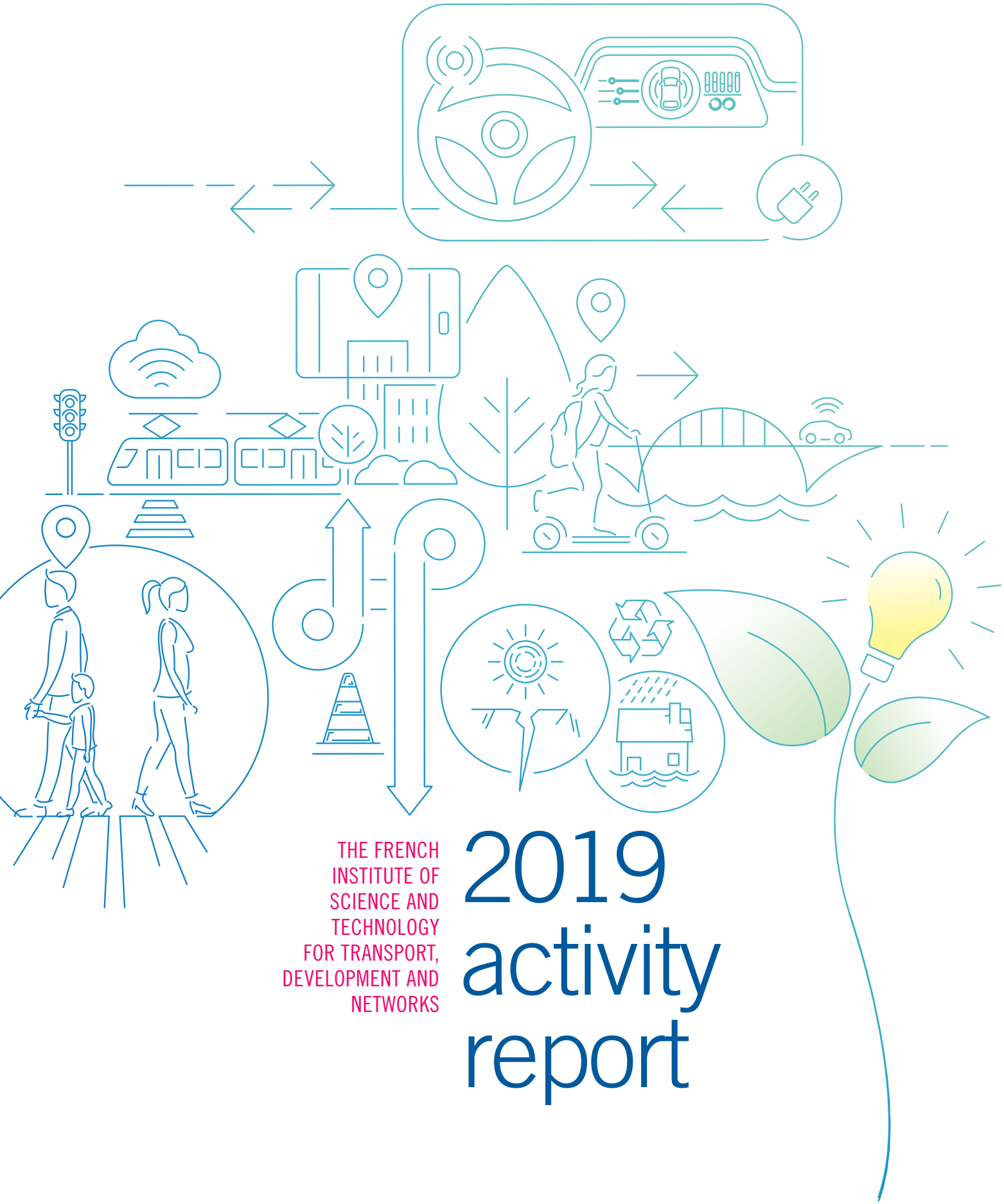

THE FRENCH INSTITUTE OF SCIENCE AND TECHNOLOGY FOR TRANSPORT, DEVELOPMENT AND NETWORKS

2019 activity report

IFSTTAR

Contents

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THE DIGITAL REPORT

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Editorial

Efforts rewarded with exciting prospects

Hélène Jacquot-Guimbal
— Managing Director of IFSTTAR

→ This special year for our Institute finally saw the creation of Université Gustave Eiffel, after a long wait while the conditions required for the birth of this establishment were put in place. Conducted with each of the university's founding partners, the HCERES evaluation highlights a number of positive points for IFSTTAR, such as our strategic and governance choices, the importance of strengthening academic links and our commitment to leading scientific activities on the themes of the city and mobility. The evaluation could not have been carried out if our departments had not been highly motivated to carry out this complex exercise, particularly in the context of a merger.

