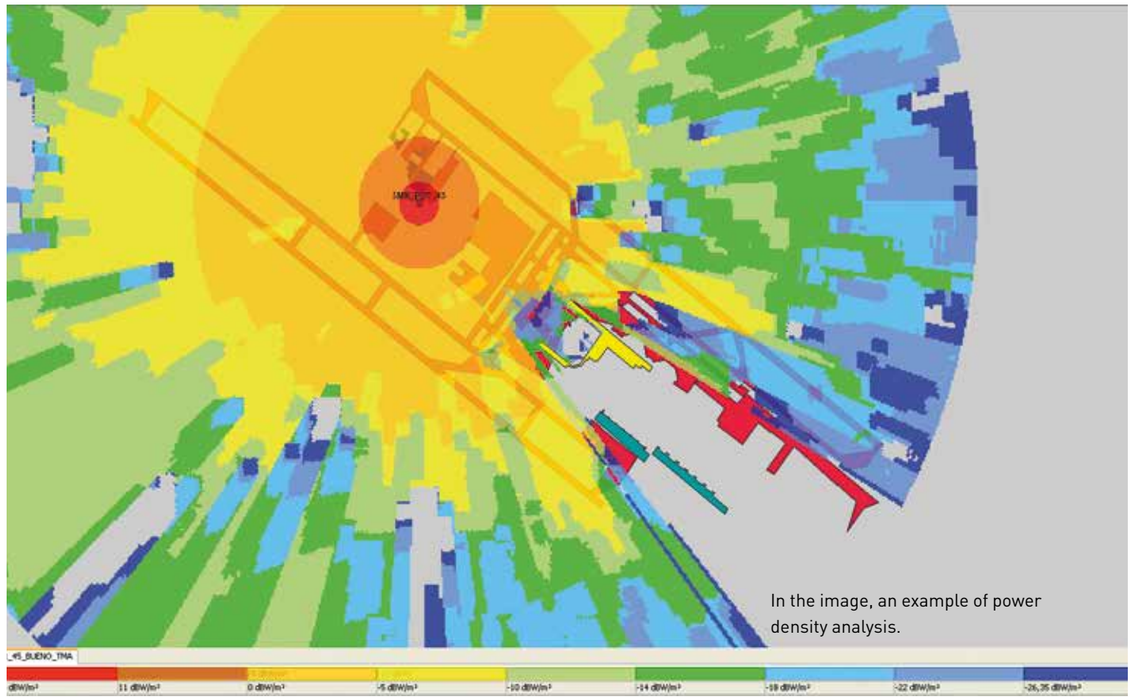
What is radio electric simulation?

The following activities are carried out to engage in the study:

- **Model of CNS systems and the environment (position of antennas, characteristics of the radiated signal, characteristics of runways, etc.)**
- **Model of the obstacles to be analysed (transformation of coordinates, locations regarding antennas, etc.)**
- **Model of flight procedures (approaches).**
- **Performance of simulations.**
- **Analysis of results.**
- **Validation (comparison with calibration parts in prior flights, etc.).**



Simulation of an instrumental landing system (ILS).



In the image, an example of power density analysis.

Eyes and ears to navigate

AIR NAVIGATION SYSTEMS: CNS

The importance of radio-electric simulation studies arises from the fact that present air navigation would not be possible without CNS systems:

- **Land/air communication systems enable interlocution –whether by voice or data– between the controller and the pilots allowing the simultaneous management of operations of more than one aircraft in a certain region of the air space.**
- **Navigation systems provide guidance to aircraft allowing them to operate with no visibility, that is to say, by IFR. It should be noted that although satellite navigation systems, particularly the GPS, are becoming increasingly important for air navigation, they do not meet the demanding requirements of aviation during all the phases of the flight. Therefore, they need to use radio aids from land during all the phases and, particularly during approach and landing, they are the only ones providing the accuracy required.**
- **Surveillance systems allow controllers to become aware of the exact position of the aircraft, which allows reducing the separation necessary among them without lowering safety. That is to say, they allow increasing the capacity or number of the simultaneous operations that may be carried out.**

The laser explorer

Ineco uses automated laser equipment for tunnel inspection

With the collaboration of **Daniel de la Hera**, civil engineer

Automated inspection technologies, such as the laser-scanner and high-definition cameras assist in tunnel preservation and maintenance. They allow obtaining 3D and 2D images reproducing any damage accurately.

Until not long ago, in order to determine their condition, inspectors had to walk every metre of the tunnels in order to analyse the status of the infrastructure and the railway equipment. Discovering fissures, drains or other hints of damage or deterioration was a slow and burdensome task until laser automated technologies started to be used to achieve measurements that were more accurate and faster than with visual inspections.

