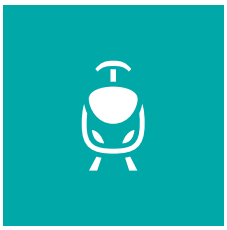
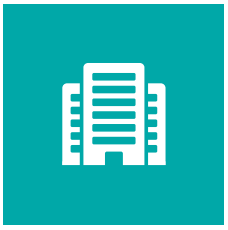
ANNUAL REPORT 2015

FRENCH INSTITUTE OF SCIENCE AND TECHNOLOGY
FOR TRANSPORT, DEVELOPMENT AND NETWORKS










IFSTTAR

SUMMARY

EDITORIAL

2015,
A GEM CANNOT BE POLISHED WITHOUT FRICTION, NORE A MAN PERFECTED WITHOUT TRIALS (CONFUCIUS)

Hélène Jacquot-Guimbal,
Managing Director of IFSTTAR

Jacques Tavernier,
Chairman of the Board of Directors

> “This year again, the quality and quantity of our scientific production further asserted our international footprint.”

Despite a backdrop of reduced staff numbers and tough economic environment, IFSTTAR nevertheless managed to maintain the momentum of its activities. This year again, the quality and quantity of our scientific production further asserted our international footprint. Scientific recognition is also evidenced by our successful bids for H2020 calls for projects. Throughout the year, the Institute also successfully publicised its previous work on climate change mitigation and adaptation.

2015 was also the year of assessments by HCERES (Higher Council for the Evaluation of Research and Higher Education). The assessments for all five departments legitimized the Institute’s strategic choices. At the end of the year, the Institute proceeded with a self-assessment and was audited by a committee of experts mandated by HCERES. Its report should be published in the second half of 2016.

Structured partnerships with universities and other research centres have been consolidated like our active participation in building the COMUE (Community of universities and research centres), in the latest Idex and I-sites (Excellence Initiative) calls for projects or in project proposals in the framework of the CPERs. Two projects have emerged to testify to the Institute’s commitment in this respect: a very academic consortium with the Sense-City Equipex (Excellence Equipment) and another, more social and economic, with the Transpolis innovation platform. On the international arena, we should mention our collaborations with our “cousins” from Quebec (Quebec Ministry of Transports as well as the setting up of International Associate Laboratories).

This year again, we proceeded with our roadmap of organisational and managerial actions in line with our commitment to continuous improvement. Our ISO 9001 certification coverage has now been extended to five of our six sites.

Our “Imagine IFSTTAR” mission statement has rooted itself even deeper with the creation of the Five Actions to improve working conditions via the facilitation of business networks, the implementation of organisational changes and support to our management actions. Our Gender equality policy was sealed into a Charter of times.

Along the same line, in 2015 an IFSTTAR decades’ cycle was initiated, a federative event for the institute. The dedicated days organised last autumn in Nantes, Marseilles-Salon de Provence and Lyon-Bron were each time successful with a good number of people, interest shown by the participants and the high-profile of personalities who took part.

Last but not least, IFSTTAR was involved in the COP21 events in Marseilles, Lyon and Paris of course, contributing or organising lectures or round table discussions on various themes such as the Road of the Future, sustainable mobility, the City of Tomorrow: positive-energy roads and railway stations, petroleum-free roadway binders, concrete used as a carbon sink, mobility and alternative energies. A solar road demonstrator was installed at the heart of the negotiation zone.

LET'S HEAR FROM

ILAB-SPINE : A FRENCH-QUEBEC COOPERATION OF EXCELLENCE

Dr Alain Moreau,
Director for Research
at Sainte-Justine UHC
in Montreal (Canada)

Inaugurated in Marseilles in October 2015 and in Montreal in June 2016, ILab-Spine brings together researchers from the Ecole Polytechnique and the Sainte-Justine UHC in Montreal, and in Marseilles researchers from the CNRS, the University of Aix-Marseilles, the Marseilles public hospitals and healthcare services (AP-HM) and IFSTTAR. Their research will focus on imaging, modelling and biomechanics of the spine and spinal cord.

WITHIN THE UHC, THE SAINTE-JUSTINE RESEARCH CENTRE IS A FLAGSHIP PAEDIATRIC RESEARCH UNIT. YOUR CENTRE HAS BEEN WORKING WITH IFSTTAR FOR OVER TEN YEARS. ON WHAT AREAS HAVE YOU FOCUSED?

Dr Alain Moreau: Researchers from the Sainte-Justine UHC are internationally acknowledged for their expertise in spinal cord deformities, particularly idiopathic scoliosis as well as complex and traumatic bone diseases. We seek to develop innovative techniques, including through the early detection of severe scoliosis, to offer surgical procedures that are as little invasive as possible, in order to preserve spine mobility. Scoliosis affects 3-4% of the paediatric population and among these one in six will receive treatment, whether physiotherapy or wearing a back brace (10% of cases) while just under 1% need to resort to surgery. Now, to offer innovative treatments, it is essential to get a better understanding of the biomechanics of musculoskeletal tissues, of three-dimensional personalised spine modelling and of biomarkers, hence our collaboration with IFSTTAR. ILab-Spine is the culmination of this partnership. Its strength lies in the synergy of skills it has brought about - in my opinion unique in the world – with orthopaedists, whose expertise in surgery of children's scoliosis is recognized worldwide, working together with leading scientists in the areas of imaging, biomechanics and modelling of the spine.

WHAT ADVANCES HAVE ALREADY BEEN MADE?

Dr Alain Moreau: The work performed both in biomechanical modelling of the spine, in the biomechanics of orthopaedic treatment (back braces, etc.) and in computer-assisted surgery allowed the customised design of corrective orthotics for children with scoliosis, all more powerful, lighter and comfortable. This is all about personalised precision medicine. We have also developed innovative devices for the treatment of scoliosis whereby we can "staple" the vertebrae together without actually binding them for good as was the case in conventional surgery. This allows maintaining mobility and flexibility of the spine while involving less invasive surgical procedures, i.e. reducing the risk of damaging the spinal cord and potential sequelae. Furthermore, to assist surgeons and optimize their interventions we have developed "navigation-simulation" systems, a kind of surgical GPS: using cameras, the surgeon determines the position of the respective tools and anatomic structures; during surgery, the software simulates installing implants and indicates the adjustments to be made to the surgical planning in order to optimize the procedure. Such systems pave the way for the future of surgery.

For more information:
About the Sainte-Justine Research Centre
www.recherche.chusj.org

Marie-Claude Dupuis,
Director of the Bus Rolling-stock department of RATP and member of IFSTTAR's Board of Directors since 1 July 2015

> "Energy transition is at the heart of IFSTTAR's research."

WHAT IS YOUR ROLE AT IFSTTAR'S BOARD OF DIRECTORS?

As a director, I contribute to steering the institution. My role as a qualified person is to inform IFSTTAR's decisions through my own experience, whether in terms of strategic management or working methods. I was probably chosen on account of my current responsibilities within RATP, and as managing director[1] of a State-owned industrial and commercial undertaking (EPIC).
Of course, IFSTTAR is a public scientific and technological body (EPST) with other constraints than those of an EPIC, but some of the processes are very close, such as the establishment of Performance contracts with the State or purchasing.

WHAT DO YOU THINK OF THE RESEARCH CONDUCTED AT IFSTTAR?

I have not been sitting on the board of directors long enough to voice an opinion. But I am in full agreement with the four thematic pillars of the 10-year scientific strategy of the Institute, recalled in 2015 during COP21: invent sustainable mobility, adapt infrastructures, control natural hazards and environmental impacts, and finally rethink and plan cities and territories. These themes echo my priorities at RATP. I am in particular responsible for the 2025 Bus plan aiming to replace our fleet of 4,500 diesel buses with electric or gas vehicles. This is both a matter of sustainable mobility and urban infrastructure.
In the longer term, research on self-driving vehicles is a major topic which IFSTTAR has already very much taken on board. This clearly involves technical, legal and societal issues.

SHOULD THERE BE FURTHER EMPHASIS ON CERTAIN AREAS OF RESEARCH?

Everything revolving around energy transition is crucial. But it is already very well reflected in IFSTTAR's four research pillars. For example, RATP is very interested in work on recovering the braking energy of the undergrounds and trams. Elected officials and industry players have huge expectations from these new modes of mobility and sustainable cities.

WHAT ARE THE STRENGTHS OF IFSTTAR?

I particularly like its openness to the world: IFSTTAR conducts many programs and international partnerships. Its multidisciplinary approach is also a strong point. In terms of sustainable mobility, for example, research covers both technologies and socio-economic or societal aspects. This is fundamental as behaviour will be critical in all these areas.

[1] Marie-Claude Dupuis was managing director of the National Agency for Radioactive Waste Management (Andra) from 2005 to 2014

HIGHLIGHTS AND EVENTS

JANUARY

World record for sensors
Two world records were respectively set for deformation nanosensors ("reproducibility of deformation sensors using nanotubes printed on flexible substrate", August 2015) and nanotubes-based transistors ("CNTs based transistors", January 2015) for the simultaneous analysis of a large number of gaseous species rewarding the long-term endeavour of Berengere Lebental and Fatima Bouanis together with their co-authors within the NACRE team and with LPICM (École Polytechnique and CNRS) under the Sense-City scientific program

FEBRUARY

4 and 5 february
Roads' Technical Days

MARCH

23 march
Inauguration of Sense-City, the connected mini-city

24-26 march
***Rencontres géosynthétiques* 2015**
Practical cases of how geosynthetic materials are used in civil engineering and environmental applications, illustrating key functions of these building materials

31 march
CNRS/IFSTTAR Forum on the car of the future
Presentation of the eco-driving simulator (LIVIC)

MAY

20-22 may
Journées Ouvrages d'Art
Meetings on engineered structures

27-29 may
International French-speaking forum on tribology, in Nantes

Shooting of a feature film in the laboratories (CPDM, LEPSIS, EMMS) and common areas of the Bienvenüe building in May 2015: *"Le secret des banquises" (The secret of ice floes)* directed by Marie Madinier, starring Guillaume Canet and Charlotte Le Bon – release in June 2016

JUNE

4-5 june
Technical sessions on Acoustics and Vibrations in Nantes

13 june
La voiture d'hier et de demain (The car, yesterday and tomorrow) in Sceaux: a whole day opened to the general public on the themes of clean vehicles (amongst others). Presentation of the eco-driving simulator (LIVIC)

19 june
Launch of the SETRIS project – Strengthening the European Transport Research and Innovation Strategies, part of which is devoted to helping bring about and setting up a more sustainable TRA (Transport Research Arena)

JULY

Hélène Jacquot-Guimbal appointed vice-chair of ETRA – the European Transport Research Alliance. Within this framework, a workshop entitled *"Transport and Climate Change; European Researchers Act"* was co-organised by ETRA and IFSTTAR on 6 July 2015 in Marne-la-Vallée with about one hundred attendants from over 30 countries (EU and non-EU). This workshop was "labelled" by the scientific conference preparing COP21 – CFCC2015 http://www.IFSTTAR.fr/ressources-en-ligne/ lactualite-IFSTTAR/toute-lactualite/fil-info/ article/atelier-transport-et-changement- climatique/

IFSTTAR organised two parallel sessions as part of the CFCC2015 conference (1st international scientific conference prior to COP21): one with the European Commission (DG ENV) and a second one with Cerema

SEPTEMBER

17-20 september

Launch of the *Décennies de la Recherche* (Decades of research) at IFSTTAR

40 years of research at the site of Bouguenais:
17: whole day of conferences;
18: visits to the site in-house teams;
19 and 20: open days in the framework of the Heritage Days

OCTOBER

1-16 october

Paris Motor Show: IFSTTAR present on the MEDDE booth

The LIVIC teams presented their driving simulator to over 1,000 visitors!

2 october

***Décennies de la Recherche* (Decades of research) at IFSTTAR**

50 years of research in the field of road safety in Aix-en-Provence

ITS World congress

5 to 9 october in Bordeaux

The conference attracted more than 10,000 people from a hundred different countries to discuss and discover the latest innovations in the field of intelligent transport systems (ITS) and brought together both public and private contract givers, network managers and operators, industrialists, scientific and technical organisations and transport associations. Other highlights of the conference included the initiative of over thirty transport ministers who engaged in a manifesto entitled "ITS against Climate Change" which calls for the mobilization to accelerate the development of ITS and design solutions geared to tackle climate issues. With the COP21 to open just a few weeks after, this latter point took on a special resonance.

Besides taking part in the scientific sessions, the main exhibition and technological demonstrations, IFSTTAR was also actively involved in the organisation of the Congress, including:

- The technical coordination of demonstrations on themes such as "Solutions for Sustainable Mobility" and "Urban Trends";
- The scientific leadership of the European Program Committee;
- The steering of two groups within the National Organising Committee (GP7 and GT2) and substantial participation in the GT1;
- Technical support to the coordinator of the "Cooperative ITS deployment challenges" part of the technological demonstrations;
- A representation at the "International Board of Directors" of the Congress.

On October 7, as part of the congress, Alain Rousset, the president of the ALPC Region (Limousin Aquitaine Poitou Charentes) signed a memorandum of understanding to launch a laboratory of uses (living lab) dedicated to intelligent transport systems, with IFSTTAR as one of its partners. In parallel with the ITS WC 2015 congress, IFSTTAR and AASHTO (American Association of State Highway and Transportation Officials) jointly organised a France/USA roundtable on connected and self-driving vehicles.

6 october

Opening of the International I-Lab Spine associate laboratory

14-15 october

20 years anniversary for the epidemiological register of road victims in the Rhone region in Lyon

One day of testimonials and exchanges on the benefits of this tool for accidentology analysis. Guest: Emmanuel Barbe, DISR. One-day conference on road safety research organised in Bron

20 october

Signing of the Paris-Est site contract with Thierry Mandon

NOVEMBER

12 november

Green-City Business in Bienvenüe: presentation of Sense-City and LVMT-related themes

30 november to 2 december

AFPS symposium

The 9th National Symposium on Earthquake Engineering (AFPS) was organized by IFSTTAR. Open to all, it promotes exchanges between the different parties concerned by seismic risk: public authorities, civil safety, insurers, researchers, architects, engineers ... A broad spectrum of topics was covered: from the behaviour of geological faults to the response of engineered structures and society (psychological, economic and social aspects). The 2015 symposium was entitled "Anticipating, mitigating and managing the effects of earthquakes in the territories" and broadened the spectrum versus previous events emphasizing on the management and anticipation of risks and their territory-specific approaches

DECEMBER

COP21 and steering of the two 2 conferences in the build up to COP21: exhibition of the hybrid photovoltaic solar road (COSYS) simulator in the negotiation zone – France pavilion

7 december

Presentation of the 5th Generation Road by N. Hautière, and of the RSNB initiative (National scientific meetings in Bron) by Laurent Meyer and Philippe Vezin – Climate generation booth – France pavilion

10 december

Hélène Jacquot-Guimbal took part in the roundtable on "Mobilities of the future" at the Grand-Palais in Paris, in the framework of the COP21 Solutions, organised by ATMB

11 december

Hélène Jacquot-Guimbal co-chaired the roundtable with DGITM, on the "Road of the future" – Climate Generation booth

11 december

Launch day of the CESAR-LCPC version 6

AWARDS AND DISTINCTIONS 2015

32 awards and distinctions (source: departments programme budget)

MAST

MIT

Emmanuel Chailleux won the 2015 trophy for Public research on Energy-Environment-Climate organised by Reed Expositions (organiser of Pollutec and World Efficiency trade fairs) and ADEME. Emmanuel Chailleux was awarded the 3rd prize for posters' session at the 2015 "Green chemistry" international conference of La Rochelle

E. Chailleux and C. Queffelec: Trophy for Public Research - Algoroute

NAVIER

Philippe Coussot received the Silver Medal from CNRS
Lucie Ducloué won the Thesis award from the École des Ponts ParisTech

GPEM

Bogdan Cazacliu received a grant from the Royal Academy of Engineering, United Kingdom, to stay at the Bristol University as visiting professor (Distinguished Visiting Fellowships Award)
Bogdan Cazacliu was also awarded the chair of Professor Visitante Nacional Senior at the Rio Grande del Sul University, 2015-2017, funded by the Brazil Ministry of Higher Education

LAMES

Milia Farès (PhD Student) was awarded the 1st prize for the best presentation at the international symposium on Non Destructive testing in Civil Engineering held in Berlin from 15 to 17 September 2015

GERS

GeoEND

Vincent Métais, 3rd year PhD student (ESEO/IFSTTAR contract RPR0F12111) received the 3rd prize as best young researcher awarded during the international symposium on Non Destructive testing in Civil Engineering held in Berlin from 15 to 17 September 2015

COSYS

GRETTIA

Mathis Garciarz and Dihya Atmani received, ex-æquo, the Best Paper prize awarded during the Autonomic Road Transport Support Systems Early Career Researcher Conference (ARTS ECR 2015)

LEOST

Ahmed Bel Hadj Mabrouk (CIFRE PSA-IFSTTAR PhD student) received the "Student Paper Award" for the best student paper at the 4th IEEE APCAP – Asia-Pacific Conference on Antennas and Propagation (2015)
Christophe Coniglio (IFSTTAR PhD student) was awarded the prize for the Best presentation at the Doctoriales COSYS 2015

LICIT

Etienne Hans received the Best paper award for the section Operation and Traffic Management at TRB 2015 - Cunard Award
Nicolas Chiabaut received the Best poster award at the Truck and Bus World Forum
Maxime Gueriau received the Best poster award at RIDA2D
Julien Monteil was awarded the International Albertis prize for the best 2015 thesis

TEMA

Laurent Dupont received the W. Portnoy award IAS-PEDCC
Son-Ha Tran was awarded the Vedecom competitiveness prize

LEPSIS

Eric Dumont received the Fresnel medal awarded by the Association Française de l'Éclairage (French Lighting association)

LISIS

Janelle Hammond received the SMAI's 1st poster prize and the 1st prize for the First-year PhD students at the "Doctoriales COSYS"

TS2

LBA

ISSS conference
BMES Reviewer Choice Award
Seminar of the Edouard Sanson Orthopaedics programme in Canada

LBMC

T. Bonci, R. Dumas, L. Cheze, V. Camomilla, A. Cappozzo received the Whithaker-Allard Innovation award for their paper entitled *"A modal approach for the soft tissue artefact mathematical representation in optimal kinematics estimations"* at the 13th International symposium on 3D Analysis of Human Movement

AME

LAE

Yuanfang Zhang received the EAA Best Paper and Presentation award in the "Young researcher" category at Euronoise 2015

EASE

Fanny Mallard was awarded ex æquo for the 4th prize of the Albertis chair on "Management of transport infrastructures" - in the thesis category

LVMT

Jean-François RUAULT was awarded the ASRDLF Thesis prize

IFSTTAR IN ITS ENVIRONMENT

2015 confirmed the financial equilibrium that had been achieved in 2014, thus proving the Institute right in its choices. To prepare the next Goals and Performance Contract for the 2017-2021 period, IFSTTAR can build up on the evaluation of its five departments by HCERES. The latter's reports, full of praises and constructive comments, vindicated IFSTTAR's strategy. The Institute's evaluation report should be published in the first half of 2016.

At the scientific level, IFSTTAR's laboratories and teams have achieved innovative results and launched new multidisciplinary projects that epitomise the organisation's approach, in spite of diminishing resources and staff. As an example one may quote the DEBATS research programme focusing on the effects of aircraft noise on health or projects aiming to analyse and evaluate the articulation between public policies, territorial institutions and the sustainable development of territories (environmental compensation measures, designing more effective exchange clusters, etc.).

A project was conducted to better define the fields of expertise of the Institution, as well as the criteria and procedures for the recognition and qualification of its experts.

The Institute continued to take part in European research projects with the launch of the new H2020 programme. Proof to this is the fact that 25 % of the amounts for signed contracts are European contracts, namely 19 projects in 2015.

The emphasis on gender equality was maintained and a Charter of Times was signed by all the members of the Institute's executive committee and circulated to all departments. An action plan for equality will be launched in the course of 2016.

In 2015, the transition to GBCP mode (Public Budgetary and Accounting management) helped optimising the financial and accounting functions by reorganising the three areas of support functions: financial and accounting management, assistance function and human resources functions. Many procedures were thus harmonised and streamlined.

IFSTTAR pursued its endeavour in developing well-balanced core partnerships to underpin its research priorities. It is currently involved in 48 core academic partnerships. Two projects bear witness to this commitment of the Institute: a very academic consortium with Equipex Sense-City and a more socio-economic consortium with the Transpolis innovation platform.

In 2015 a cycle of "IFSTTAR Decades" (*Décennies de l'IFSTTAR*) was initiated. The events organised in Nantes, Marseilles-Salon de Provence and Lyon-Bron were all a great success, attracting many participants and prominent personalities.

After another tough year, the Institute again demonstrated its adaptability and transformation capacity by keeping up the momentum of activity of its research teams and of its support, thanks to the commitment of all its staff in a context of limited resources.

Jean-Paul Mizzi
Deputy managing director
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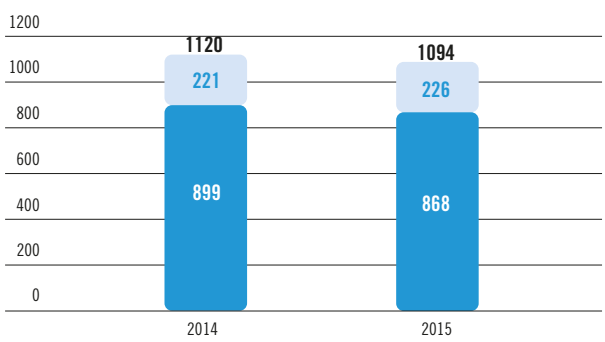
INSIDE THE INSTITUTE

Serge Piperno,
Scientific Director

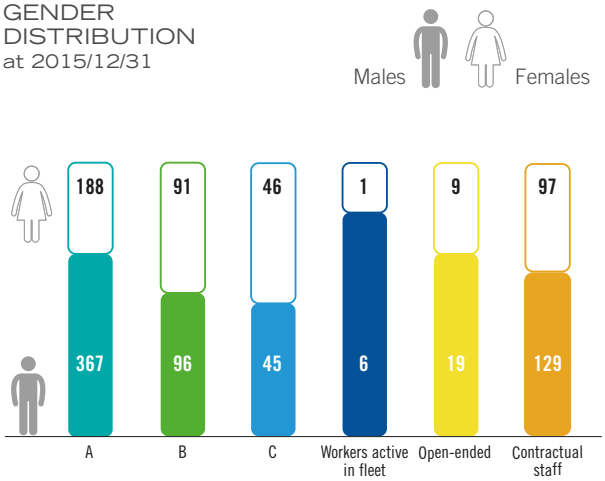
In 2015, IFSTTAR continued its effort to prioritise its themes of scientific research.
Initiated in 2013, this action echoes the evaluation process undergone by the Institute's departments (as research structures), and IFSTTAR itself as an Institute. It aims to hone in on the Institute's scientific strategy to better cope with the scientific breakthroughs and public spending objectives. In 2015, IFSTTAR's departments selected a number of themes for which their respective competences and achievements were most likely to have the biggest impact (impact combining various aspects such as academic, leveraging, support to public policies, etc.).
These priorities were presented and discussed with the teams, in particular through a cycle of general meetings at every site, and then confirmed by the Scientific Council.
This process was completed at the beginning of 2016 with the elaboration of a revised scientific strategy drafted in order to take these priorities, and then crossing them with the expectations of our governing bodies and partners for the development of the new Goals and Performance Contract.

HUMAN RESSOURCES

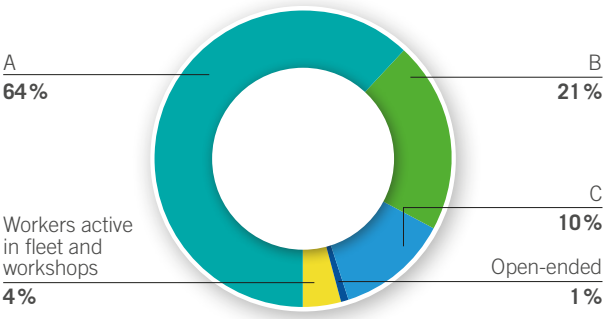
ACTUAL NUMBER OF AGENTS at 2015/12/31



GENDER DISTRIBUTION at 2015/12/31



PERMANENT AGENTS DISTRIBUTION at 2015/12/31



TOTAL NUMBER OF AGENTS at 2015/12/31

1094

Namely **1069 FTE**

654 414

AVERAGE AGE DISTRIBUTION
at 2015/12/31

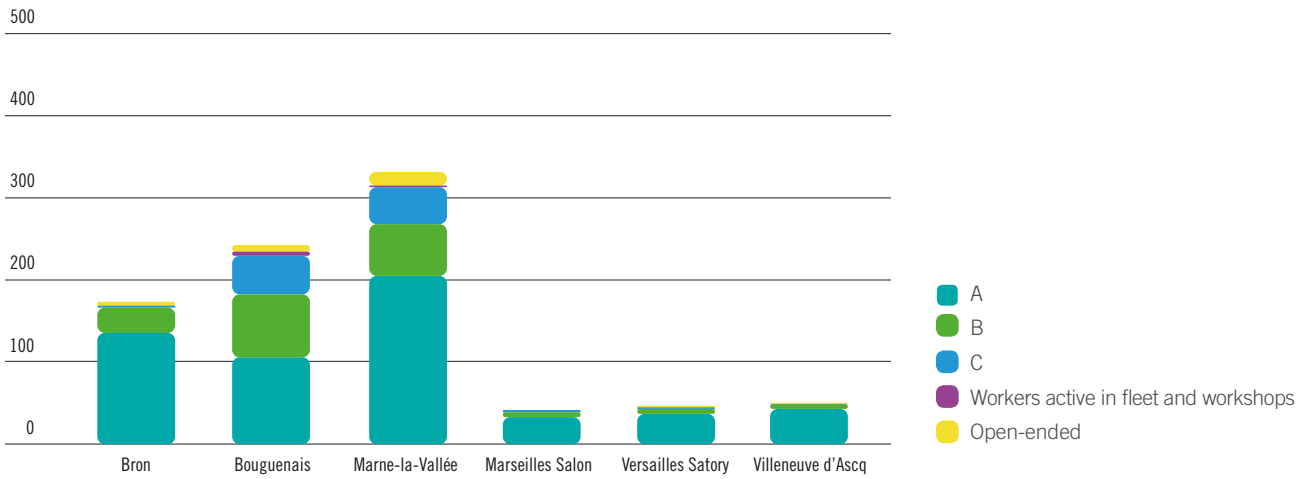
Permanent employees

	Males	Females
Permanent employees	47	46
A	47	48
B	46	45
C	48	47
Workers active in fleet and workshops	45	47

Non-permanent employees

	Males	Females
Non-established staff	58	58
Contractual staff with open-ended contract	50	44
Contract-based PhD students	26	26
Other subsidised FTC	27	28
Other agents paid on own funds	29	28

DISTRIBUTION BY IFSTTAR'S SITES
at 2015/12/31



QUALITY

In 1979, via the LCPC, IFSTTAR was one of the five founding laboratories of RNE, which later became COFRAC in 1994, hence its “COFRAC Essais” accreditation number No 1-0005

IFSTTAR’s three quality diplomas

IFSTTAR’s Quality Management System (QMS) has been certified ISO 9001 since October 2002, its certification being renewed every three years since (2005, 2008, 2011 and 2014)

N° 22230-3
Quality Management System for the sites of Lille-Villeneuve d’Ascq, Marseilles-Salon de Provence, Versailles-Satory (LIVIC and LPC), Nantes, Marne-la-Vallée.

IFSTTAR is accredited by COFRAC Essais as per ISO 17025 for seven test programmes

Accreditations
N° 1-0005
(Paris site)
N° 1-0535
(Nantes site)
For scope see
www.cofrac.fr

IFSTTAR is accredited by COFRAC for products certification as per ISO 17065 for the CE marking of aggregates (regulation 305/2011 for construction products), notified body No. 1165, for control audits in-factory of aggregate quarries production, as per system 2 +

Accreditation
N° 5-0533
For scope see
www.cofrac.fr

Highlights

- After the LCPC/INRETS merger in 2011, the aim of the Institute was to extend ISO 9001 certification of its QMS to all IFSTTAR sites.
- Accordingly, the Lille/Villeneuve d’Ascq site, which houses 2 laboratories of the COSYS department, LEOST and ESTAS, was certified in November 2013. The sites of Marseilles/Salon-de-Provence (2 laboratories of the TS2 department, LBA and LMA) as well as that of Versailles/Satory (2 laboratories, LIVIC for the COSYS department and LPC for the AME department) were further certified in November 2014.
- In 2015, the certification effort was extended to cover the whole site of Marne-la-Vallée (apart from 2 UMRs) with 3 new laboratories (2 laboratories of the AME department: DEST and SPLOTT, and 1 laboratory of the COSYS department: GRETTIA). Altogether, in the space of 3 years, nine new laboratories were thus certified.
- In 2016 the whole site of Lyon/Bron will be certified.

Organisation of the quality process
The Metrology and Standardisation delegation (DQMN), reporting to the Managing Director, is in charge of the quality management system set up to address the requirements of baselines NF EN ISO 9001, NF EN ISO/CEI 17025 (Cofrac testing), NF EN ISO/CEI 17065 (Cofrac product certification) as well as the State notification for CE marking.
In 2015, the Quality delegation relied on two networks: 58 quality correspondents (QCO), and 32 internal auditors (IA), working in the laboratories and support services.

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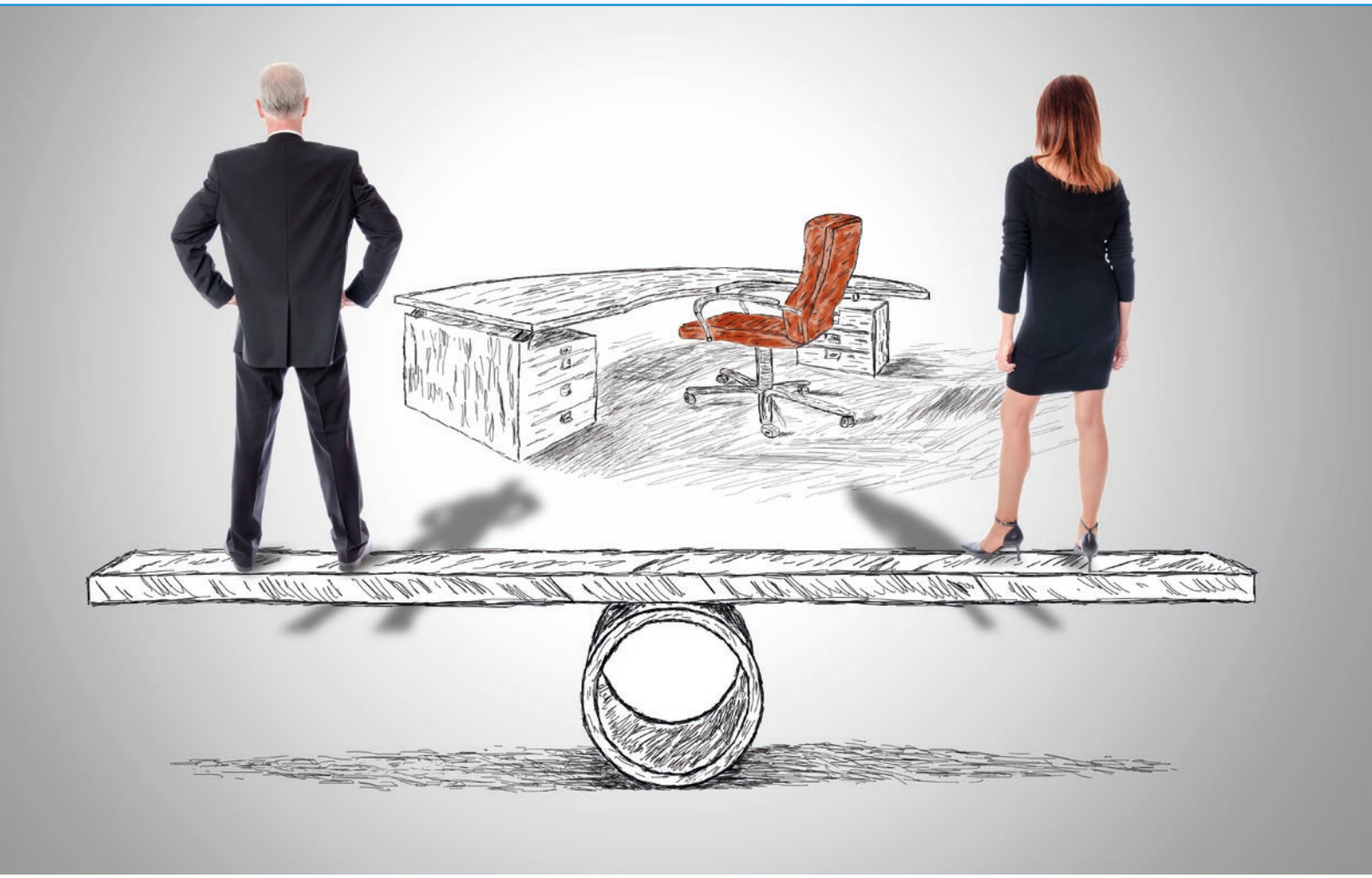

GENDER EQUALITY AT WORK ON TRACK

égalité professionnelle à l'Ifsttar

In 2015, IFSTTAR continued its endeavour to develop an action plan for gender equality at work, essentially focusing on two aspects:

- First by beefing up its charter for improved professional-personal life balance submitted to its Committee on hygiene, safety and working conditions (CHSCT) and to its Technical committee before it was eventually signed off by its Executive committee members in the summer; the document's circulation was accompanied by a formal presentation within each unit and laboratory and a poster campaign across all sites of the Institute;
- Second, thanks to an extensive survey (over one hundred questions) that was launched between May and June, targeting all agents to get a better insight into IFSTTAR's real situation in terms of gender equality; the findings of the survey were analysed in depth in autumn 2015 and the work is to be finalised early 2016 before beginning to work out IFSTTAR's gender equality final action plan.

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PhD ACTIVITIES

PhD training

2015 proved a record year in terms of number of thesis defences. Besides, a follow-up mechanism was set up to monitor the progress of PhD students trained at IFSTTAR, covering up to five years after their defence.

Thesis duration (2015 defences)

98 theses were defended in 2015, 45 of which were fully or partly financed by IFSTTAR, either through subsidising or backed up against research agreements.
The average duration of these 98 theses, regardless of the fields of research, is 3.46 years. The median duration of 3.20 years was reached as early as 2015, which was actually the value targeted under the Goals and Performance Contract.

The life of PhD students after IFSTTAR

In 2015 the Institute chose as one of its objectives to be able to consolidate data regarding the career of PhD students trained at IFSTTAR – 428 PhD graduates trained between 2011 and 2015 –, to provide as comprehensive a view as possible. To this end, an additional module was developed by the IFSTTAR IT department to monitor the progress of IFSTTAR PhD students, under the stewardship of the Scientific Division and integrated into the information system dedicated to theses (PhD students portal). Each PhD graduate was contacted individually and, subject to the applicable CNIL personal data protection arrangements, was thus able to alter, complement and finally sign off his/her respective data. The response rate stood above 97 %.

The employment ratio in 2015 (open-ended contracts, or “EDI” –, and temporary work contracts, or “EDD”) of the 79 IFSTTAR PhDs who defended their thesis in the course of 2014, was 83 % one year down the line (48 % for EDIs and 35 % for EDDs). 2/3 of the open-ended contracts were in the public sector and for the vast majority in France.

Almost 9 out of 10 temporary contracts were in the public sector (mainly post-doctoral fellows, 1/3 of them overseas).

The employment ratio two years after thesis defence was 91 %, and 95 % for those three to four years down the line, including all fields of research alike, circa 80 % of which as open-ended contracts. These values are clearly above the national statistical data actually available (employment ratio of 69 % after 3 years).