Our contributions to the T20 summit in Tokyo, on behalf of Université Gustave Eiffel, also mark a change in visibility for IFSTTAR. The mere presence of the term «infrastructure resilience» in the recommendations submitted to the political leaders of the G20 is an achievement of which we can be justly proud. The collaborative projects set up in this context with our partners in Université Gustave Eiffel are intended to be long-lasting and to have an international impact.

The scientific life of the Institute is as vibrant as ever, with, for example, the solutions developed as part of the FastCarb project for CO_2 storage by the carbonation of recycled concrete.

We should also mention the large number of projects and transfer actions in the field of road safety: the publication of a collective work, the consultation of our experts by the National Road Safety Council (CNSR), a seminar on detailed accident studies (EDA), a symposium on the safety of motorised two-wheelers, etc. These are just a few of the contributions and key events that illustrate our expertise and work in the area of public policy support.

An innovation for IFSTTAR in 2019 is the joint organisation of an international summer school that involved many educational players in Paris, Montreal and Brussels around the topic of the circular economy. This important subject is also at the heart of the E3S (Smart, Sober and Secure Eco-neighbourhood) project being developed in Châtenay-Malabry. Implemented by the Eiffage Group and the partner institutions of the I-Site FUTURE, E3S offers a testing ground for new research activities in the fields of sustainable urban development: low carbon, the circular economy, nature in the city and new practices. Opened in March, the Transpolis platform has also been very well received. This unique research facility has quickly allowed us to create new partnerships with academic and private players.

« International collaborative projects set up with our partners in Université Gustave Eiffel »

Finally, we should draw attention to scientific activities that are open to society, such as the conferences organised during the Future Days, the Bron National Scientific Encounters and the Petit Campus and ELEA educational series of publications. They are increasingly popular with young people, teachers, elected representatives and the general public. With Université Gustave Eiffel, this dissemination of knowledge and all IFSTTAR's other activities will continue on a larger scale, bolstered by the virtuous continuum of teaching, research and expert appraisal. ●

return to contents

Let's hear from…

© MTES/B Suard

Bernard Larrouturou

— Director General for Research and Innovation at the Ministry of Research, Higher Education and Innovation

« Valuable expert appraisals for public policies on sustainable development »

→ How would you assess IFSTTAR's contribution to the research landscape?

Bernard Larrouturou: Under the joint supervision of MESRI* and MTES** and within the framework of public policies for research and innovation, IFSTTAR has been active since 2011 on a wide range of scientific and technological subjects: transport, the intelligent city, materials, biomechanics, risk prevention, etc. In these areas, IFSTTAR has been able to make scientific and technological contributions of the highest level, provide valuable expert appraisals for public policies on sustainable development, and develop its partnerships on an international scale, in interaction with the socio-economic world.

→ What do you expect from Université Gustave Eiffel?

B.L.: The organisation of teaching and research based on major research universities, enabling stronger partnerships, is now at the heart of ministerial policies. We attach great importance to the success of the Université Gustave Eiffel, on all of its sites, each with its own unique character.
The University is preparing its first five-year contract with the State, which will define the institution's objectives and major training and research projects. The first challenge is to successfully merge the entities that make it up, while building on their strengths and their links with the business world and other European players.

→ What are Université Gustave Eiffel's development goals over the next ten years?

B.L.: We are confident that Université Gustave Eiffel will become a major university with a global presence in the field of sustainable development. Indeed, its activities are focused on themes that are becoming increasingly crucial on every continent, particularly in the context of the crisis we are currently experiencing: how can we make our cities more resilient and more resource-efficient? How can we make daily travel simpler? How can we promote community harmony? On all these subjects, Université Gustave Eiffel benefits from a number of strengths thanks to the players it brings together. ●

* Ministry of Higher Education, Research and Innovation

** Ministry for the Ecological and Inclusive Transition

return to contents

IFSTTAR becomes université Gustave Eiffel

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Thomas Lesueur

— Commissioner General for Sustainable Development at the Ministry for an Ecological and Solidary Transition

→ How does the Ministry for an Ecological and Solidary Transition (MTES) see IFSTTAR's role?