At the request of Adif, the railway infrastructure manager, Ineco has used them over the past few years in multiple projects to inspect railway tunnels. These include, the Guadarrama tunnel (28 kilometres), the fourth longest in Europe; the bi-tube tunnels of San Pedro (8.9 kilometres), the third longest in Spain, or the tunnel of Regajal (2.4 kilometres), all of them located in Madrid. We should also mention the tunnels of La Garriga, Sant Andreu and Llogaia in Catalonia.

Thermographic images

Automated devices can gather a large amount of georeferenced data –that is to say, data located accurately– which are sent remotely and subsequently processed using software. They allow obtaining 2D or 3D images of the tunnel which accurately reproduce any damage presented in the lining, such as fissures, cracks, spalling, humid surfaces, water leaks, crystallisations, steps between segments, etc. Geometrical profiles are also obtained to test loading gauges.

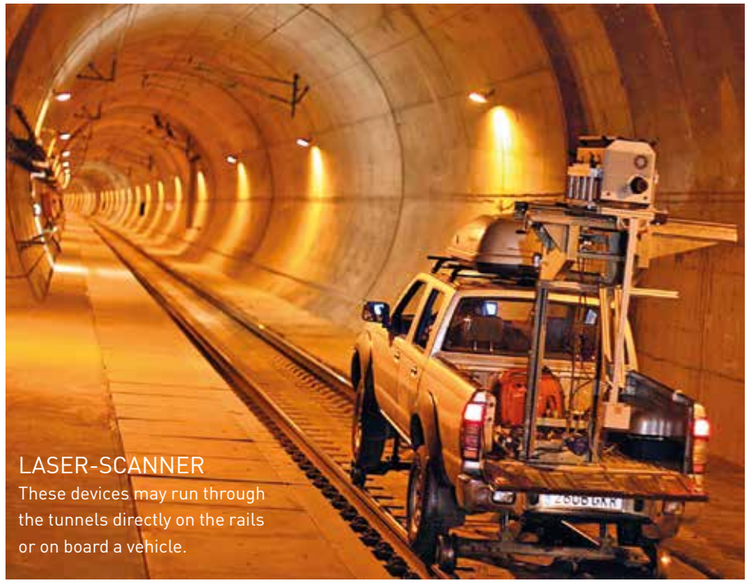
Another functionality offered by this equipment, as in the case of the laser-scanner, is the generation of thermographic images which, through anomalies and temperature differences, are very useful to detect wet or humid points, holes, air inclusions or defects.

Discovering damages or deterioration in tunnels was a slow and burdensome task until automated laser technologies started to be employed

Data analysis

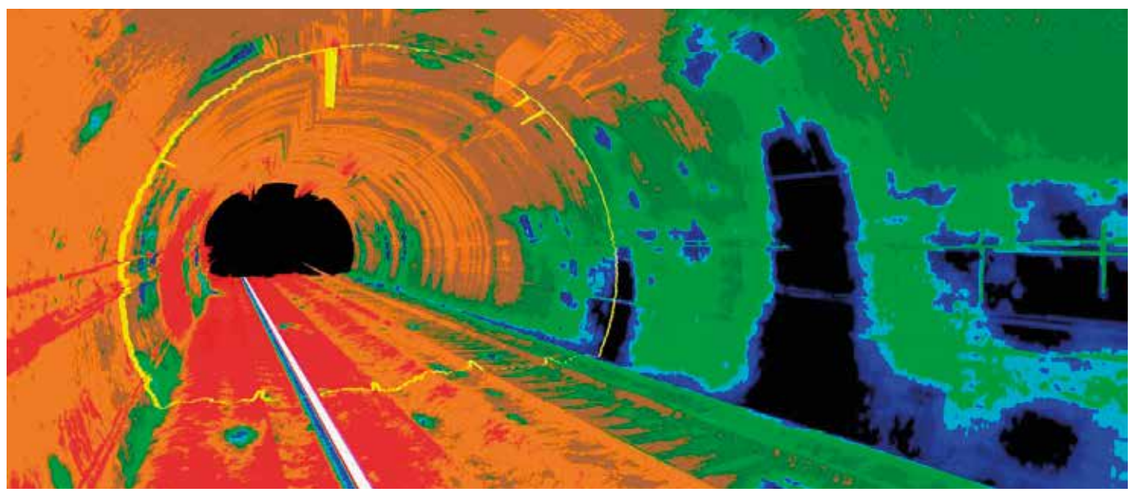
A significant advantage of automatic systems as compared to visual inspections is that information may be stored and, therefore, it is possible to make comparisons among the successive inspection campaigns. It is thus possible to monitor the damages detected or to control repairs. Costs are also reduced since few personnel is required to set them up and operate them.