98

thesis defences

With a median duration of **3.20** years

9

HDR defences (accreditation to supervise research)

13

contractual PhD students, during the 2014-2015 academic year conducted:

10 teaching missions

3 expert assessment missions, as part of the research agreement to fund their thesis (Keolis, Solétanche Bachy International, Toyota)

63

new IFSTTAR PhD students joining in 2015, with:

29 subsidised PhD contracts, including:

7 with regional cofunding (Hauts-de-France, Pays-de-la-Loire) and

3 with cofunding backed up against a research agreement (Debats, Mines de Douai (2))

8 PhD contracts with research agreements (for the following projects: Emodi, Happy Hand, Lmac 2IDANL, MacCoy Critical, Magnum, Megan, Secur2RM, Soldugri, Vicat)

26

other funding arrangements, including:

2

civil servants (ITPE, IPEF)

7

CIFRE with an IFSTTAR-subsidised contract of employment (Geomatech, Renault (2), Schneider Electric, Siemens, STPF-Vinci, Usirf)

2

TRI/ETI fundings (Railenium, Vedecom)

3

other fundings (ADEME, Région Rhône-Alpes, Cerema (2))

12

within joint research units

Employment ratio of 2014 PhD graduates after one year:

83 %

48 % open-ended contracts

68 % in the private sector

32 % in the public sector

35 % temporary work contracts

14 % in the private sector

86 % in the public sector

Employment ratio of 2013 PhD graduates after two years:

91 %

62 % open-ended contracts

Employment ratio of 2012 PhD graduates after three years:

96 %

80 % open-ended contracts

Employment ratio of 2011 PhD graduates after four years:

95 %

77 % open-ended contracts

REGIONAL SCENE

In every region where it is present, IFSTTAR has been involved in the State-Region planning contracts, proposing a number of projects and besides it has continued to strengthen its partnerships in the framework of the "Investments for the Future". A nationwide roundup of what was done in 2015

CPER Nord – Pas-de-Calais for 2015-2020

The *Nord –Pas-de-Calais* State-Region planning contract for 2015-2020, signed on 10 July 2015, involves 5 signatories for a "contractualised" total of 2.2 billion euros: the State and the regional council, but also the departmental councils of *Nord* and of *Pas-de-Calais*, as well as the *Métropole Européenne de Lille*. The State is the largest contributor, with M€ 894 of new contractualised credits, namely M€ 140 more than for the previous contract, while the regional council put in M€ 847 in its areas of intervention. Furthermore, European operational programmes for 2014-2020 account for over 1.2 billion euros for the *Nord – Pas-de-Calais* region. Designed by the government to underpin the territorial reform, the CPER already boasts many projects and actions in conjunction with the *Picardie* region. This convergence will be reinforced towards the end of 2016 with the merger of the Picardie and *Nord – Pas-de-Calais* CPERs henceforth forming one single contract. The CPER has selected 7 areas for its core projects:

- Mobility (rail, road, river, port): 781 million euros that will result in 1.2 billion operations;
- Ecological and energy transition: 451 million euros;
- Higher education, research and innovation (ESRI): 170 million euros contractualised;
- Digital: 322 million euros (very High-speed broadband and development of digital usage);
- Innovative businesses: 14 million euros;
- A territorial component with a 380 million euros package;
- 46 million euros specifically devoted to employment.

The ESRI component of the CPER includes "Attractive and functional campuses, connected campuses" for a total M€ 83.12 and "Attractiveness and competitiveness" with M€ 87.16 devoted to research. Out of these M€ 87.16, the State covers M€ 17 from its ministerial budget while the Region contributes M€ 51.32, to which are added so-called "sign-posted" or earmarked credits for certain projects by some organisations and schools (M€ 8.59), the *Métropole Européenne de Lille* (M€ 7.4) and the *Département du Nord* (M€ 1.82). Fifteen major federative scientific projects were selected in the framework of this "Attractiveness and competitiveness" strand, among which the ELSAT 2020 project.

ELSAT 2020, A FEDERATIVE PROJECT OF THE CPER INVOLVING IFSTTAR

The federative project chosen for the area of transports and in which IFSTTAR is taking part is called ELSAT 2020 (Ecomobility, Logistics, Safety and Adaptability of Transports). It is steered by CISIT (international campus for safe and intermodal transports), a regional grouping for academic research in the field of transports. ELSAT 2020 pledges to be a broader and more cross-disciplinary extension (including Human and Social Sciences) of CISIT, the flagship project of the 2007-2013 CPER. In its development, the strategy was to capitalise on past successes and the commitment of its partners to embark on a long-lasting collaboration.
ELSAT 2020 brings together 9 universities or educational institutions and 5 research bodies (namely 27 laboratories), as well as two technological development centres. The ELSAT 2020 project addresses, in a more comprehensive manner, the new challenges (societal or technological) arising both at European level with the new technological roadmaps imposed by industrials needs (ACARE, ERRAC, ERTRAC… JTI Shift2Rail, PPP Green vehicles), or from research programmes such as Horizon 2020, and to key components in the regional and national development as established in the 34 plans for industrial revitalisation of the *Commission Innovation* 2030, in the SRI SI and the Master Plan for the Third Industrial Revolution in the *Nord-Pas-de-Calais* region.

The scientific project led by ELSAT 2020 is organised around 6 scientific programmes, 2 of which crosscutting in Human and Social Sciences. Based on an on-going analysis of societal, industrial and economic requirements, 4 strategic programmes-objectives have been defined with their respective extensions into research themes:

- Human beings in transports and their mobility;
- Optimisation of mobility systems and Logistic;
- New materials and structural concepts;
- Right-sizing and performance of the vehicle functions.

The two crosscutting objectives are "Innovation and behavioural changes brought about by ICTs in mobility and logistics" and "Mobility and sustainable accessibility systems at the crossroads of economic, legal an social considerations".

These strategic objectives aim to provide answers to three major challenges of modern society while remaining fully in line with the key elements of development: energy and the environment; mobility and logistics; safety, security and reliability. Each one of the strategic objectives impacting these societal challenges is then cascaded into application projects in 4 main economic sectors of transport where the CISIT grouping is a recognised stakeholder and contributor: railways; automobile; aeronautics; logistics.

IFSTTAR accounts for about 10 % of the total staffing of these projects in terms full-time equivalent mobilised for ELSAT 2020. The total cost earmarked for this federative ELSAT 2020 project is M€ 27.6 of which M€ 10.45 in equity, M€ 10.15 from the CPER (Region M€ 7, State M€ 2, 5, École des Mines de Douai M€ 0.65), and M€ 7 from other sources such as FEDER in particular.

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CPER and the latest advances of the Investments for the Future programme in Ile-de-France region

After negotiations that lasted for several months, the sixth generation of the Planning Contract was adopted by the Île-de-France region and the State. Official signing took place on 9 July 2015, between Jean-Paul Huchon, President of the Île-de-France region and Jean-François Carenco, prefect of the Île-de-France region and prefect of Paris.

This new State-Region Planning Contract (CPER) for 2015-2020 provides for over 7.3 billion euros of public investments by 2020, including 4.428 billion contributed by the Île-de-France region and 2.902 billion by the State.
This CPER is based around four thematic components and one crosscutting aspect dedicated to prospective:

- The multimodal mobility component: 5.314 billion of investments scheduled for daily transports, to which the *Société du Grand Paris* will add its share;
- The higher education and research, innovation, digital and employment component with a programme allotment of 788.52 million euros;
- The ecological and energy transition component, with a 323.21 million euros package, out of which 156 million for energy retrofitting of buildings and the development of renewable energies;
- The territorial component, targeting the implementation of a housing revitalisation plan, with a total budget of 641.86 million euros shared between the Region and the State.

CPER STRAND FOR HIGHER EDUCATION AND RESEARCH, INNOVATION, DIGITAL AND EMPLOYMENT

This strand includes 5 areas, for which the region and the State can rely on additional backing from the departmental councils:

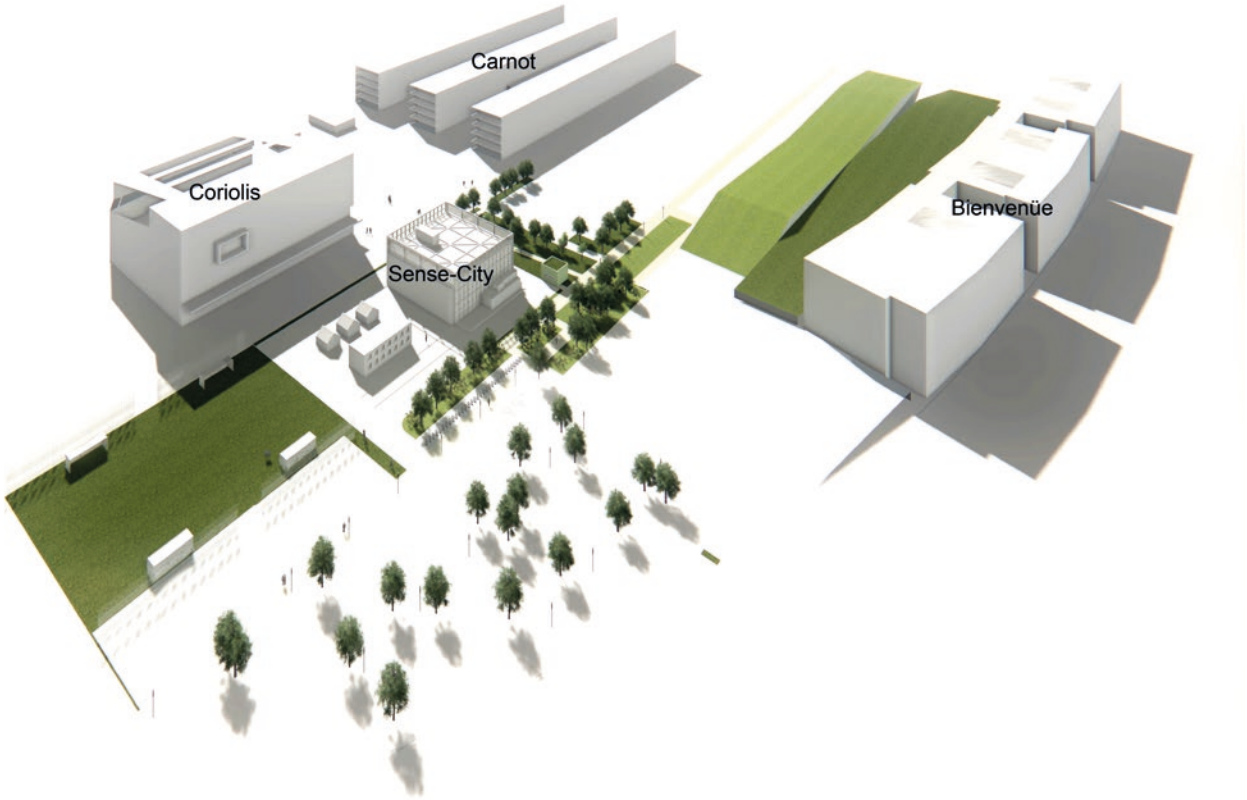
- Improving the living conditions of overseas students and researchers;
- Promoting a successful democratisation of higher education in particular by facilitating easier access to higher education across the whole territory;
- Fostering the attractiveness and international appeal of universities and research centres in the Île-de-France region;
- Promoting synergies, research partnerships and networks;
- Encouraging citizen participation in the Science & Society dialogue and mainstreaming it.

While IFSTTAR is directly concerned by the strand on attractiveness and international appeal, it should also be noted that the institutions making up *Comue Université Paris Est* (primarily UPEC and UPEM) have sometimes had some sizeable operations budgeted as part of improving the living conditions and reception of foreign students and researchers.
One may also recognise the consistent support provided to competitiveness clusters, notably Advancity of which IFSTTAR is a member via its site in Marne-la-Vallée.
As far as attractiveness and international appeal are concerned, IFSTTAR's most noteworthy operation was its participation in the URBACLIM platform, budgeted for 1.50 million euros and whose aim, within the Sense-City infrastructure, is to establish an ultra-dense meshing with 54 sensors spanning 250 m² and 18 measurement points. This is meant to provide real-time monitoring of many air quality parameters. Installation of this network began in 2015 with 3 analysers (particles, NOx, Ozone) and one automatic air sampler. After this first phase, at the spring of 2016 the complete network including 56 air quality sensors (NOx, Ozone, COV, PM, T°C, HR) will be supplied and commissioned.

SENSE-CITY

Concerning the construction of the climate chamber, the contract was notified in April 2015 to the grouping owning the project (BIA, Verdoia, Scooping and Illimelgo). The said grouping completed all the studies in the course of 2015. The building permit was delivered by the Champs-sur-Marne municipality on 6 October.
Sense-City, the first communication-enabled mini-town, a 250 m² mock-up intended for the study of the smart road and building, was inaugurated on 23 March 2015 with over 180 participants, 25 % of whom from the industry. Over 11 articles and features from the regional, national and specialised press paid tribute to this new shared research platform. Throughout the year, many delegations and personalities visited this facility, such as IDRRIM, Métrolab or JP Planchou, VP for research at the IdF regional council. In parallel to this, INRIA and UPEM officially joined the Sense-City consortium, whose scientific production significantly increased in 2015: over 7 papers in publications with reading committees and more than 20 presentations in various national and international seminars conferences.
To date there are already 11 on-going collaborative projects connected to Sense-City, 6 of which directly using Sense-City as their trial platform. These projects deal with

3D representation of the future Sense-City climate chamber



air and water quality, networks of sensors and electromagnetic communications in urban areas, energy in buildings and districts or smart roads. Acknowledged by the scientific community, in 2015 the researchers of Sense-City, who devise the technologies of tomorrow for "smart cities", set two world records with their work. The first record concerned deformation sensors using carbon-based nanotubes on plastic that can be sunk into the thickness of construction materials. The second record concerned carbon nanotube-based transistors for concurrent analysis of a great number of gaseous species. The projects conducted under the scientific programme of Sense-City followed from the joint work of the NACRE team between IFSTTAR and LPICM (*Ecole Polytechnique* and CNRS). These two projects are helping turn the idea of our towns as sustainable places into something ever more tangible.

VÉDÉCOM ENERGY TRANSITION INSTITUTE (ETI)

VéDéCoM (Low-carbon connected vehicle and its mobility) was established in February 2014 to mutualise the research efforts of industrial and academic partners in the field of electric, self-driving and connected vehicles and more broadly speaking ecomobility. Apart from IFSTTAR, the founding members of the VéDéCoM ETI are PSA group, Renault, Valeo, Safran, and *Université de Versailles Saint-Quentin en Yvelines*. Supported by the Mov'eo competitiveness cluster and local municipalities (*Versailles Grand Parc, St Quentin en Yvelines* and the General Council of the Yvelines), today it gathers more than 40 partners.
Actively involved within VédéCom, IFSTTAR has seconded 4 people to this Institute, since January 2015, devoting 80 to 100 % of their time (Stéphane Laporte, Sébastien Glaser, Jean-Christophe Smal and Benoît Lusetti), let alone the other projects deployed in partnership.

The multi-annual convention between IFSTTAR and VéDéCom was signed on 30 November 2015
A service agreement was finalised between IFSTTAR and VéDéCom for 2015 and a new one will be established for 2016.

IFSTTAR thus largely contributed to VédéCom's leading event in 2015: the successful demonstration of a self-driving vehicle on an open road.

- During the ITS World conference in October 2015 in Bordeaux, the VédéCom vehicle equipped with on-board devices and sensors (GPS, radars, lidars…) was able to move about on an open road without a driver, albeit fully respecting road signs (green lights, give way…) and negotiating specific infrastructure features such as roundabouts. This self-driving was made possible, amongst other things, by the use of a SLAM algorithm (Simultaneous Localization And Mapping) jointly developed with INRIA. This algorithm was particularly instrumental in going past the roundabouts precisely and without hesitation. Telecommunication systems were used successfully to respect traffic lights.
- During the tests conducted early November under peak traffic conditions in Versailles, the VédéCom vehicle again demonstrated its robustness by moving unattended under downgraded weather and traffic conditions. Moreover, the presence of disorderly vulnerable mobile elements (pedestrians) was perfectly well managed.

At COP21, VédéCom exhibited a demonstrator of climate solutions based on micro-grids.
IFSTTAR is also very active in VédéCom's various scientific entities: COSS (Strategic and Scientific Guidance Committee), and the three field-specific committees corresponding to VédéCom's three areas of research.
The latter's main mission is to define the programme to recruit PhD and post-doc students and sign off the recruiting.
IFSTTAR's representatives within the committee are:

- Vehicle electrification: Zoubir Khatir
- Driving delegation and connectivity: Didier Aubert, co-pilot
- Shared energies and mobility: Jean-Marie Burkhardt and Gérard Scémama.

At the present day, IFSTTAR has 3 thesis supervisions. The first one started 3 years ago and aimed to develop a new detection, monitoring and identification method for road markings. The other 2 theses began in December 2015 on the issues of co-piloting and ecomobility.

In parallel with the above theses, several post-docs have been and are still co-supervised by IFSTTAR researchers. On the real-estate side, with the perspective of the cluster devoted to vehicles of the future at the site of Versailles-Satory, SEMPAT, a semi-public company was established in 2015. This company will be in charge of "porting" the future building in Satory, right next to the IFSTTAR premises, designed to host VéDéCom and part of the laboratories and workshops of IFSTTAR. Taking advantage of the temporary occupation authorisation awarded under the public domain by the Ministry of Defence to IFSTTAR, and with the support of all stakeholders concerned (Prefecture, Ministry of Defence, *France Domaine*, *Etablissement public Paris-Saclay, Ville de Versailles, Versailles Grand Parc*, Yvelines Departmental Council), in 2015 the Institute already allowed VédéCom to start working on a vehicle electrification laboratory within a plot of land containing a hangar. This facility will later be equipped with the most state-of-the-art machines. The facility is to be completed in 2016.

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Pays de la Loire CPER for 2015-2020

IN THE PAYS DE LA LOIRE REGION, THE RESEARCH ACTIVITY OF THE CPER 2015-2020 WAS BASED AROUND 7 THEMES: BIOLOGY AND HEALTHCARE, AGRIBUSINESS AND PLANTS, HUMAN AND SOCIAL SCIENCES, MECHANICS AND MATERIALS, MATHEMATICS, ICTS, SEA AND ENVIRONMENT, CITIES AND TERRITORIES. THE GLOBAL OUTLAY FOR THE RESEARCH-INNOVATION PART IS AROUND A HUNDRED MILLION EUROS, OUT OF THE 1.2 BILLION ALLOTTED TO THE CPER.

In 2015, IFSTTAR teams took an active part in the kick-off of three core projects with the regional partnerships established in the framework of GIS LirGec (Civil engineering in Pays de la Loire region) and in that of the IRSTV research federation (Research Institute for the sciences and techniques of the City).
These projects brought together four IFSTTAR departments represented in Bouguenais, research laboratories of the Nantes University, *École Centrale, École d'architecture* and CSTB. They hold the promise of serious opportunities for IFSTTAR to bolster its implication in three major challenges:

- Development of resilient land transportation infrastructures, in the framework of the PRIIC-ICE (integrated regional platform for construction engineering and ecoconstruction) project;
- Energy transition *via* the deployment of offshore wind-farming, and more specifically with the simulation and monitoring of structures and anchorage or foundations, under the PRIIC - Mer project-action;
- Metropolisation and urban environments: noise pollution, natural hazards (floods and submersions), pollutions and microclimatology, in the S2EPdL project (environment monitoring in Pays de la Loire region).

With the "leveraging effect" of investments by the State, the territorial organisations and FEDER respectively, over 5 years these three projects will mobilise around M€ 2.5 to deploy very large-scale experimental platforms or *in-situ* measurement networks.

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The Rhône-Alpes CPER for 2015-2020

THE FRENCH PRIME MINISTER, MANUEL VALLS, VISITED THE HÔTEL DE RÉGION ON 11 MAY 2015 TO SIGN THE PLANNING CONTRACT COMMITTING THE PARTNERS FOR SIX YEARS.

Over 2 billion euros is the amount of this package for the new planning contract signed between the Rhône-Alpes region and the State for the 2015-2020 period. If you add to this the local authorities' contributions, altogether it is 4.5 billion euros that will be invested in territorial planning projects. Five priorities underpinned the choices made by the State and local authorities: railways, higher education and research, innovation, digital and ecological transition. M€ 360 were earmarked for higher education and to boost collaboration within the scientific community, bridging the gap between the world of academia and economic players and improving campus attractiveness. The investments scheduled for innovation form part of the regional innovation strategy with, amongst other things, energy storage and networks, smart buildings, smart mobility systems and technologies, digital transformation. M€ 287 for ecological and energy transition will be intended to save and diversify energy: calls for projects on biomass plants, heat funds, zero-waste territories, circular economy…

Other domains are also covered under this contract: water and biodiversity, risk prevention, environmental health, and environmental education.

Around the Transpolis platform project, several proposals were put forth by IFSTTAR under the heading of higher education, research and innovation:

- (a) A first topic was about the "smart city" concept to take into account the growing importance of information technologies in the development and management of the urban ecosystem. A development platform for urban mobility systems also ought to act as a development platform for ITS solutions in favour of mobility. The future mobility urban ecosystem will be a combination of infrastructures, vehicles, users, all of which communication-enabled.

The cost to be borne as part of the CPER was priced at M€ 7.5.

- (b) A second topic dealt with the concept of "multi-energy stations" to underpin the development of vehicle drive trains based on technology/fuel associations of increased diversity and specificity according to the performances sought for. The additional investment required as part of the CPER was tagged at M€ 5.
- (c) The last topic looked at setting up a fleet of heterogeneous vehicles to run on the Transpolis platform (Fromenteaux site). It would help develop vehicles that should be seen as platforms for the integration of different technologies tested in operation on the Transpolis platform. In the longer run, this project will help build up a fleet of heterogeneous vehicles for this platform to serve the "mobility" community and in doing so reflect the actual diversity and required "mix" to better approach certain issues. The cost of the vehicles for a 5-year period was estimated at M€ 2.5.

Finally, the cofunding secured was set to M€ 5 distributed as follows: M€ 4.25 for IFSTTAR and M€ 0.75 for Transpolis SAS.

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The PACA CPER for 2015-2020

The 2015-2020 State-Region planning contract for the PACA region was signed on 29 May 2015 by Manuel Valls in Marseilles and for a total package of 1.67 billion euros "contractualised" by the State and the Regional council. The State will pledge M€ 826 while the Regional council will be the largest donor with M€ 844 in its areas of intervention.
Close to 2.5 billion euros could thus be earmarked, through a leveraging effect, over the next 6 years by the State, the Provence-Alpes-Côte d'Azur region, the European Union and local governments. This contract is structured around five priorities:

- Employment and youth, crosscutting priorities for the regional territory;
- Consolidating the knowledge economy and strategic sectors;
- Boosting multimodal accessibility;
- Setting the course for ecological and energy transition;
- Ensuring solidarity within territorial development.

A genuine public policy tool for equal territorial opportunities, the 2015-2020 CPER will drive investment to boost the level of equipment of the territory and prepare it for the future. The ESRI component of the Provence-Alpes-Côte d'Azur CPER is part of the second priority: consolidating the knowledge economy and strategic sectors, for which two thematic priorities were chosen: offering players in the higher education and research arena more attractive and functional campuses and upholding the competitiveness and attractiveness of the territories with the additional crosscutting priority of supporting a dynamic, consistent and economically sustainable site policy also liable to meet cross-compliance criteria. The research part is receiving M€ 88.57 in funds from the State (M€ 39.77) and the Region (M€ 48.8).
The selected research projects are in keeping with the five strategic action domains of the regional SRI-SI, striving to foster the emergence and reinforcement of core partnership projects, and in particular in the inter-academic projects which can help gather momentum at the regional scale.
Beyond research, the priority entitled "Setting the course for ecological and energy transition" backed with M€ 275.28 (chiefly from ADEME and Barnier funds) is cascaded around three intervention areas: Energy-climate change, circular economy and resources; risk prevention, reconquest of biodiversity

and the preservation of natural resources embodied in flagship demonstration projects.
The projects chosen are articulated with IFSTTAR's research activities:

- energy: Cité des énergies (a partnership platform on new low-carbon energies, including solar, biomass in a close relationship with the industry;
- risks: Digue 2020, IMREDD and PORTE.

The IMREDD project (Mediterranean Institute on Hazards, Environment and Sustainable Development) is part of an exciting campus operation.

The Institute, which was involved in the proposal-making process for the Higher education and Research part alongside other organisations and universities of the region, acts as one of the project's stakeholders for:

- Digue 2020, a flood-protection dike demonstrator, this platform offers an innovative concept for a dike liable to withstand all known failure mechanisms: a homogeneous soil-lime dike based on a multidisciplinary approach (material characterisation, construction technique, innovative monitoring method) and jointly supported by Irstea (project leader), Cerema and IFSTTAR for total cofunding of M€ 1.164;
- PORTE (an observation and monitoring platform for natural hazards in the PACA region intended to improve the resilience of territories): a scientific platform project for the observation, analysis and modelling of natural hazards (seismic, landslides, floods, tsunamis, swells, fires), vulnerabilities and resilience of the territories and populations in regions. A cross-disciplinary undertaking, PORTE has brought together many teams from CNRS (project leader), AMU, BRGM, Cerema, IFSTTAR, IRD, Irstea and OCA. The cofunding amount totals M€ 2.020 for an initial cost proposal of the project of M€ 4.5 in cofunding.

For both projects additional FEDER funds are currently being applied for.

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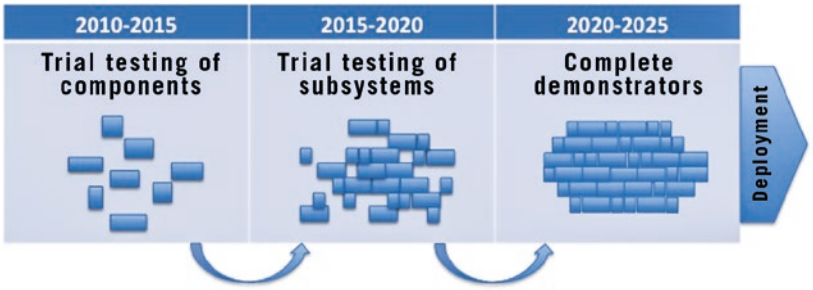
NATIONAL SCENE

5th Generation Road

R5G is a federative project aiming to address the challenges of ecological transition by cutting off the energy consumption linked with the operation and usage of roads through innovation.
Given the scale of the challenge, the aim is to have an integrated approach to innovation and propose full-scale "positive energy road" demonstrators.
The "5th generation road" is an infrastructure which:

- Better addresses the variability of use and contexts thanks to ITS: manages information both for road users and administrators;
- Manages to the best the various road modes (two-wheelers, private vehicles, freight, public transport) by bridging the gap between transportation policies and design while also taking into account new types of vehicles in road uses (e.g., electrical cars);
- Contains multiple micro- or nano-sensors that allow characterising its service status, traffic, risks to the user (frost, humidity, adherence, accidents, bottlenecks…);
- Retrieves energy to power its own facilities or even the vehicles;



- Is built or rebuilt with minimum impact on non-renewable natural resources and in particular fossil energies;
- Diagnoses its own weaknesses;
- Absorbs CO_2;
- Better resists the effects of climate change;
- Offers flexible interfaces to other transport modes.

TO INDUSTRIALISE THESE TECHNOLOGICAL BREATHROUGHS, THE CHOICE WAS MADE TO PROCEED IN THREE STAGES (SEE FIGURE BELOW):

- The first stage aims to develop, test and certify the various components of the 5G Road;
- The second ambitions to integrate a subset of these components into "thematic" 5GR demonstrators and identify implementation issues if any. These thematic demonstrators are no longer necessarily linked with road-specific techniques but rather more broadly aim to tackle the challenges of mobility;
- The third stage will consist in combining all of the relevant innovations, through cross-fertilisation of the theme-specific demonstrators so as to assess the synergy between these innovations and societal challenges in terms of mobility. This is where the innovation charters come into play, notably the Roads and Streets Innovation Charter steered by Cerema.

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Demonstrator for thermodynamic self-heating roadway in Egletons

5GR-related projects conducted in 2015

R2I MIRANDA (MEASUREMENT OF ROAD INDICATORS VIA NOMADIC INSPECTION DEVICES)

Building upon the demonstrator developed in the framework of an R2I in 2013 and 2014, 2015 was then devoted to full-scale experimentation on a CD44 (1 000 km) and publicising the experience.
Various papers, publications, presentations were prepared (FIRM, RGRA, AIPCR) which all attracted keen interest and generated contacts for further large-scale experimentations, either with network managers or vehicle fleet owners. A proposal was made to integrate this demonstrator within phase 2 of the SCOOP project but it did not materialise as the tool is not (yet) designed to directly provide more safety to the user and in real-time but rather to report the status of the network to its manager. In view of the high demand, the extension of this application to urban networks was postponed (because it is much more complex and possibly less promising). Rather it was decided to focus on a broader deployment on the most appropriate networks such as roads across open fields, working in particular with county authorities for this matter.

A proposal along this line was made in the new convention between DGITM (French Directorate-General for Infrastructure, Transportation and the Sea) and IFSTTAR, which is due to come into force in 2016. Other network managers such as the DIR for highways or motorways could be given the demonstrator to test.

R2I SOLAR ROAD

2015 was essentially devoted to optimising the joint use of semi-translucent coated roadstone and PV cells.

This topic was covered as part of a Master 1 session aiming to study aspects of formulation, sustainability and energy performance of translucent coating layers. The study was since carried through in the framework of a post-doc. The actions carried out also helped optimising the conditions of implementation of semi-translucent coating layers. An automated device for Pmax (peak power) characterisation is currently being developed as part of the study on PV panel performance.
This action is conducted jointly with the COSYS/SII laboratory.
The device under development will be used in the context of the mock-up monitoring campaign at SIRTA (follow-up of the Pmax and energy production capacity as a function of weather, seasons/lighting).
An experimental campaign aiming to study the ageing of semi-translucent coated layers was launched in the course of 2015 and will continue in 2016.
This campaign consists in exposing in continuous mode coated materials under the prevailing atmospheric conditions and monitor the evolution of their optical and mechanical properties.
In conjunction with the R2I team for thermodynamic self-heating roadways, the lab started working on 5 mock-ups of three-tier structures. These compounds are instrumented with temperature probes and intended to validate the computation models. One of these compounds, including a porous structure facilitating water circulation and covered with a photovoltaic layer and a semi-translucent surface, was presented at COP21.

R2I CSHG (FROST-PROTECTED SURFACE ROADWAYS)

Reworking the water tightness between the binder layer and the base layer at the end of 2014 on the Egletons demonstrator, made it possible the following year to study the fluid flow behaviour across the drainage coated layer, as well as the thermal exchange properties of the roadway with its environment. The modelling work conducted in parallel (thesis by Sarah Asfour) provides a good precision feedback on the measurements made with the demonstrator. Besides, these results can be extrapolated to the various geometrical dimensions of the roadway (width, cant, thickness of the drainage layer…) and climatic conditions. Another thesis, following up on the previous one, was launched end of 2015 to tackle the design of comprehensive energy loops and their phase-locking (Cerema/IFSTTAR thesis by Grégoire Rivière).
In view of designing such comprehensive energy systems for frost-protected surface roadways, a bibliographical study was also conducted in 2015, from a cost and technical angle, on “low power” geothermal aspects of pumping, recharging and energy-storage. The resulting data may be used in the thesis work recently started.
Lastly, in response to the H2020 FTI call, Cerema and IFSTTAR joined in the INFRASMART French-English and Spanish project submitted in November 2015 to produce self-heating roadway demonstrators at a quasi-operational stage. The project involves mechanical durability testing on the various types of structure, using IFSTTAR’s FABAC machines and thermal testing on mock-ups within the Sense-City compound. Some of the test plates made in Spain will be connected to a geothermal circuit.
The endeavour to obtain the publication of a call for projects of the Investments for the Future program on Roads finally came to fruition in July 2015 with such a call being launched by ADEME with a 60 million euros endowment.

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IFSTTAR solar road demonstrator

EUROPEAN SCENE

Europe: coordination of several H2020 projects

SUCCESSFUL COMPLETION OF THE H2020 INFRASTAR PROJECT COORDINATED BY IFSTTAR (ODILE ABRAHAM (GERS))

INFRASTAR "Innovation and Networking for fatigue and reliability analysis of structures" – Training for Assessment of risk".
INFRASTAR is a European consortium of 4 research centres and 3 businesses that brings together a network of high-level experts in the field of geotechnical engineering applied to bridges and wind farm facilities and several of IFSTTAR's scientific departments. INFRASTAR aims to train very high-level scientists (in particular by promoting the mobility of PhD students and post-docs across Europe) in this area and broaden as much the scope of cooperation for its partners and their customer base. This ETN training project is supported by the Pays de la Loire region and fits perfectly into the 2014-2020 Regional Strategy for Smart Specialisation.
The INFRASTAR project brings a special focus on new energies such as "onshore and offshore wind farms; constructions at sea; offshore techniques" via an analysis of infrastructure fatigue, the development of more environment-friendly facilities and innovative methods for the management of civilian infrastructures.

Success of the H2020 INFRAVATION BIOREPAVATION project coordinated by IFSTTAR (Emmanuel Chailleux (MAST))

This initiative involves 3 European countries plus the United States, with 7 partners forming the competence core of the project (plus two associate partners).
The project focuses around innovation with biomaterials that can be incorporated into recycled roadway materials and on the sustainability of such new materials as they are put to the test of traffic conditions.
This project is part of an eco-design undertaking. Out of the 7 partners involved, 3 are industrial partners while 4 are research bodies. The funding mechanism of the INFRAVATION call for projects allows European work to be articulated at a broader international scale.

The French-German team of DISTRANS

The DISTRANS international team, in which IFSTTAR (Corinne Blanquart, AME/SPLOTT) and the DLR transport research institute have been associated since 2014, chose to direct its efforts in 2015 towards a comparison of spatial models of food distribution and the pertaining supply-chain and transportation challenges, as well as current developments related to e-commerce.
A number of innovative e-commerce concepts in the area of food retailing differentiated from standard e-commerce offerings were examined.
Differences can be observed.
The standard bearers of these concepts are mostly German start-ups, or logistics service providers, whereas in France the major players of the retail business have taken the lead for innovation. This study will give rise to joint-publications and co-supervising of related theses.

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INTERNATIONAL SCENE

Official opening of the International associate iLab-Spine Laboratory

Inaugurated in Marseilles on 6 October 2015, the International associate spinal cord biomechanics and imaging laboratory "iLab – Spine" is the fruit of a long-term cooperation between researchers of the *École Polytechnique de Montréal*, the UHC Sainte-Justine, the *École de technologie supérieure*, the *Hôpital du Sacré-Cœur de Montréal*, AP-HM, CNRS, IFSTTAR and Aix-Marseilles University.
The Laboratory was granted support via the A*MIDEX excellence initiative.
The laboratory's research work focuses on spinal cord imaging, modelling and biomechanics in order to better understand, prevent and cure these traumas and pathologies.
In the area of transportation, two-wheeler users are particularly concerned by the prevention of spinal cord lesions. The work of iLab-Spine for instance contributed to the development of back and cervical protections and to the implementation of evaluation standards. In the area of sports performance, they contributed to the development of specific protection devices for sliding sports and acrobatic arts.
From a clinical point of view, achievements include the management of victims, with enhancements such as new spine immobilisation devices, advanced imaging biomarkers and, last but not east, the treatment of spinal cord traumas and deformations. One of their ground-breaking achievements has been the implementation of simulation tools to evaluate and optimise repair strategies for spinal cord traumas or pathologies.

Opening ceremony of the iLab-Spine laboratory

Climate change, environment and transports: IFSTTAR involved in the organisation of several events

COP21 (12/2015), CFCC CONGRESS (7/2015), EUROPEAN SEMINAR IN PARIS (7/2015)

2015 was marked by several joint and coordinated scientific and political events with the COP21 under the French presidency.
IFSTTAR (DAEI) organised two parallel sessions in the framework of the CFCC2015 conference (1st international scientific conference taking place ahead of COP21): one with the European Commission (DG ENV) and one with Cerema.

Upstream from the two sessions of the CFCC scientific conference bringing together researchers in the field of the Road of the Future in connection with climate change, an update was made on research work on transports. A workshop *"Transport and Climate Change; European Researchers Act"* was jointly organised by ETRA (European Transport Research Alliance and IFSTTAR) at the Institute's head office, with Hélène Jacquot-Guimbal the acting vice-chair in 2015.
Some one hundred participants from over 30 countries (in and outside EU) gathered for this workshop under the aegis of CFCC.
IFSTTAR was also involved in the major international coalitions on climate which recently emerged, in its own special relevant fields of research, with initiatives such as ITS for the Climate launched at the world ITS congress in Bordeaux in October 2015, Low Carbon Road and Road Transport Initiative supported by AIPCR, and the *"Navigating a Changing Climate"* Think Climate Initiative under the aegis of AIPCN.

On 13 November, IFSTTAR staged a colloquium on the French national plan for climate change mitigation (PNACC) in the area of transport systems and infrastructures. The Institute also took part in a number of regional events such as MEDCOP 21 on 4 and 5 June in Marseilles or in Lyon on 1 and 2 July for the World Climate and Territories summit. Building on this increased visibility, IFSTTAR attracted many solicitations to take part in discussion panels and conferences at COP21, covering such themes as the

Road of the Future, sustainable mobility or the city of tomorrow.

IFSTTAR solutions were thus presented on the *Génération Climat* booth at the Bourget and at the Grand-Palais in Paris: positive energy roads, positive energy railway stations, petroleum-free roadway binders, concrete used as carbon sink, alternative mobility and energies.
Visitors of the COP21 French pavilion at Le Bourget were thus able to discover the first demonstrator of the "hybrid solar road" designed and developed by IFSTTAR.
The Institute's commitment to "climate solutions" is not new (c.f. *Trajectoire*, November 2015). The challenges highlighted during these exchanges were then summarised in a joint communication by IFSTTAR and ETRA during the "info day transport" of COP21 on 6 December 2015. On this occasion a number of initiatives were announced to facilitate knowledge sharing as part of scientists' efforts to work in a network.

COP21: IFSTTAR proposes solutions and makes it known

The Institute took advantage of the preparations for COP21 to engage with its partners and organise encounters. On 6 July 2015, the Institute jointly organised a workshop with ETRA. Labelled by the CFC conference, it was entitled: "Transport, climate change and research".