Thomas Lesueur: IFSTTAR is the only public scientific and technological institution supervised by the Ministry. It plays an essential role in ensuring the success of the ecological transition, encouraging the development of new forms of mobility, designing the city of tomorrow, etc. MTES is in charge of transforming public policies that are at the heart of our daily lives. In order to formulate these policies, so that they are effective and appropriate, we need science and knowledge. IFSTTAR thus provides direct access to the research sector in order to answer the Ministry's questions. As a leading player in the field of transport and travel innovation, IFSTTAR was, for example, very much in demand in 2019 in the context of the *France Mobilités* initiative. In particular, its experts organised and led twenty *Master Classes* devoted to the conditions for the emergence and dissemination of innovative projects for the mobility of people and goods. These dealt with topics such as the economic models for the new freight services and "open ivnnovation".

→ What are the Institute's main contributions in the field of sustainable development?

T.L.: Improving the reliability of transport, developing a circular construction economy, increasing the use of renewable materials and alternative bio-materials, increasing the resilience of cities and infrastructures, contributing to the sustainable development of regions... All these objectives, which lie at the heart of IFSTTAR's activities, respond to the challenges of sustainable development. It is a vast field of research and innovation that covers the security of populations, the maintenance of infrastructures and environmental challenges all at the same time.

→ What do you expect from Université Gustave Eiffel?

T.L.: In 2019, Université Gustave Eiffel was a major project jointly managed by IFSTTAR and Université Paris-Est Marne-La-Vallée (UPEM), to which the Commissariat Général au Développement Durable (General Commission for Sustainable Development) contributed in its capacity as IFSTTAR's supervisory body. By bringing together a research organisation with a university and engineering schools, this new establishment represents a powerful means of disseminating the latest techniques and scientific knowledge throughout society. Research results will be more quickly and easily accessible to professionals. At another level, Université Gustave Eiffel also aims to create a culture of sustainable development in the training of all students. Finally, interdisciplinarity will enable new ideas to emerge and open the way for a new approach to the issues of the sustainable city and mobility. ●

"The issues of sustainable development lie at the heart of IFSTTAR's activities"

return to contents

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To find out about all the highlights

2019 highlights

JANUARY

13-17 January (Washington, DC.)
TRB2019
98th annual meeting of the Transportation Research Board (TRB).
⇨ FIND OUT MORE

14 January
Joint ceremony presenting best wishes for the new year at ESIEE Paris 1
The Founding members of Université Gustave Eiffel meet together.
⇨ FIND OUT MORE

23-24 January
46th ATEC ITS Congress 2
The *Rencontres de la Mobilité Intelligente* bring together all the stakeholders involved in Smart Mobility.
⇨ FIND OUT MORE

IFSTTAR's role in the Grand Paris Express adventure 3
In collaboration with IFSTTAR and CERIB, la Société du Grand Paris intends to conduct trials with fibre-reinforced concrete.
⇨ FIND OUT MORE

1

2

FEBRUARY

6-7 February (Nantes)
Technical Road Days (JTR) 4
The essential gathering of French public and private players in the field of land transport infrastructure.
⇨ FIND OUT MORE

7 February (Versailles)
Launch of the MobiLab cluster 5
A new research cluster to support innovation in the Yvelines automotive industry.
⇨ FIND OUT MORE

18 February
Partnership between Transpolis and Lacroix City
Vincent Sabot, Managing Director of Lacroix City, and Dominique Fernier, President of Transpolis, sign a partnership agreement.
⇨ FIND OUT MORE

20 February
Seminar@SystemX
Stéphane Espié (IFSTTAR) and Samir Bouaziz (SATIE - Université Paris-Saclay) lead a seminar at IRT SystemX.
⇨ FIND OUT MORE

MARCH

12 March
RECYBETON Symposium
Feedback day to present the results of the national project
⇨ FIND OUT MORE

14 March
SHM-France : Testing and monitoring structures
The 2nd national SHM-France symposium brings together some 80 persons.
⇨ FIND OUT MORE

return to contents

4

6


10


5

18-20 March
Biennale des territoires
Discussions centred on a new vision of the resilience of transport networks and presentation of the MIRE study.
⇨ FIND OUT MORE

26 March
National consultation on natural risks 6
IFSTTAR has a joint stand with IRSTEA and CEREMA.
⇨ FIND OUT MORE

APRIL

8-12 April (Nantes)
1st Infrastar Training School
A week of training on the problems of concrete fatigue in the context of wind turbine and bridge foundations.
⇨ FIND OUT MORE