It is in the data analysis, mapping and evolutive control pathologies where Ineco, thanks to its extensive experience and analysis systems available, more actively contributes to the development and evolution of "intelligent" maintenance of railway infrastructure.«

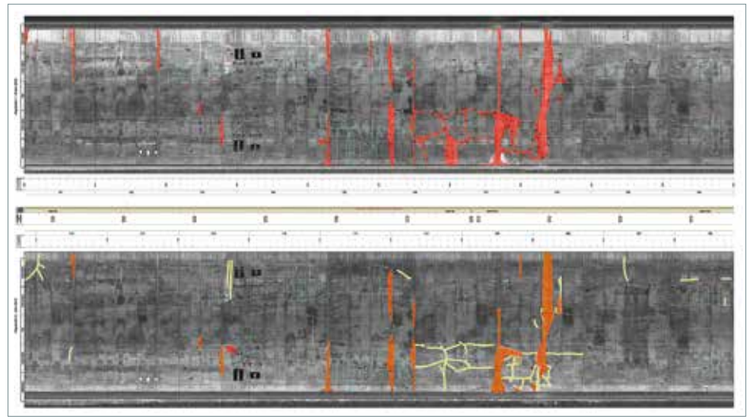


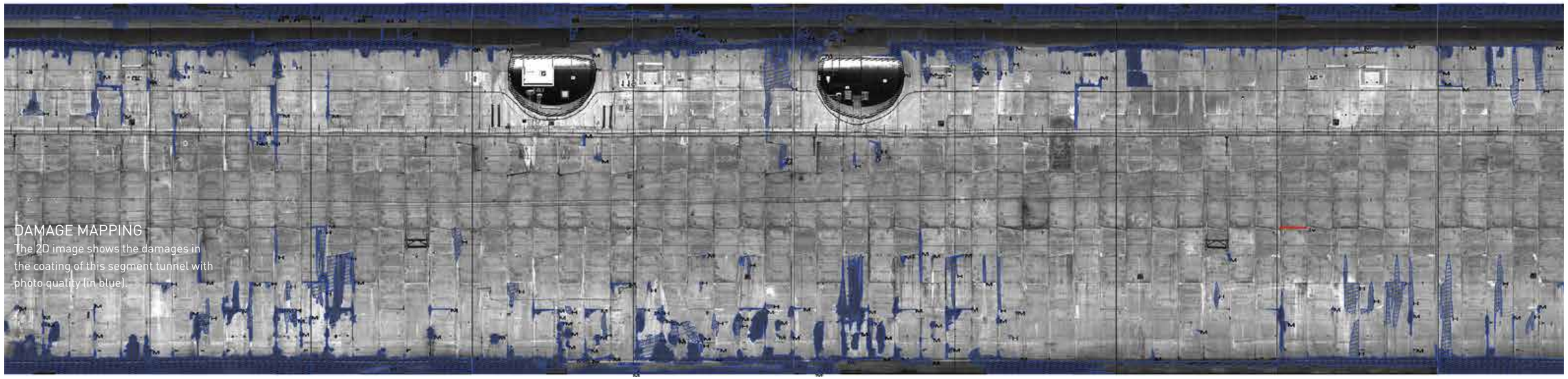
LASER-SCANNER
These devices may run through the tunnels directly on the rails or on board a vehicle.

THE TUNNEL, IN 3D
On the left, in black and white, 3D representation of tunnel damages. In colour, thermographic image: the colder green and blue areas, indicate humid areas and leaks.



It is in the data analysis, mapping and evolutive control conditions where Ineco experience more actively contributes to the development and evolution of "intelligent" maintenance of rail infrastructure





DAMAGE MAPPING
The 2D image shows the damages in the coating of this segment tunnel with photo quality (in blue).

Technical characteristics

Main types of automated systems used by Ineco.

■ Laser-scanner: a group of rotating mirrors generating a laser beam. The device can simultaneously obtain three types of data: black and white photo-quality images, thermographic images and topographic data creating a 3D profile of the tunnel surface.
Ineco has used two types of laser-scanner:

☐ GRP 5000:
→Performance speed ≈ 3 km/h
→Image resolution (size of the pixel): 5x5 mm

☐ TS3:
→Performance speed ≈ 3.5 km/h
→Image resolution (size of the pixel): 2x2 mm

■ Laser and artificial vision systems (digital cameras):
→It employs digital high-speed and high-resolution cameras jointly with high-power and linear projection lasers along a single transverse plane.
→Performance speed ≈ 20 km/h
→Image resolution (size of the pixel): 1x1 mm

DIGITAL CAMERAS
Artificial vision systems use digital high-speed and high-resolution cameras with high-power lasers.

Ineco's experience

■ In 2009, Adif entrusted Ineco with the drafting of a project to waterproof the GUADARRAMA TUNNELS of the high speed line Madrid-Segovia-Valladolid. Both the laser-scanner and the high-resolution cameras were used jointly with high-power lasers. The bi-tube infrastructure, with two 28 kilometre-long tunnels, has been operational since 2007.