Implementation of IFSTTAR-MTQ (Ministry of Transport-Quebec) agreement

After many years of collaboration, 2015 sealed the official cooperation agreement between the two bodies. The aim is to fit the current workstreams into a broader action plan for sharing knowledge and methodologies for the design, monitoring and usage of roads. All of IFSTTAR's departments are concerned by this new endeavour, as well as several labs and departments of the MTQ. The various discussions engaged about the prioritisation of actions to be carried out together in the fields of environment and climate change, the evolution of infrastructure assets, materials and road safety all strive to create more synergy between experts, facilitate experience feedback for road networks, encourage data sharing for the mutual benefit of research.

INTERVIEW WITH DR KENJI WATANABE

A VISITING RTRI RESEARCHER AT IFSTTAR

"I work for RTRI (Railway Technical Research Institute, Japan), which is the central research institute of JR (Japan Railway), and my expertise is in geotechnical engineering. I had the great opportunity to work at IFSTTAR (GERS) for a year as a visiting researcher from November 2014 to October 2015. This was as part of the activities within the collaborative agreement between IFSTTAR and RTRI.

Although France and Japan are located very far away from each other, we have many things in common in our long history of geotechnical engineering and railway engineering.
Therefore we can enjoy the mutual benefit of sharing our knowledge and experience, e.g. comparing our techniques, design codes and practical issues in these engineering fields. This was one of the purposes of my stay.

I discussed with many IFSTTAR researchers and tried to get a global understanding of our joint area of research, touching on questions such as our "Purpose" (what do we want to achieve?), "Skills and Equipment" (what can we do?), and "Experience" (what have we done so far?) in order to better adjust the course of our future collaboration.

I was involved in the "SSHEAR" project, which focuses on the scouring and erosion phenomena. IFSTTAR's advanced research and achievements in this area were most instructive. We successfully conducted "collaborative model experiments" by applying the French knowledge and know-how to a Japanese experimental technique I had developed just before coming to IFSTTAR.

I really enjoyed the fact that all of the members of GERS were very friendly and welcoming, as well as their openness to regular discussions with me. I learnt a lot during my stay, and not only related to our research but also about history, culture and language.

I hope we can strengthen our collaborative relationship in the future, based on my experience and the friendship we have developed with IFSTTAR!"

SCIENTIFIC LIFE
RESEARCH/EXPERTISE

2015 was especially eventful for the Institute's scientific life. HCERES (Higher Council for the Evaluation of Research and Higher Education) completed the evaluation of all five of the Institute's departments ("Materials and Structures", "Geotechnical engineering, Environment, Natural hazards and Earth sciences", "Components and Systems", "Transport, Health, Safety" and "Planning, Mobility and Environment"). This evaluation, initiated with the submission of self-assessment files in October 2014, led to the visit of an adhoc committee of external experts, appointed by HCERES, who drafted an assessment report. IFSTTAR is particularly proud of the outcome of these assessments, which most importantly highlighted the benefits of restructuring the Research Institute into several departments of 200 staff each, which is the typical size of large research laboratories, but also the recognition of the production of our teams for their research work in all the expected areas (publications, training through research, education, promotion, expertise, support to public policies). Of course, there is still room to improve the performance of our departments and therefore the implementation of the experts' recommendations, as discussed at the Scientific council, will be monitored with great attention. As far as evaluation is concerned, in 2015 the Institute itself entered into the assessment process of HCERES (with a file submitted in October 2015, a site visited end of December, and the assessment report to be published in the second half of 2016).

From an organisational point of view, some of the roadmaps launched by the Scientific Division have now come to fruition. Besides the definition of priority themes of action, already touched upon in the "Strategy" document, the Scientific Division's organisation has gone through a number of changes: on the one hand, a department dedicated to "Promoting and sharing scientific and technical knowledge" was set up in order to bring under the same banner all the activities publicising IFSTTAR's research and researchers among the world of academia, the industry and the public at large, through various channels (publishing, Open science, scientific mediation, image & multimedia, scientific culture events). On another hand, the mechanisms underlying scientific activities, amongst which the management of incentivisation tools – which were reviewed in 2015 – and the coordination of the agents in charge of the various work streams, have now all be gathered under the Scientific Division. These mechanisms and tools were reviewed in 2015, with a view to their upcoming involvement upstream in the preparation work for the next Goals and Performance Contract. Finally, 2015 marked the beginning of the centralised management of researcher communities under MEDDE. Let us also mention the "peer support and accompaniment" mechanisms backed up against a network of senior experts available to provide help and guidance to research staff in a non-hierarchical context. 2015 was rich in terms of reflection on the research strategy but it also saw a number of success stories such as the Institute's high-level exposure at the French pavilion as part of COP21, with its demonstrator for translucent, photovoltaic and thermal road, the CNRS silver medal awarded to Philippe Coussot (Navier Laboratory), not to mention some 385 papers published in international publications, 8 patents, 5 software programs, 98 IFSTTAR theses defended.

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MATERIALS AND STRUCTURES DEPARTMENT

The department develops its research and experts assessments on materials, transport infrastructures and large civil engineering structures, in particular in the area of electricity production and transportation. It stands at the interface between upstream academic research and downstream applications related to these fields of expertise. Compared with more academic laboratories, it is also characterised by its large-size research facilities requiring big technical teams. The department's three core themes are:

1. **Sustainability of strategic infrastructures;**
2. **Development of circular economy in construction;**
3. **Disruptive innovations in transport infrastructures.**

Each main theme breaks down into research actions, as follows:

Durability of strategic infrastructures (transports, networks, power generation)

- Instrumentation, testing, monitoring and management of infrastructures and engineered structures;
- Internal swelling of concrete materials;
- Sustainability of cement materials;
- Sustainability of polymers, cables and reinforcements;
- Mechanical behaviour of reinforced concrete structures;
- Modelling and sustainability of linear infrastructures, as well as repair and reinforcement;
- Repair, reinforcement, risk mitigation and life-cycle extension.

Developing a circular economy in construction

- Alternative materials for infrastructures and buildings;
- Life cycle of infrastructures and materials recycling;
- Optimised production processes.

Innovative transport infrastructures

- Innovative roads;
- Innovative structures and materials;
- Innovative railroads.

2015 AT A GLANCE

DURABILITY OF STRATEGIC INFRASTRUCTURES

- The MIRANDA demonstrator's design was completed; this facility allows monitoring the evenness of road networks from smartphones on board fleets of commercial vehicles.
- In his accreditation to supervise research, André Orcési summarised the foundations of a doctrine on structural health monitoring, vulnerability and structural robustness.
- Badreddine Kchakech's thesis defended end 2015 helped secure a better insight into the coupling between thermal history and the risk of expansion in concrete through internal sulphate attacks.
- Manuela Da Cruz's thesis defended in July 2015 was instrumental in modelling and understanding the oxidative ageing of HDPE (high-density polyethylene) used in civil engineering and public works applications.
- Arnaud Rolland's thesis defended in March 2015 helped clarify the mechanical behaviour and sustainability of reinforced concrete structures via internal composite reinforcements.
- Launch of the ADEME OCEAGEN Future Investments program aiming to produce a demonstrator for floating windfarm foundations and to qualify new anchoring components.
- In the framework of the post Fukushima MACENA (Controlling the confinement of an enclosure in the event of accident) ANR project, a reinforced concrete finite element macroscopic crack model and a probabilistic macroscopic modelling of gas cracking-transfer coupling were developed.
- Improvement of the roadway cracking models by means of the X-FEM approach (jointly conducted with *Ecole centrale de Nantes*, within the team of Nicolas Moes) and development of a multilayer analytical model (M4-5n).
- Launch of the Soldugri (2015-2018) ANR project on modelling and the sizing of roadway structures reinforced with fiberglass cladding.
- ORSI CCLEAR feedback seminar on the findings of the joint research between Cerema and Météo France on climate change adaptation for road infrastructures.
- Launch of the European Fasstbridge project (Infravation) on the repair of metallic structures via bonded composites.
- Development of a seismic vulnerability diagnosis method adapted to historic monuments.

DEVELOPING A CIRCULAR ECONOMY IN CONSTRUCTION

- IFSTTAR – ARMINES (Écoles des Mines of Douai and Alès) agreement for joint research on the characterisation, production and use of recycled aggregates.
- Conclusion of the research operation on Bio-sourced and natural materials for sustainable construction (MaBioNat): study of the ageing of composites reinforced with natural fibres, applications in the building industry.
- Partnership of the CPDM laboratory with the Lyon-Turin "Euralpine" Tunnel, Vicat and Holcim for the recovery of excavated material.
- Maxime Piton completed his thesis on heat exchanges in rotary kilns, with the aim of recovering the fatal heat of heat-exchanger type rotary kilns.
- Setting up of a joint team between PETRA – IFSTTAR / CNRS / University of Nantes / *École des Mines* of Nantes / Oniris, to promote innovation in the production of a large range of materials for transport infrastructures and the building industry, including polymers and agro-materials.

INNOVATIVE TRANSPORT INFRASTRUCTURES

- Trials at the fatigue test track to check the sustainability of concrete roadway slabs incorporating cable systems for inductive charging of electric busses (Bombardier contract).
- Experimentation with fibre optics to detect cracks in roadways.
- Development of a self-heating solution (jointly with Cerema) providing both for energy recovery in the summer and heating of the roadway in the winter.
- Completion of the tests on alternating bending stress behaviour of concrete pillars reinforced with a layer of ultra-high performance fibre-reinforced concrete (UHPFRC) in the steel overlapping section at the pillar/base plate junction.
- FUI REVES (labelled by Railenium) project: launch of the project to use coated material for railway roadbed in tunnels.
- Development of a dynamic model to design railway structures (thesis by Olivier Martin, Viscorail model); project launched with Railenium to instrument several segments of the TGV BPL tracks (Le Mans – Rennes), in order to monitor and model their behaviour.
- VIF-PLATIF research operation – feedback seminar (70 participants) on research developments in the field of railways (FUI NBT, thesis by Olivier Martin on ballast behaviour).
- Launch of the CSA-FOX European project (2015-2018).
- Contribution to the state of the art on the recycling of materials in transport infrastructures.

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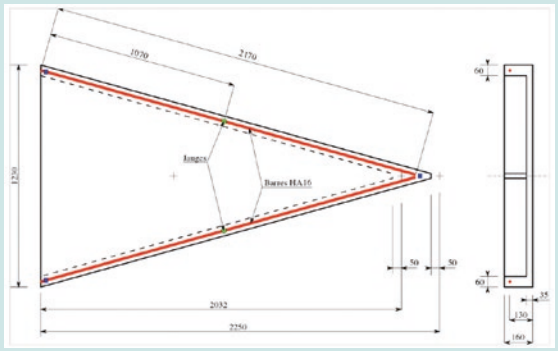
FOCUS ON 2015

RESUMPTION OF TRIALS ON IFSTTAR'S STRUCTURE TESTING PLATFORM

On Tuesday 10 March 2015 was the first structure test to take place since the test platform was moved to the site in Marne-la-Vallée. This test was conducted as part of an agreement with the Lafarge cement company. This agreement involves the design of a digital model for the structural behaviour of an ultra-high performance fibre-reinforced concrete (UHPFRC) and testing of the structures to validate the model, all of which documented in a PhD thesis (by Thomas Guénet) made partly at Université Laval in Québec and partly at IFSTTAR's MAST/EMMS laboratory. The proof body is a triangular shape ribbed plate reinforced with UHPFRC concrete, see Figure 1.



Geometry of the proof body

- The test was successfully conducted thanks to the engagement of the whole team and their commitment to overcome many difficulties:
- Difficulties in mounting the assembly as a closed frame to avoid connecting it to the test platform, as the latter's nuts had not been approved;
- Difficulties in calibrating the sensors and producing the acquisition system (the issue probably being of electrical nature and due to the new building);
- Hydraulic problems (oil cooling not yet satisfactory, manual start-up as soft as possible because the piping brackets vibrate and need strengthening).

Closed frame mount for the bending stress test on the UHPFRC concrete triangular plates

This thesis project is part of an industrial and economic optimisation action for the UHPFRC structure elements aiming to ensure their ductility at structural level whilst adjusting the quantity of fibres and optimising the manufacturing mode. An original digital model based on a micro-mechanical approach was developed within the Code_Aster finite element software. Thomas Guénet successfully defended his thesis on 31 March 2016.

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R&D Deputy Director: **Jean-Michel Torrenti**
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GEOTECHNICAL ENGINEERING, ENVIRONMENT, NATURAL HAZARDS AND EARTH SCIENCES

The GERS department's core activity is geosciences as applied to civil engineering and spatial planning. It spans most of the skills harboured at IFSTTAR in the fields of geotechnical, geology, hydrology, environmental chemistry, geophysics and monitoring. The department has six in-house laboratories and takes parts in two mixed research units. Its teams are distributed across several IFSTTAR sites: Nantes-Bouguenais (60%), Marne-la-Vallée (30%), Bron (7%), with another four agents based in Grenoble at the UMR ISTerre.

The GERS Department agents conduct finalised research in four pillar areas under IFSTTAR's Goals and Performance Contract:

- Geotechnical engineering and in particular the development of technologies for foundations, anchoring and supporting structures, the design of earthfills or improvement of earthwork techniques;
- Prevention of natural hazards from the knowledge, modelling and forecasting of hazards (seismic, hydraulic or rockfalls) to the study of construction design strength and the designing of protection mechanisms;
- Water and urban planning with two main focus areas, i.e. the influence of urban planning facilities on the associated water and heat balances as well as on the quality of surface and underground waters and the evaluation of pollution resulting from the use of recycled materials in civil engineering;
- Development of geophysical techniques and innovative non-destructive methods for investigating near-surface layers and monitoring civil engineering structures.

The research projects are often applications-oriented and combine laboratory characterisation of material properties, testing on small-scale models, in-situ experimental follow-up, digital modelling, and sometimes hardware developments. As required more fundamental research may focus on materials and processes (for instance solid-state nuclear magnetic resonance on lime-treated soils) or on the methodologies (regional Bayesian statistics, coda-wave interferometry, guided waves).

The department possesses outstanding scientific facilities, including:

- A geotechnical centrifuge equipped with an earthquake simulator to conduct tests on small-scale models,
- Rockfall station designed to test the firewall blocks protective equipment,
- An ultrasound measurement bench to test new geophysical measurement methods on small-scale models and laboratories specialising in soil mechanics and chemistry.

Participating in and steering miscellaneous scientific and technical associations, scientific councils as well as standardisation and experts assessments are historically part of the activities of the department's agents in addition to their research work. These activities are indeed essential to nurture exchanges with professional circles and bring to the fore scientific issues related to applications and responding to operational needs.

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2015 AT A GLANCE

SEC 2015 INTERNATIONAL SYMPOSIUM – SHRINKING AND SWELLING OF SOILS, CLIMATE AND CONSTRUCTION

Organised on 18 and 19 June in Marne-La-Vallée, this symposium co-organised by IFSTTAR and Cerema (and labelled as part of COP21), brought together some one hundred participants from 19 countries. It enabled the attendants to take stock on the main outcomes of research programmes, some of which coordinated by IFSTTAR, that led to major breakthroughs in understanding the shrink-swell processes according to the nature of the soil and prevailing climate as well as on the construction techniques liable to provide efficient protection against such phenomena.

9th NATIONAL EARTHQUAKE ENGINEERING COLLOQUIUM

The 9th colloquium of the French association for earthquake engineering (AFPS) was organised at IFSTTAR (Marne-la-Vallée) from 30 November to 2 December 2015. Some 250 participants from all backgrounds concerned by earthquake risks attended the event: public authorities, civil security, insurers, researchers, architects, and engineers… The 2015 edition of this colloquium was entitled “Anticipating, limiting and managing the consequences of earthquakes in territories”. This event broadened the spectrum versus previous years by insisting on the management and anticipation of risk and drilling down into territory-specific adaptations.

PUBLICATION OF THE DRAFT STANDARD EN ISO/DIS 22476-15.2: GEOTECHNICAL INVESTIGATION AND TESTING – FIELD TESTING – PART 15: MEASURING WHILE DRILLING

The agents of the GERS department take part in a dozen French and European standardisation committees. The draft standard ISO/DIS 22476-15.2 is the latest addition to the array of European standards covering geotechnical exploration and tests. It deals with the measurement devices that can be used while drilling (both in terms of implementation and interpretation). An agent of GERS was appointed as editorial secretary for the publication of this draft standard.

COMMUNICATION DAY ON “CULTIVATING ON URBAN SOIL” (ANR JASSUR PROJECT)

On 6 June 2015, IFSTTAR jointly organised with the City of Nantes and Association des Jardiniers des Eglantiers an “Open Day” for the general public on urban community gardens in the framework of the ANR JASSUR “Urban community gardens and sustainable cities” project (2013-2016). This day brought together some fifty participants and was covered by the local TV network téléNantes. Amongst the various activities: lectures, discussion panels and pedagogical workshops on the quality of soils and urban biodiversity.

THE PERMANENT ACCELEROMETER NETWORK (RAP) NOW HAS A DATA CENTRE OF ITS OWN

RAP is the benchmark French network for seismic activity observation.
Over the last few years this network has been reinforced with now a total 160 stations in Metropolitan France and overseas territories. Since many years it is coordinated by IFSTTAR agents of UMR ISTerre. The RAP network is one of the constituent parts of the Excellence Equipment (Equipex) RESIF, which is now equipped with a data centre that, after four years of construction work has now entered the consolidation phase. RAP-generated data is now freely accessible and heavy data downloading activity was observed from the very first months after commissioning of the data centre in 2015. This research infrastructure enabled France to join the EPOS European Geological Observatory and the International Federation of Digital Seismic networks (FDSN).

FOCUS ON 2015

DAM SAFETY: STUDY OF SCALE EFFECTS ON THE RESISTANCE OF ROCK/CONCRETE INTERFACES

The re-assessment of earthquake hazard in France and the fact that there are fewer floods both bear on the sizing of containment structures and are liable to challenge the calculations in terms of slippage resistance of the concrete gravity dams operated by the French Board of Electricity EDF under the supervision of the technical department for Electrical power, big dams and hydraulic structures /Design and engineering department in charge of large-scale dams. The CIBEFHY research project, funded by EDF, aimed at checking shear strength computing methods for interfaces between concrete and the foundation of hydraulic structures based on small-scale model testing. In actual practice, the resistance of this interface is assessed by means of shear tests made on interface samples extracted through core sampling.
The purpose of the project was to determine at a larger scale how geometrical irregularities on the rock surface at the base of gravity dams may influence resistance of the interface with the concrete cast on top.
Beside issues relating to the topographical characterisation of surfaces and the modelling of the yielding effects identified with localized damage, the project included shear tests directly applied to test cubes of various dimensions. Five such tests were conducted successfully in 2015 on 5-tonne heavy “instrumented test cubes” formed of a block of granite with concrete cast on top. These test cubes were then subjected to a 500-tonne thrust in a large-size Casagrande shear test apparatus at the Cerema centre in Bron. Several IFSTTAR teams helped instrument and monitor the test cubes equipped with deformation gauges and acoustic signal sensors to identify internal disruptions and with a fibre optics network near the rock-concrete interface to observe accurately the mechanism of disruption.

5-tonne granite-concrete test cube placed in the large-scale Casagrande shear test apparatus at the Cerema centre in Bron, prior to testing

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SV
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NAVIER
Director: **Karam Sab**
Deputy Director: **François Chevoir**

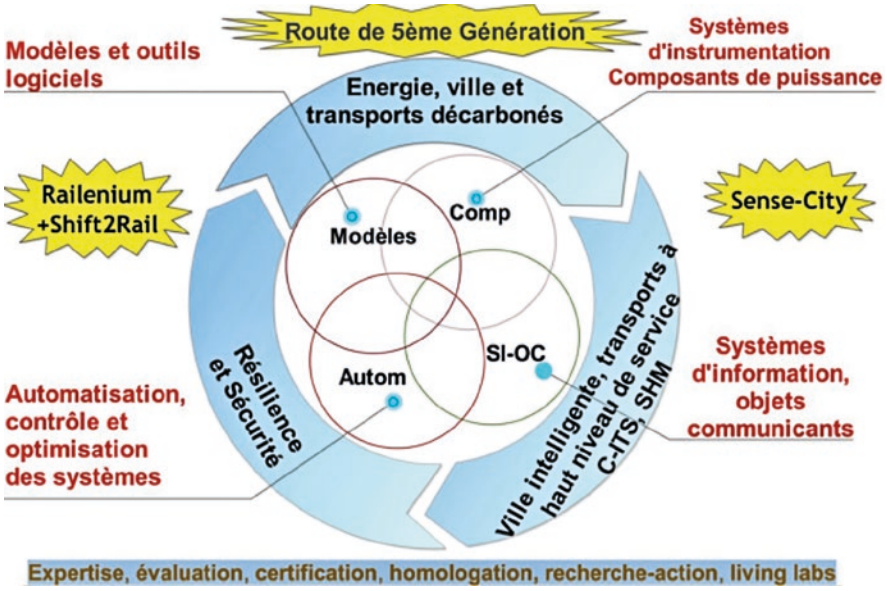
ISTERRE
INSTITUTE OF EARTH SCIENCES
Director: **Stéphane Guillot**

COMPONENTS AND SYSTEMS DEPARTMENT

The COSYS Department ambitions to develop the concepts and tools needed to improve the basic knowledge, methods, technologies and operating systems for a renewed understanding of mobility, infrastructure networks and large urban systems. The department thus aims to improve on several criteria: effectiveness, safety, security, carbon footprint and impacts on the environment and health. Contributing to the effectiveness, low-carbon consumption and resilience of cities and transport systems which play a central role at the service of the whole economy, offering high value-added services to make territories even more attractive for both business and quality of life, are the targets identified by COSYS. These are the objectives that underpin the roadmap of the 5th-Generation Road (R5G) steered by the department.

Knowledge production inspired by breakthrough practices, transforming such knowledge into useful products and theoretical rationale for public policies, evaluation of the changes brought about by innovations within its remit are all in the department's DNA.
Its staff comprises 270 people in all, including 90 PhD students, across 5 sites and COSYS also boasts 11 laboratories covering a wide spectrum of scientific disciplines from information and communication sciences and technologies to engineering sciences.

The department has been involved in the I4S (Inference for Structures), a joint project team with INRIA Rennes Bretagne Atlantique since 2013, in two "mixed units", LICIT with ENTPE and the SATIE TEMA team, but also in two joint research teams with CEA-LETI (CARMIN) and École Polytechnique (NACRE).
It also takes part in two GIS scientific panels (ITS and DURSI), providing for the presidency of the scientific council and coordination tasks.
The department takes a very active part in European and international action. It steers or co-steers Eurnex, Nearctis and Hycon2 excellence networks and contributes to technological platforms or councils such as ECTP, ERRAC or ERTRAC.
It gave its input to over 45 projects of FP7 while continuing its work within H2020.



The department is also strongly involved in the Future Investments programme: it coordinates several TRI (Railenium, SystemX and Jules Verne) and ETI (VéDéCom and Efficacity, Equipex Sense-City). It is heavily involved in an industrial relationship with businesses of all sizes in the fields of transports, infrastructure, energy and telecommunications.
One of the core ambitions of COSYS is also to create jobs through start-ups or transfers of technologies.
The department's scientific mission statement is based around four pillars designed to address some of the major societal and economic challenges identified. The department has focused its most salient competences around these pillars.
In the area of traffic engineering, in order to further develop innovative regulation strategies based on a fine-grain targeting of users, in 2015 Ludovic Leclercq received the ERC's (MAGnUM) Consolidator excellence award, for the very first time in the whole history of IFSTTAR.
This recognition, envied by many, has boosted IFSTTAR's reputation to new heights, a feat that will probably be difficult to overcome in the near future.
The European Marie-Curie Career Integration Grant awarded the SmartWALK project of Valérie Renaudin that resulted in the development of pedestrian navigation algorithms with hitherto unseen performance levels.
In the area of railways, after a first selection round, COSYS was chosen, via Railenium, to take part in two consortia acting as associate members of Shift2Rail.

This enhanced international visibility also materialised in the organisation of an academic quarter dedicated to traffic regulation at the University of California in Los Angeles (UCLA) but also in the conclusion of expertise on rail wear for the Geneva tram system or truck safety in the Mont-Blanc Tunnel, and last but not least, it triggered Mitsubishi's interest for the department's distinctive competences in terms of understanding and assessing the ageing of power components.

A clear indication as to the interest in making this a long-term endeavour, R5G (5th Generation Road) has become the hallmark, visible both in France and overseas, of IFSTTAR's resolve to be involved in the areas of energy transition and the mutation of transports.
Amongst other things, ADEME's call for the road of the future (Route du Futur) demonstrated that this concept has now been embraced by all players, thus heralding a new dimension and a new status for innovations conducive to the deployment of cooperative mobility, self-driving vehicles, electromobility and integration to the energy smartgrid. The increased momentum of transportation's integration into the broader picture of the economy has been demonstrated in the ramping up of the partnership with ESI around vehicle simulation and by the extended scope of the contract with Valeo.
The department's activity in the field of industrial deployments materialised in particular in the creation of start-ups such as TACV (very lightweight self-guiding mass-transport systems) and ECOTROPY (concurrent engineering to produce an anticipated assessment for the energy retrofit of existing buildings and thus offer digital tools instrumental in setting up the GPEs (Energy performance guarantee).

The knowledge base developed helps better exploit transport infrastructures, improves the evaluation of pollutions linked with traffic or urban activities, paves the way for a transition to sustainable mobility and positive-energy territories and promotes the active mobility of citizens at all ages. Railway and building industry players all need our research and experts' appraisal, simulation and data processing capabilities while automotive OEMs look to our breakthroughs in terms of vision.

In terms of communication, we have held dozens of interviews, round table panels, invited high-profile personalities to our sites, let alone the hybrid solar road demonstrator at COP21 (MAST-COSYS) introduced by the French Secretary of State for Transports at the French pavilion.

These few albeit significant examples echo the very good rating COSYS received from HCERES.

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FOCUS ON 2015

MAGNUM: EVER MORE EFFICIENT MULTIMODAL MANAGEMENT OF URBAN TRANSPORT NETWORKS THANKS TO A BRAND NEW FORM OF MULTI-SCALE MODELLING

Ludovic Leclercq, a researcher at IFSTTAR, received a European Excellence grant (ERC Consolidator Grant) after a highly competitive selection process gathering the best European researchers.
The theme of the MAGnUM (Multiscale and multimodal traffic modelling approach for sustainable management of urban mobility) project is dynamic modelling of movements at metropolis scale and the development of innovative regulation strategies based on fine-grain targeting of users. The plan is to develop a new generation of dynamic, multi-scale and multi-modal models for urban traffic and geared to better depicting the influence of local phenomena on the global operation of transport systems. An unprecedented approach will be used to analyse the users' behaviours and choices: the use of serious and multi-player gaming simulating urban movements. The diversity of models devised will then be used to develop effective regulation and low-environmental footprint strategies.
These strategies will be designed with a view to leveraging the opportunities offered by the deployment of new technologies.
The MAGnUM project, scheduled for a 5-year period, will be conducted at the LICIT laboratory, which is part of the COSYS department. LICIT is a mixed entity partnering with ENTPE in this project.

DESCRIPTION OF THE ERC GRANTS

The purpose of ERC calls for projects is to reward and encourage the excellence of the project initiator at various stages in his/her career, for instance to deploy their activity through the supervision theses and post-doc research.
More specifically speaking, the "consolidator" call is intended for researchers who did their PhD between 7 and 12 years before.
Project owners should be able to demonstrate their innovation capacity, their ambition and the feasibility of their scientific proposal. There are no pre-defined themes for this call for bids and excellence alone is taken into account to assess the potential (of both the project owners and their scientific proposal). The maximum prize money per project is 2 million Euros.
For further information: http://erc.europa.eu/

DEPARTMENT ORGANISATION

COSYS
COMPONENTS AND SYSTEMS
Director: **Frédéric Bourquin**
Deputy Director: **Marion Berbineau**
Administrative Manager: **Annick Bertrand**

ESTAS
EVALUATION OF AUTOMATED TRANSPORT SYSTEMS AND THEIR SAFETY LABORATORY
Director: **Joaquin Rodriguez**

GEOLOC
GEOPOSITIONING LABORATORY
Director: **Valérie Renaudin**

GRETTIA
ENGINEERING OF SURFACE TRANSPORTATION NETWORKS AND ADVANCED COMPUTING LABORATORY
Director: **Jean-Patrick Lebacque**
Deputy Director: **Régine Seidowsky**

LEMCO
COOPERATIVE MOBILITY MEASUREMENT LABORATORY
Director: **Jean-Marc Blosseville**

LEOST
ELECTRONICS, WAVES AND SIGNAL PROCESSING FOR TRANSPORT LABORATORY
Director: **Charles Tatkeu**

LEPSIS
ROAD OPERATIONS, PERCEPTION, SIMULATORS AND SIMULATIONS LABORATORY
Director: **Didier Aubert**
Deputy Director: **Éric Dumont**

LICIT
TRANSPORT AND TRAFFIC ENGINEERING LABORATORY
Director: **Nour-Eddin El Faouzi**
Deputy Director: **Ludovic Leclercq**

LISIS
INSTRUMENTATION, SCIENTIFIC INFORMATICS AND SIMULATION LABORATORY
Director: **Patrice Chatellier**
Deputy Director: **François Derkx**

LIVIC
VEHICLE INFRASTRUCTURE DRIVER INTERACTIONS LABORATORY
Director: **Dominique Gruyer**
Deputy Director: **Olivier Orfila**

LTN
NEW TECHNOLOGIES LABORATORY
Director: **Zoubir Khatir**

MACSI
MATERIALS ASSEMBLIES COMPOSITES FOR INTELLIGENT STRUCTURES LABORATORY
Director: **Monssef Drissi-Habti**

SII
STRUCTURES AND INSTRUMENTATION LABORATORY
Director: **Louis-Marie Cottineau**
Deputy Director: **Vincent le Cam**

TRANSPORT, HEALTH, SAFETY DEPARTMENT

The department brings together most of the teams working in the field of health and/or safety for transport. In fact, most of TS2's scientific scope can be summarized as "safety, accessibility, comfort and health of human as transport users, with a focus on land transportation".

A leading emphasis of the department is that of ground transportation safety, especially road transport.
In terms of primary safety, associated factors can be ascribed to the vehicle, infrastructure or the user himself: the department especially strives to understand human factors and their interactions with the vehicle and only to a lesser extent with the infrastructure.
In terms of secondary safety, the department delves into the aspect of injuries (whether lethal or not) caused by road accidents, the injury mechanisms behind them while also appraising potential protection tools. In terms of tertiary safety, the emphasis is on what happens to the victims (and their relatives) in the aftermath.
In 2015, IFSTTAR launched an institute-wide crosscutting investigation to define the priority fields of work for the next few years. First of all, the TS2 department showed a great commitment to contributing to IFSTTAR's overarching

mission in terms of "Evaluation and aid to public decision-making in the area of transportation" (for TS2 more specifically, this includes road safety). This activity, which is not so to speak a "research theme", however remains a central activity for the department.
Likewise, research on "vulnerable users", which is present in the various priority themes, is paramount for TS2, in particular in terms of positioning at the European scale. The TS2 department thus works on 7 strategic research themes:

1. **Assessment and aid to decision-making in the field of transport;**
2. **Primary road safety factors and man-machine interactions;**
3. **Consequences of mobility on morbidity;**
4. **The virtual human;**
5. **Users of self-driving and connected cars;**
6. **Mobility for weakened people, ageing and handicaps;**
7. **Health and day-to-day mobility.**

The last workstream is essentially carried by the Department's joint research units (UMRs) and focuses on healthcare applications (surgical simulation, modelling for training purposes, orthopaedics, functional rehabilitation, everyday life accidents and MSD (Musculoskeletal Disorders), handicap, sport medicine and performance, development of surgical implants…), ergonomics applications (walking aids for handicapped, sports in general, aeronautics, work stations…), enhancing the knowledge of environment-related sanitary risks, returning to work and consequences on the family environment.

TS2 is a very multidisciplinary department, both by nature and out of necessity in order to address the above-mentioned priorities. It combines disciplines pertaining to Human and Social Sciences with Engineering or live Sciences.

With its three UMRs, it is deeply anchored in the world of academia.

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FOCUS ON 2015

"20 YEARS ANNIVERSARY OF THE REGISTER"

Organised within the framework of Decades of research at IFSTTAR, in partnership with Arvac (Association of the register for victims of road accidents), this celebration of the "20-years anniversary of the register was held in Lyon on 14 October 2015. The event gathered over one hundred people among whom researchers, but also clinicians, decision-makers, representatives of non-profit organisations or stakeholders in the area of road safety.
The purpose of this event was to take stock on the knowledge gathered over 20 years of existence and in particular demonstrate the benefits of this Register as a channel for an innovative approach to road accidentology. The agenda was organised around three main themes of knowledge: traumatisms, causes of accidents and future of victims and their relatives. Two prizes were awarded on this occasion for past or on-going epidemiologic projects on traumas and their management. The meeting concluded with a speech by the French interministerial delegate for Road Safety, Mr Emmanuel Barbe, who recognised the Register for the quality of the work achieved and encouraged its extension to the newly created region of Auvergne-Rhône-Alpes. A study is underway to assess the modalities and feasibility of such an extension. This day was also an opportunity to highlight a number of research tracks for the coming years, in particular on how to manage the wounded in conjunction with the clinicians of the Arvac network.

2015 AT A GLANCE

DISCO PROJECT

DISCO (Investigation of (dis) comfort in driving: development of a methodology to measure discomfort) is an industrial project funded by Toyota TME which involved a partnership between TS2 (LMA/LESCOT) and COSYS (LEPSIS). The idea was to identify the relevant variables involved in measuring the feeling of discomfort experienced through temporary pressure under various driving situations and which may alter the driver's inner state. Experimentation on a driving simulator, through physiological - subjective (questionnaires) and objective (driving parameters) - measurements made it possible to identify these inner state alterations. Amongst other things, discomfort was assessed *via* correlations between these various measurements. This project is currently on-going as part of DISCO+ "toward the development of a pertinent measure index of (dis)comfort in driving". Identification of such an index is likely to shape the design of future driver assistance systems.

DRIVECOG PROJECT

The DriveCog project, investigated by the UHC of Reims, was conducted by LESCOT and UMRESTTE, jointly with the UHC of Strasburg and the Sainte Périne Paris 16 hospital. The driving activity, under natural conditions, of 20 participants suffering from Alzheimer and of a control group of 21 people was recorded over a one-month period. An activity analysis tool tailor-designed for this project, Naturalistic Driving Assessment Scale (NaDAS), showed that ageing drivers suffering from Alzheimer showed poorer driving performance than ageing drivers without pathology and it highlighted the potential benefit of keeping track of critical events (accidents, quasi-accidents, incidents).

INAUGURATION OF ILAB-SPINE

Inaugurated on 6 October 2015 in Marseilles, iLab – Spine, the International Associate Laboratory for spine imaging and biomechanics crowns the long-standing collaboration between researchers of the *École polytechnique*, the Sainte-Justine UHC, the *École de technologie supérieure*, the Sacré-Cœur hospital on the Montreal side, and on the French side researchers from the *Assistance publique-Hôpitaux de Marseille* (AP-HM), CNRS, IFSTTAR and the University of Aix-Marseilles.
The laboratory has received the support of the A*MIDEX excellence initiative. The laboratory's research work revolves around spine imaging, modelling and biomechanics with a view to better understanding, preventing and curing traumas and pathologies.

IRCOBI 2015 CONFERENCE

The IRCOBI conference, the benchmark in the field of the biomechanics of shocks and transport users' safety was held in September 2015 in Lyon. The 2015 edition, organised by LBMC, attracted some 215 participants from 17 countries.
Besides thirty plus universities, the attendance comprised most of the world's leading car manufacturers including Google for automated vehicles, many equipment manufacturers and all crash-test dummy manufacturers. Several transportation research institutes and institutional representatives (Europe, USA, Japan, Korea, India…) took part. The head of the Spanish Road Traffic Division gave a lecture entitled *"Trying to apply science to motor vehicle safety policy decision making"*.

"20 YEARS ANNIVERSARY OF THE REGISTER"

On the occasion of the event "Decades of research at IFSTTAR", UMRESTTE and Arvac celebrated the 20 years anniversary of the Register for victims of road traffic accidents in the Rhône region. A unique tool for assessing the trauma consequences of traffic accidents, this register to date remains a pre-requisite to France's European commitments to keep a track-record of the numbers of serious victims. So essential that the latest Interministerial Road Safety Committee decided to *"ensure the sustainability of this register from a technical and financial point of view and as a first step to extend it to the whole of the newly created Rhône-Alpes-Auvergne region"*.