24 April
EVRA project: our trials supported by the State 7
Elisabeth Borne, Minister of Transport, announces the winners: two consortia, one of which is led by IFSTTAR, have been selected.
⇨ FIND OUT MORE

MAY

17 May
Signing of a framework agreement between OSMOS and IFSTTAR
OSMOS is a firm specialising in structural health monitoring.
⇨ FIND OUT MORE

20-24 May (Nantes)
EPFW Symposium - European Friction Workshop
2nd edition of the European symposium on pavement skid resistance.
⇨ FIND OUT MORE

26-27 May (Tokyo)
T20 Summit 8
Université Gustave Eiffel's proposals for resilient and low-carbon infrastructure selected in preparation for the G20.
⇨ FIND OUT MORE

JUNE

Launch of the Logistics City chair 9
IFSTTAR, UPEM and the Sogaris group launch a chair devoted to research on urban logistics.
⇨ FIND OUT MORE

7 June
The Université Gustave Eiffel and CEREMA join forces for the mobility of tomorrow 10
The future university and CEREMA sign an agreement cementing their common will to work for the infrastructures and vehicles of tomorrow.
⇨ FIND OUT MORE


7

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11-12 June (ESIEE Paris)
1st Franco-Swedish workshop
The "*Smart Cities and Mobility*" workshop encourages the sharing of knowledge and expert appraisals between Swedish and French players in research, innovation and training.
⇨ FIND OUT MORE

15-27 June
The Paris-Brussels-Montreal International Summer School
The summer school focuses on an immersive and interactive learning process around the circular economy.
⇨ FIND OUT MORE

18 June
IFSTTAR and UPEM welcome a delegation from Djibouti
The delegation is made up of the Minister of Higher Education and Research and the President of the University of Djibouti.
⇨ FIND OUT MORE

8

9

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return to contents

12


11

13

20 June
The Bridge Encounters *(Journées et Rencontres Ouvrages d'Art)*
The Bridge Encounters of the Scientific and Technical Network of the MTES are organised jointly by IFSTTAR and CEREMA.
⇨ FIND OUT MORE

24-25 June
International Workshop on CO_2 Storage In Concrete (CO2STO) 11
Conference organised by IFSTTAR and the national FastCarb project, in partnership with the Association Universitaire de Génie Civil, the École française du béton, the Fédération de l'Industrie du Béton, and RILEM.
⇨ FIND OUT MORE

24-28 June
POLLUSOLS Summer University
On the theme "integrated approach to non-point source pollution of soil and sediment".
⇨ FIND OUT MORE

27 June (Nantes)
4th colloquium of the ECOMAT LIA
Within the framework of the International Associative Laboratory ECOMAT, a delegation of 7 Canadians is welcomed.
⇨ FIND OUT MORE

Creation of the wood-bio-based cluster 12
IFSTTAR, the Île-de-France Region, the Institut FCBA, Université Paris-Est, EpaMarne and FrancilBois announce the creation of the Booster.
⇨ FIND OUT MORE


14

JULY

3 July
Opening of the TRANSPOLIS platform 13
The 1st full-scale laboratory city devoted to urban mobility on a scale of 1 in Europe".
⇨ FIND OUT MORE

3-4 July
The 2019 *RST Transports et Déplacements* ("RST Transport and Travel Days") study day
The 15th edition takes place on the Marne-la-Vallée site.
⇨ FIND OUT MORE

9-10 July
RED project feedback symposium
The ANR RED project teams present the results of four years of research.
⇨ FIND OUT MORE

AUGUST

27-30 August (Lyon)
ERSA Congress 14
Under the theme "*Cities, regions and digital transformations: opportunities, risks and challenges.*"
⇨ FIND OUT MORE

SEPTEMBER

7 September
New Chair entitle "the Circular Economy and Metropolitan Urban Metabolism"
IFSTTAR and the Métropole du Grand Paris are creating a research chair on the circular economy and metropolitan urban metabolism.
⇨ FIND OUT MORE

10 September
IFSTTAR receives the HCERES expert committee
3-day visit of the HCERES committee for evaluation and constructive discussions.
⇨ FIND OUT MORE

17 September
Franco-Japanese discussion workshop 15
The workshop consolidates partnerships and encourages the mobility of young researchers in the field of the ageing of concrete and structures.
⇨ FIND OUT MORE