■ Inspection and follow-up control of the damages in the REGAJAL TUNNEL: this Madrid-Valencia line tunnel was opened in 2010 and it is 2.5 kilometre-long. The railway manager requested Ineco to perform a follow-up control of the salt deposits accumulated in the tunnel walls for their subsequent elimination.

■ Study of damages and thermography of the TUNNELS OF SAN PEDRO in Madrid (Madrid-Valladolid high-speed line). Since 2010 Ineco has been taking preventive inspection and control actions by ongoing and automated monitoring.

■ Study of the loading gauge outline and thermography of the TUNNEL OF LILLA: it is located in Tarragona, is 2 kilometre-long and has swollen as it runs across sites with clay rocks and chalk veins. It is part of the Madrid-Barcelona-French frontier high speed line (Lleida-Barcelona stretch).

■ Inspections in several TUNNELS IN GIRONA, (Madrid-Barcelona-French frontier high speed line): tunnels of La Garriga (758 metres), Sant Andreu (649 metres) and Llogaia (1,713 metres).

■ Study of damages of the TUNNELS OF ABDAJALÍS (Córdoba–Málaga high speed line). 2 x 7,2 kilometre-long.

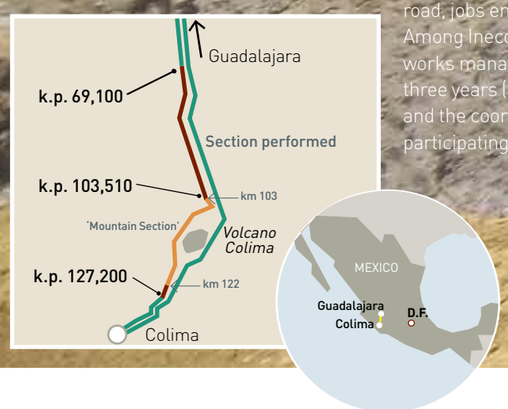
■ Inspection Madrid–Hendaya conventional line: TUNNELS OF LA BRÚJULA, PANCORBO and AMEYUGO. 2,5 kilometres in total.

Close horizons

Expansion to four lanes of the last section of Guadalajara-Colima highway

Ineco, which acts as manager and supervisor of this important Mexican road axis, manages the construction of a new section to conclude the splitting into four lanes of all the 148-kilometres alignment.

The Guadalajara-Colima highway is located in the Central-Western region of Mexico and is part of the Manzanillo-Tampico cross axis. Ten thousand vehicles use this highway every day and, after the expansion, will complete the journey in less than three hours. This 18.7 kilometres section is the last one to be expanded to four lanes, but also the most complicated one: it runs between k. p. 103.5 and 122.2, near the slope of Colima volcano, which is 3,820 m high and is located in the state of Jalisco. Since June 2013, the new highway segment is being constructed under Ineco's management. This new segment is spaced apart from the current one that is 16.5 km long and is known as 'Mountain Section'. The alignment includes 22 large structures between 30 and 140 m high, necessary to offset the unevenness of the area. Once the construction is finished, scheduled for the end of 2015, a highway part will be reserved in each direction and the modernisation process started in 2011 will come to an end. Back then, Ineco –leading a group of Spanish and Mexican companies– was awarded a 14-year contract to become the Administrator and Supervisor of Guadalajara-Colima highway. Banobras (Mexican Public Works and Services Bank), concessionaire of the road, implemented a new management model in which a supervisor coordinates the "Operator" and the "Maintainer" of the road, jobs entrusted to different companies. Among Ineco's tasks is the renovation works management performed in the last three years (see *itransporte 40* and *46*) and the coordination of all the companies participating in the project.«



Inecomex's engineer Isaac Mateo Valencia looking at the two ends of the valley where one of the four bridges of the 'Mountain Section' of the Guadalajara-Colima highway is to be built.

PHOTO: RICARDO CÉSAR NAVARRO PÉREZ (INECOMEX'S CIVIL ENGINEER)