DEPARTMENT ORGANISATION

TS2
TRANSPORT, HEALTH, SAFETY
Director: **Bernard Laumon**
Administrative Manager: **Patricia Chapuis**

LBA
BIOMECHANICS AND APPLICATION LABORATORY
Director: **Stéphane Berdah**
Deputy Director: **Pierre-jean Arnoux**

LBMC
BIOMECHANICS AND IMPACT MECHANICS LABORATORY
Director: **Philippe Vezin**
Deputy Director: **David Mitton**

LESCOT
ERGONOMICS AND COGNITIVE SCIENCES APPLIED TO TRANSPORT LABORATORY
Director: **Hélène Tattegrain**
Deputy Director: **Claude Marin-Lamellet**

LMA
ACCIDENT MECHANISM ANALYSIS LABORATORY
Director: **Catherine Berthelon**
Deputy Director: **Michèle Guilbot**, **Thierry Serre**

UMRESTTE
EPIDEMIOLOGICAL RESEARCH AND SURVEILLANCE UNIT IN TRANSPORT, OCCUPATION AND ENVIRONMENT
Director: **Alain Bergeret**
Deputy Directors: **Martine Hours, Jean-Louis Martin**

PLANNING, MOBILITY AND ENVIRONMENT

The AME department lies at the crossroads of most research work at IFSTTAR as it involves Human and Social Sciences, Environmental Sciences and Engineering Sciences from the angle of transports and mobility and their interconnection with social and economic dynamics, the environment, the territories and the planning policies.

The research is divided into three workstreams.
The first one looks at the analysis of people and goods mobility by measuring practices, the understanding of their determinants (social and economic, spatial, psychological) and the evaluation of their social, environmental economic performance.
The second workstream is dedicated to the effects of mobility, transport and infrastructures in their respective environments by looking at their generated nuisance, energy consumption, infrastructure-related risks and safety. Work also tackles the mitigation of these effects, including avoidance (action at the source) and compensation measures, as well as the acceptability of solutions considered or deployed to curb such effects.
The third and last workstream focuses on sustainable mobility and spatial planning for the territories, first from the angle of interactions between networks, mobility and territories and secondly through an analysis of mobility (transportation and road safety) and spatial planning policies.
During the same year 2015, the AME Department held an in-house seminar. This event, introduced by a lecture on mobility prospective by Georges Amar (former Director of Prospective at RATP), aimed to showcase the technical competences of the Department and launch inter-laboratory scientific reflection workshops with a view to preparing new projects and topics for PhDs and post-docs.
A first workshop focuses on analysing and assessing public policies. Besides taking stock on the state of research in terms of evaluation (supply and demand), the aim is first to improve and build up on existing methods (taking into account imperfect competition of: spatial effects, macro-economic or redistributive effects, etc.), and secondly study the articulation between the environmental and the socio-economical dimensions.
A second workshop looks at environment as a driver for social, organisational and technological breakthroughs in the area of transport and mobility, with several themes such as transport-habitat interactions and modal transfer.
The third workshop focuses on innovations in the fields of transport and mobility, and in particular how digital tools are pervading the world of objects (vehicles, infrastructures) and in the operational and business processes that put them into interaction. This workshop also involves researchers of the COSYS department.
Lastly, a fourth workshop addresses interactions between people mobility and freight transport from two angles. The first one explores the modalities of freight traffic and passengers within the same transportation modes while the second investigates the effects of e-commerce on the logistics and the consumers' mobility.

2015 AT A GLANCE

"MOBILITÉ EN TRANSITIONS. CONNAÎTRE, COMPRENDRE ET REPRÉSENTER", A BOOK COORDINATED BY IFSTTAR (DEST) AND CEREMA RESEARCHERS, WHICH STUDIES THE MAJOR MUTATIONS UNDERWAY IN THE AREA OF PEOPLE'S SPATIAL MOBILITY

The years 2000 for the first time in history saw stagnation in the use of cars and as such they mark a turning point in the evolution of day-to-day mobility. This new trend of our societies should be read against the backdrop of the on-going digital transition, an environmental transition that is much hoped for by everyone, and the increasing financial pressures on both households and public authorities. This book, gathering some forty contributions, proposes to explore further the root causes and consequences of such changes in the current context. To do so, surveying methods need to be adapted, while analyses need to be deepened and diversified, and finally the aid-to-decision tools need to be rethought anew.

JIFT SESSIONS
INTERNATIONAL FRENCH_SPEAKING ENCOUNTERS ON TRIBOLOGY

Organised in May 2015 by the EASE Laboratory under the aegis of the French mechanical engineering association (Association Française de Mécanique), they aim to foster networking and discussions between industry players, managers, research and academic institutes on issues revolving around tribology. They emphasise the complementarity between fundamental research on friction, lubrication and wear on the one hand, and on another hand applications in various fields of human activities. These days brought together 90 participants in Nantes, with 65 papers presented and two lectures on the physics of water drops (ESPCI Paris) and tires (Michelin).

JF RUAULT, PHD STUDENT AT LVMT

He won the Philippe Aydalot thesis award given by ASRDLF (Regional association for French-speaking Scientists, member of RSAI) for a project on the impact of transit consumption on the development and metropolitan integration of territories in the Île-de-France region around Paris.

B. GAUVREAU, A RESEARCHER AT LAE, DEFENDED HIS HDR* ENTITLED "MULTI-SCALE AND CROSS-DISCIPLINARY APPROACH TO ENVIRONMENTAL ACOUSTICS"

His research ambitions to build up in-depth knowledge of all acoustic phenomena involved in the urban and suburban environments. By developing experimental and digital reference databases, his aim is to identify the physical processes at play in situ during sound propagation so as to conduct statistical analyses (variability and representation in space and time of influential observable factors, epistemic and random uncertainty of the indicators) and to validate prediction models.

*HDR: accreditation to supervise research

F. BAOUCHE, PHD STUDENT AT LTE AND LICIT (COSYS DEPARTMENT)

He defended his thesis that proposes a multi-objective methodology for locating charging stations in order to determine the optimum itinerary with rerouting to these stations whenever the charge status of the electric vehicle's battery is insufficient to complete a journey.

FOCUS ON 2015

DEEM (ENERGY/EMISSION DIAGNOSIS OF MOBILITY MODES)

The BETTI (Integrated Environment-Transport Assessments for Territories) research project funded by ADEME and also involving the Department's DEST and EASE laboratories made it possible to develop the DEEM, a tool producing a standard estimate of consumptions and emissions of citizens' daily movements at the scale of urban regions aiming to become an aid-to-decision making for public transport policies (towards low-carbon mobility).

In September 2015, IFSTTAR (AME-DEST), Cerema (technical department for territories and cities) and ADEME (transports and mobility department) organised a nationwide day of discussions for local authorities eager to undertake a DEEM action on their recent or upcoming survey on households and mobility. Ten such local authorities were in attendance. The morning session addressed the experience feedback from three pilot conurbations whose representatives described the various potential uses of this tool.

In the afternoon, the participants broke out into workshops to investigate ways to analyse the resulting data around five central themes: space and time comparisons, prioritisation of the challenges, differentiation of the territories and populations, knowledge of the local fleets of vehicles and penetration of new technologies, prospective simulation.

The day wound up on a summary of exchanges and the way forward for a tentative club of "DEEM cities".

DEPARTMENT ORGANISATION

AME
PLANNING, MOBILITY AND ENVIRONMENT
Director: **Gérard Hégron**
Deputy Directors: **Anne Aguilera**
Michel André, Michel Bérengier
Administrative Manager: **Alexandra Richard**

DEST
ECONOMIC AND SOCIAL DYNAMICS OF TRANSPORT LABORATORY
Director: **Francis Papon**
Deputy Director: **Laurent Hivert**

EASE
ENVIRONMENT, PLANNING, SAFETY AND ECO-DESIGN LABORATORY
Director until end of April 2015: **Agnès Jullien**
Director, for interim period: **Véronique Cerezo**

LAE
ENVIRONMENTAL ACOUSTICS LABORATORY
Director: **Judicaël Picaut**
Deputy Director: **Joël Lelong**

LPC
MOBILITY AND BEHAVIOUR PSYCHOLOGY LABORATORY
Director: **Valérie Gyselinck**

LTE
TRANSPORT AND ENVIRONMENT LABORATORY
Director: **Serge Pélissier**

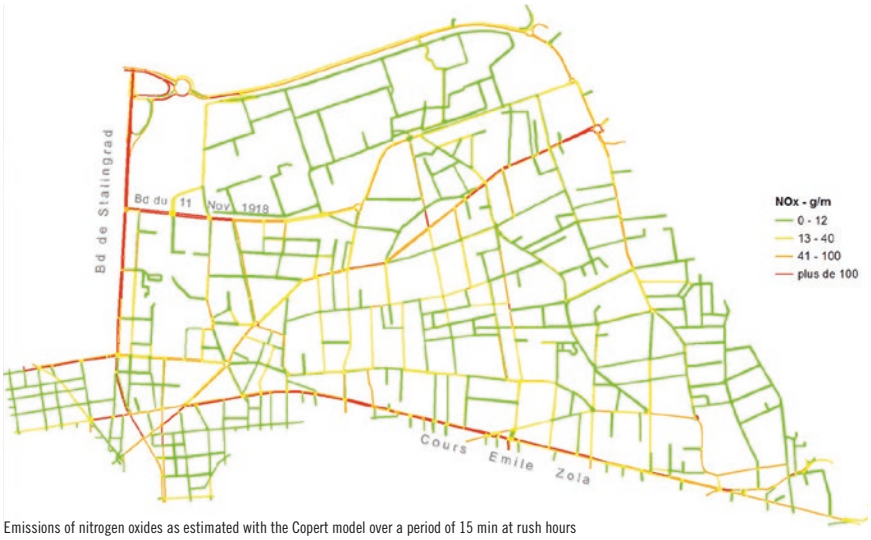
LVMT
CITY, MOBILITY AND TRANSPORT LABORATORY
Director: **Pierre Zembri**
Deputy Directors: **Olivier Bonin,**
Fabien Leurent

SPLOTT
PRODUCTION SYSTEMS, LOGISTICS, TRANSPORT ORGANIZATION AND WORK
Director: **Corinne Blanquart**

AXIS 1

INVENTING SUSTAINABLE MOBILITY

Consistency of representation scales for traffic and pollutants



Emissions of nitrogen oxides as estimated with the Copert model over a period of 15 min at rush hours

This project, conducted between 2013 and 2015 and funded by MEDDE as part of the PST Rhône-Alpes, aimed to compare the static and dynamic modelling scales for an urban district and to evaluate various estimation methods for associated pollutant emissions. The partners to this project, IFSTTAR (COSYS/LICIT and AME/LTE), ENTPE, Cerema and TSS, were thus able to identify precisely scaling issues between static and dynamic modelling and define two concepts to characterise representation differences in infrastructure geometries: a) the completeness, which defines the level of detail at which the network topology is represented, b) the fineness which defines the dimensions considered.

As regards environmental coupling, the project allowed some breakthroughs on:

- The relevance of outputs of traffic models in assessing consumptions and pollutant emissions;
- The coherence of the results obtained via different environmental modelling chains liable to be deployed based on traffic and emission models.

Amongst other things, these modelling chains made it possible to establish a ranking of the various spatial planning scenarios. One of the outcomes of the project was the development of coupling software to facilitate the processing of trajectory data generated through dynamic traffic simulation by various emission computing models (Copert, HBEFA and Phem).

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Understanding mobility to better design electric vehicle-enabled services

In partnership with Renault and its institute for sustainable mobility, between 2010 and 2014 LVMT conducted some research in order to better identify the potential of electric mobility. Research in socio-economics and systemics: because the automobility system is to be rethought from scratch, by adding to the traditional players (car makers, operators of road networks or public transport, users, territorial communities) a number of newcomers: energy providers, equipment manufacturers for batteries and charging stations.
This need to rethink and the specifics of its implementation in the Saclay-Satory territory were addressed in a first thesis.
A second thesis explored the acquisition potential of French households in terms of electric cars, showing that a 30% rate could be envisaged by 2025.
A third thesis studied the management of mobility in businesses, investigating the potential for electromobility spurred by public policies: the French case highlights both a great complexity in management modes and sub-optimisation of public policies.
Moreover, a "Meta-observatory" of mobility modes was undertaken at international level: the first outputs established a typology of countries and a typology of metropolises from the angle of mobility. Lastly, at several space scales, services backing other value-adding factors on top of the electric car were designed with an emphasis on financial profitability or collective optimisation.

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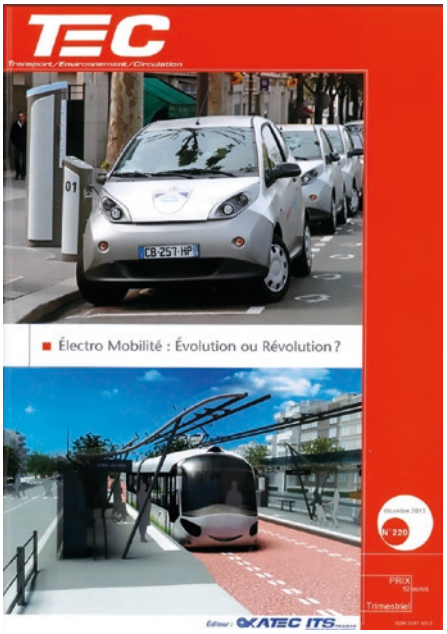

Services at various space scales to anchor electric cars at territorial level

Cognitive radio for railways via dynamic allocation and opportunistic reuse of the spectrum

The ANR CORRIDOR project (COgnitive Radio for Rallway through Dynamic and Opportunistic spectrum Reuse) (2011-2015) steered by IFSTTAR (COSYS/LEOST) brought together SNCF, Thales Communication & Security, EURECOM, LabSTICC, DOAE and TELICE.
It is the first research project in Europe to address smart radio for railways (speed, electromagnetic disturbance, poor radio coverage in rural areas…).
The project looked at three types of transmission: control-command, on-board video-surveillance and on-board Internet. The work focussed on smart mobile terminals, smart fixed infrastructure assets, management of mobility and cooperation between the mobile terminal and infrastructure.
Tests made on the IRIS 320 train and OpenAirInterface platforms allowed to acquire real-life signals at 300 km/hr (database of these measurements available on request).
A channel emulator was developed by Eurecom with these signals in order to assess different processing algorithms.
A final workshop was held on 25 June 2015 with over 60 participants from academic and industrial circles.
The results demonstrated the feasibility of considering wireless multiservice communication networks that rely on the combination of heterogeneous access technologies (GSM, WIFI, LTE, 5G…) rather than on a dedicated infrastructure.
The system's resilience potential was highlighted by the real-time analysis of the electromagnetic environment, the detection of scramblers whether deliberate or not and out-of-band emissions.

http://corridor.ifsttar.fr/index-fr.php

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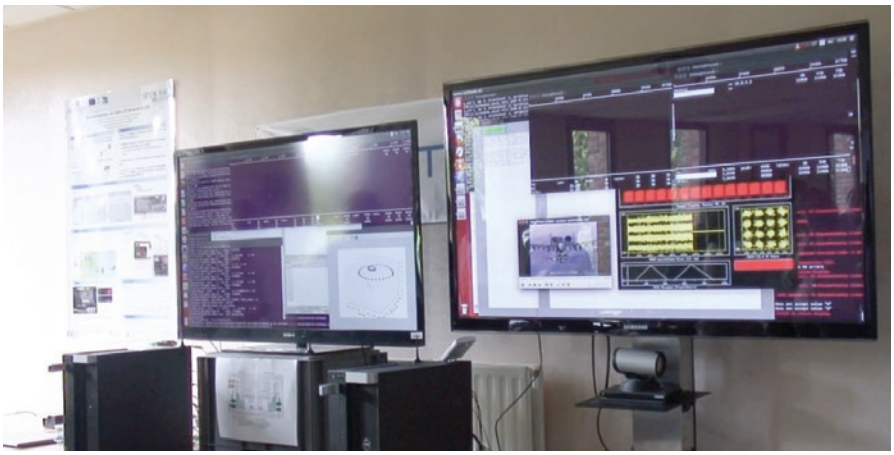

ANR CORRIDOR project demonstration on 25 June at the IFSTTAR site in Villeneuve-d'Ascq

DeGIV project – Detection and handling of incidents on board a railway car

The DeGIV research project (2011-2015) materialised with the development of a smart audio/video IP sensor capable of detecting abnormal events such as muggings, fights or acts of vandalism in order to improve passengers comfort and security in public transport. This project, initiated in the SYSTEMATIC competitiveness cluster, won the FUI 11 call for projects. Detection is provided via analysis of audio and video signals from two microphones and a camera fitted into the unit.
The on-board processing unit supports the charging of the functions provided. The network communication layer allows transmitting the signals detected to the Control Station's central processing unit (wire or wireless) and meets the Onvif specifications that provide for interoperability with other existing or future IP sensors. IFSTTAR contributed functions capable of modelling a normal audio ambience and detect potential events such as screaming, paint sprays even against a significant noise background. The method deployed can be used with many other noise patterns.

The DeGIV partners and the sensor installed on board a car of RATP's line 14

The Institute also studied how to combine two DeGIV units in order to detect and monitor several individuals by combining the contents of two images of the same scene. Three semi-industrial prototypes were developed and evaluated in service on a car of RATP's line 14 in Paris.

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Hybrid rechargeable electric vehicle: HYBRELEC

The HYBRELEC project labelled by the MOV'EO cluster and financed by ADEME (2009-2015) was coordinated by Valeo and had the following partnering organisations: Michelin, Leroy Somer, Johnson Controls, GKN Driveline, Leoni, IFP-Energies nouvelles, IFSTTAR-TEMA, Lamih and Cevaa. The project aimed at producing two demonstrator vehicles, one full-electric HYBRELEC 1 and the second one a hybrid rechargeable electric vehicle, HYBRELEC 2.
These vehicles had to feature a consistent set of innovative technologies (electric power train and heat management) based on generic mechatronic building blocks.

Full-electric demonstrator vehicle DemoCar HYBRELEC 1

HYBRELEC allowed covering a whole set of technological bricks required for the emergence of a French-based sector of system optimisation for electrification of the power train. The major challenge in this project was to demonstrate the industrial feasibility and competitiveness of the combination of innovative technologies liable to significantly reduce CO_2 emissions at an affordable price such as to enable large-scale deployment of low-carbon vehicles. IFSTTAR contributed its competences in various parts of the project and did a benchmark on the Nissan Leaf electric vehicle: the objectives were to establish a methodology for rolling trials factoring in a relevant metrology to identify potential operating constraints for the innovative components (converters, motors and battery) and to measure the vehicle's performance and in particular its autonomy.

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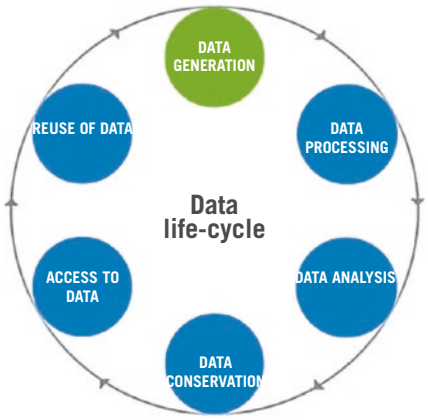
GEBD network: large-size database facility



Data life-cycle
(extract from "An initiation to the management and sharing of data from research", 2014, Inist-CNRS)

The "GEBD network" cross-disciplinary project addresses access to, use and leveraging of databases for research on the city and mobility. It was selected by the MEDDE's DRI as one of its collaborative projects and involved IFSTTAR, IGN and IRSTV from January 2011 to March 2015.
From OECD to the European Commission and the opening of public data, several initiatives aim to promote the reusability and life-cycle extension of the data from research. On the back of this project's momentum the scientific network "Belgrand" was launched and supported by collaborative tools: seminar, prototype IT infrastructure including a Dataverse archival system, geographical baseline management tools as well as a legal framework to take into account both intellectual property rights and the rights of physical entities regarding their personal data.
The outcomes of this project included recommendations in order to build up on the teams' expertise and meet the new demands of funders for the opening of data: quoting the data files and their authors, archiving data sets at the time of significant publications, building metadata models with documentation departments… These tasks are paving the way for a large-size facility that will enable researchers to reference their productions and get information about the data, their uses and access modes.

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Nationwide estimate of the number of victims of serious road injuries, MAIS3+ project

The European Commission is asking its member states to estimate the number of victims of serious road injuries based on the international codification for traumas, Abbreviated Injury Scale (AIS). Severity is defined as serious starting from level 3 as per AIS (MAIS3+).
In providing an estimate of the number of serious road injuries in France, two sources of data on road traffic accidents are used: the *Registre du Rhône*, and the national compendium of law enforcement units.
The first one is close to being comprehensive and directly codifies injuries with AIS based on medical data, but it does so only for the Rhône departement. The second one (BAAC) covers the whole national territory but it is not quite comprehensive and is somewhat biased. By reconciliating the two databases via a process of capture-recapture, it is possible to derive an estimate of the BAAC's correction coefficients. Considering the wounded common to both sources, a prediction model of the MAIS 3+ is estimated based on the characteristics of the accident and the injured. The number of road injuries is thus estimated to stand at 300,000 in 2012, and victims of serious injuries MAIS 3+ in the area of 30,000.
This work was supported by DSCR.
France is now in a position to meet the expectations of the European Commission regarding the tracking of road injury numbers. The tracking procedure should however be enhanced by a more extensive insight into the AIS severity of the injured in terms of geographical distribution.

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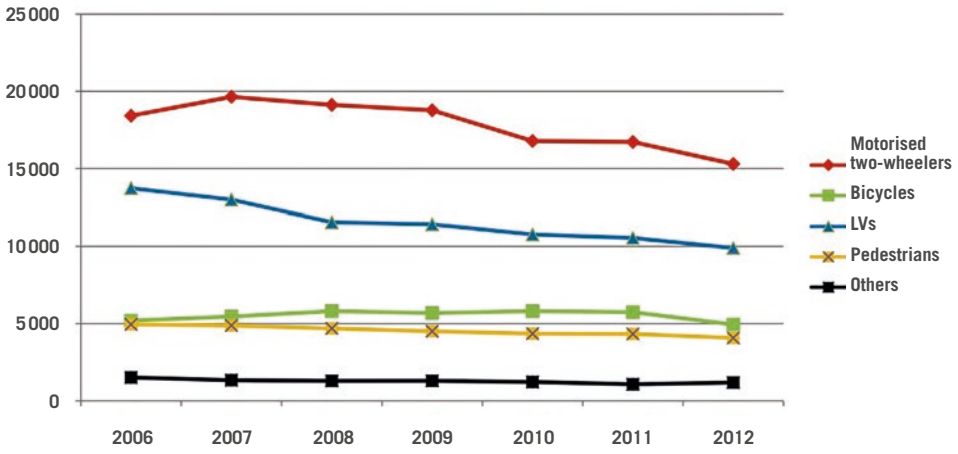

Number of victims of serious road injuries (MAIS3+), per type of user, France, 2006-2012

Teenager pedestrians: accidentology and mobility (PAAM)

The PAAM project (IFSTTAR/TS2/LMA, Universities of Paris Sorbonne and Caen), funded by the FSR (French road safety foundation) (2012-2015), had as its objective to better identify the contours of mobility and pedestrian accidentality of teenage schoolgoers and specify the geographical, psychological and sociological determinants of both these variables and their relations, in order to understand the peaks of pedestrian accidents for teenagers joining middle school. A study on the accidentality of middle school students covering the whole French territory based on a sample of accident reports (2002-2011) was further complemented by a study on the mobility and geographical distribution of accidents for 10-15 year-olds (with typical scenarios) in the Lille conurbation.
On the same playing field, a first survey of 2,500 teenagers between 10 and 16 years old identified their socio-demographical (age, gender, social and economic background) and psychological (gender roles, perceptions of social norms, risks, rules, supervision level) determinants of detailed mobility practices and risk behaviours as pedestrians.
A second survey covering 300 middle school students helped outline a sensitive mapping of their real pedestrian environment and analyse the factors used to assess the pleasantness, comfort and safety of road environments to characterise their representations of routes deemed positive and/or negative as pedestrians.

Cloud of words used by middle school students to describe their favourite pedestrian route (Source: PAAM)

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The virtual human being to understand the vulnerability of pedestrians and improved available protections: the child pedestrian example

In 2012, 115 children below the age of 14 were killed in French road accidents among whom 36 child pedestrians. Children protection is therefore a crucial challenge. By using virtual children models, it is possible to predict the lesional workup of a child pedestrian victim of an accident according to the vehicle's shape.
The aim of the child pedestrian project was to develop a digital tool to evaluate the risk a child pedestrian is exposed to according to various environmental factors.

- An accidentological and epidemiological study of child pedestrians was conducted to establish the typical accident scenarios. This child pedestrian is victim of an accident predominantly at the age of 6. Most of the time, he/she will be hitted by a light vehicle at an average speed of 26.4 km/hr. The shocks are essentially at head, abdomen and lower limbs level.
- A multimodel parametric analysis tool was developed to simulate a pedestrian shock and predict the risk of injury: at the global scale for the multi-body simulation of the vehicle/pedestrian contact and at the local scale by finite elements simulation of the head/car hood contact.
- This work highlights the influence of car design on the head injuries suffered by children.

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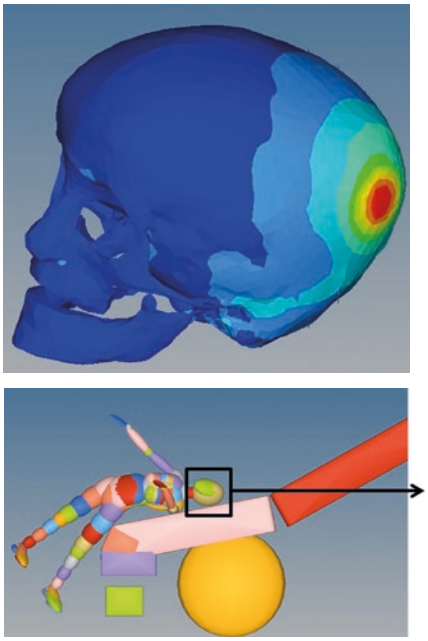


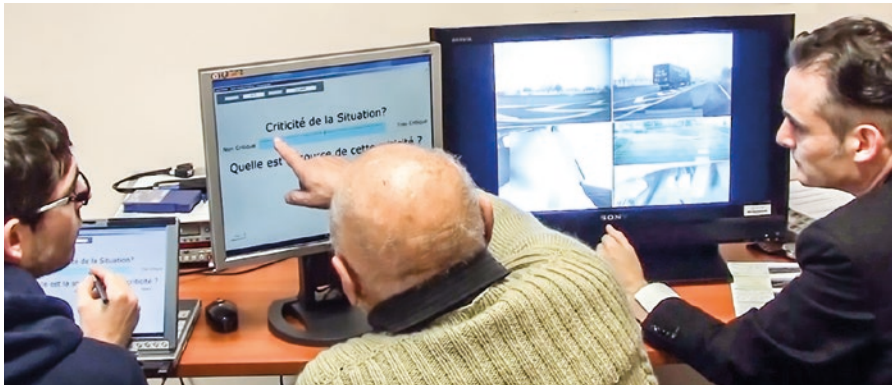
Global simulation of the accident (bottom figure) and local simulation of the head/hood impact (top figure)

For safe and sustainable mobility of ageing drivers

The SAFE MOVE for older drivers project (2011-2015) was funded by ANR. Also associated in this work were industrial partners (Continental, PSA and OKTAL), CNRS, INSERM, LESCOT, UMRESTTE and LEPSIS, with a "twin" project carried out in Sweden with VTI and Volvo Cars. The aim was to identify the determinants of safe and sustainable mobility for ageing drivers and propose tailored solutions in terms of training and driver assistance systems. Combining a cohort-type approach with an experimental one, the outcomes confirmed that cognitive self-assessment was determined by variables such as personality, gender and lifestyle, and that it was indeed well co-related with the self-assessment of one's driving performance. The benefits of a purely cognitive training programme were compared against those of cognitive training combined with immersion on a simulator for 70-year old plus drivers over or under-estimating their cognitive capacities.

The results showed that the benefits of training are more clear-cut for drivers with a tendency to under-estimate their cognitive capacities while other types of action should be suggested to the "over-estimators".

The specification, design and development of assistance-function demonstrators for seniors on both simulators and real vehicles carried out as part of this project demonstrated that senior drivers were interested in these technologies and helped identify those critical situations for which driver assistance functions would be useful.



After driving the instrumented vehicle, the ageing driver visualises his/her journey and evaluates the difficulties they might have encountered in specific driving situations

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SCOOP@F

The purpose of Cooperative Intelligent Transport Systems (C-ITS) is to offer services that improve the users' safety and comfort as well as the management of infrastructures through the communication and sharing of information between vehicles and the road infrastructure.

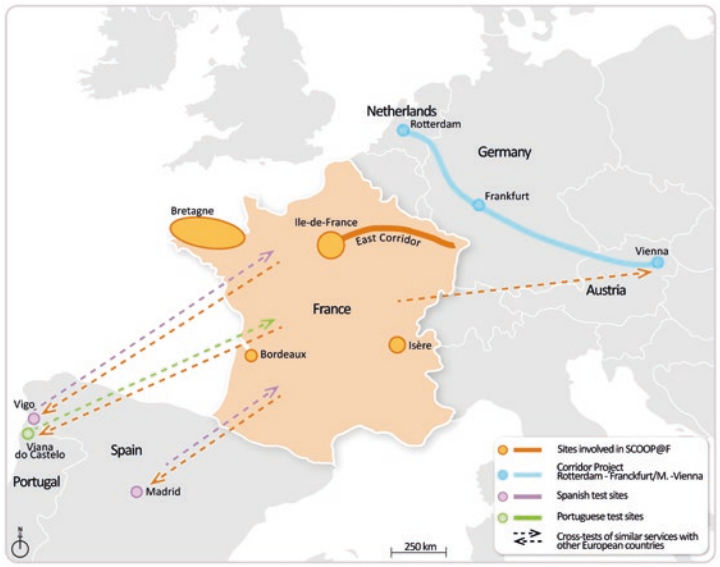
In order to pave the way for a potential nation-wide deployment of C-ITSs, MEDDE proposed the SCOOP@F research project for the deployment of C-ITS.

Funded by the INEA agency, this project is to unfold between 2014 and 2018 and will take place on 5 French sites (with 18 partners including Renault, PSA, local authorities in Britanny, *CD Isère, DIR Atlantique, the Ouest* and *Île-de-France* regions, Sanef, LAB, Télécom Paris Tech, University of Reims, Cerema and IFSTTAR) and 3 European sites (Spain, Portugal and Austria).

Its aim is to study the impact of new services for road safety and information via experimentation on real sites (2,000 km of equipped roads) with some 3,000 vehicles.

The second objective is to validate these technologies' interoperability by defining a body of specifications common to the countries involved in SCOOP.

In 2015, the task force drafted the equipment's technical specifications, proceeded with the development and table-testing of the first components commissioned. The teams also defined the impact studies to see how the introduction of C-ITS might impact stakeholders, including road users, the staff of road management companies but also any other organisations involved.



© Consortium SCOOP

SCOOP@F in the European context of C-ITSs

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SIGIFret - Simulations of innovative management of freight traffic

The SIGIFret project forms part of the PREDIT research programme (2012-2015) with SNCF Réseau and IFSTTAR as its partners. The project was organised in two parts, first of which was to assess the usefulness of an aid to traffic operations management tool. To this end, the Paris-Le Havre line was chosen for a case study on account of its traffic mix and the presence of two critical railway hubs: Mantes-La-Jolie and Rouen-Rive-Droite. We considered several disturbance scenarios to which we applied four different regulation strategies for comparison purposes. The findings clearly demonstrated the usefulness of an optimisation tool for better integration of freight and passenger trains at the level of traffic operations management.
The objective of the project's second part was to address freight train integration in the planning phase. In order to do this, a capacity computing method was designed, the idea being to integrate the maximum number of additional trains to an existing time grid, paying particular attention to freight trains. The method developed made it possible to overload the existing time grid on several time scales. For the period covering the rush hour and around peak period, the method enabled us to add 332 extra trains including over 100 freight trains (over twice their number in the current scheduling grid).

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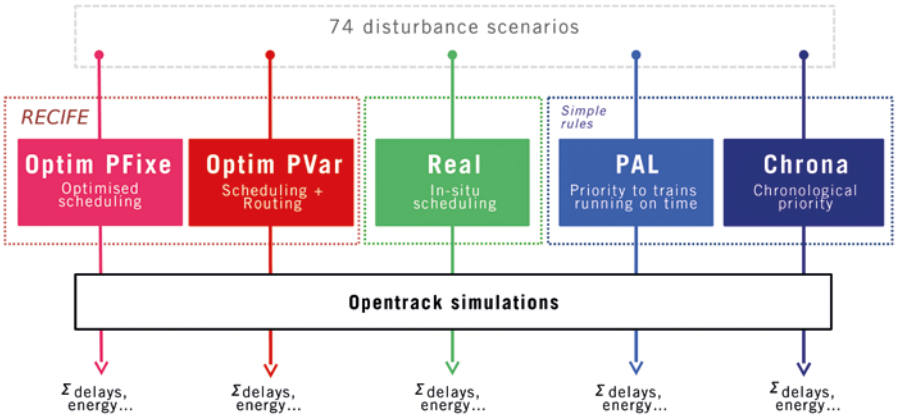
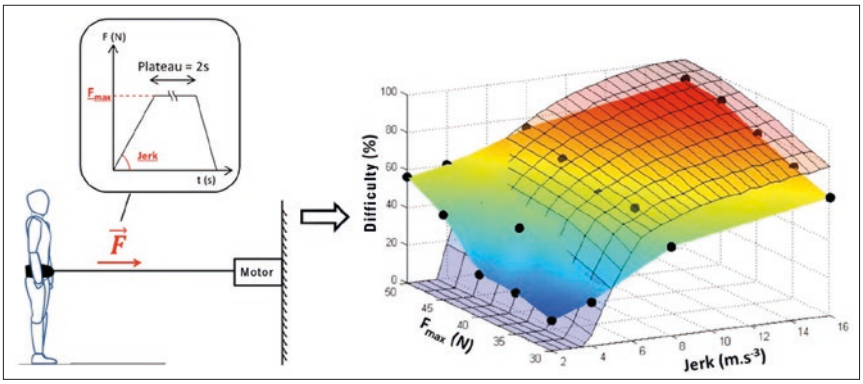


Evaluation by simulations of the gains derived from using the RECIFE traffic operations management aid-to-decision tool

Simulation of balance keeping and risk of falls in transports



Effect of disturbance parameters on the perceived loss of balance. Left: experiment protocol; Right: comparison between experimental results (colour background) and results predicted by our tool (transparent meshing)

This project is centered around the thesis of Pascal Vallée, funded by IFSTTAR between 2012 and 2015. This thesis built up on the previous efforts to model the balance-keeping mechanisms by Zohaib Aftab in his thesis financed by the Rhône-Alpes region (2009-2012). The aim was to propose a digital tool liable to assess the risk of fall and discomfort experienced by standing passengers in public transport due to the vehicle's dynamics (acceleration, braking…).
Particular attention was paid to validating this tool based on experimental data from the literature and further complemented by experiments on volunteers at the laboratory. This tool was used to assess possible changes to the emergency braking profiles of trams in order to mitigate the risk of falls for passengers whilst preserving the braking performance (collaboration with STRMTG). Other applications are currently underway or considered for the future (adjustment of acceleration/deceleration profiles at station entry/exit for trams, discomfort caused on the trains by occasional track defaults, etc.).

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SPRINT, Supervision of traffic conditions

Traffic conditions on the network of the DIRIF (interdepartmental directorate of roads of *Ile-de-France* region) are getting increasingly complex.
Initial dynamic traffic regulation operations are currently being assessed and should be increasingly resorted to in the future. To optimise their management (activation – de-activation), DIRIF is seeking to acquire a real-time decision-making tool that would be more advanced than the current SIRIUS, to help them determine traffic conditions in real time across the whole network and to predict short-term conditions (< 1hr).
DIRIF called on LICIT and its expertise in dynamic traffic modelling to address the scientific and technical challenges of such a solution and sign off the technical and functional concept ("proof of concept"). The commission was contractualised in the form of a research convention between DIRIF and IFSTTAR with two work phases in 2014 and 2015. Phase 1 (June 2013 – May 2014) aimed to produce a "prototype for real-time assessment of traffic conditions comprising a mesoscopic traffic model and a real data assimilation loop on a much simplified network".

The prototype was validated on a corridor (A1) but a good number of scientific locks, although resolved in theory, called for additional testing before they could be validated at the scale of a broader network. This was done in phase 1bis (June 2014 – May 2015).

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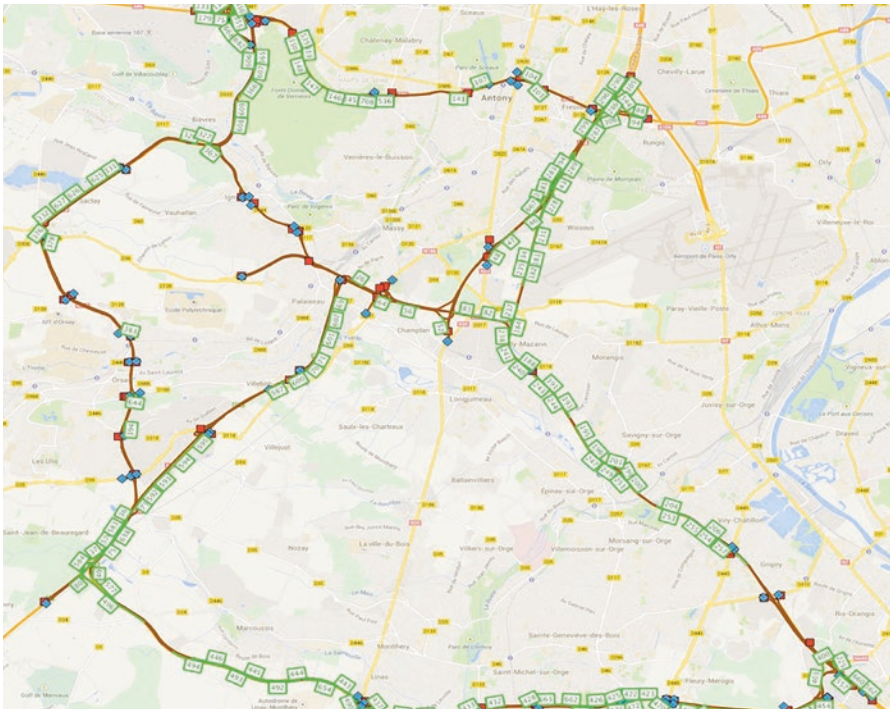

Assimilation of loop data: scope of the DIRIF's test network

Fully automated driving: acceptability, trust and learning to resume manual control

Self-driving vehicle as imagined 60 years ago in an advertisement for Carolina Power & Light Company, published in Wilmington News daily, 18 January 1956

William Payre's thesis on fully-automated self-driving, funded by the VEDECOM Institute and supervised by Patricia Delhomme and Julien Cestac (AME/LPC), was defended at Paris 8 University on 8 December 2015. This is the first thesis in France on the use of self-driving vehicles and their acceptability; it explored the need to train users to resuming manual control over this type of vehicle. Three studies were conducted, two of which on IFSTTAR's driving simulator in Satory, in collaboration with LEPSIS.
The impact of various forms of training to fully automated self-driving on performance and safety (response time, quality of control resumption) was examined in situations where resumption of manual control was either urgent and unexpected, or scheduled.
It was observed that the impact on overconfidence, which increases response time in situations of urgency could be mitigated by a short practice of fully-automated self-driving (vs. simple oral and written information). During resumption of manual control, the accomplishment of a task not related to driving protracted response times, although it did not actually alter the precision of the use of pedals. These studies show the need to plan a specific familiarisation procedure for this new type of driving.
The results of these studies have been published in numerous communications and published in two articles, a third is under assesment.

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Theses

AME-DEST
ACHIT HAMZA
Economic analysis of the damages and compensations for road traffic accidents: a victim-based approach

COSYS-GRETTIA
ATMANI DIHYA
Dynamic allocation in multimodal transport systems

COSYS-LEPSIS
ATTAL FERHAT
Classification of driving situations and detection of critical events for a motorised two-wheeler

TS2-LBA
AURIAULT FLORENT
Virtual traumatology for pregnant women victims of road accidents to help design and evaluate specific protection devices

COSYS-ESTAS / COSYS-LICIT
CUNIASSE PIERRE-ANTOINE
Theoretical and experimental study of congestion phenomena on an urban railway network

COSYS-ESTAS
DARRAGI NESRINE
Contribution to the modelling and verification of complex critical systems

COSYS-LEPSIS
DARTY KÉVIN
Quality evaluation of agents' behaviours in simulation: application to a driving simulator in a virtual environment

TS2-UMRESTTE
DIAKITE AISSATA
Role of alcohol and psychoactive substances in highway accidents in Abidjan, Côte d'Ivoire (ASMA-CI study)

MAST-NAVIER
DURAFFOURG SIMON
Analysis of the fatigue durability of car bodies submitted to increasingly stringent mission profiles

COSYS-GRETTIA
FOULLIARON JOSQUIN
Use of probabilistic graphic models for the implementation of a prognosis-based maintenance policy

TS2-UMRESTTE
GRASSET ALICE
Epidemiology of bicycle accident injuries, aspects of primary and secondary safety

AME-DEST
GRIMAL RICHARD
Auto-mobility at the turn of millennium: a nested approach, individual and longitudinal

TS2-LMA
GUEHO LUDIVINE
Psychosocial approach of the effects of gendered identities on reported risk behaviours reported when driving and in various situations for young drivers

COSYS-LEPSIS
GUILBERT DAVID
Analysis and classification of vehicle signatures as derived from magnetic sensors for the development of intelligent traffic management algorithms

COSYS-LICIT
HANS ETIENNE
Modelling of bus lines for real-time prediction and dynamic regulation

TS2-LBMC
JAYYOSI CHARLES
Characterisation and modelling of the fracture behaviour of human liver tissues for the prevention of liver damage risks

COSYS-LEPSIS
JOULAN KARINE
Assessment of road visibility as seen from the driver: contribution to driving assistance systems

COSYS-LEPSIS
LEMONNIER SOPHIE
Allocation of visual attention in a natural and dynamic situation: approaching a crossroads at the wheel

AME-LTE
LIEVRE AURÉLIEN
Development of a lithium-ion battery management system for "mild hybrid" vehicles - Determination of the status indicators (SoC, SoH and SoF)

MAST-NAVIER
LIU YAN
Digital and experimental study of the non-linear properties of rail fastening systems

TS2-UMRESTTE
MARIE DIT ASSE LAETITIA
Vehicle driving regulation for ageing men and women

COSYS-LEOST
MEHMOOD MUHAMMAD OWAIS
People Detection Methods For Intelligent Multi-Camera Surveillance Systems

COSYS-LTN-SATORY
NOGUER NICOLAS
Aid to the reliability analysis of a fuel cell by way of simulation

COSYS-LTN-SATORY
OTHMAN DHOUHA
Study of silicon-carbide switches and potential use in aeronautic applications

MAST-NAVIER
PAGNOUX GEOFFREY
Highlighting and simulation of damage to amorphous carbon coatings for internal combustion engine application

AME-LPC
PAYRE WILLIAM
Fully automated driving: acceptability, trust and learning to resume manual control

TS2-LBMC
PENG JUNFENG
Parametric study and modelling of the driving posture of Chinese drivers. Comparative analysis with European population, influence of anthropometry and driving usage

COSYS-LEOST
RABAH MHAMAD-HASSANEIN
Methodology for the design of metamaterial-based antennae and theory of characteristic modes: application for smart radio

TS2-UMRESTTE
RANDRIANTOVOMANANA ELIETTE
Understanding and qualifying social and territorial mobility inequalities as well as road risk for teenagers

COSYS-LEOST
SANGO MARC
Traceability of the requirements and verification by observers for the critical software programmes of railway systems

AME-LPC
STEFANOVA TÉODORA
Study of cognitive and motivational factors in pedestrians' risk-taking at level crossings based on the environment: commonalities and differences between Australia and France

TS2-LBMC
STELLETTA JULIEN
Deformable volume modelling of a lower limb's musculo-skeletal system

COSYS-ESTAS
SUN PENGFEI
Model engineering for the safety of railways' critical systems

TS2-LBMC
TISSERAND ROMAIN
Balance-restoring mechanisms and assessment of fall risk among ageing autonomous people

COSYS-LEOST
TOUATI NADJAH
Optimisation of the waveforms of a driver assistance radar, capable of withstanding downgraded electromagnetic environments

COSYS-LTN-SATORY
TRAN SON HA
Study of the impact of micro-voids in the chip attachments for power electronics modules

TS2-LBMC
VALLEE PASCAL
Assessment of the risk of a fall after a loss of balance

TS2-LBMC
ZAPATA EDISON
Resistance of the human distal radius submitted to a load representative of a fall: Experimental and digital study

HDR - Accreditation to supervise research

TS2-LBMC
BEILLAS PHILIPPE
Contributions to the biomechanics of shocks in the assessment of abdomen damage risks in the event of accidents.
Accreditation to supervise research in biomechanics, 10 July 2015

TS2-LBMC
BERMOND FRANÇOIS
Biomechanical behaviour of public transport users during *ex vivo* and *in vivo* fast dynamic loadings, 29 May 2015

COSYS-LTN
ALEXANDRE DE BERNARDINIS
Architectures of static converters and associated command-control for fuel cell systems and power mechatronics: application to electric vehicles, 10 April 2015

TS2-LMA
THIERRY SERRE
Geometrical modelling of the human body and digital simulation of a road accident for a vulnerable use, 1st October 2015

AXIS 2

ADAPTING INFRASTUCTURE

Energy-generating facilities, an innovative technique for sustainable cities

Loading test for a geothermal pile

Energy-generating facilities rank among low-energy geothermal techniques, just like geothermal probes.
Depending on cases you may be talking about piles, moulded partitions or tunnels which, in addition to their traditional primary function as foundation and retaining structure, will support heat exchanges with the surrounding soil.
The objective is to meet heating and cooling needs in neighbouring buildings or infrastructures. In energy facilities, the system for energy exchange with the soil, whose temperature varies very little throughout the year, is comprised of heat-exchanger tubes installed at the same time as the structure is built thus not needing to drill dedicated holes like in the case of geothermal probes. In the framework of the ANR GECKO project steered by PECOME, IFSTTAR and other institutional and academic partners conducted a number of actions aiming to promote this technique and overcome some of the scientific challenges: in-lab and in-situ tests, digital simulations and finally recommendations.
The technique of energy-generating structures now finally seems to be taking off. IFSTTAR, on behalf of EFFICACITY, has been conducting experts' assessments on metro stations of the Grand Paris looking to expand this technique.
Besides, a COST action steered by IFSTTAR and including 22 countries is currently underway to disseminate this technique across the rest of Europe.

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Non-destructive evaluations and probabilistic models for optimised monitoring of infrastructures (ANR-EvaDéOS)

Coordinated by LMDC (University Paul Sabatier in Toulouse) and involving some 11 partners, the ANR-EvaDéOS project seeks to propose a global method for the monitoring of reinforced concrete assets building in all of the required actions, namely assessment of degradation indices through indicators mainly derived by way of non-destructive methods, prediction of their development if any and implementation of a decision-making process to prioritise maintenance actions and optimise monitoring of the structures [Balayssac et al. NDTCE2016]. The non-destructive (ND) assessment developed within this project aims to provide indicators for concrete durability in relation to the corrosion of its reinforcement steel (W, poro et Pc). The proposed approach consists in a combination of techniques associated with a data fusion methodology. This approach is based on in-lab testing campaigns before it is applied to concrete structures for validation.
IFSTTAR piloted the inter-laboratories campaign to characterise the water content gradients by means of various ND techniques [Villain et al. NDTCE2016] and with EDF co-piloted Task 3 which consisted in analysing the needs of managers and validating the approach on 3 different types of structures.
A method was developed to optimise the positioning of non-destructive measurements so as to keep their number to a minimum. The degradation models were applied to the structures using a Bayesian approach. In parallel with this, a digital test bench was built with advanced models, weather reports and various updating schemes.
This test bench was used to compare the predictive capacities of various simplified models allowing for the constraints specific to the respective managers. Monitoring optimisation was based on a decision tree, which, depending on the level of degradation noted during a given inspection, resulted in effecting maintenance or a repair, or nothing at all. The decision-making probability was then defined as a function of the distribution of the degradation index corresponding to a proportion of the facing inspected for which depassivation of the steel reinforcement had been observed.

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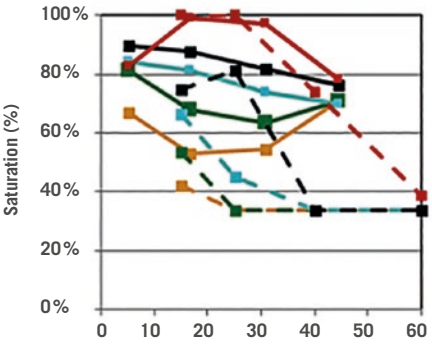

Saturation degree profiles obtained via apparent resistivity inversion using THR sensors sunk in slab 27 of Eva-C1 concrete [Fares, 2015 thesis]

Physical mechanisms and modelling of plaster drying

In the framework of a cooperation project with Saint-Gobain we studied the drying mechanisms of gypsum plaster (in the form of boards as used in the building industry). During the manufacturing process 80% of the water initially present in the paste (and not partaking the material's setting) must indeed be removed. This drying operation is very costly. We used MRI (magnetic resonance interference) to study the changes in water distribution in the porous substrate during the drying process, and X-ray microtomography to assess developments in the porous structure.
We were thus able to show that ions in solution at the end of the setting process are transported, crystallise and accumulate under the sample's surface, which tends to significantly slow down the drying process. Having secured this information we could finally model the phenomenon in its entirety and predict the drying speed quite easily according to experimental conditions. This will allow modelling and optimising drying during the real-life process.

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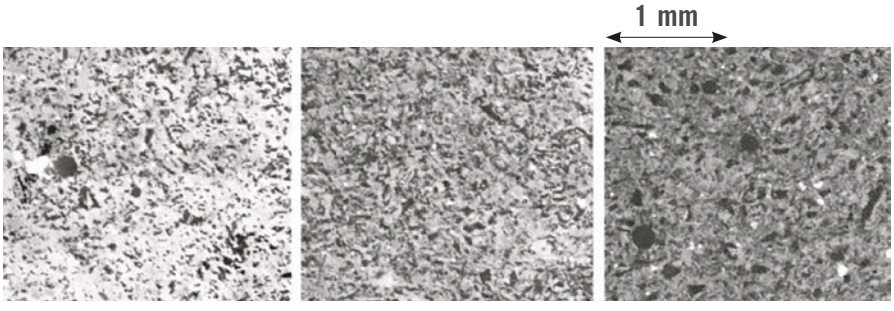

Images obtained through microtomography of the structure of a plaster sample after the 4th imbibition-drying cycle at various distances from the surface: (a) 40 mm, (b) 190 mm, (c) 1.7 mm. The brighter zones correspond to the solid phase. The material's physical appearance beyond a distance of a few hundreds microns is the same as that of the image (c). This shows that the formation and accumulation of crystals under the free surface tends to clog the pores of the structure

Neoval: the future metro of Rennes is being prepared at IFSTTAR

Intended for airport shuttles and automatic urban subways, the Neoval tyre-mounted transport system is designed to run on a specific infrastructure. Siemens France, who are in particular in charge of the construction and the equipment for Line B of the *Rennes Métropole* subway system, called upon IFSTTAR's technical support to better control the various performance parameters of the Neoval's rolling structure. A 100-m long demonstrator made in continuously reinforced concrete was thus built at IFSTTAR's site in Nantes.
To start with, this facility made it possible to show the feasibility of using a slipform paver to build this innovative linear structure characterised by its specific shape and design.
Then several types of surfacing were done and tested for the rolling track. The surface properties were measured from different aspects: evenness, texture, friction, rolling noise.
The outcome of these actions made it possible to fine-tune the constructional arrangements of the continuously reinforced concrete structure and come up with solutions to optimise comfort (limited longitudinal deformations), safety (tyre grip on surface) and environmental considerations (limited noise).
In 2014 and 2015 the project called upon the competences of 5 laboratories within 3 departments: MAST (MIT, LAMES), COSYS (SII), AME (EASE, LAE).
Other innovative features of this structure will also be tested on the demonstrator in the framework of upcoming joint actions between IFSTTAR and Siemens.

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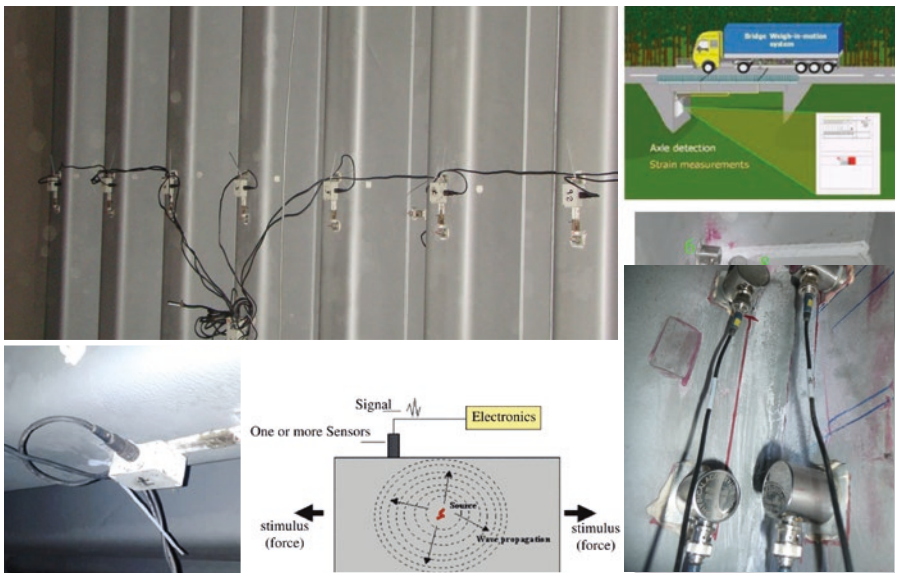
Construction of the rolling track demonstrator using the slipform paver

Multitechnical model for the monitoring of cracks on metal road bridges



Coupling of acoustic emission and weigh-in-motion techniques as deployed on the Cheviré bridge (department 44)

Steered by AIT (Austrian Institute of Technology) and bringing together 15 partners, the TRIMM (Tomorrow's Road Infrastructure Monitoring & Management) European project was scheduled over a 3-year period (2011-2014) and it ambitioned to map out the requirements in terms of structure monitoring and develop a costs-benefits assessment tool for works monitoring and management techniques.
The key technologies identified for the monitoring of roadways and bridges were investigated with a view to improving indicators as well as the processing and interpretation of data.
IFSTTAR was heavily involved in this project through the participation of its AME, COSYS and MAST departments. The MAST/SMC Laboratory contributed to batch 3 of the project, i.e. "Traffic Loading and Acoustics Monitoring".
The purpose was to correlate traffic load measurements with acoustic activity in order to monitor the development of cracks. To this end, the central part of the Cheviré bridge located on the Nantes ring road was instrumented using two different techniques:

- Weigh-in-motion in order to determine the level of traffic, load and speed of lorries;
- Inspection by acoustic emission to "listen" to acoustic activity whenever the crack is propagating.

The processing and analysis of signals made it possible to highlight a correlation between the parameters derived from acoustic signals and the road traffic parameters.
The study also helped define indicators to monitor cracking on a metal part used in a bridge according to traffic intensity.

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SIPRIS (Instrumentation systems for risk prevention, 2010-2015)

Coordinated by Advitam and involving 8 partners, the Île-de-France SIPRIS project took 4 years and allowed to develop innovative systems combining sensors, models and information processing to carry out low-cost in-situ assessments of the physical condition of components deemed to be the most critical to motorway infrastructures. In a preliminary phase, ASF and Cerema conducted an analysis which highlighted the loss of pre-stressing in viaducts with independent spans and prestressed beams (*VIPP* in French), washouts and cross-members supporting signposts. A major partner in this project, IFSTTAR (*via* LISIS and SII) developed the PEGASE2 wireless instrumentation platform, did some heavy experimenting and designed several innovative methodologies: inverse modelling to identify damaged areas in prestressed concrete beams from a few measurements such as deformation, cross-member electromagnetic damping, detection of incipient cracks *via* fibre optic sensors, early detection and quantification of scouring via continuous vibration analysis and off-line topological derivatives, using finite elements modelling. Instrumentation of two "VIPP" beams on the Varèze bridge (motorway A7) confirmed the relevance of fibre optics inserted at the core or bonded on the surface in order to achieve a spatially continuous measurement of the deformation for early detection and location of cracks in prestressed concrete bridges.

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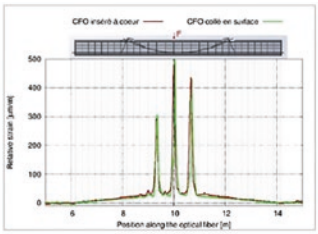

From left to right Varèze bridge, bonded fibres, deformation amplitudes as measured along the fibre and showing the location of cracks

ORSI MCV: controlling the life cycle of structures

The ORSI MCV (IFSTTAR incentivising and strategic research operation) was deployed (2012-2015) as part of an endeavour to provide a global vision of structures performance in their environment. Looking at the whole service life of infrastructures to make the right decisions today and take short-term actions and/or anticipate on the longer term is a genuine challenge for infrastructure managers. In this context, the ORSI MCV set the stage for a joint reflection between IFSTTAR and Cerema on structural risks, degradation mechanisms as well as inspection, diagnosis, monitoring and management methods for such works. The ORSI MCV supported 5 theses, the CEDR "RE-GEN" (Risk Assessment of Ageing Infrastructure) European project and established some scientific cooperation projects with LNEC in Portugal. Moreover, it welcomed the participation of PCI 53 on dynamic inspection to achieve better interaction between instrumentation and structural evaluation, not to mention the work of the Cerema's DTer Méditerranée for the development of a generic surveillance, analysis and monitoring system for the structural health of traffic-supporting infrastructures also exposed to thermal effects (Sysadyp). The ORSI MCV turned out to offer a discussion platform for studies on the pathologies of reinforced concrete infrastructures caused by steel corrosion, on the assessment and management of masonry structures and, last but not least, on the development of an imaging system for tunnels (high-yield inspection methods).

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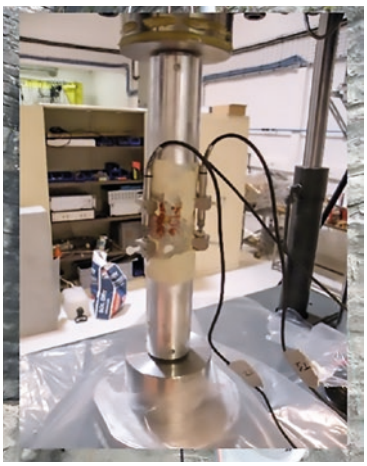

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Direct traction test on a 50-mm diameter mortar test cube

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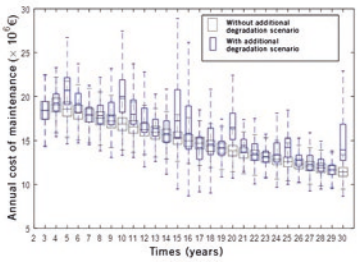
Radar measurements made by rope access technicians at the water intake tower of the Chazilly dam



"RE-GEN" CEDR project: Illustration of maintenance solutions factoring in uncertainties and integrating, or not, additional degradation scenarios linked with climate change

Theses

GERS-NAVIER
AGOFACK NICOLAINE
Behaviour of oil cements and well integrity

COSYS-SII
AMHAZ RABIH
Automatic crack detection in roadway images thru selection of minimal paths

MAST-NAVIER
BESSAIES HELA
Polymers and rheological properties of a cement paste: a generic physical approach

MAST-NAVIER
BLEYER JÉRÉMY
Digital methods for the ultimate strength design of civil engineering structures

GERS-NAVIER
BOHN CÉCILIA
Computing displacements and safe-sizing of mixed foundations and rigid inclusions

GERS-GMG
CHEMEDA YADETA
Impact of hydrated lime on the surface properties of kaolinite and its rheological behaviour

MAST-NAVIER
CHIVOT GUILLAUME
Digital simulation study of the basic mechanisms of deformation of colloid gels and glass

MAST-CPDM
DA CRUZ MANUELA
Multi-scale approach to the thermo-oxidative ageing of polyethylene used in civil engineering and public works applications

GERS-NAVIER
DAO LINH QUYEN
Study of the anisotropic behaviour of Boom clay

MAST-EMMS
DAVIAU-DESNOYERS DOMINIC
Study of the deferred behaviour of partial prestress beams in fibre-reinforced concretes

MAST-NAVIER
DIB DAYANA
Theoretical and digital analysis of the deterioration by micro-crack of composite materials with a quasi-brittle matrix

MAST-NAVIER
EL ASSAMI YASSINE
Homogenisation of concrete *via* polarisation methods

MAST-LAMES / MAST-FM2D
FARES MILIA
Evaluation of water and chloride content gradients *via* non-destructive electromagnetic methods

GERS-NAVIER
FEIA SADOK
Effect of injecting production water on the permeability of oil tanks not lined with cement

GERS-SV
FORISSIER DELPHINE
Characterisation of ballast-tightening status *via* the study of seismic wave propagation

MAST-NAVIER
FOURMENTIN MARINE
Impact of the distribution and transfers of water on the properties of lime-formulated construction materials: application to hemp concrete

MAST-NAVIER
GAYE ABABACAR
Comprehensive experimental and digital three-dimensional analysis of local mechanical fields in a polycrystal: micromechanisms of crystalline plasticity and slipping at the rock salt borders

MAST-MIT
GENNESSEAUX ERIC
Excavability and formulation of materials treated with hydraulic binders for trenches

MAST-NAVIER
HAFFNER BENJAMIN
Stability of suspension foams

MAST-EMMS
KCHAKECH BADREDDINE
Study of the influence of concrete warming up on the risk of expansions associated with the internal sulphate reaction

MAST-NAVIER
LABORIE BENOÎT
Foaming of complex fluids

MAST-NAVIER
LAVERGNE FRANCIS
Contributions to the study of deferred deformations of viscoelastic composite materials

MAST-NAVIER
MAILLARD MATHILDE
Spreading of yield-stress fluids

COSYS-LISIS
MICHELIS FULVIO
Immersed monitoring of concrete durability *via* wireless nanosensors

MAST-NAVIER
NAJM DÉSIRÉE
Which vibration sensors to use for health surveillance of mechanical structures?

GERS-SRO
NGOM MAMADOU DOUDOU
Digital and experimental studies of the initial condition of stresses in a slope

GERS-NAVIER
NGUYEN THI THANH HANG
Long-term behaviour of lime-treated soils

MAST-NAVIER
NGUYEN THI THUY LINH
A micromechanical approach of a bubble suspension's behaviour in a yield-stress fluid

GERS-NAVIER / COSYS-LISIS
PAYEUR JEAN-BAPTISTE
Behaviour modelling of a reinforced embankment under railway load (of the TGV type)

MAST-GPEM
PITON MAXIME
Intensification of energy and heat transfers in a counterflow drum mixer

MAST-CPDM
ROLLAND ARNAUD
Mechanical behaviour and durability of concrete structures reinforced with internal composite steels

MAST-NAVIER
SECK MAMADOU DIAGA
Understanding of the drying mechanisms in construction materials: the case of gypsum plaster

MAST-SMC / MAST-CPDM
SHUBINA VARVARA
Evaluation of biosurfactants *vis-à-vis* the corrosion reinforced concrete steels

MAST-NAVIER
TAYEB FRÉDÉRIC
Digital simulation of the non-linear mechanical behaviour of gridshells made of elongated beams and ordinary cross-sections

COSYS-LISIS
TEBCHRANY ELIAS
Contributions of ultra broadband and of the polarisation diversity of the ground radar in the inspection of civil engineering works

MAST-MIT
THEMELI ANDRÉA
Study of the potential for using natural bitumen in the production of hard bituminous binders and high-modulus asphalt mixes

MAST-FM2D
WANG BIYUN
Application of NMR/MRI and gammadensimetry analyses to the repair of ageing concrete – Study of the water transfers, impact on the hydration of repair mortar and on the durability of repaired concrete

MAST-NAVIER
WONE MICHEL
Rheology of concentrated non-Brownian suspensions: a digital study

GERS-GEOEND
XIAO XIAOTING
Determination of water content gradients in concretes *via* electromagnetic methods

HDR - Accreditation to supervise research

GERS-GMG
DIMITRI DENEEL
Contribution to the understanding
of the physico-chemical evolution of materials
used in civil engineering,
29 June 2015

MAST-SDOA
ORCESI ANDRÉ
Management of engineering structures across
their life-cycle / Crosscutting approach from modelling
to decision-making,
22 October 2015

MAST-NAVIER
MICHAEL PEIGNEY
A few contributions to variational approaches
in non-linear mechanics,
29 January 2015

AXIS 3

Measurements and recordings of motor scooters on track and the LSEE's experimental facility

CONTROLLING NATURAL HAZARDS AND ENVIRONMENTAL IMPACTS

Assessing and reducing the noise of motorised two-wheelers

Launched in June 2011, the ASCOOT project (Acoustics of Scooters and motorcycles) was completed in 2015. Its purpose was to reduce the noise of motorised two-wheelers without altering their performance.
Funded by ADEME, the project was conducted by a consortium including Peugeot Scooters, IFSTTAR and Vibratec (project leader).
As far as IFSTTAR was concerned two laboratories from AME department were involved: LAE and LTE. This cross-disciplinary project succeeded in characterising the noise of motorised two-wheelers, designing and producing acoustically optimised demonstrators and assessing them in an urban environment.
The LAE laboratory essentially focused on the acoustic characterisation of mass-produced two-wheelers and of demonstrators, and built the scooters' noise emission laws (both mass production and demonstrator) into the Symubruit dynamic traffic noise evaluation tool.
Meanwhile, the LTE carried out some experimentation at LSEE (laboratory for environment simulation and evaluation) in order to evaluate the acoustic enhancements of demonstrators inserted into several urban traffic scenarios.
The ASCOOT project eventually offered a better insight into the perception of urban noise integrating 2-wheelers and highlighted the relevance of evaluating the changes affecting noise in an appropriate environment. It also made it possible to establish a first guide for the design of low-noise scooters for industrial production.

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Acceptability of priority action areas for the improvement of air quality (AZAP)

Source: French Minister of Ecology, Sustainable Development and Energy

This research led by the AME/LTE laboratory was part of the Primequal Call for research proposals (APR) "Contribution to the evaluation of experiments in ZAPAs" (priority action zones for air) jointly conducted with Acoucité and Air Rhône-Alpes (2011-2015). The key question was the acceptability of a ZAPA-type measurement. It is indeed based on the principle of banning or limiting access of a delineated area to those vehicles that most contribute to atmospheric pollution. The acceptance potential for this type of measurement according to its characteristics was explored and the psychological and socio-economic factors that play a role in its acceptability were also identified.
A questionnaire-based survey was carried out with a sample of 1,000 people. The original feature of this survey was that it included a psychological component (relating to attitudes and behaviours) as well as economic, with the presentation of a number of scenarios (relating to compensatory measures in terms of costs/benefits, and a trade-off between environmental efficiency and equity). We started by characterising the respondents according to their attitudes to air pollution and the environment, their modes of mobility and their evaluation of living environment. We then worked on the acceptability of 10 actions based on the principles of incentivisation, taxation or restriction, aiming to mitigate air pollution with particular attention paid to ZAPA (priority action zones for the improvement of air quality).

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Test for sensitivity to PAHs (White clover and Birdsfoot trefoil)

One of the research sites investigating the impacts of palladium and PAHs (A71)

Effort to identify bio-indicators for two road pollutants: palladium and PAHs (polycyclic aromatic hydrocarbons)

This research was conducted in the framework of a thesis co-funded by IFSTTAR and ADEME (Nathalie Clément, 2012-2015). It aimed to identify potential passive bio-indicators of the contamination of earth ecosystems by pollutants respectively associated with petrol and diesel engines. The first phase strove to identify species impacted by direct attacks from these two pollutants, within an environment where the only source of contamination was road traffic (a motorway section in the Sologne region). Higher plant species raise a barrier to the dispersion of both pollutants in the air, but at ground level the compounds with organic matter are mobile. Four plant species that are directly threatened by potential impacts were selected to test their sensitivity (effects on germination, growth and development) at various exposures to the pollutants (ground contamination) under controlled conditions (tests performed in a phytotron facility). White clover (*Trifolium repens*) tends to store PAHs in its root system and responds to high ground contamination (10-1 mg.g-1) through its functional features: usually stretched length (shortened) and number of leaves (deficit). Since it offers a high sensitivity threshold, it could be tested as an active bio-indicator in more contaminated environments (urban, industrial). Inra (Versailles), AgroCampus Ouest (Angers), Université Paris-Est, LEB Aquitaine Transfert and Cofiroute were associated with this thesis.

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The EVREST project: optimisation and evaluation of a range extender for electric vehicles

The EVREST project, funded by ADEME in the framework of the ERANET Electromobility+ European call for projects, took place between July 2012 and June 2015. Its objective was to examine the aptitude of electric vehicles equipped with range extenders to satisfy several uses of mobility, to check their performance and the acceptability of such a solution. The project relied on an analysis of usage profiles and of users' expectations tapping into a database fed by the three participating countries. This typology was then associated with several optimised technologies (the range extenders considered were using either a combustion engine or a fuel cell). Scenarios of electro-mobility, current and looking to the horizon of 2025, were then proposed along with their environmental implications, their assumptions on transport technologies and policies. Among the outcomes of this project, it stands out that a fairly small-size range extender optimising the electric vehicle's range to 300 km might satisfy over three quarters of the users apart from a few longer journeys every year.

IFSTTAR acted as the project's coordinator with two labs from AME: LTE and DEST.
The European partners came from Germany (Karlsruhe Technological Institute, Chemnitz Polytechnic University and University of Stuttgart), Austria (Vienna's University of Natural Resources and Life Science) and France (LET-CNRS and Peugeot Motocycle).

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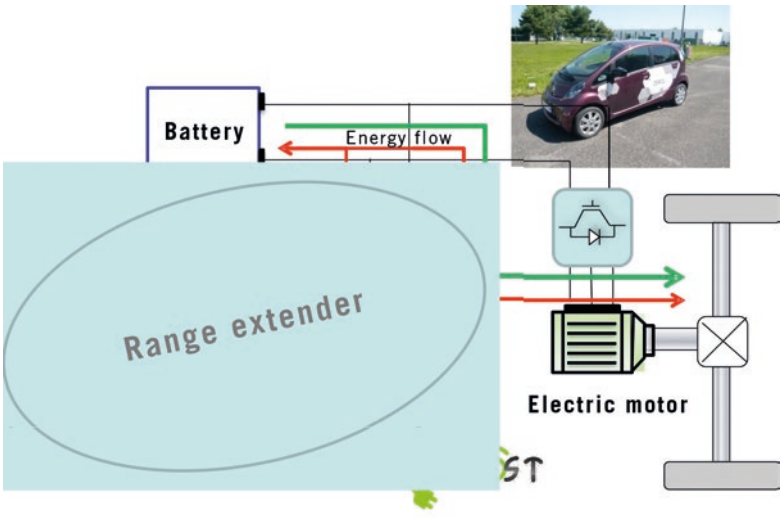
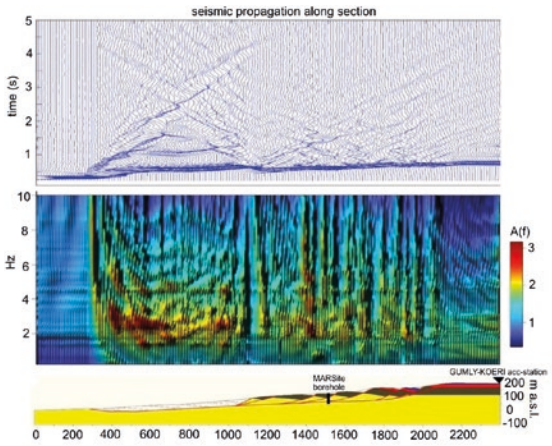


Reference electric vehicle (picture) and schematic diagram of the range extender

MARSite: developing new evaluation methods for seismic hazards from field observations at the "supersite" on the Sea of Marmara



Digital modelling (FLAC 2D code) of the local seismic response of a landslide in Turkey: (top figure) Propagation of seismic waves; (middle figure) Transfer function (site effects); (bottom figure) Longitudinal section across the landslide

The MARSite European project (started in 2012 and to be completed in 2016) is one of the 3 European projects of the FP7 programme devoted to the concept of the SUPERSITE: these projects are dedicated to long-term and high-resolution monitoring of geologically active areas in Europe subject to multiple natural hazards. The MARSite project brings together various cross-disciplinary research teams (INERIS, Turkish universities, etc.) around the themes of landslides and quakes in the Sea of Marmara region in Turkey.
In particular it focuses on a highly-populated zone 30 km west of Istanbul and situated a mere 15 km north of the North-Anatolian fault (NAFZ): this zone is the centre of many active landslides.
The aim is to appraise the conditions for reactivation of these landslides under seismic circumstances. The work involved the following tasks:

- reconstruction of the geological-geotechnical model of a landslide based on geophysical and geomorphological measurements;
- analysis of its susceptibility to the "landslide during quake" hazard *via* non-conventional pseudo-static methods;
- analysis of its local seismic response by means of digital modelling in dynamics.

The research concluded to the fact the response of this site is governed by its internal structure in tilted blocks: the latter are sensitive to high-frequency seismic signals such as those that could be generated by the NAFZ during future earthquakes.