Staying in contact

Two new tools for air navigation and high speed

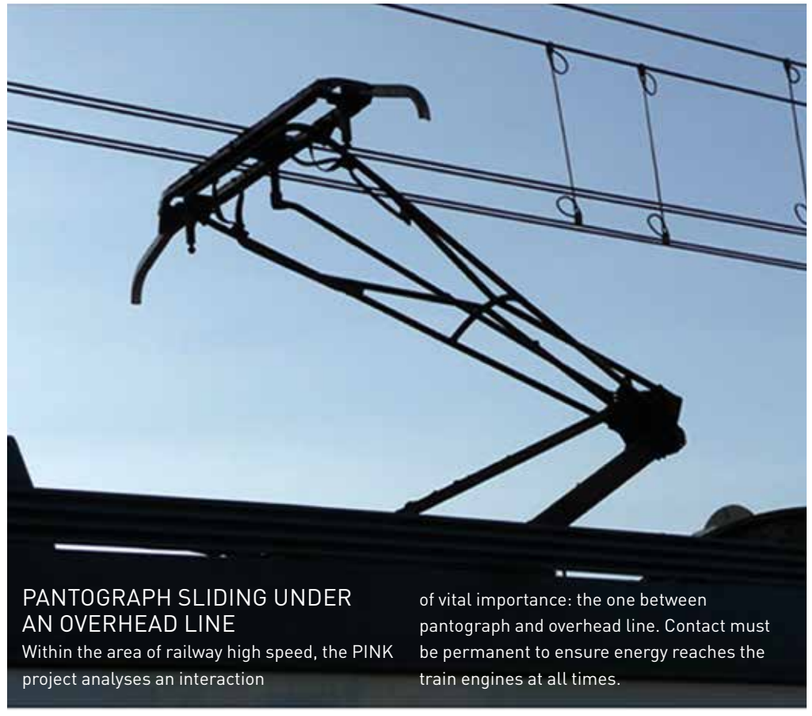
With the collaboration of **Víctor Quiñones**, aeronautical engineer (HECCO project manager) and **Francisco Javier Guerrero**, BSc in Industrial Engineering (PINK project manager)

The purpose of HECCO is ensuring the quality of voice communications between controllers and pilots, whereas PINK is aimed at analysing how to enhance other types of contact: between pantograph and overhead line.

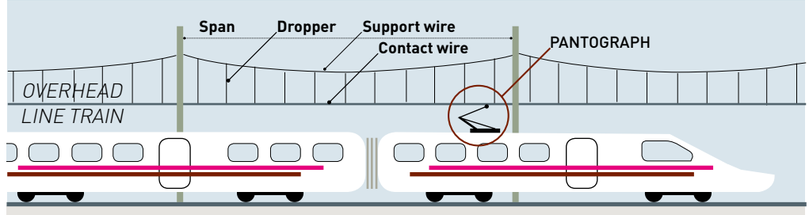
Two teams from Ineco have completed both innovation projects in very different areas, but with one feature in common: being oriented to improving interaction between two elements of their modes of transport.

In the case of **HECCO**, the purpose was to assess the quality of oral communication among aircraft pilots and air traffic controllers, performed by radio. The international entity Eurocontrol considers that up to 30% of incidents in air traffic management (ATM) are related to deficiencies in the voice communication channel. The CDTI (Industrial Technological Development Centre) has supported the project with the collaboration of Madrid's Polytechnic University (UPM).

In the high-speed field, **PINK** deals with the analysis of another vital interaction: the one existing between the pantograph and the overhead line. There must be permanent contact to ensure the energy reaches the train's engines; but as this contact is performed in motion, overvoltage takes place in the wire which may lead to wearing, or rather voltage is so low that contact may be lost. PINK has studied this phenomenon by means of a simulation tool (ANSYS), by accurately reproducing interactions between the different types of overhead lines and pantographs.«



PANTOGRAPH SLIDING UNDER AN OVERHEAD LINE
Within the area of railway high speed, the PINK project analyses an interaction of vital importance: the one between pantograph and overhead line. Contact must be permanent to ensure energy reaches the train engines at all times.



A VITAL INTERACTION
The electric power reaches the engines through the pantograph, which must be in sliding and permanent contact with the wire. Ineco now has available a study tool that allows a thorough investigation of this phenomenon.

PINK

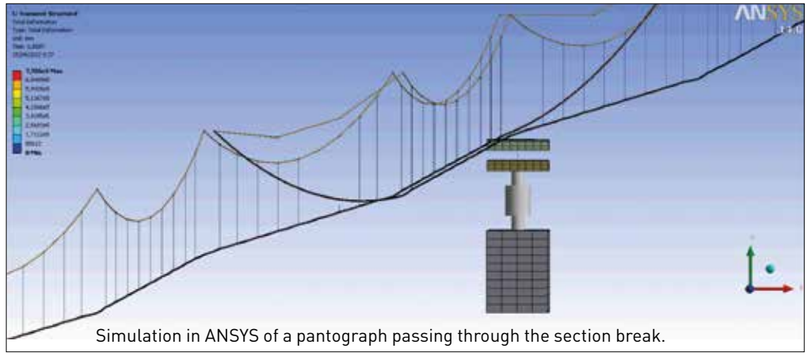
Without losing thread

In order to increase the speed of high-performance trains it is necessary to study the interaction caused by contact of overhead line and pantograph. The study of this phenomenon helps to understand and enhance the performance of both, as well as to predict the behaviour of new designs. As a result, Ineco has developed PINK, an analysis of the simulation of dynamic interaction between pantograph and overhead lines in railway lines, specifically applied to high speed lines. Simulation tool ANSYS was used for the study. This tool applies the finite element method. In this way, the problem of the high costs of tests performed on trains in service is avoided.

Experience confirms that the commercial success of the lines largely depends on the speed at which the journey is completed, which, at the same time, conditions many other elements: alignments (minimum radius on ground plan), safety systems, braking systems, maximum slopes, etc. Energy distribution is performed universally through the overhead line or catenary. The union between the overhead line and the vehicle is performed through the pantograph, which must ensure the uninterrupted powering of engines by means of sliding and permanent contact with the catenary wire. However, under the dynamic actions produced by the pantograph, the overhead line is deformed and oscillates. As a result of its inertia, the pantograph cannot instantly follow the movement of the overhead line and accomplish permanent contact.

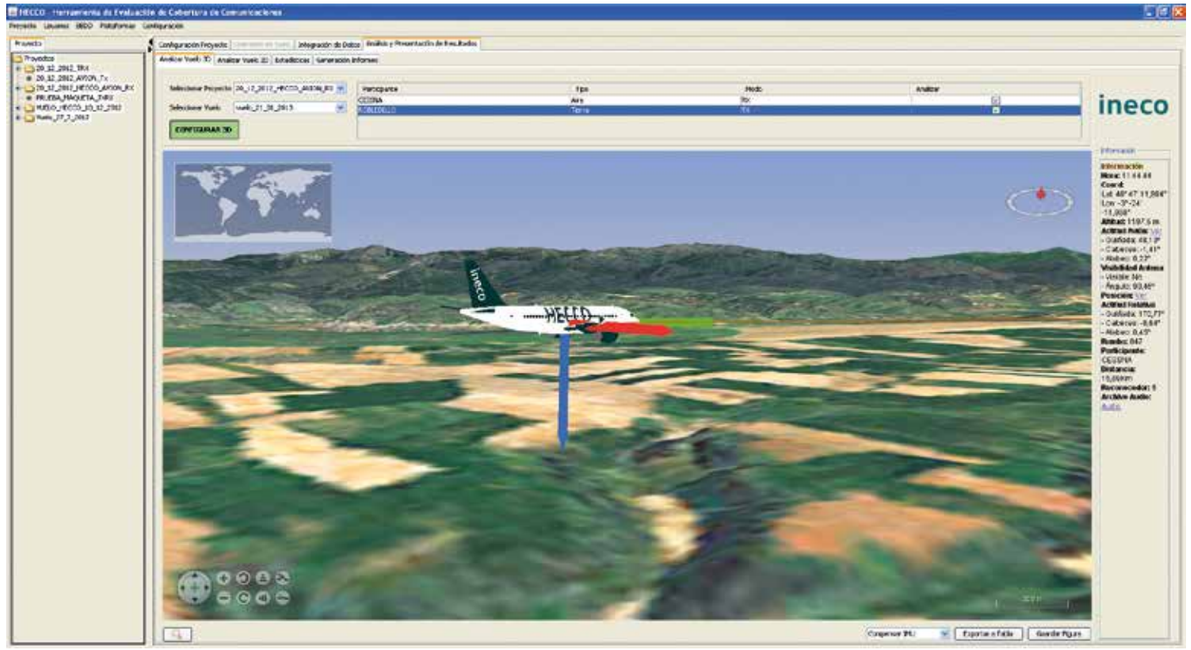
Consequently, the loss of contact generates electric arcs which bring about premature wearing of both systems, as well as discontinuous supply of electrical traction engines. The dynamic performance of the overhead line-pantograph system is one of the greatest limitations for existing high-speed railway systems. Nevertheless, this interaction had not been thoroughly investigated, although it is of major importance as it is closely related with interoperability, and because the wave propagation effect in flexible overhead lines limits the increase in speed. As a result, it became necessary to perform a thorough study such as the PINK project which was presented at the Second European Forum on Railway Running Gear which took place in June in Alcalá de Henares (Madrid).«

CALCULATION SIMULATOR
The use of a finite element calculation simulator has allowed reproducing several types of interactions between different kinds of pantographs (mass concentration type of two and three bodies) and overhead lines: with one or more spans, with fake support wire, stitched catenary, etc., as well as the use of one or two contact wires, the off-centring of the wire, the compensation systems, section breaks, tangential points and crossed points or performance of the wire when interacting with more than one pantograph.



Simulation in ANSYS of a pantograph passing through the section break.

According to Eurocontrol, up to 30% of air traffic incidents could be related to the air-ground communication channel quality. However, there was no procedure or regulation to verify its quality



ASSESSMENT OF AIR-GROUND VOICE COMMUNICATION QUALITY WITH HECCO

It allows making a completely objective assessment, as it uses state-of-the-art techniques for voice analysis, synthesis and recognition. Above, the 3D analysis module; bottom left, the configuration module; and bottom right, the operating module.