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Development of low-noise poro-elastic pavement

In the framework of the PERSUADE (2009-2015, financed through the 7th FPRD) European project, low-noise poro-elastic pavement surfaces were developed. The main objectives of the project were to produce cost-efficient poro-elastic road surfaces boasting acceptable profitability and to move from an experimental concept to a technology liable to be deployed in real-life conditions.
12 partners were involved with a total budget of 4.7 million Euros: research institutes (BRRC (project coordinator), DRD, VTI, ZAG, IBDiM and IFSTTAR), universities (TU Gdansk, KU Leuven) and road contractors (NCC, Duravermeer) or other companies specialising in the recycling or tyres (HET and ETRA).
Many different aspects were covered: laboratory optimisation of the coating mix and performances (WP2), sizing of the roadway structure (WP3), construction of several poro-elastic sections in Belgium, Denmark, Poland, Slovenia and Sweden (WP4), monitoring of the performance of such test sections on site and in lab (WP5), environmental impacts (WP6) or cost/benefits analysis (WP7).
IFSTTAR's AME/LAE laboratory focused on the characterisation of the wearing surface's elasticity, a parameter which plays a key role in reducing noise for this type of coating. The surfaces thus developed resulted in a noise reduction ranging between 8.3 and 12.7 dBA for a durability in excess of 17 months in the best case.

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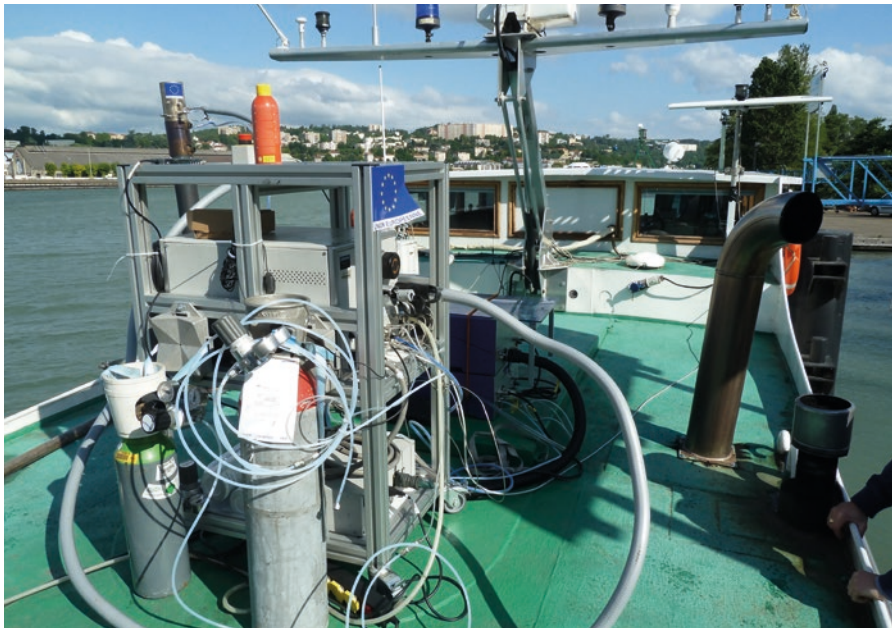
Measurement of rolling noise (ISO 11819-1 method) when passing on the poro-elastic test board of Kalvehave in Denmark

Innovative propulsion and motorisation for river transport



Instrumentation on the rear deck of a CFT (major river transport operator) ship to measure pollutant emissions

The French organisation in charge of rivers and waterways, VNF (Voies Navigables de France), in association with FEDER and the Rhône-Alpes region, launched a research programme for river freight between 2013 and June 2015 (30 months) involving 3 ships of CFT (Compagnie fluviale de transport) and VNF, to evaluate on the one hand pollutant emissions and on the other hand the potential consumption savings of existing craft. The question of the impact of river transport has come to the fore as it is again becoming popular and has only recently been subjected to restrictions for the pollutant emissions of its diesel engines, unlike road transport which was targeted much earlier on. The CEA-Liten and IFSTTAR-AME/LTE instrumented all 3 boats to analyse and then model the consumptions and running characteristics over long periods to characterise their emissions of pollutants (CO, HC, NOx and particles).

Instrumentation on the deck of the VNF motorboats to measure pollutant emissions

With the help of BE ENAG who specialise in hybrid engines and naval architect Mauric, realistic solutions were explored by the CEA and IFSTTAR, using the LTE's simulation tools (VEHLIB model) and altering the propulsion engines and energy management on board. IFSTTAR-LTN studied a bow thruster solution. Consumption savings range between 3 and 15 % depending on the boat and the type of hybridisation (diesel-electric). Besides, river craft are now more polluting per tonne transported than lorries, although they still do boast an advantage in terms of CO_2.

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Theses

MAST-NAVIER
ALLANI ANISSA
Design and optimisation of tuned mass dampers for civil engineering structures

COSYS-LICIT / AME-LTE
BAOUCHE FOUAD
Tools for optimisation of electric vehicles consumption

AME-EASE
BOSQUET ROMAIN
Energy modelling and identification of trains for ecodesign of highspeed railways

AME-EASE
CLEMENT NATHALIE
Identification of bio-indicators for two road traffic pollutants: PAH & Palladium

MAST-NAVIER
HOXHA ENDRIT
Enhancing the reliability of buildings environmental evaluations

GERS-NAVIER
NGUYEN VAN-LINH
Digital modelling of the hydromechanical behaviour of fractured multiphase porous substrates: Analysis of the conditions for fracture propagation

MAST-NAVIER
WANG BIN
Reduction of the acoustic fields of dihedral-shaped structures by optimising network resonators

HDR-Accreditation to supervise research

AME-LAE
BENOIT GAUVREAU
Multiscale and crossdisciplinary approach to environmental acoustics,
16 December 2015

GERS-GEOEND
DONATIENNE LEPAROUX
Imaging of subsurface *via* wave propagation techniques,
19 May 2015

AXIS 4

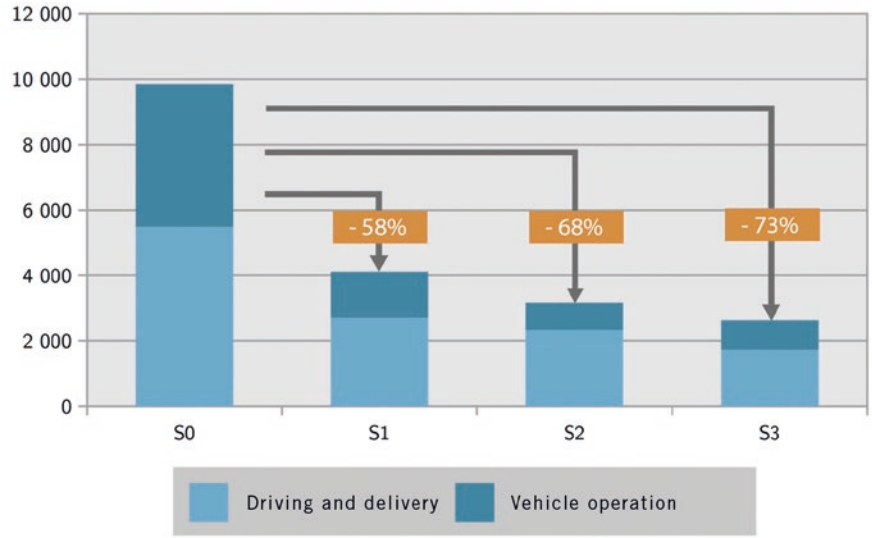
DESIGNING AND PLANNING SUSTAINABLE CITIES AND TERRITORIES

Assessing the logistic performance of short food circuits

Funded by the *Conseil Régional du Nord – Pas-de-Calais*, the ALLOCIRCO (logistic alternatives for short food circuits in the Nord – Pas-de-Calais region) project was steered by IFSTTAR (SPLOTT), Cerema (DTer Nord Picardie) and the chamber of agriculture of the Nord – Pas-de-Calais region. This two-year long project (2013-2015) aimed to offer supply-chain and transport organisations some insight into new efficient circuits, from an economic, social and environmental point of view for both producers and the territorial authorities. Logistic issues are often overlooked when considering the performance of short food circuits. The ALLOCIRCO project has however demonstrated that they are a key driver, provided the solutions are tailored to the diversity of circuits. This work illustrated the benefits of logistic optimisation and detailed the modalities best suited to the main types of circuits previously identified. An analysis of several logistic scenarios thus showed that replacing a direct trace delivery by a delivery round significantly reduces vehicle operating costs as well as environmental costs. Collective organisation modes (mutualisation) do generate additional benefits but in lesser proportions.

In due course, the project's partners wish to develop a free web application to compute the costs, transportation time and environmental impact of deliveries.

Comparative operating costs of 4 supply-chain scenarios for contract catering in the northern region of Douais (Source: Cerema; Raton et al. 2015)



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TGV connections and local economic dynamics: a comparative insight based on the distinction between productive, residential and intermediary territories

With researchers from SPLOTT (AME) joining forces with those of two French universities, the BASECOGV project (funded by PREDIT between 2013 and 2015) aimed to study the potential "indirect economic fall-backs" from HSL/HST (high-speed lines /trains). These infrastructures could indeed help delink the location of consumption from that of production, via the changes it engenders on local demand (tourism, multi-residential patterns, etc.). A broad corpus of statistics, describing amongst other things the evolution of transport networks in France between 1982 and 2010, made it possible to test this assumption empirically. Our analysis shows that "the propensity to consume elsewhere one's local income" is indeed linked to the difference in available amenities from one town to another and is a decreasing function of intercity travel time. Thus, the share of local income spent outside the territories is greater for "productive" towns (whose revenues are mostly dependent on exports, e.g. Chalon-sur-Saône) than for "residential" towns (where jobs target individuals that reside locally, like in La Rochelle). This quantitative study was further complemented by monographs about 6 towns connected to HSL/HST in different ways. Case studies confirmed the conditioning nature of these transport infrastructures and services on not only the level of local consumption expenditure but also on the very structure of production. This work finally allowed to propose some indicators liable to enhance socio-economic calculation practices in France.

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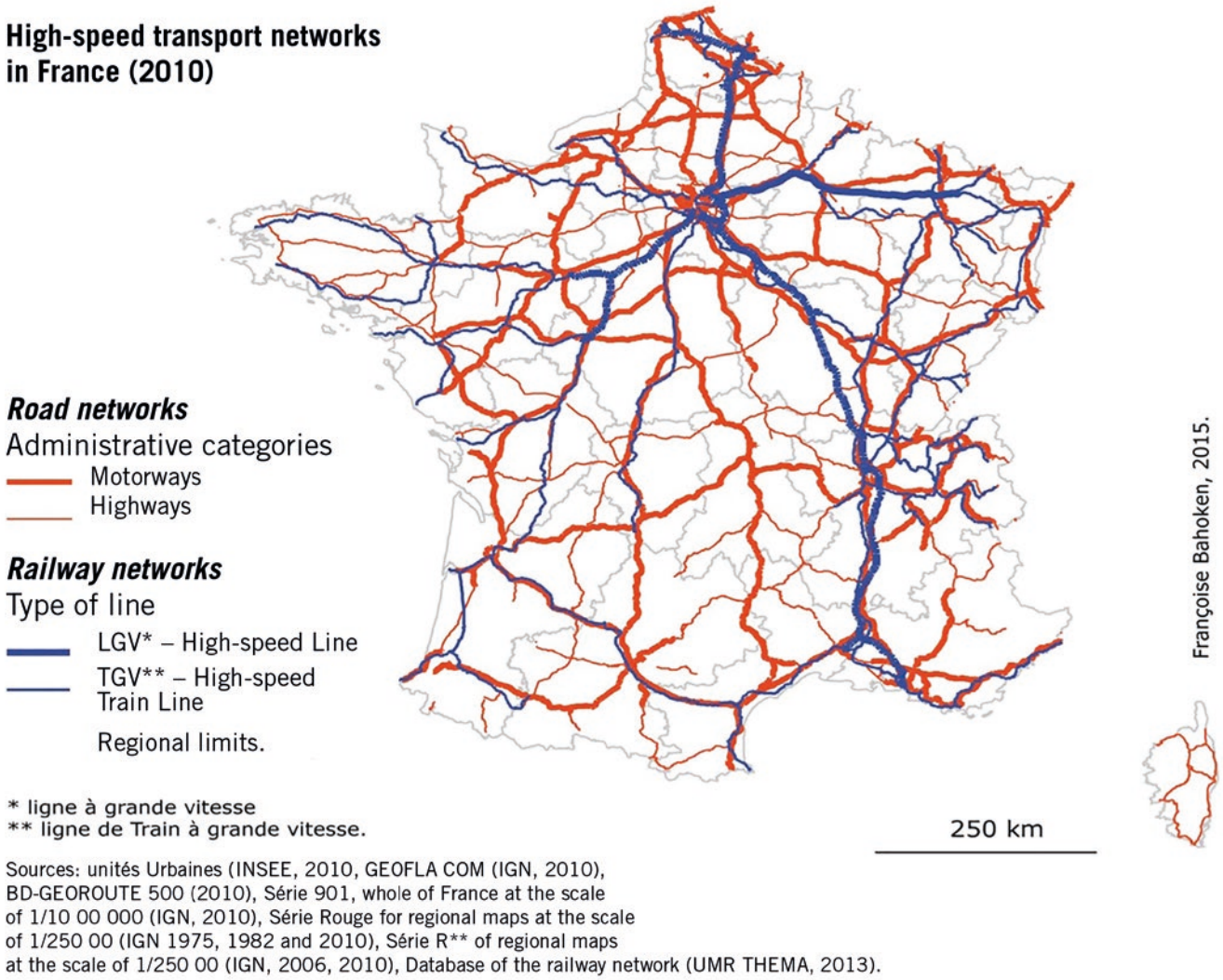

High-speed transport networks in France (2010)

A range of modes less energy-consuming and less polluting than individual cars

An environmental diagnosis tool for local mobilities
BETTI: environment budgets of transport in integrated territories

Given a positive evaluation by Predit4 as early as in 2009, the BETTI project (2011-2015), involving researchers from DEST, EASE and Cerema, has been granted support from ADEME. This BETTI project sought to analyse the environmental impacts of various mobility modes. It formed part of "strategic environmental evaluation" approach by proposing a method to establish local assessments to inform public policy-making.
Based on a number of full-scale trials, the DEEM (Diagnosis for the energy-related emissions of mobility) tool to standardise consumption and emission estimates for all daily movements of passengers was thus developed for urban regions. Any new survey circulated by Cerema is now enhanced with these estimates in addition to a standard procedure to analyse their results. The standardisation of this method could not be applied to freight transport for lack of available standard collections of local data (freight transport surveys for towns, cordon surveys). The resulting diagnoses are used as aids to decision-making for local transport policies aiming at low-carbon mobility as showed also in the two theses developed in the framework of this study.
The 1st (thesis by Quang-Nguyen Nguyen) sought to improve the understanding of the articulation in time (over one year) of individual mobilities based on residential locations. The 2nd (thesis by Claire Papaix) looked at economic evaluation of local mobility policy measures to be combined in order to help reduce CO_2 emissions.

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Study individual preferences in terms of ecological compensation measures

Ecological compensation is defined as the set of actions in favour of the environment (restoring, leveraging…) that enable offsetting the damages that could not be avoided or mitigated during the construction of a facility. Conducted over the 2014-2015 period by the AME/EASE laboratory and the Nantes University, this "IFSTTAR incentivising research" C3E (Environmental compensation and experimental economy) study sought to explore individual preferences for ecological compensation measures subsequent to the construction of a road infrastructure. Based on a hypothetical situation (land clearing for the construction of a motorway), respondents from a representative national sample were asked to take part in a choice-making exercise where they would point out their preference from a selection of ecological compensation measures. Analysis of the findings highlighted on the one hand the individual heterogeneousness of preferences for compensatory measures and on the other hand the role played by certain socio-economic and geographical factors (for instance the forest cover on the respondent's zone of residence) in the variability of these preferences. This exploratory work need to be followed up by other research tasks to better identify the ecological compensation modes preferred by people affected by the construction of an infrastructure on their territory.

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City-HUB: innovative design for more efficient urban transport exchange hubs

Within the framework of the 7th FPRD, City-HUB (2012-2015), this project brought together 9 research institutes (UPM, KTI, TOI, CERTH, NEA, VTT, IFSTTAR, CDV). It seeks to contribute to the designing and operation of intermodal public transport systems, aiming to make them seamless, attractive, energy-clean and safe, by gathering acknowledged experts in urban design and integration, transport operators and other professionals as well as local and regional authorities and user organisations. This project examined 26 hubs and how they could be adapted to targeted vulnerable populations: seniors, youth or people with mental or physical handicaps. A typology was thus established. Surveys with their users show that the key factors defining a good hub are: ensuring security and safety, information availability, conditions for the transfer from one mode to the other, management of emergency situations.
For the operators, information is paramount. These hubs have an impact on the local economy and land usage when transport and town-planning policies are integrated thanks to a strong commitment of political and operational stakeholders. The performances of the 5 pilot sites are evaluated through the IPA method (Importance performance analysis). Validation of the City-HUB model was tested through semi-structured interviews and an evaluation grid with criteria defining them.
This work will give rise to a publication at Taylor & Francis in the course of 2016.

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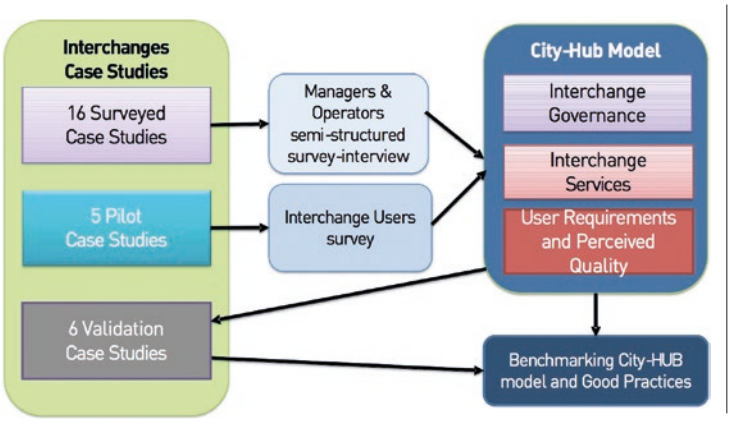
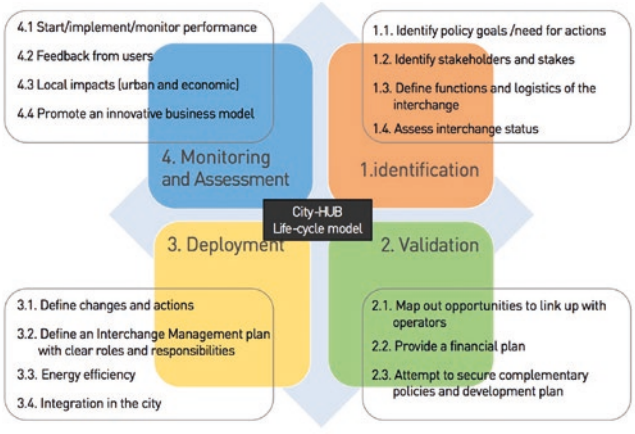


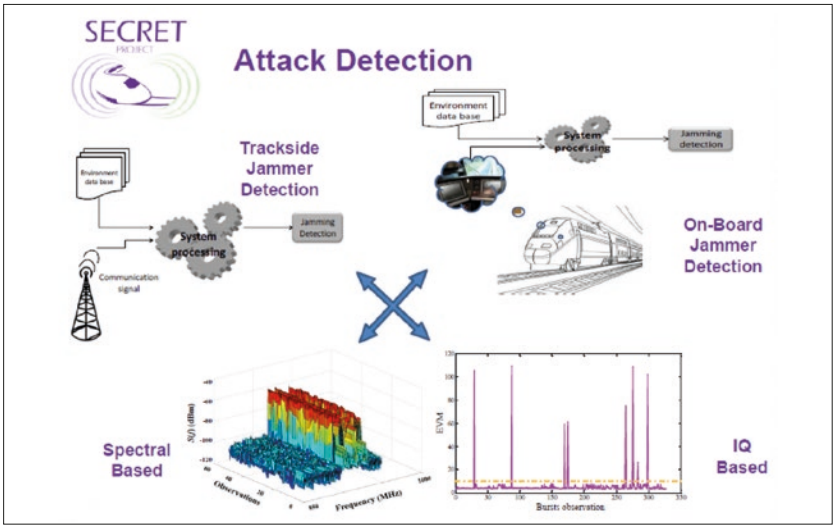
Phases of the City-HUB project



City-HUB model according to the hub's lifecycle.

Protecting the railway network from intentional electromagnetic interference

With 10 partners and coordinated by IFSTTAR, the European project entitled SECRET (SECurity of Railways against Electromagnetic aTtacks) focussed on the protection of railway communication and signalling systems from intentional electromagnetic (EM) interference.
SECRET came about in response to the increasing threat of intentional EM interference bearing on our critical infrastructure assets.
The risk was assessed on a voluntary basis by addressing certain EM attacks and their effects, by encouraging railway stakeholders to work towards better resilience of their systems. A second objective was to develop resilience solutions faced with this type of potential attack.
The final conference that concluded this project, on 29 October 2015, showcased the results and demonstrations liable to inspire each player in seeking to achieve such resilience.
The results presented concerned the tests to evaluate the network components' response to intentional EM interference– and show how everyone can strengthen their products– as well as the EM attacks detection methods.
Indeed, detecting these attacks enables you to prove that you are being a victim of an EM attack and not mistake this for a technical failure. The project also put forward a number of proposals for a resilient architecture which, combined with detection, ensures that communication will be maintained in order to support the transmission of critical information and thus remain in control of the network. The project also proposed and tested a resilient communication architecture coupled with detection so that the transmission of critical information not be threatened by the presence of EM attacks.



Development of EM attacks detection methods for the surveillance of railway infrastructure and vehicles

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Crowd dynamics: modelling of pedestrian movements

A crowd is a complex system whose group dynamics resulting from multiple individual interactions can be difficult to grasp and has for long puzzled scientists of several disciplines. Thanks to technological advances it is now possible to use crowd motion models to get a better representation of real-life phenomena. Bachar Kabalan's thesis (2013-2015) investigated several potential enhancements of the discrete 2D model developed by the dynamics team of Laboratoire Navier since 2005.
The first one concerns pedestrian navigation to their destination.
A velocity field assigning to each pedestrian, as a function of their respective position at every moment, a direction towards their wanted destination is obtained by resolution of an eikonal equation. Three types of behaviours were then integrated into the model:

- Thrust, through an original approach based on the theory of collision between rigid bodies in a rigorous thermodynamic environment;
- "forcing one's way" as modelled by a repulsive social force;
- "normal" avoidance by adopting a cognitive approach.

The sensitivity of the model's parameters was studied using a numerical experience plane, which highlighted those parameters having the main effects on the outgoing flow of pedestrians in the case of a bottleneck.
Applications of this work were used for pedestrian flows in constrained and highly anthropised spaces: footbridges, public places in towns, railway spaces.
In conjunction with LVMT (City, Mobility, Transport laboratory), the crowd model was coupled with the CAPta model for assignment of traveller flows to a network of mass transport and was thus applied to pedestrian movements within the Noisy-Champs railway station.

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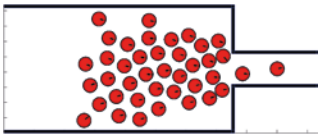
(1)


(2)

Funnel phenomenon during the normal evacuation of a bottleneck– Comparison of tests (1) with the model's simulation results (2)

RETMIF: reducing the emissions of freight, scenarios for the Île-de-France region

In order to mitigate the atmospheric pollution caused by road transport, over 200 European towns have put in place so-called low-emission zones (LEZ).
These zones, by barring access for the older vehicles, alter the freight transport and delivery activity. Their consequences on the economic activity of freight transport are to be evaluated as they affect the level of efficiency of these LEZs. The RETMIF project (ADEME, AACT-AIR 2013, in partnership with the IAU of the IDF region, the City of Paris and APUR) made it possible to:

- identify the economic behaviours (macro and micro) of delivery firms upon introduction of a low-emission zone, by means of ex-post surveys in London, Berlin and Göteborg, as well as ex-ante surveys in Paris;
- and then to build on such knowledge in order to fine-tune the computing of the impact on pollutant emissions when introducing such zones to Paris.

It was observed that deploying a LEZ has economically a stronger impact on very small transport and delivery companies.

A LEZ seems to reduce the number of transport firms delivering goods in town; and in fact this reduction is probably beneficial to the urban market of freight transport as it encourages the players, whether public or private, to press for its modernisation. Regarding the impact studies for the Paris region, we noted that the reduction of emissions from the older utility cars ("Euro II") would be important because of their high emission rates, though there is only a fairly small number of such vehicles. For more recent utility cars (Euro III to V), which accounted for the majority in 2014, and in the case of a more ambitious scenario authorising only Euro VI vehicles in 2020, a LEZ would noticeably reduce their share of the total fleet.

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Theses

GERS-EE
ALLARD AUDE
Contribution to hydrologic modelling at the scale of a city: application to the city of Nantes

COSYS-GRETTIA / AME-LVMT
BARO JOHANNA
Multi-scale modelling of urban morphology based on gridded data of the population and built-up space

AME-LVMT
BOUTUEIL VIRGINIE
Towards a sustainable mobility system: understanding and harnessing the potential of corporate car fleets as a driver for change

AME-SPLOTT
DOUDNIKOFF MARJORIE
Implementation and evaluation of a carbon market instrument for maritime transport (regular shipping lines): consequences on European networks and harbours

COSYS-LIVIC / COSYS-LEPSIS
GIMONET NICOLAS
Identification of downgraded driving situations *via* roadway image analysis

AME-LPC
GRISON ELISE
Planning and choosing an itinerary in urban environment: multiple approaches of a cognitive problem

GERS-EE / ERA 31
KHALIFA ABDERRAHMEN
Contribution to the microclimatic modelling of wintry situations in urban environment

AME-DEST
LAM QUOC DAT
Energy efficiency of the various forms of distribution in Vietnam, a comparison with France

AME-LVMT
LIBOUREL ELOÏSE
The Mediterranean railway corridor: planning, politicisation and territorialisation of a spatial planning project

AME-LVMT
MILION CHLOÉ
Study of people mobility based on mobile radio measurements

AME-DEST
MINSTER CLOTILDE
Analysis of people mobility in rural spaces as a contribution to the understanding of the demographic renewal of these spaces and in sustainability

AME-SPLOTT
MORVANT CAMILLE
The capacity allocation process on the French railway network: what place for freight?

AME-DEST
PAPAIX CLAIRE
Implementation of public policy instruments fostering low-carbon people mobility in urban environment

AME-LVMT
RIOT ETIENNE
Planning of the major historical railway stations for the European railway market. A comparative analysis of the integration of competitive principles in the spatial planning and management of the stations of London St Pancras, Paris Nord and Milano Centrale respectively

EXPERTISES

Evaluation of crash test digital modelling for road restraint system connections

ASCQUER (Association for the certification and qualification of road equipment) has set up an evaluation committee to examine the files of applicants for marking of connection structures based on digital studies for which IFSTTAR provides digital simulation expertise.
This experts' assessment activity is scheduled over a three-year period (2015-2017) and takes place in the framework of certification process for road restraint system connections as per standard EN1317 and the technical reports of series TR16303.
The connection certification procedure depends on the difference of response to the shock of the two common sections of barriers to be connected. In certain cases, examining the file will suffice while others may go as far as a real crash test of the device (where there is a significant difference of dynamic deflection between the two connected barriers). To this is often added device performance assessment using digital impact simulation; it is thus possible to test various vehicle categories at several impact points along the connection structure.
The organisation applying for certification of its product should then produce to ASCQUER simulations liable to help evaluate the product's performances. Such digital simulations will be submitted to LBMC for assessment.

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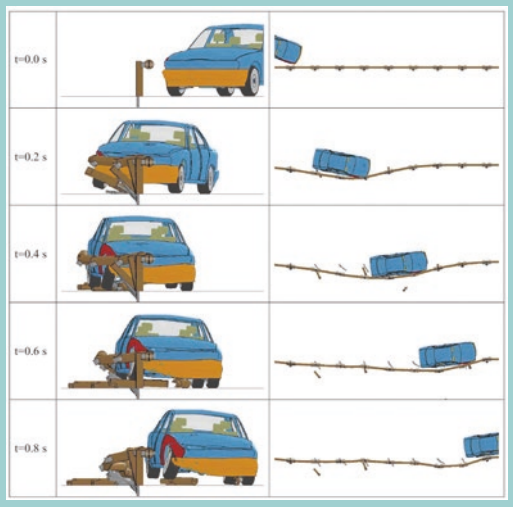

Digital simulation of a TB32 crash test
(vehicle weighing 1,500 kg, 20°incidence, 110 km/hr.)

Contribution of road infrastructure to the reduction of the number of fatalities by 2020

Marie-Line Gallenne and Dominique Bouton were both entrusted by the experts' committee of the French national council for road safety (CNSR) with the coordination of the research on the contribution of road and urban infrastructures to improving road safety. A group made up of experts from motorway companies, county councils, the Cerema syndicate of road facilities and IFSTTAR was then set up. This working group relied on the scientific literature and both national and international technical doctrine to draw a list of recommendations aiming to reduce accidentality linked with road infrastructure condition, layout and equipment and to outline requirements conducive to developing optimised solutions. The dossier was handed over to the experts' committee in June 2015 and submitted to the CNSR in October 2015.
It follows on the proposals made in November 2013 to achieve the objectives set by the French minister for Interior to fall "below 2,000 fatalities by 2020", and the specific dossier risk-prone users established in June 2014.

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Ergonomic assessment of a prototype smartphone application

In the framework on an industrial agreement with Orange, and in close partnership with the designers of A+B, an experts' assessment was carried out by IFSTTAR/LESCOT from December 2014 to April 2015. The purpose was to apply expertise grids linked to the design of systems used in driving situations and covered under a European agreement such as the "European Statements of Principles" to assess a prototype smartphone-based application developed by Orange.
The designers' approach was based on the requirement for safe use while driving and to this end had incorporated a number of innovations such as voice recognition and gesture-based dialogue, as well as limited and simplified interactions such as placing an incoming call on hold and pre-recorded text messages. The assessment of functional features was instrumental in defining recommendations to develop an enhanced version of this application. For instance, it was suggested to increase the size and spacing of certain touch-screen areas that must be easily accessible. In terms of voice-control, the benefits of making the dialogue more natural were highlighted insofar as the attention requirement for this type of interaction should be minimised. The recommendations were presented and discussed in the context of in-depth reviews with the team of designers/developers of the mobile phone service so that these may be incorporated with due respect to technical feasibility.

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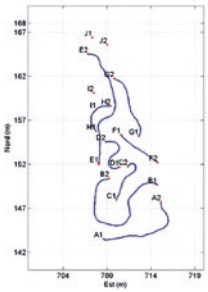
Study of the automatic mapping of sheaths by low-cost inertial measurements

Experimental site in Chambéry

Reference traces, source: ERDF



Inertial traces computed by GEOLOC

From November 2014 to February 2015, the GEOLOC Laboratory conducted a study commissioned by ERDF on the use of inertial measurement apparatus for 3D sheath mapping. The idea was to test existing methods for the geopositioning of dynamic objects by inertial measurements as a timesaving, reliable and low-cost solution for sheath mapping as per Class A precision requirements.
After acquiring the signals from a 9-degrees-of-freedom inertial unit placed along the outside of 8 sheaths located at a trial site in Chambéry, the traces were computed in post-processing by a to and from estimate using a “strapdown”-type mechanisation. Having determined the coordinates of both ends of the sheaths, weighted fusion of both traces was then applied.
One of the important outcomes of this study is the endorsement of inertial and magnetic measurements in mapping sheaths as this process is simpler and less costly than calling on human specialists of such measurement. Potential improvements were also proposed such as building velocity profile variations into the computing of traces and using a compact unit comprising all the sensors to be slipped into the sheaths. This unit called ULISS (Ubiquitous Localization with Inertial and Satellite Systems) is currently under development at the GEOLOC Laboratory.

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Public debate on the Grand-Lille Express Network project

The Nord-Pas-de-Calais region has called upon the French national commission for public debate (CNDP) to organise a public debate on the Réseau Express Grand Lille (REGL) project. This railway infrastructure project involves 56 km of new tracks and ambitions to address the mobility needs of the Grand-Lille inhabitants. In particular it targets the congestion of all main roads in the Lille metropolis. Very much like the RER in Paris, this REGL would change the railway interconnection of the central urban area of this Region through a network of cross-through links, both rapid and running at frequent intervals, with significant passenger transport capacities.
The issues raised by this project were debated in Internet chatrooms and in the framework of 97 encounters with the public bringing together 3,800 participants in all. CNDP called on the expertise of several IFSTTAR agents from Villeneuve d’Ascq to provide some technical or scientific background on questions such as the evaluation of railway infrastructure capacities, the potential contribution of these new links in terms of mobility, the routing options and their relation with a territorial planning policy, cost aspects, etc.
After completing this round of debates, the Nord-Pas-de-Calais region entrusted the Railenium / I-Trans / IFSTTAR grouping with a definition study for a multi-annual research and innovation programme named “TER du futur”.

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Plotting of the REGL project (CNDP credit)

Health impacts of infrasounds and low-frequency sounds emitted by wind farms: IFSTTAR participates in the Anses assessment

In spite of the growing interest for renewable energies, the population is concerned about the potential health impact of wind farms.
Many local citizens point to the noise caused by wind farms and in particular infrasounds and low frequencies.
The regulation governing wind farms was updated in 2011 with the introduction of minimum distances from any inhabited area and the classification of wind farms as environmental protection facilities.

However, low-frequency and infra-sounds were not taken into account as they are more difficult to measure. In this context, the French ministries in charge of Environment and Health respectively called upon the national agency for food, environmental and labour health safety (Anses) to:

- take stock of the knowledge on health impacts of the low-frequencies and infra-sounds associated with wind farms;
- review existing European regulations on the management of potential health hazards related to wind farms;
- run a campaign of measurements on the audio impact of wind farms;
- better take into account these potential health effects in the impact studies on wind farm projects and the regulation.

This referral was handled by a cross-disciplinary working group (acousticians, epidemiologists, biologists) whose report to be published in 2016 will put forth the recommendations of Anses.

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Draining of the A1 - A3 motorway junction: sizing recommendation for drainage ditch

This picture taken on a road in the north of France illustrates this recurrent problem of water resurgence at the junction between two structures of different permeability characteristics: the water trapped into the materials seeps up to the surface under the effect of road traffic and causes abnormal fatigue of the structure (photo credits, Cerema Nord Picardie)

Road drainage lies at the crossroads of geotechnics and sanitation, although it is not addressed by either of these two fields. There are only few methodological documents covering this domain. And yet, many structures suffer pathologies that result from excessive water build-up internally and for which drainage is often recommended, albeit without specifying any dimensional characteristics for the solutions as one would expect at the project or Contractors shortlisting stage for design studies. The recommendation formulated by IFSTTAR in July 2015 in the case of the rehabilitation of a motorway road surface for the commune of Roissy is yet another illustration thereof. The selected contractor had to propose a turnkey solution to the prime contractor, including the geometrical definition of the structure and the choice of materials to be used. A cornerstone of this solution depended on the drain, which needed to be consistent with the flowrates to be drained. The main issue during this work was to evaluate the said flowrates while the project definition file included no information on this aspect. The final sizing proposed was concluded to within 20 days during the worksite preparation stage. The solution essentially relied on previous worksite feedback dating back to 1978 and some data documented in the Guide du Drainage Routier (Guide to Road drainage), published by Ed. Sétra in 2006. The solution, as it were, met the requirements of the worksite, and the expectations of both the contractor and the prime contractor.

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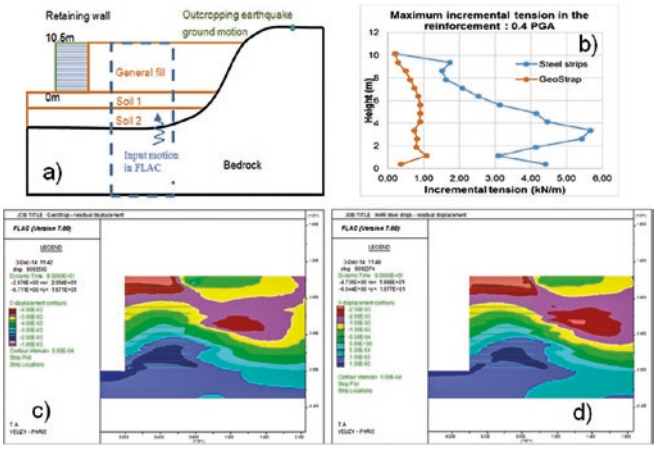
Digital evaluation of the performance of a "Terre Armée" retaining wall: comparative study between extensible and non-extensible reinforcements

The retaining walls sold by the Terre Armée company have demonstrated very high performance even in situations of severe earthquakes. The in situ observations made in Japan on 1,423 structures after the 2011 quake further testified to the robustness of Terre Armée's reinforced earth walls.
Less than 1 % of the structures inspected in situ showed significant breakage; most of them actually resulted from the absence of protection solutions to resist the erosion induced by the great tsunami or were caused by liquefaction of the subsoil. In Japan, most retaining walls are built with high-adherence steel reinforcements. For sites exposed to aggressive environment, synthetic reinforcements made out of high-toughness and rigidity fibres can be considered.
This joint project (IFSTTAR-Terre Armée) focuses on the dynamic response of retaining walls in the face of seismic tremors using finite differences digital simulations (FLAC) and involved the following tasks:

- reconstruction of the geotechnical model of a retaining wall with 2 reinforcement solutions, i.e. of its foundation soil and of its natural subsoil;
- definition of a convolution procedure for the reference seismic stress in order to derive a reliable representation of the seismic stress at the base of the structure;
- relative comparison of the results for the 2 reinforcement solutions chosen.



a)Retaining wall modelled with its foundation soil and natural subsoil; b)Maximum tensile increments in the 2 types of reinforcements following exposure to the seismic stress; c)Residual displacement in a model for the reinforcement solution with synthetic fibres (GeoStrap) and d) with High-Adherence Reinforcement (HAR) steel

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Parliamentary commission on the future of TET trains

Established on 24 November 2014 by the French Secretary of State for Transports, Alain Vidalies, the commission had six months to clarify the needs and services pertaining to a special category of trains, caught in the middle between high-speed trains and the public-service regional trains (TER). TETs (trains for territorial equilibrium) offer a range of services including day and night, fast and slower, varying ranges and sometimes are even blended into other transportation offers. They are mainly funded through a levy on the turnover of the national railway operator, SNCF, which tends to increase mechanically as a result of production cost escalation and decreasing interest for its services.
Last but not least, the rolling stock is obsolete and must be renewed in the very short term.
The commission, comprising twelve members (8 elected representatives and 4 experts including the director of LVMT), organised a number of hearings (36) and field visits (including two outside France). It was assisted by two consultancies, Roland Berger and Atkins, for the purpose of taking stock of the current offer, establishing an international comparison (5 countries) and proposing a network structure and an organisation better geared to the needs of territories and to the expectations of users.
Amongst other things, it suggested a strong reinforcement of the Rail Authority, adjustments to the offering combining savings in the production of said offer and strengthening of lines liable to boost revenues. An opening of the night-train market was also among the proposals.