HECCO

Loud and clear

Air navigation services are meant for ensuring safety and efficiency of operations. ICAO classifies them into two kinds: ATM services (Air Traffic Control and Management) provided by information processing systems and, ultimately, by people (operators), and CNS services (Communication, Navigation and Surveillance). The first service of this type was oral communications by radio or ground-air, between pilot and operator, known as Aeronautical Mobile Service (AMS).

It is the main means to perform information and air traffic control tasks and is made up of a series of radio stations operating at HF band (for remote ocean areas) and mainly at VHF band (118–137 MHz) with amplitude modulated carrier. Stations are deployed around a geographical area so that they provide radio coverage to the air space under responsibility of the corresponding Movement Control Unit: en route control centres, TMA, or control towers at airports.
Although technology has been enhanced throughout the years, it continues to be basically the same as in early times and will continue to be used, as it is deemed a basic service with mature and reliable technology. The increase in air traffic over the last decades has brought about increased safety requirements and more complexity in its management, where, according to Eurocontrol, 30% of incidents could be related to the quality of the air-ground communications channel. However, to date there is no procedure or regulation to verify its quality and the assessment has always been made subjectively: the listener ranked the audio quality on a 1-5 scale (from "illegible" to "perfectly legible"), with factors such as tiredness, degree of attention or experience influencing the assessment.

DOUBLE INSTALLATION

The tool, which is installed both in control centres and in aircraft (synchronised through GPS), generates and sends a message –previously recorded and based on real conversations– which acts as a pattern, with a predefined time sequence. At the other end of the link, and taking into account the time period in which the message must be delivered, the tool activates the voice recognition procedure and automatically determines audio quality or, in the worst-case scenario, the failure to to recognize sent message.

HECCO (Voice Communication Quality Assessment Tood) allows making a completely objective assessment, as it uses, for the first time in the specific field of air traffic control, state-of-the-art techniques for voice analysis, synthesis and recognition. It allows collecting and postprocessing data and synchronisation via GPS and is capable of importing, integrating and correlating external data obtained through other radio frequency signal analysis applications during check flights.

Furthermore, it records and manages all the data, such as voice quality assessment grade, position of each station participating in the flight at every moment, strength of the signal received in receiving equipment, etc., and indexes them with a time-space reference. It also allows generating different kinds of graphs and visually represents the flight status on a GIS (Geographic Information System) base. The system was tested at laboratories and subsequently in a real environment with check flights. The results were presented at the World Air Traffic Management (ATM) Congress 2014, held in Madrid in March (see *itransporte 51*).«


Global Air pilots with Israel Gómez and Luis Paisán, from Ineco, during the tests.

PICTURE: INSTITUTO CERVANTES-NEW YORK

The world says ¡hola!

Spanish is the second most extended language in the world, with 470 million speakers located in about 20 countries. And it is America, with the US and Brazil taking the lead, where it has been growing the most.

By *itransporte*

Si está leyendo esta frase sin necesidad de traducción, es que forma parte de una de las mayores comunidades lingüísticas del mundo: la hispanohablante. (If you can read this without the need for translation, this means you are a part of one of the most important linguistic communities around the world: the Spanish-speaking community).

Arisen from the evolution of Latin in the Kingdom of Castile, in the Iberian Peninsula during the Middle Ages –that is were it took is name as "Castilian"– Spanish is the heritage of 21 countries, including Spain, and it is spoken by 548 million people. As reported by the Instituto Cervantes, the official Spanish entity in charge of the international promotion of the language, this figure includes 470 million native speakers, 58 million speakers with "limited proficiency" and about 20 million students around the world. In addition, it is the third most used language on the internet and the second one in Facebook and Twitter, after English and Mandarin, used by 1.35 billion people, but almost exclusively natives. The situation of Russian and Hindi is similar. The case of the dissemination of Spanish, French and English is very different, especially the latter, which is presently a global lingua franca, as Latin in Classical Times or French until the 19th century.

AN AMERICAN LANGUAGE_ The most booming community of Spanish speakers in the world is in the United States: a total of 46.9 million out of the 316 million of Americans are latino (64% are of Mexican descent), based on the latest data of the Census Bureau, plus 11 million illegal immigrants. A group which also presents a strong demographic dynamism driven by population which is younger than the country average and has high birth rates. Apart from the above, two other issues account for the boom of Spanish at an English-speaking country: the ever growing social and economic and educational level of the third cultural community in the United States and the high rate of use of the language among its members which has remained the same over successive generations. Based on the data compiled by the Instituto Cervantes, over 73% of Hispanic-American families use Spanish. The United States Census Bureau projected that if the trend is unaltered, by 2050 the Hispanic population will have increased threefold placing the country at the lead of the Spanish-speaking nations around the world.