For more information: download the full report at:
http://www.developpement-durable.gouv.fr/IMG/pdf/Rapport_TET_d_avenir.pdf

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Assessment of the CNIT
in view of an extension to line E of the RER

The route of the RER Line E extension from Saint-Lazare railway station to Mantes-la-Jolie runs underneath several problematic locations, such as the stations of *Porte Maillot* or La Défense. At La Défense, the CNIT, which is a listed monument, could be destabilised by subsidence caused by underground works.
To this end, the structural resistance of the work must be inspected.
Given that the CNIT is a vaulted structure in reinforced concrete 6 centimetres thick, on top of three abutments interconnected by prestressing cables, it was decided to check the durability of the concrete, its mechanical strength characteristics as well as the residual tension in the cables.

- Type of project: Experts assessment on behalf of RFF
- Dates: 2014-2015
- External and internal partners: Cerema/ DTer IDF/Laboratoire de Sourdun, Cerema/DTer NP/ Laboratoire de Lille, Cerema/DTer CE/Laboratoire de Lyon, Freyssinet
- Outcomes and deliverables: the CNIT's concrete boasts a mechanical strength similar to that initially designed and its predictable durability would be 100 years approx. (under similar conditions of operation). Tension in the tie-bars is, save exceptions, in the confidence interval of 5 % of the design tension.

Instrumentation and monitoring of the structure throughout the works for the digging of RER E tunnels were recommended.

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Characterisation of Young modulus for a concrete core sample extracted from an abutment of the CNIT (IFSTTAR/MAST/EMMS)

Assessment of the condition of prestressing cables
by propagation of guided elastic waves for non-accessible anchoring zones

The methodology for testing the anchorage points of prestressing strands by means of guided elastic waves and the associated experimental system developed by IFSTTAR have been handed over to engineering firm Advitam (Freyssinet/Vinci group) as part of a transfer of technology.
This co-development resulted in the development of the USCAN© field device. A patent for this process was jointly registered by Solétanche-Fressinet and IFSTTAR (early 2015).
Validation of the methodology took place in two phases, first in-lab at IFSTTAR on the replica of a real anchorage supplied by the Freyssinet company, and then on the Pont de Normandie (a structure operated by CCIH – Chambre de commerce et d'industrie du Havre as part of a State concession). IFSTTAR ran a first feasibility campaign on site with its own system (May 2011) at the managing company's request. The post-mortem analysis of the tested strands confirmed the results of the reflectometry technique by guided elastic waves.
The CCIH then entrusted the Advitam company with the production of the testing assembly for the 8,848 strands of 148 anchorage points (namely a total 61,000 constituent wires tested between the end of 2012 and early 2014). Throughout this period, IFSTTAR used its own referral system to conduct more specific external control actions at the request of the Ministry and CCIH.

Periodical monitoring campaigns on the targeted anchorage points have already been scheduled for the future.

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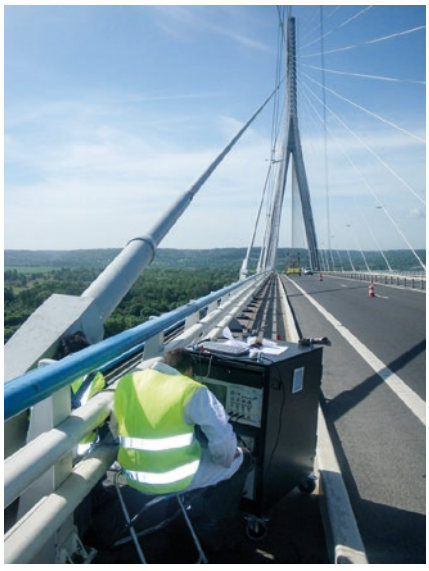

Installation of the replica of a prestressing cable anchorage IFSTTAR/ Labo GéoEND (left). IFSTTAR measurements by reflectometry of guided elastic waves on an anchorage point of the Pont de Normandie (right)

Large-size slabs for the overpass of the New Road of the Reunion Island

In the framework of the construction of the New road of the Reunion Island, LCPC Experts was approached by Egis to assess the calculation notes of the Vinci group regarding the dimensioning of the shallow foundations for the overpass project.
Although the latter features spans of significant length, its shallow foundations rest on circular mounts 20m in diameter laid into layers of sand and gravel. The geotechnical context is a complex one as this layer lies just above the basalt substratum, which is heavily sloping.
Besides, this viaduct is potentially exposed to substantial stresses caused by the cyclone-induced swells let alone shocks such as caused by ships. LCPC Experts conducted a detailed analysis of the viaduct's foundation behaviour. First of all, the study focussed on the influence of the sloping basalt layer on the potential movements of the slab. The focus then turned to the foundation slab's response to the impact of swells and/or ships crashing into the structure. Finally a number of observations were formulated concerning the digital computations produced by Vinci for their calculating notes. Besides, IFSTTAR by virtue of its involvement in the development of geotechnical calculation standards (Eurocode 7 and French application standards) was able to provide Egis with explanations on the various normative aspects of the sizing of such foundation slabs.

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Assessment of the concrete of the East side wall of one of the Vauban basins at the Toulon arsenal

To ensure the maintenance and repairs of part of the French Navy's fleet, the Toulon arsenal has developed large-scale infrastructures, among which the "Vauban" basins built in the early 20th century.
The latter, although still operational, have recently been found to show a deformation on one of the crane runways opposite a side wall in one of the basins during topographical measurements made on site. IFSTTAR's laboratory for the Physical and chemical behaviour and durability of materials was called upon end of 2014 to conduct an assessment on the concrete of this structure, and to try to identify some explanations as to these deformations. During the surveys carried out at the beginning of 2015 in the side wall, core samples were extracted for the proposed physical and chemical characterisations. The latter highlighted the presence of seawater inside the concrete, in particular in those areas regularly immersed. The surfaces observed by scanning electron microscope clearly showed that some areas of the structure are subject to marine attacks, notably causing the formation of pathogenic products characteristic of a degradation of the cement matrix, such as brucite or ettringite. At the scale of the whole structure, such degradations could account for local subsidence effects resulting in a deformation of the surface. The reinforcement work scheduled should keep the structure in operating condition, safely and durably.

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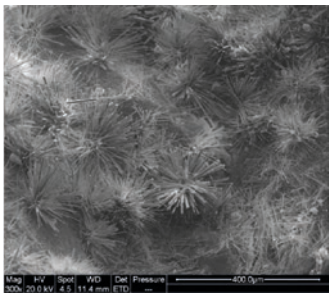
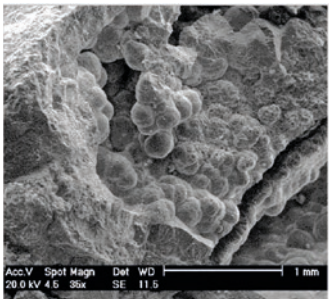

Acicular ettringite needles



Spherical brucite crystals

Standardisation of SymuVia data models, dynamic traffic simulator

For many years, the COSYS/LICIT laboratory has been collaborating with CSTB (scientific and technical centre for the building industry) for the development of EveCity, a 3D digital urban platform featuring simulation modules for physical phenomena in cities. Recent work has made it possible to couple the SymuVia dynamic traffic simulator, developed by LICIT, with EveCity in order to model and visualise traffic in the simulated areas and possibly couple this with other traffic-related modules. From January 2014 to June 2015, CSTB entrusted LICIT with an assessment mission to see how to improve interoperability between the platform's modules by improving the data models exchanged and this by relying on the CityGML standard 3D digital urban model.
To this end, LICIT designed and developed an extension to the CityGML model in order to model all of the concepts useful in dynamic traffic simulation. So as to handle the whole modelling chain, LICIT also developed an extension of CityGML to compute environmental externalities linked with road traffic. The dynamic traffic simulator SymuVia was then updated to restore these various data that could thus be handled by other components of EveCity. Finally, LICIT designed and implemented a module that makes it possible to allocate the atmospheric emissions of traffic identified by the simulation to surface elements directly derived from the CityGML model.

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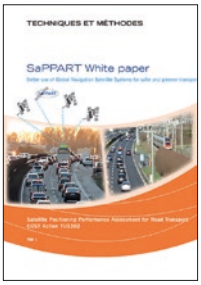
EDITORIAL POLICY

IFSTTAR's publishing

IFSTTAR launched its new collections in September 2015 with a number of publications putting the emphasis on Open Access via the use of Creative Commons licences. They are available from IFSTTAR's digital library.
With 2,000 visitors and 1,000 documents downloaded free of charge, the library which opened in 2014 boasted twice as many hits in 2015. This Open Access circulation comes on top of the sales of hard copy works. For the third time since 2010, a paper released in the magazine Recherche Transports Sécurité (RTS) under the aegis of IFSTTAR and published by Necplus was awarded the Aperau prize for the best scientific paper on spatial planning and town planning. The 2015 winner for this prize was the paper written by Jean-Marie Halleux and Marie-Caroline Vandermeer, on the impact of mobility management by Walloon businesses on home-workplace journeys. The paper is available in open access on the magazine's website.
After being the LCPC's flagship magazine for 50 years, the Bulletin des laboratoires des ponts et chaussées (BLPC) experienced some publishing issues in the early 2010. In 2015, a survey addressed past or potential contributors and readers of the BLPC in order to better understand their expectations regarding publication acting as the mouthpiece of research towards the professional circles, whether in terms of contents, services or editorial content.

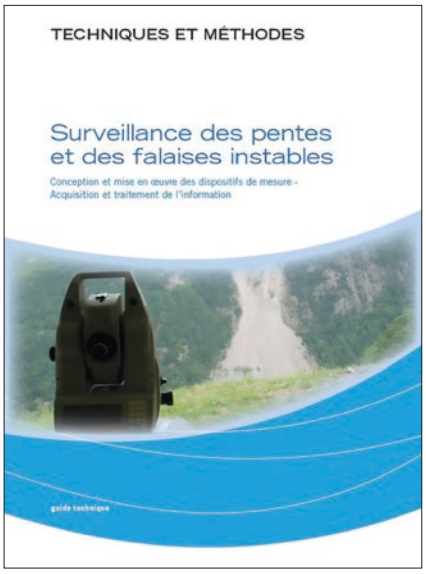
In 2015 IFSTTAR published two works and contributed to two others



White paper: Better use of Global Navigation Satellite Systems for safer and greener transport. Marne-la-Vallée: IFSTTAR, 2015. Techniques et Méthodes, TMI 1. 58p

Ifsttar & Cerema, Inspecting engineered structures (Auscultation des ouvrages d'art) [online]. Marne-la-Vallée : Ifsttar, 2015. cahiers interactifs, CII1. Available on the web: http://www.ifsttar.fr/collections/CahiersInteractifs/CII1/

Monitoring unstable slopes and cliffs: design and implementation of measuring, acquisition and information processing devices



Cover page of the handbook on monitoring of unstable slopes and cliffs

This technical handbook, initiated and supported by the French Ministry for Ecology, Sustainable development and Energy, is intended to update and supersede the 1994 LCPC guide entitled *"Surveillance des pentes instables"* (Monitoring unstable slopes). It was drafted by a working group steered by Céline Bourdeau Lombardi from IFSTTAR and comprising Julien Arpaia, Laurent Dubois, Jean-Paul Duranthon, Sylvain Gardet, Margaret Herbaux, Patrice Maurin, Pierre Pothérat, René Stock and Gratien Vinceslas from Cerema.
This handbook, intended for infrastructure assets managers, prime contractors and clients as well as design and engineering firms, describes in detail the process of devising a monitoring strategy to address the risk of unstable slopes or cliffs threatening people and assets and for which stabilisation or reinforcement work cannot be envisaged. This approach is articulated in four phases: characterisation of the site, choice of the measuring systems, their deployment and finally monitoring and analysis of collected data.
Emergency procedures are also addressed. This handbook, however, does not delve into the establishment of crisis management.
Fact sheets presenting the characteristics of sensors frequently used for the monitoring of unstable sites and case studies are also presented.

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Publication of the AFGC guide on paraseismic reinforcement by means of bonded composites

The code of practice for the construction of buildings and engineered structures offers a set of recommendations aiming to achieve acceptable seismic performance for the work to be constructed. In France, the new seismic zoning map and the regulatory evolution instilled by Eurocode 8 will enable these objectives to be achieved for new structures. As for existing structures, it may in certain cases be necessary to provide reinforcement against seismic hazards.
The document entitled "Renforcements parasismiques de structures béton armé par matériaux composites" (paraseismic reinforcement of concrete structures by composite materials) presents the outcomes of the researches conducted by the AFGC group specialising in the strengthening of reinforced concrete structures by means of fibre-reinforced polymers (FRP), steered by University of Lyon 1 and IFSTTAR, with University of Lyon 1 providing the secretariat.
More specifically, this document, after reminding general considerations concerning the seismic behaviour of structures, proposes a project study approach, as well as design and sizing rules, and finally presents a number of completed projects.
The purpose of the document is to offer some background knowledge on the use of FRPs in the paraseismic strengthening of existing structures. It builds upon and complements existing guides on paraseismic engineering.

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AFGC guide on Paraseismic strengthening of reinforced concrete structures by composite materials


BORDEAUX
CLAVEAU

LEVERAGING RESEARCH, RELATIONS WITH THE INDUSTRY

Beyond its core missions around the production of knowledge and training, disseminating and transferring the outcomes of research to social and economic players is another priority mission of the Institute since its creation, which decided to this very end to set up a team dedicated to the leveraging of innovation, technological transfer and entrepreneurial development (Vitte). Its primary objective is to boost, in the short- and medium-term, the Institute's innovation potential in responding to the demands of society and the industry within its fields of activity. These transfers can take place whenever such research, training and expertise are developed jointly with the industry.

Overall, the leveraging and economic transfer mechanism is organised around four major lines of action:

- Organising an effective protection process for the knowledge acquired as well as their usage and underpinning this process by sensitising the researchers themselves and helping write down their rights protection into collaborative and partnership agreements;
- Developing and deploying a promotion tool for the research outcomes that can be leveraged;
- Organising the leveraging and transfer mechanisms along three strategic pillars: licensing operations, development of "in-house" products successfully marketed under the mlpc® brand name, the entrepreneurship activity which includes the spinning off of dedicated subsidiaries and support to those researchers who wish to set up their own business in order to leverage their research work in connection with the Institute's laboratories;
- Improving the Institute's practices in terms of incentivising, selection and accompaniment for the development of innovative solutions that factor in the upstream-downstream chain of usage and targeted users.

In 2015, this action resulted in a proactive effort to better understand the challenges of innovation and the support strategies most likely to improve the capacity to create value based on IFSTTAR's research.

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TRANSPOLIS, a first in Europe: creation of the unique city-laboratory dedicated to urban mobility

CREATED IN 2011, TRANSPOLIS IS BUILDING AND FITTING OUT AN EXPERIMENTATION FIELD FOR DEVELOPMENT AND IMPLEMENTATION OF TRIAL PROGRAMMES UNDER CONTROLLED CONDITIONS CLOSE TO REAL-LIFE GEARED TO ASSESSING AND DEVISING TECHNOLOGIES SERVING THE FUTURE OF OUR URBAN TRANSPORT SYSTEMS.

A truly novel platform, TRANSPOLIS SAS is open to all mobility stakeholders (NGOs, industrialists, researchers, local governments, users, instructors, public administration) and it articulates its offering around 4 major services:

- the full-scale urban mobility laboratory based on the systemic approach intrinsic to urban mobility solutions and the dynamic mobilisation of multiple players with complementary competences (vehicle technology, infrastructure, energy networks, telecoms, users, local governments, transport operators, spatial planning…);
- digital simulation and modelling;
- trial sites for vehicle and road equipment;
- consultancy on human factors and usage, including the issue of innovation acceptance by citizens.

Having originated and been incubated within the LUTB Transport & Mobility Systems competitiveness cluster, TRANSPOLIS is a new tool dedicated to urban mobility and transport systems. This platform federates several sites with a total surface area of 90 ha in phase 1 until 2018 and is also associated with the sites of Lyon Saint-Exupéry and La Valbonne; from 2018, in phase 2, it will ramp up to 140 ha with the full integration of the sites of La Valbonne and Fromentaux.

TRANSPOLIS SAS as a company is quite a case of its own in Europe. It was actually initiated by players in the field of urban mobility solutions for tomorrow: Renault Trucks, Colas, Aixam Groupe Polaris (USA), Vibratec, Eve System, Adetel Group and the French Institute of science and technology for transport, development and networks (IFSTTAR), which were later joined in 2014 by the Syndicate of Road Equipment manufacturers (SER).

Looking ahead to the launch of the city-laboratory in 2018, TRANSPOLIS has just gone one step further in its development with the arrival of three new strategic partners – the VICAT Group, GROUPAMA AUVERGNE-RHONE-ALPES and *Caisse des Dépôts et Consignations* – alongside its founding shareholders who have confirmed their continued support by committing to a capital increase of over 2 million euros.

The arrival of these new strategic shareholders at TRANSPOLIS is further evidence to its federative role and confirms the need to provide a research and experimentation arena for the various players of urban mobility. This initiative will help mutualise the costs between private and public stakeholders, of complementary size and nature: large industrial groups, medium-size enterprises, SMEs and very small businesses, academic research and public institutions.

The first real-size laboratory dedicated to urban mobility, TRANSPOLIS stands out by its multidisciplinary approach in developing the solutions imagined by industry specialists in partnership with research teams in order to address the expectations of users, transport operators, local governments and service providers. Tomorrow's mobility will be shaped by the dual influence of growing urbanisation and pervasive digital technologies.

These changes prompt us to rethink our approach to lifestyles and practices in terms of urban mobility. It is also now essential to take into account the modification of urban spaces, which is why, in addition to proposing a platform for technical experimentation, TRANSPOLIS insisted on placing human beings at the heart of their evaluation capacities. TRANSPOLIS has thus developed specific methods and competences to factor the reality of uses into the design phases such as the assessment of user acceptance for the mobility solutions of tomorrow's cities.

TRANSPOLIS offers many benefits for industrialists and researchers who wish to test new technologies using a modular infrastructure. For their projects, TRANSPOLIS proposes to replicate situations close to reality whilst in a safe and controlled environment.

TRANSPOLIS also facilitates the deployment of a transverse approach calling on players in various domains (vehicles, infrastructures, energy, networks and telecoms, street furniture

or mobility services) in order to develop and experiment solutions with interfaces concerning several sectors.
Traffic lights, roundabouts, parking areas and highway tolls, road surface or public lighting along thoroughfares are all to be found on this site to help everyone explore the solutions to reinforce tomorrow's transport safety and efficiency.
Self-driving vehicles are of course one of the topical areas for TRANSPOLIS which already caters for mass transport players and can support them in programmes to develop their technologies and solutions. Supply-chain operators are invited to come and try a dedicated modular intermodal platform intended to simulate road-rail exchanges. More broadly speaking, this real-size city-laboratory helps define and improve the various future transportation modes for both people and goods as the trend will push towards their combination.

Finally TRANSPOLIS is also designed to support the assessment and formulation of energy solutions. In addition to fitting out the first electric charging stations, the Fromentaux city-laboratory will also, for instance, propose to test the bus of the future by providing a bus stop that captures energy. In due course, a charging station will be built near the bus stop to facilitate the performance evaluation of the various energies available (natural gas, hydrogen, bio-ethanol).

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FOCUS ON 2015

2011 Creation of TRANSPOLIS SAS to develop a city-laboratory dedicated to urban mobility unique in Europe

2012 TRANSPOLIS is awarded the DGE Label for "Mutualised innovation platform"

2013 Acquisition of "Fromentaux " property by the Conseil Général de l'Ain. Financial backing to IFSTTAR from the State (DGE), Région Rhône-Alpes and Grand Lyon

2014 Takeover-merger of Lier S.A. by TRANSPOLIS SAS. TRANSPOLIS boasts 15 staff and 1.3 million euros in revenues. New clients have chosen to trust TRANSPOLIS: Navya (self-driving vehicle), Peugeot Scooters, AFT-IFTIM

2015 Signing of the lease between IFSTTAR and the Département de l'Ain and signing of the agreement between TRANSPOLIS SAS and IFSTTAR

Transfer of Renault Trucks' customers at the La Valbonne test centre to TRANSPOLIS

New funds raised for a total 2 million euros and new investors join in

Kickoff of the project for the "Fromentaux" site

Revenues up by 40 %

2016 First mock-up of the city-laboratory completed to run the first experimentations

2018 Scheduled opening of the first city-laboratory in Europe dedicated to urban mobility and innovative transport systems

FOUNDING PARTNERS

NOUVEAUX PARTENAIRES INVESTISSEURS

PARTENAIRES INSTITUTIONNELS

CIVITEC

AN IFSTTAR CREATION FOLLOWED BY A SUCCESSFUL TRANSFER TO A FRENCH PUBLISHING GROUP FOR SIMULATION SOFTWARE

CIVITEC, a spin-off of IFSTTAR's LIVIC Laboratory, proposes a platform dedicated to the modelling and simulation of environment perception systems (sensors) and associated command-control.
The range of Pro-SiVIC® software programmes enables safety and automotive industry players to design, assess and validate the reliability of these systems.
CIVITEC is a start-up that came up with the clever vision of an emerging need in the market of self-driving vehicles. Created in 2009, the company then developed a highly efficient simulation tool to design and validate the on-board perception systems that are vital to automobile driving assistance systems.
After proving the originality and usefulness of this technology, the company needed to raise funds to pursue its development and follow its clients.

This is a fast-growing market and the need arose to find a business structure able to support the activities of CIVITEC at international scale, where the highest-potential markets lie: Asia, Germany and United states essentially.
With the advent of self-driving vehicles, industrial challenges have become strategic for several global groups. To crank up to a higher dimension, it was decided to transfer the company to a French industrial player, a process that was structured throughout 2014 and completed at the very beginning of 2015.
A majority stake (80 %) in the company's equity was acquired in March 2015 by ESI, a simulation software publisher.
IFSTTAR has kept 20 % of the shares and two of its researchers continue to be involved part-time, as scientific directors.

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CONTRACTS

Fostering relations with socio-economic players remains a priority for the Institute

In terms of developing partnerships with economic players, 2015 was first and foremost marked by the preparatory stages of the CARNOT 3.0 project formalising the "plan-contracts" established in 2011 to prepare for this candidacy. By way of reminder, the purpose of this plan was to further professionalise IFSTTAR by means of methods, tools, charters, projects incubated by dedicated working groups… so as to streamline and fool proof the contracts, and simplify their preparation and management as much as possible. With this label, the Institute would hope to give broad visibility to its implication in industrial innovation or with local governments. The work was conducted by a "project" team in charge also of regularly informing and engaging all the laboratories and support departments in order to collect any specific expectations and make sure that the Institute as a whole understood the structural importance of this project.
End of 2015, a proposal was put forth to ENPC to join in this candidacy and build up an even stronger project. This project will thus benefit from two common UMRs (Navier and LVMT) and be able to rely on the experience of the school in terms of industrial chair and – by combining the respective contributions – it will boost the related volume of activity.
The proposal will be finalised early 2016.

This year also marked a turning point for IFSTTAR's involvement in the Future Investment Programme (PIA). The conventions for the secondment of agents in the Vedecom and Efficacity ETIs and the SystemX RTI were officialised in 2015, thus adding to the inauguration of Sense-City. Altogether, twelve such secondment conventions were signed in 2015. In parallel, an observatory was set up by the Management in 2015 to ensure that such assignments were both clear and satisfactory for the career development of concerned agents. Its first in-house surveys conducted in this framework showed that the agents who had chosen to be seconded are globally happy with the content and environment of their task. Their only concern would be that their scientific production, at least for some of them, might go "dormant" over this period of time. Negotiations for further secondments under the Railenium RTI were initiated but they will only become effective in 2016.

In terms of contracts generating own resources, IFSTTAR has continued to make progress despite the pressure on staff numbers. Contractual revenues were up by 18 %, in line with the growth rates already recorded in 2013 and 2014.

Likewise, the conventions signed have grown in volumes while remaining stable in number (approximately 160 conventions signed annually for the last 3 years but a growth up by 15 % in value, let alone the above-mentioned secondment conventions). It is interesting to note that as of 31 December 2015, IFSTTAR was managing about 400 contracts, namely on average one contract per researcher/engineer. Even though from this respect the situation is quite disparate, this average would point to a relative stabilisation of the number of contracts in the future.

As far as collaborative research is concerned, IFSTTAR has established an outstanding position in R&D projects benefitting from FUIs (Single Interministerial Funds), with a success rate close to 50 %. Its expertise, in particular in supporting SMEs and very small enterprises in these projects is acknowledged and very much appreciated. For instance, in 2015 the DIDRO project was notified. This FUI project concerns the development of a service offering to check the physical integrity of dikes from a drone. In this project, IFSTTAR was able to bring together around a high-technology SME, Redbird, both "end users" to validate the application (dike managers), a large company manufacturing drones (Airbus) and scientific partners to consolidate the best technologies to be harnessed for this application.

IFSTTAR is keen both to retain its traditional partners, generally from the world of large enterprises and to enhance its appeal to innovative businesses so as to involve them in partnerships.
To address the first point, IFSTTAR continued its framework contract development policy in 2015 while seeking to better envisage the longer term and also to improve contractual contents.
In this respect, the need had been identified to establish a mechanism liable to centralise the Institute's best practices in terms of framework contracts, in order to give more legibility and recognition to the "carriers" of such contracts. To this end, a charter was drawn up and its deployment will be organised in 2016 through operational actions.

Finally, in 2014 IFSTTAR had set up a new additional team within the DPM (in support of project setting up: AMP). This team did its self-assessment end of 2014, and building on the findings fine-tuned its service offer and objectives. As a result it attracted many requests in 2015, and contributed operational support to over 60 projects. It has acquired methodologies to optimise its backing to researchers and engineers so as to further raise the "excellence profile" of the projects. It now holds a central place in promoting crosscutting relations between IFSTTAR and the world of industry.

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DEVICES

ECODYN 3 MLPC®, a new generation of devices to improve markings visibility

Resulting from a close cooperation between IFSTTAR, Cerema and Vectra, this new generation of the ECODYN device is designed to measure night-time visibility of road markings and thus help infrastructure managers optimise their maintenance policy.

Based on the experience of previous generations, Ecodyn 3, a product qualified by IFSTTAR in 2015, boasts several assets:

- Money- and time-saving: the system is designed to operate simultaneously with 2 measuring heads. Axial and edge markings can be tested in daytime in a single run and at traffic speed (up to 130 km/hr); more ergonomic and user-friendly: state-of-the-art technologies (information systems, geopositioning, digital imaging, MMI, optics) are all integrated for easier operation.
- Guarantee of continuity and compliance with the standard: repeatability and reproducibility were compared and enhanced versus previous generations. The whole setup is developed in compliance with applicable standards and methods.
- Open and customisable system: all of the data is accessible, whether raw or processed; users may customise their processing as per own requirements.

Geopositioning of the measurements allows for easier extraction of the data for transfer to the geographical information systems.

A successful development thanks to the respective assets and contributions of three partners.

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Ecodyn 3 mounted onto a vehicle and Ecodyn 1 laid on the ground

PATENTS

Gravitational filtration device for run-off waters

The European framework directive on water and the recommendations of the Masterplan for Water Resources Development and Management set limits to total suspended solids (TSS). Now the problem is that earthwork operations are liable to cause serious discharges of TSS into the neighbouring waterways when the bare soil is washed out.
The filtration system should therefore be adapted to high flow rates and to the particulate fillers of earthworks effluents. In order to devise such a system, multiple filtration tests were made on laboratory soil columns.
The purpose of the tests was to test the efficiency and clogging resistance of various materials (filters) and filter superpositions. The challenge in so doing is the need to use filters of natural origin: sands, organic plant fibres, aggregates, etc.
After choosing the filters and establishing the device structure, the system was actually built in conjunction with two companies, NGE Guintoli and Géco.
It was then tested in real-life conditions.
The benefit of this filtration device is that it is modular and can thus be adapted to local water characteristics and effluent reduction goals.
It also makes it possible to recycle *in situ* the clogged filters, and thus help confine the degradation of water ecosystems near the earthworks while generating a limited amount of waste.

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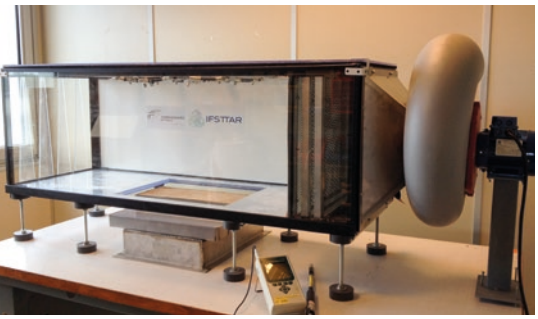
Gravitational filtration device for run-off waters

Aeraulic chamber



Aeraulic chamber to simulate the air-borne dust phenomenon

Reduction of the water consumption resulting from watering of jobsite roads is part of a self-imposed effort for energy and consumables savings in the area of earthworks. The water is primarily used to contain dust.
A fine knowledge of the air-borne dust mechanism is one of the scientific challenges in achieving a sustainable solution in order to:

- reduce sanitary and safety nuisance caused by air-borne dust;
- optimise watering consumption on jobsites.

To address these requirements, an aeraulic chamber was designed at IFSTTAR in association with the French syndicate of earthwork professionals (SPTF). This action has a dual objective: scientific and operational.
The scientific objective consists in understanding the air-borne dust mechanism and quantifying associated emissions. Meanwhile, the operational objective is geared to finding solutions to the potential phenomenon of air-borne dust from the ground in connection with real-life conditions of implementation.
The end purpose of this chamber is to be able to adapt watering to the level of nuisance and to the local watering requirements. To do so, this aeraulic chamber is equipped with systems replicating the factors that blow the dust off the surface of a compacted soil.
The various types of factors studied at laboratory level were traffic, wind, air and soil humidity, watering.
The behaviour of the particles submitted to this air-borne phenomenon was controlled by means of various types of sensors placed both within the chamber and also in the test tubes being checked.

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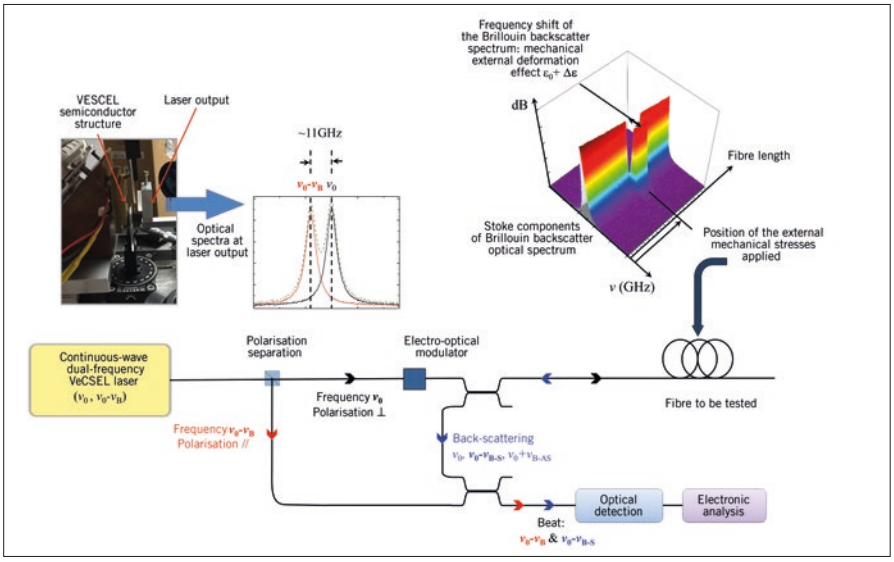
Low-cost fibre-optics sensor based on Brillouin's backscatter principle

A unique characteristic of fibre optics is to allow measurements to be made on physical parameters along the fibres and according to their position. Distributed detection techniques are usually based on the backscatter phenomenon of light at the core of the fibre. In the so-called "Brillouin effect" backscatter, an optical pump wave is backscattered by acoustic waves that cause a shift in the frequency of optical components.
This frequency shift is close to 11 GHz at a wavelength of 1.55 µm in a silica-based single mode fibre. Variations in this shift will provide indications as to the temperature and mechanical constraints and thus allow them to be measured. Existing solutions to measure this shift are currently based on optical heterodyne detection but they encounter difficulties in producing the high-frequency detection systems (>10 GHz) sought for. The proposed solution with this patent is based on a surface emitting semiconductor laser at 1.55 µm in an extended cavity.
On output from this laser, the two frequencies shifted by 11 GHz are in phase, with two orthogonal polarisations and optical power >10 mW.



Configuration of a fibre-optics distributed sensor based on the Brillouin effect, with a dual-frequency semiconductor source VESCEL semiconductor structure

Using this laser source provides a high-amplitude optical heterodyned signal at the level of the low-frequency sensor <1 GHz. The source is produced in association with CNRS's photonic and nanostructures laboratory (LPN).
The outcome expected from this work is a distributed sensor based on the Brillouin effect with higher performance than currently achieved and at a much lower cost.

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Process to detect a flaw in one out of a strand of metallic wires, in particular in the case of an anchorage area for a civil engineering structure

Metallic cables of civil engineering structures tend to deteriorate under the combined action of corrosion and mechanical fatigue. Being able to assess the condition of such cables is paramount.
Constructional and protective arrangements make it very difficult to inspect from the outside the part of the cable that is not directly accessible (metal sheath wrapped around the cable, itself injected with wax or cement slurry), and even more so in anchorage areas due to the presence of massive metal parts and high concentrations of passive reinforcements. The inspection process developed by IFSTTAR is notably based on the generation of ultrasound waves from an accessible section of the wire making up the buried cable. These guided ultrasound waves feature very specific characteristics for propagation along the wire over a significant distance compatible with the dimensions of the anchorage areas.
This process therefore supports non-destructive wire-by-wire testing of the buried cable over several metres.
A public-private partnership between IFSTTAR and Vinci/Freyssinet/Advitam resulted in the co-development of the USCAN® field-testing device.
IFSTTAR also filed a joint patent with Solétanche-Freyssinet.

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IFSTTAR inspection device in operation on site

SOFTWARE

To leverage its software developments, IFSTTAR has several complementary strategies: a sales strategy in line with the Institute's leveraging policies and partnerships; an SaaS (Software as a Service) strategy to facilitate the use of its scientific applications by the community; and finally a "free software" strategy which is part of the broader, open innovation approach.

TEMPUS, free software platform for multimodal graphs manipulation, and testing-demonstrating of route optimisation algorithms on real-life networks

The TEMPUS Route Planner (www.tempus-project.org) is an open-source platform, adaptable to any urban network, for the manipulation of graphs representing multimodal networks, the testing and demonstration of route optimisation algorithms on real-size networks and comparing their respective efficiency. All existing transport modes are supported in the route planning process: private cars, public transports, shared vehicles, bicycles, etc. At present the platform's architecture comprises:

- a C++ core with a modular architecture;
- a WPS server to invoke the main services of the core via a standardised interface;
- a graphic interface in the form of a Quantum GIS plug-in (free GIS tool).

The new version 2.0, fruit of a partnership with Oslandia and Mappy, focuses on performance enhancements and open-endedness.
Primarily, it brings the following improvements:

- use of the latest C++11 specification;
- a new plug-in implementing hierarchical contraction strategies;
- an increased flexibility of the graphs' data structures;
- a small memory footprint of the structures through optimisations and the use of serialisation to avoid fragmenting memory.

The "contraction hierarchies" algorithm can be used to address route-planning requests very promptly thanks to an effective pre-processing phase during which shortcuts are added to the graph. In conjunction with the newly improved data structures, it is now possible to handle requests on very large-size networks.

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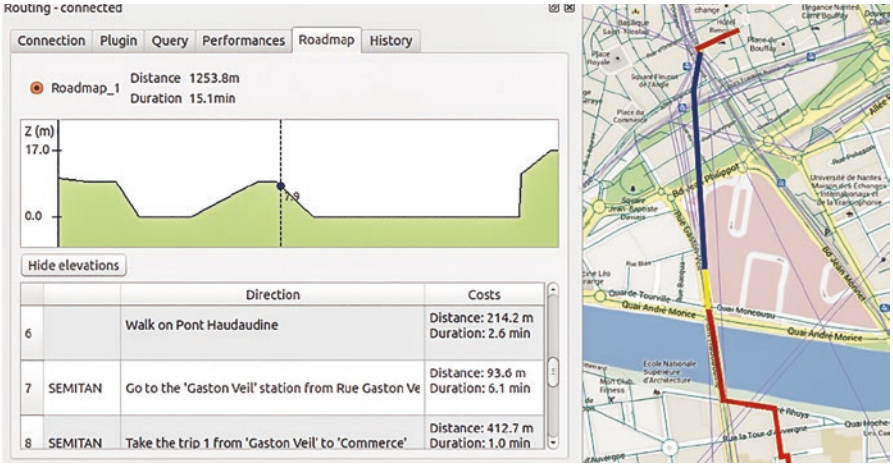

FloMix: computation code for a better insight into concrete mixing

As part of an effort to model concrete mixing, a computation code called FloMix is being developed at the GPEM laboratory.
Phenomena within the concrete flow in the mixer are indeed not well-known. The main objective of this code is to get a better understanding of these phenomena and ultimately enhance the process. Also, the complex stirring process of a complex fluid further compounds difficulties, which for the sake of simulation requires analysing new mathematical problems, and such analysis cannot be dissociated from the development objectives.

The work is based on the GPEM computing stations and was the subject-matter of an IFSTTAR thesis (N. El Khouja). FloMix allows simulating viscoplastic flows of the Bingham-Drucker-Prager type in confined and stirred environments by displacing in epi-cycloidal mode obstacles representing the blades of planetary mixers.
The code is designed to take into account other non-standard material behaviours to comprehend the process as a whole. This model gave rise to publications on the mathematical work (relevance of the approach, approximability). FloMix in particular made it possible to optimise the interpretation of the viscoprobe signal (collaboration with Couvrot company). Future simulations will strive to predict and better interpret the signal from new immersed sensors placed in the mixer. Optimisation of algorithmic performance is also a central perspective.

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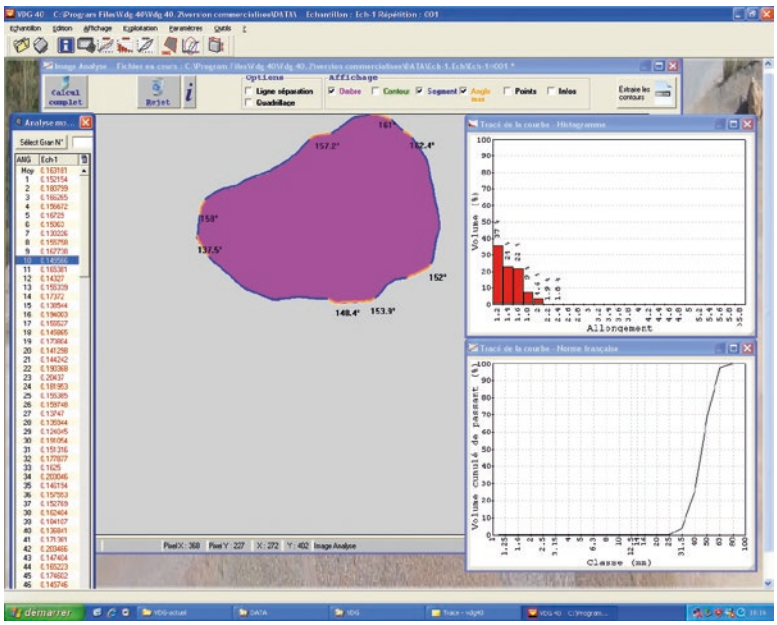
The VDG40.2 videogranulometre also measures ballast angularity

For high-rate recycling of used railway ballasts to be possible, the problem of changes in their geometrical characteristics under the action of rail traffic in their former lifecycle must be tackled. It is quite easy to characterise the granulometric evolution of the ballast and remove excessively small fragments by means of screening, however, it is much more difficult to appraise its residual angularity, which needs to be good enough to ensure the stability of the rehabilitated tracks. To address this need, a ballast angularity characterisation module, initially developed for research purposes, has now been added to version 5.80 of the VDG 40.2 videogranulometre software, an mIpc® device dedicated to the geometrical characterisation of aggregates via an optoelectronic process. The fruit of a joint effort between IFSTTAR and Cerema, this newly integrated module allows visualising the silhouette of every particle under analysis, quantify the blunting of edges and compute an average angularity coefficient for the analysed sample. It is now thus possible with a single analysis operation on the ballast sample to determine its granulometric curve, the distribution of the elongating factors of its particles as well as its angularity.
Besides, this angularity module is user-configurable, making it possible to characterise the angularity of smaller-size gravel samples.



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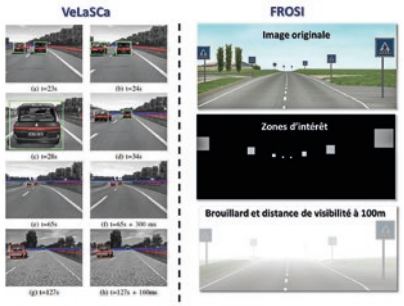
DATABASES

Databases play a central role in IFSTTAR's scientific approach. Most of the time they remain an internal tool for research purposes. When possible by virtue of contractual agreements, intellectual property and data protection laws, IFSTTAR opens access to data sets based on an Open Data strategy. In this case, the objective is to maximise their circulation and promote their reuse by the largest number.

Virtual data: an effective alternative for aid to prototyping and to the evaluation of perception systems



Virtual images reproduced by VeLaSCa and FROSI

In designing perception systems, great attention must be paid to assessing the objects' dynamic attributes.
This assessment is made from the data processed by several sensors (cameras, radars, laser telemeters).
To allow for this assessment and validation of these perception systems, it is also important to have field references available.
Using the pro-SiVIC "research" platform, two databases were designed, containing the data generated by on-board sensors (VeLaSCa and FROSI) within an environment that virtually reproduces the test tracks in Satory (Versailles).
The VeLaSCa database contains information from a front camera, a laser telemeter and two reference sensors characterising the dynamics of each virtual vehicle including their intervehicle data. This database simulates the journey of an egovehicle navigating over more than three kilometres with five vehicles-obstacles. The FROSI database is dedicated to the evaluation of road sign detection algorithms under downgraded circumstances (daytime fog). This second database contains 504 sets of images including many types of panels and signs with varying orientations, ranges and sizes. A reference is supplied in the form of a depth map. For each set of images, seven types of uniform fog are generated with visibility distances ranging from 50 to 400 metres.

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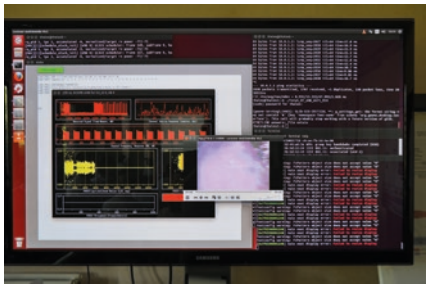

HSL-HST and motorway networks

Cognitive radio for railways

The CORRIDOR ANR project was the first European research project to pave the way for the development of Cognitive Radio technologies (RI[1]) dedicated to railway applications. The project looked at three types of transmissions typical of railways (instrumentation and control, CCTV and Internet on board) in order to devise a better transport offering.
The objectives of the project were to design, develop and appraise the fundamental bricks of a CR system adapted to the requirements and constraints of high-speed railway (high speed, electromagnetic disturbance, poor coverage in rural areas…). To do the in-lab evaluation of these bricks, tests were run at 300 km/hr. on the HSL Atlantique line with the SNCF train IRIS 320 and Eurecom's OpenAirInterface platform. They allowed to acquire the electromagnetic spectra in a MIMO configuration (Multiple Input Multiple Output) at 771.5 MHz (5 MHz of band) and at 2.6 GHz (30 MHz of band). Two configurations are available, one with the transmitter in railway rights-of-way and the second one with the transmitter at a distance from the track in "telecom operator" like mode.

[1] The Cognitive Radio is a radio or system capable of analysing its electromagnetic environment and dynamically, as well as independently, adjust its operational radio parameters to adapt system operation accordingly, i.e. throughput, interference cancellation, interoperability, access to other radio networks…
Partners: Thales communications, RSM department - Telecom Bretagne, Eurecom, LaBSTIC - UBO, IEMN-DOAE, IEMN-TELICE, COSYS/LEOST.

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TRIALS

Wehner/Schulze machine

Building up on a long experience of using the Wehner/ Schulze machine for predicting adherence over time, IFSTTAR shares with private and public organisations its expertise in grinding tests, analysis of measurement results and understanding of grinding/polishing phenomena.
In 2015, the EASE laboratory, which manages the adherence and surface characteristics test benches (BMACS) and is home to the Wehner/Schulze machine, undertook many assessments for French (including Eurovia) and foreign (including Tarmac company in the UK, and the Centre de recherche routière in Belgium) organisations.
The tests can be carried out in compliance with the new European standard EN 12697-49, for evaluation of Friction After Polishing (FAP) of coated materials, or based on a protocol derived from research conducted by IFSTTAR to monitor the evolution of adherence through the grinding cycles.
In parallel, IFSTTAR coordinates the work of the French group of Wehner/Schulze machine users who aim to harmonise practices in terms of grinding tests on coating materials and aggregates. In 2015, the group defined a common metrological testing procedure for the seven Wehner/Schulze machines used in France and conducted a first cross-testing campaign to assess the homogeneousness of these machines as a group.

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Wehner/Schulze machine

CERTIFICATION

IFSTTAR, in partnership with Cerema, has a long experience of inspections and tests for the certification of products to be used in civil engineering, amongst other areas. IFSTTAR was notified under reference No.1165, for the application of compliance procedures for the CE marking of several product families such as aggregates, drop-on materials, retro-reflective road studs and protection kits against rock falls. IFSTTAR also carries out voluntary certification activities, either under its own responsibility, or on behalf of certification bodies (Afnor Certification, CERIB, AFCAB, ASQPE et ACQPA) outsourcing to it audit and testing operations across a wide range of domains covering concrete constituents, steel built into structures or anti-corrosion paint on metal structures.
Each product family forms a sector application of its own, managed by a sectorial supervisor who draws out the intervention programmes of auditors and laboratories, for all the relevant operations (documents review, audits-inspections, testing) provided for under every certification baseline. This activity calls on 150 qualified auditors every year.
In this competitive context, IFSTTAR and Cerema together apply a Quality system compliant with the European standard NF EN ISO/CEI 17065 and their competence and independence is acknowledged by a COFRAC accreditation for product certification.
In 2015, IFSTTAR delivered 117 CE certificates for aggregates, for 274 quarries, and 2 CE certificates for Drop-on products, both of which are accessible on the website www.ifsttar.fr sous under the Research/Expertise heading (“*Recherche / Expertise*”).

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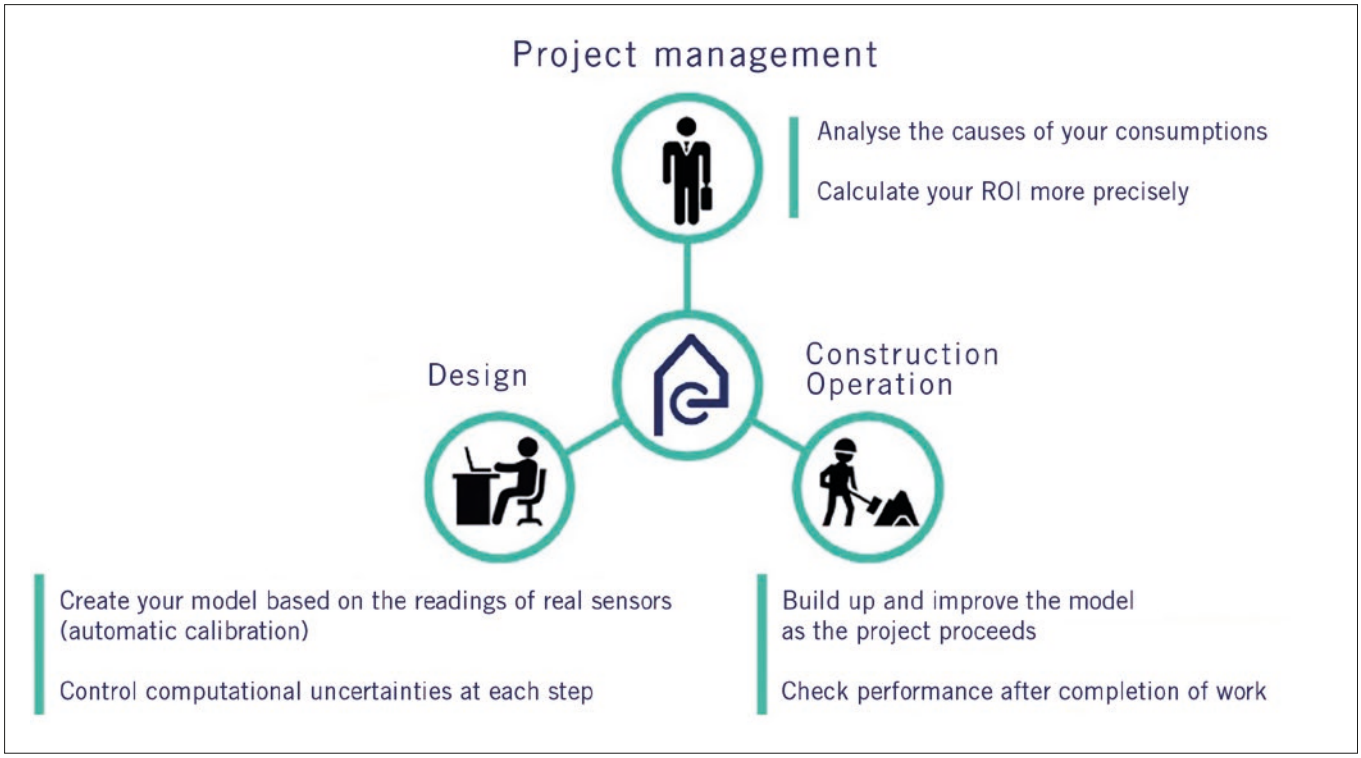
START-UP

ecotropy



AN INITIATIVE TO GUARANTEE THE ENERGY PERFORMANCE OF BUILDINGS

Ecotropy, a spin-off company of IFSTTAR's SII laboratory, just recently created at the end of January 2016, proposes a platform dedicated to modelling and simulation of energy efficiency of buildings. In France, 16 billion euros are spent every year to improve the thermal efficiency of buildings. But such expenditures do not always translate into the results expected: after retrofitting, an average gap of 40 to 50 % is usually observed between the expected energy consumption levels and the actual figures. Ecotropy ambitions to help engineering departments or firms involved in the retrofitting work better target the retrofitting operations most apt to reduce such gaps. The company offers a "turnkey" design solution to make an in-depth energy diagnosis of the building, study the various potential retrofitting scenarios and see to it that the expected performance is achieved post works. It is 500,000 homes/year that are at stake!

The originality of their approach lies in the combination of measurements made by sensors placed across the whole building and a thermal modelling procedure based on optimisation algorithms. The digital model thus created is ten times more accurate than the current state-of-the-art and is much simpler to get to. Ecotropy is currently supported by the KIC Inno Energy[1], European incubator, the Eco-Innovation Factory by Atlanpole[2] mechanism and the IT-Translation[3] investment fund.

Ecotropy looks to leverage over 16 years of cumulative research at IFSTTAR (COSYS department, SII and LISIS laboratories) in the field of scientific computing applied to buildings energy. This work was crowned with the development of the ReTroFiT software and two patents filed for thermal diagnosis of buildings and optimisation of their regulation systems.
The Ecotropy company benefits from a collaboration agreement under which it has an exclusive licence to use the modules of the ReTroFiT software dedicated to thermal retrofitting of buildings.
This collaboration resulted in several pilot projects and will involve the co-development of further software modules according to a joint roadmap.

[1] http://www.kic-innoenergy.com/
[2] http://www.ecoinnovationfactory.fr/
[3] http://it-translation.fr/

APPENDIX

GOVERNANCE

BOARD OF DIRECTORS AS OF 12/31/2015

Chairman: Jacques TAVERNIER

Vice-chairwoman: Christine BOUCHET

Representative of the state

Ministry in charge of public works:
Laurent TAPADINHAS (full member),
Ministry of Ecology, Sustainable Development and Energy
Jean-Philippe TORTEROTOT (deputy member), *Ministry of Ecology, Sustainable Development and Energy*

Jacques Tavernier,
Chairman of the Board of Directors

Jacqueline Lecourtier,
Chairwoman of the Scientific Board

Ministry in charge of transports:
Christine BOUCHET (full member),
Ministry of Ecology, Sustainable Development and Energy
Xavier DELACHE (deputy member),
Ministry of Ecology, Sustainable Development and Energy

Ministry in charge of the environment:
Philippe GUILLARD (full member),
Ministry of Ecology, Sustainable Development and Energy
Thierry HUBERT (deputy member),
Ministry of Ecology, Sustainable Development and Energy

Ministry in charge of research:
Frédéric RAVEL (full member),
Ministry of Education, Higher Education and Research
Philippe TOUSSAINT (deputy member),
Ministry of Education, Higher Education and Research

Ministry in charge of higher education:
Alain BERNARD (full member),
Ministry of Education, Higher Education and Research
Jean-Baptiste VERLHAC (deputy member), *Ministry of Education, Higher Education and Research*

Ministry in charge of the budget:
Laurent TAPADINHAS (full member),
Ministry of Ecology, Sustainable Development and Energy
Thibaut CHAGNAS (deputy member),
Ministry of Finances and Public accounts

Ministry in charge of industry:
Michel FERRANDÉRY (full member),
Ministry of Economy, Industry and Digital
Catherine BELLANCOURT (deputy member), *Ministry of Economy, Industry and Digital*

Ministry in charge of healthcare:
Ghislaine PALIX-CANTONE (full member),
Ministry of Social Affairs, Health and Women rights
Corinne DROUGARD (deputy member),
Ministry of Social Affairs, Health and Women rights

Ministry in charge of interior affairs:
Manuelle SALATHE (full member),
Ministry of the Interior
deputy member seat under replacement

Ministry in charge of defence:
Hisham ABOU-KANDIL (full member),
Ministry of Defence
Rémi CASSIER (deputy member),
Ministry of Defence

Qualified individuals

Marie-Claude DUPUIS, *RATP*
Anne-Marie HERBOURG, *ADSTD*
Pierre IZARD, *SNCF*
Carole LE GALL, *Engie*
Yves METZ, *Ingerop*
Guy SIDOS, *Vicat*
Diane SIMIU, *WWF France*
Jacques TAVERNIER, *Usirf*

Employee representatives

SUD Recherche EPST-Solidaires:
Christine BUISSON (full member),
Maryse BASSEPORTE (deputy member)
SUD Recherche EPST-Solidaires:
Christophe GRANSART (full member),
Philippe BON (deputy member)
UNSA: Laurent LEBOUC (full member),
Franziska SCHMIDT (deputy member)
CGT: Paul MARSAC (full member),
Nathalie BOTTICCHIO (deputy member)

The Chairman of the Scientific Board, the Managing Director, the Scientific Director, the budgetary control authority and the accounting officer attend the meetings in an advisory capacity.

SCIENTIFIC BOARD AS OF 12/31/2015

Chairwoman: Jacqueline LECOURTIER

Vice-chairman: Reinhard GRESSEL

Scientific and Technical individuals

Philippe BISCH, *Syntec Ingénierie*
Daniel CLEMENT, *Ademe*
Pierre-Etienne GAUTIER, *Inexia*
António GOMES CORREIA , *Universidade do Minho (Portugal)*
Valérie ISSARNY, *Inria*
Vincent KAUFMANN, *EPFL*
Corinne LARRUE, *University of Tours*
Barbara LENZ, *DLR*
Philippe MARTIN, *Sciences Po*
Jérôme PERRIN, *Védécom*
Jean-Eric POIRIER, *Colas*

Employee representatives

CFDT: Pierre-Olivier VANDANJON (full member), Hugues CHOLLET (deputy member), Gilles VALLET (full member) and Erik BESSMANN (deputy member)
CGT: Reinhard GRESSEL (full member), Fabien CHIAPPINI (deputy member), Olivier BURBAN (full member) and Charles TATKEU (deputy member)
Force Ouvrière: André ORCESI (full member) and Florent BABY (deputy member)
Sud Recherche EPST-Solidaires: Sébastien AMBELLOUIS (full member) and Thomas ROBERT (deputy member)

Guests in an advisory capacity

Hélène JACQUOT-GUIMBAL, *Managing Director of IFSTTAR*
Serge PIPERNO, *Scientific Director of IFSTTAR*

JOINT ETHICS COMMITTEE IFSTTAR-IRSTEA

Denis BARD, *Chairman of the committee, professor of epidemiology and risk assessment at EHESP (School of Public Health, Rennes, France), doctor in medecine;*
Céline BOUDET, *Dialog with Society Manager (INERIS);*
Pierre-Benoît JOLY, *Director of research INRA and Director of IFRIS;*
Brigitte LAQUIEZE, *Philosopher (French Academy of Agriculture);*
Hervé LE BOULER, *Forest Policy National Manager (FNE);*
Claire LEVALLOIS-BARTH, *Assistant professor of law at Telecom ParisTech and Coordinator of the Chair Values and Policies of Personal Information*;
Yves PAGE, *expert in Road Safety – Accident Research (RENAULT);*
Bertrand THELOT;
Dominique THOUVENIN, *Professor of law at University Denis DIDEROT (Paris 7) and titular of the Chair Health, Law and Ethic at EHESP (School of Public Health, Rennes, France).*

EXECUTIVE BOARD AS OF 12/31/15

Managing Direction

Hélène JACQUOT-GUIMBAL, *managing director*
Jean-Bernard KOVARIK, *deputy managing director*
Jean-Paul MIZZI, *deputy managing director*
Claire SALLENAVE, *director of the office and communication manager*
Thierry FRAGNET, *head of the office*

Deputy directorate

Brigitte MAHUT, *temporary deputy director of Versailles-Satory site*
Jean-Paul MIZZI, *deputy director of Marseilles-Salon-de-Provence site*
Philippe RIGAUD, *deputy director of Villeneuve-d'Ascq site*
Claire SALLENAVE, *deputy director of Marne-la-Vallée site*
Philippe TAMAGNY, *deputy director of Nantes site*
Daniel TINET, *deputy director of Bron site*

Operational directorate

Directorate for European and International Affairs
Agnès JULLIEN, *temporary director*

Directorate for Partnership and Resources
Brigitte MAHUT, *director*

Scientific Directorate

Serge PIPERNO, *director*
Antoine FREMONT, *deputy director*
Dominique MIGNOT, *deputy director*

Secretary General

Anne-Marie LE GUERN, *secretary general*
Eric GELINEAU, *head of legal affairs and governance bodies*

Departments

Materials and structures (MAST)
Thierry KRETZ, *director*
Bruno GODARD, *deputy director on Marne-la-Vallée site*
Christian TESSIER, *deputy director on Nantes site*
Jean-Michel TORRENTI, *deputy director for research and development*

Geotechnical engineering, environment, natural hazards and earth sciences (GERS)
Eric GAUME, *director*
Philippe COTE, *deputy director*
Jean-Pierre RAJOT, *deputy director*
Jean-François SEMBLAT, *deputy director*

Components and systems (COSYS)
Frédéric BOURQUIN, *director*
Marion BERBINEAU, *deputy director*

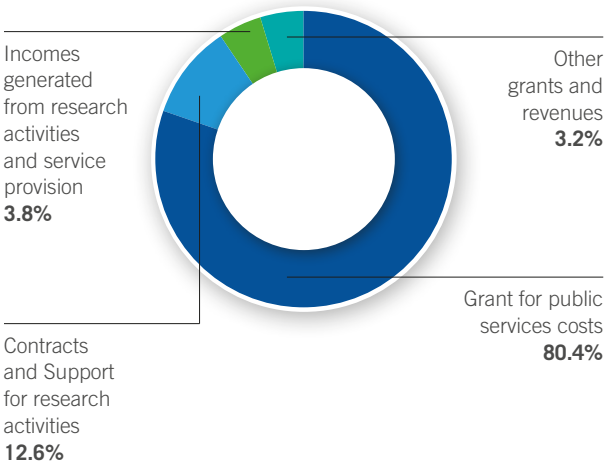
Transport, health, safety (TS2)
Bernard LAUMON, *director*

Planning, mobility and environment (AME)
Gérard HEGRON, *director*
Anne AGUILERA, *deputy director in charge of scientific program*
Michel ANDRE, *deputy director in charge of scientific program*
Michel BERENGIER, *deputy director in charge of organization and quality*

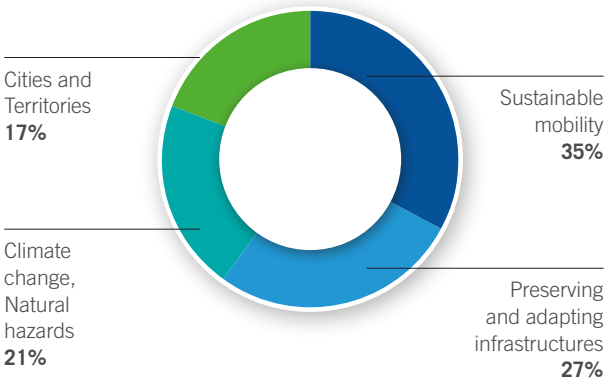
OUTGOINGS AND INCOMINGS

Financial Resources and Expenses excl. depreciation

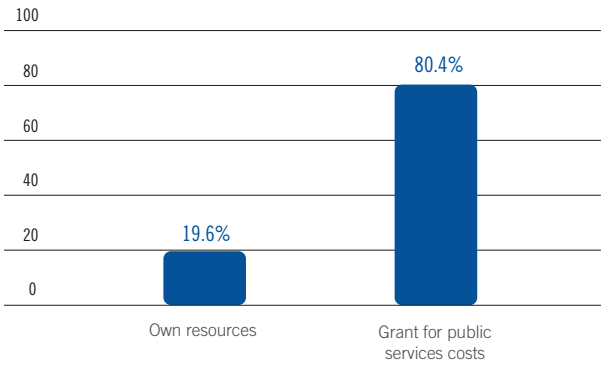
BREAKDOWN OF INCOMES 2015 IMPLEMENTED BUDGET



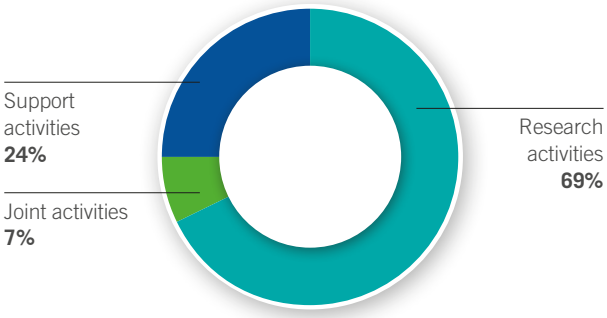
BREAKDOWN OF AUTHORISED EXPENSES PER RESEARCH UNITS



BREAKDOWN BETWEEN GRANT FOR PUBLIC SERVICES COSTS AND OWN RESOURCES



BREAKDOWN OF AUTHORISED EXPENSES PER DESTINATION



Financial Resources and Expenses excl. depreciation

REVENUES	EUROS	%
Ministry of Ecology, Energy, Sustainable Development and Territory planning	**€83,886,413**	**80.4%**
Grant for public services costs	€83,886,413	
Contracts and Support for research activities	**€13,153,436**	**12.6%**
Research contracts with public or private third parties	€3,680,993	
Grant for project or research programs	€9,472,444	
Incomes generated from research activities and service provision	**€4,003,891**	**3.8%**
Fees for patents and licenses	€377,160	
Service provision	€3,547,271	
Product sales	€79,460	
Other grants and revenues	**€3,347,973**	**3.2%**
Other grants	€1,463,864	
Financial revenue and other daily management income	€1,804,557	
Extraordinary income	€65,042	
Financial operations - Capital assets	€14,510	
TOTAL REVENUES	€104,391,714	100%
TOTAL RESOURCES	€104,391,714	

AUTHORIZED EXPENSES

BREAKDOWN OF AUTHORIZED EXPENSES PER DESTINATION	EUROS	%
Activities performed by research units	**€71,100,296**	**68.8%**
Sustainable mobility	€24,551,021	
Preserving and Adapting infrastructures	€19,544,650	
Climate change, Natural hazards	€15,018,992	
Cities and Territories	€11,985,633	
Joint activities	**€7,502,080**	**7.3%**
Major research facilities	€1,139,122	
Research leveraging	€537,660	
International exchanges	€1,000,949	
Scientific and technical information	€3,023,067	
Scientific partnership	€1,522,817	
Continuing education	€278,465	
Support activities	**€24,705,602**	**23.9%**
Social action	€1,149,166	
IT shared resources	€4,381,936	
Real estate - maintenance	€766,097	
Real estate - major renovations, acquisitions, constructions	€622,599	
Head office overheads	€8,138,181	
Research units overheads	€ 9,350,866	
Financial operations		
Other general expenses	€296,757	
TOTAL EXPENSES	€103,307,978	100%
TOTAL	€103,307,978	

BREAKDOWN OF AUTHORIZED EXPENSES PER DESTINATION	EUROS	%
Staff expenses on subsidy for public services	€76,395,637	73.9%
Other staff expenses (expenses on research contracts)	€3,576,494	3.5%
Unprogrammed operating and investments	€22,197,867	21.5%
Programmed investments	€1,137,980	1.1%
TOTAL EXPENSES	€103,307,978	100%

LABORATORIES LOCATION

BELFORT

Bâtiment F
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Research unit:
LTN/FClab

GRENOBLE

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Research unit:
ISTerre

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ESTAS, LEOST

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CPDM, EMMS, FM2D, SRO, SV, GRETTIA, LEPSIS, LISIS, DEST, LVMT, SPLOTT

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CS4
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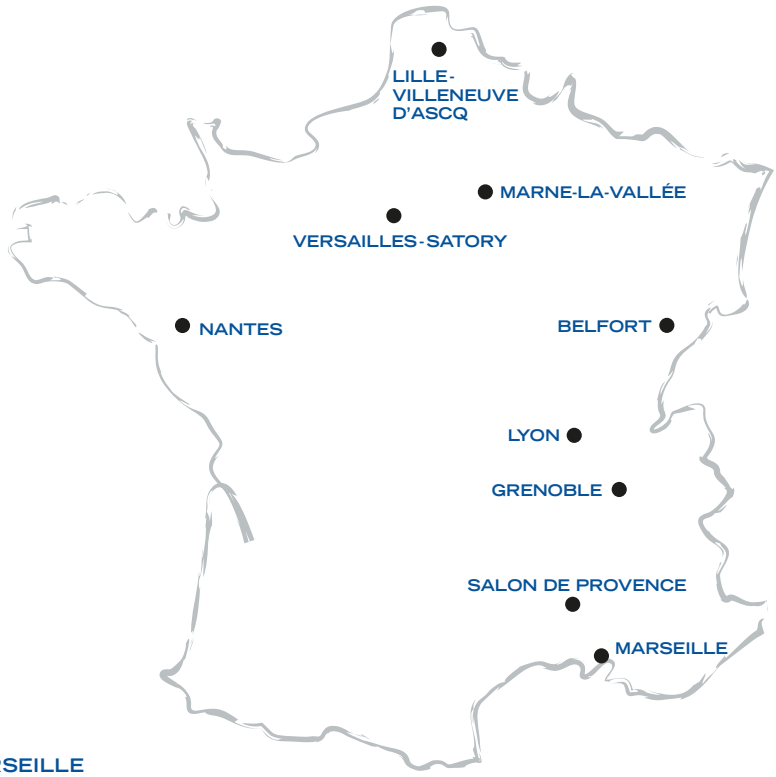
Fax: +33 (0)2 40 84 59 99
Research units:
MIT, LAMES, GPEM, SMC, TC, AI, EE, GEOLOC, MACSI, SII, EASE, LAE



MARSEILLE

Faculté de médecine secteur Nord
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Fax: +33 (0)4 90 56 25 51
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VERSAILLES - SATORY

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Research units:
LEMCO, LTN, LPC

SECOND ADDRESS IN VERSAILLES

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Fax: +33 (0)1 40 43 29 30
Research unit: LIVIC

ACRONYMS

2R	Motorised Two wheelers
AASHTO	American Association of State Highway and Transportation Officials
ADEME	French Environment and Energy Management Agency
AFGC	French Association of Civil Engineering
AFPS	French Association for Earthquake Engineering
AIPCN	World Association for Waterborne Transport Infrastructure
AIPCR	World Road Association
AIS	Abbreviated Injury Scale
ANR	French National Research Agency
ANSES	French Agency for Food, Environmental and Occupational Health & Safety
APUR	Paris Urbanism Agency
ASCQUER	Association for the certification and qualification of road equipments
ASF	South of France Roadways
ASRDLF	Regional Science Association - French language
ATMB	Mont Blanc Motorways and Tunnel
BE	Design Office
BPL	Bretagne - Pays de la Loire
BRRC	Belgian Road Research Centre
CDV	Centrum dopravního výzkumu
CEREMA	Centre for Studies and Expertise on Risks, the Environment, Mobility, and Urban planning
CERTH	Centre for Research and Technology Hellas
CFT	River transport company
CNDP	National Commission for Public Debate
CNSR	Road Safety National Council
COST	European cooperation in the field of scientific and technical research
CPER	Project Contract State-Region
CSTB	French Scientific and Technical Center for Building
DGE	Company Directorate General
DG ENV	General Directorate for the Environment
DGITM	French General Directorate for Infrastructure, Transport and Maritime Affairs
DIR	Interdepartmental Road Directorate
DIRIF	Île-de-France region Interdepartmental Road Directorate
DRI	French Directorate for Research and Innovation
DSCR	French Road Safety and Traffic Delegation
EDF	French Electricity Company
ENPC	French National Civil Engineering School
ERDF	French Network for Electricity distribution
ETI	Intermediate-sized enterprise
ETRA	European Transport Research Alliance
FEHRL	Forum of European National Highway Research Laboratories
FDSN	Federation of Digital Seismograph Networks
FEDER	European Regional Development Fund
FIRM	FEHRL Infrastructure Research Meeting
FRP	Fiber Reinforced Polymer
GPE	Energy Performance Guarantee
HCERES	High Council for Evaluation of Research and Higher Education
HST/HSL	High Speed Train/ High Speed Lane
IAU	Planning and Development Agency
IBDiM	Instytut Badawczy Dróg i Mostów / Road and Bridge Research Institute
IFSTTAR	French Institute of Science and Technology for Transport, Development and Networks
IGN	French National Institute for Information on Geography and Forests
INRA	French National Institute for Agricultural Research
IRSTV	French National Institute for Research on Urban Sciences and Techniques
IRT	Technological Research Institute
ITE	Energetic Transition Institute
KTI	Közlekedéstudományi Intézet Nonprofit
LEZ	Low emissions zone
LNEC	Laboratório nacional de engenharia civil
LPICM	Laboratory of physics of interfaces and thin films
LPN	Laboratory of photonics and nanostructures
LSEE	Environmental simulation and evaluation laboratory
LUTB	Lyon Urban Truck and Bus
OCA	Observatory of Côte d'Azur region
ORSI	IFSTTAR Strategic and Incentivized Research Operations
PCRD	Framework Programme for Research and Technological Development
PIA	Investment for the Future Programme
PREDIT	Programme of Research, Experimentation and Innovation in Land Transport
PST	Scientific and Technological Cluster
R2I	IFSTTAR Incentivized Research
RAP	Permanent accelerometric network
REGL	Grand Lille Express Network
RGRA	Roads and Planning Publication
SER	Trade Union of Road Manufacturers
SMEs	Small and medium-sized enterprises
SNCF	French National Railway Company
SPTF	French Trade Union of Road Maker
SRI-SI	Regional Innovation Strategies -Smart Specialisation
STIC	Information and Communication Sciences and Technologies
STRMTG	National Technical Agency for Ropeway and Guided Transport Safety
TC	Public transportation
TET	Territorial Balance Trains
TGV/LGV	High Speed Train/ High Speed Lane
TOI	TransportØkonomisk institutt
TPE	Very small enterprise
UCLA	University of California in Los Angeles
UPEM	University Paris-Est in Marne-la-Vallée
UPM	Universidad politécnica de Madrid
USIRF	French Union of French Road Industry Associations
VNF	Waterways of France
VTI	Väg och transportforskningsinstitutet

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