DICCIONARIO
DE LA LENGUA CASTELLANA,
EN QUE SE EXPLICA
EL VERDADERO SENTIDO DE LAS VOCES,
SU NATURALEZA Y CALIDAD,
CON LAS FRASES O MODOS DE HABLAR,
LOS PROVERBIOS O REFRANES,
Y OTRAS COSAS CONVENIENTES
AL USO DE LA LENGUA.
DEDICADO
AL REY NUESTRO SEÑOR
DON PHELIPE V.
(QUE DIOS GUARDE)
A CUYAS REALES EXPENSAS SE HACE
Esta obra.
COMPUESTO
POR LA REAL ACADEMIA ESPAÑOLA.
TOMO PRIMERO.
QUE CONTIENE LAS LETRAS A.B.
CON PRIVILEGIO.

Cover of the dictionary of Spanish language of the RAE (Royal Spanish Academy), 1726, with an illustration of Don Quixote by Gustave Doré.

The other major source of new speakers in the continent is, paradoxically, the only vast territory in South America which is not a former Spanish colony: the Portuguese-speaking Brazil which, with a population of over 200 million is one of the largest emerging economies in the world, the so-called BRICs, jointly with Russia, China, and India. In 2005, the Brazilian government approved a law whereby Spanish lessons became compulsory at schools both private and public. Thus, at present, there are more than 12 million Brazilians taking Spanish lessons and almost half a million speakers.

SPANISH IN ASIA_ Spanish, present in Asia too: As from 2009 the Philippines which, together with Cuba was the last Spanish colony to declare its independence in the late 19th century, has reintroduced to its syllabus Spanish, which was its official language until 1973. Spanish demand also grows in other countries without any historical link to Spain. Being considered a world economic power, China is also relevant as there is renewed interest in Spanish. In this case, this interest arises from the growth in tourism and the commercial exchange with Spain and the rest of the Latin countries.

AND WHAT ABOUT SPAIN?_ While Spanish is growing in other parts of the world, the number of speakers in Spain is falling. In this case, due to demographic reasons: owing to the ageing of the population –a common phenomenon in Europe as a whole– and the fall in immigration stemming from the economic crisis, in 2014, Spain lost over 220,200 inhabitants as compared to 2013 standing at 46.5 million, as per the INE, the Spanish statistics institute. Likewise, Spain's strength as a tourist destination (in 2013 it broke its own record with 60.6 million visitors) is a driver for the sector related to learning of Spanish for foreigners. As to the language as an economic asset, over 100,000 companies and 500,000 jobs are related to the cultural industries in Spain accounting for about 3% of GDP.«

Foreign students of Spanish at the University of Castilla La Mancha (left) and University of Deusto, Bilbao (above).

Guarantors of Spanish

The Instituto Cervantes, which was created in 1991, is the most recently established public institution for the promotion of Spanish as compared to its British, French and German equivalents, the British Council (1934), the Alliance Française (1883) and the Goethe Institut (1925), respectively. Even though the payroll and budget of Instituto Cervantes are much smaller, tuition increases 8% p.a., i.e., there were 130,128 students enrolled in the 2012-2013 course. It is present in 86 cities in 43 countries in the 5 continents. During the last fiscal year, it taught 14,529 courses and 66,281 students sat for examinations in different centres located in more than 90 countries to obtain the Diploma in Spanish as a Second Language (DELE). In addition, 92,000 students enrolled in Aula Virtual, the Institute's online education centre. A total of 1.4 million students attended over 5,000 cultural activities held around the globe.

Spanish is the official language in...

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PICTURE: INSTITUTO CERVANTES-NEW YORK

The Hispanic Nobel prizes

Hispanic literature is ranked fourth in number of prizes after the English, French and German literatures (with the same number of prizes and ranked second and third). Out of the 110 Nobel Prizes in Literature awarded to date, 11 are held by Hispanic writers, being the most recent the Peruvian Mario Vargas Llosa in 2010. In 1990 it was awarded to the Mexican Octavio Paz; in 1982, Gabriel García Márquez (Colombia); in 1971, Pablo Neruda (Chile); in 1967, Miguel Ángel Asturias (Guatemala); and in 1945, Gabriela Mistral (Chile).
The list is completed by the Spanish writers José Echegaray in 1904 (shared with Frederic Mistral), Jacinto Benavente in 1922, Juan Ramón Jiménez in 1956, Vicente Aleixandre in 1977 and Camilo José Cela in 1989.

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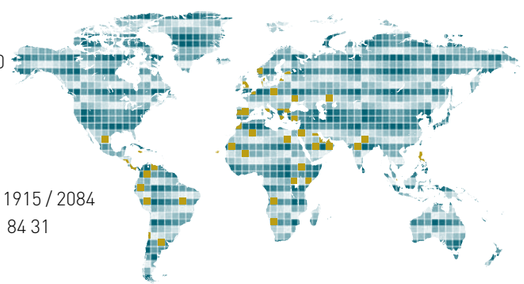

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