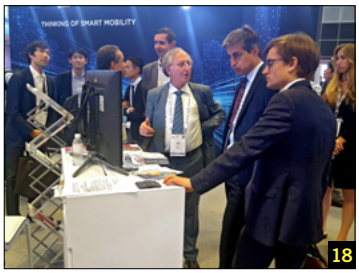
17-19 September
Urban Engineering Summer University, EIVP
With the theme "*the streets of tomorrow*".
⇨ FIND OUT MORE

23 September
1st sessions of the *France Mobilités* Master Classes 16
Objective: to promote the emergence and dissemination of innovations for the mobility of people and goods.
⇨ FIND OUT MORE

return to contents


15


16


18

17

30 September-3 October
Smart Rivers
Presentation of projects on dyke instrumentation, masonry structures and innovative concretes.
⇨ FIND OUT MORE

OCTOBER

2 October
Launch of the Mobility and Intelligent Transport Chair
Collaborative innovation for a reinvented mobility, that is more responsible and at the service of users.
⇨ FIND OUT MORE

3 October (Paris)
Grand Paris Circulaire 16
This 3rd edition focuses on the circular economy for the region and the stakeholders of the Grand Paris
⇨ FIND OUT MORE

6-10 October (Abou Dhabi)
26th World Road Congress
On the French pavilion, IFSTTAR presents, in particular, adaptation to climate change with Sense-City, the Transpolis autonomous vehicle trials, the resilience of bridges as well as monitoring and maintenance tools.
⇨ FIND OUT MORE

8 October (Bron)
National Scientific Encounters (RNSB) 17
Conference-debate on "*How the social and solidarity economy can participate in the urban project*".
⇨ FIND OUT MORE

21-25 October (Singapour)
ITS Singapour 18
World Congress on Intelligent Transport Systems.
⇨ FIND OUT MORE

28 October - 1 November (Tokyo)
WCRR
The World Congress on Railway Research provides an opportunity to present the work of IFSTTAR.
⇨ FIND OUT MORE

29 October
IFSTTAR and RTRI strengthen their partnership
Two agreements are signed between IFSTTAR and the RTRI (Japanese Railway Technical Research Institute).
⇨ FIND OUT MORE

NOVEMBER

4 November
Jacques Cartier meetings
Coloquium organised around "Collaborative research in medical technologies and their integration".
⇨ FIND OUT MORE

7 November
Opening of the EVASYM inernational laboratory
The advent of the EVASYM LIA is a concrete expression of the successful partnership between several institutions in France and Quebec.
⇨ FIND OUT MORE

21 November
Innomob: a laboratory without walls
IFSTTAR and DLR reinforce their joint commitment to developing innovative solutions and methods for mobility.
⇨ FIND OUT MORE

26 November
Opening of the Sense-City 2nd mini-city
Mini-city 2 is inaugurated in the presence of the outstanding facility's partners.
⇨ FIND OUT MORE

27-28 November (cité Descartes)
Future Days 2019
The Grand Paris event on the cities of tomorrow brings together more than 500 participants.
⇨ FIND OUT MORE

DECEMBER

15 December
Decree creating Université Gustave Eiffel
Birth of the new university to invent the cities and territories of tomorrow.
⇨ FIND OUT MORE

IFSTTAR becomes université Gustave Eiffel

return to contents

Spotlight on…

CIRCULAR ECONOMY

A first summer school divided between Montreal, Paris and Brussels

In June 2019, some 50 students, young researchers and professionals discovered the experiments and strategies for the circular economy in three major French-speaking metropolitan areas: Montreal, Brussels and Paris. Visits were organised as part of the first "Cities, regions and the circular economy" summer school.

→ How are Montreal, Brussels and Paris breaking with the linear economy (take-make-consume-throw away)? What strategies do they implement in the areas of waste recycling, food supply or even the rehabilitation of industrial buildings? To find out how the three major cities answer these questions, students, young researchers, entrepreneurs and professionals in urban planning, architecture and urban economics participated in the first "Cities, regions and the circular economy" summer school. Organised by the Université de Montréal, the Université Libre de Bruxelles, IFSTTAR and the "Urban Metabolism" group of the Futurs Urbains Labex, this summer event took place from 16 to 30 June 2019. "*For two weeks, the participants went out in the field to discover a large number of trials and exchange ideas with project leaders and local authorities, for example. The objective was to show them what these cities are doing and how to set up a circular economy project, what difficulties are encountered, the organisational methods chosen, etc.*", explains Corinne Blanquart, director of IFSTTAR's AME department and French coordinator of the summer school.

At the end of two weeks of meetings and visits, the participants made documentaries of about five minutes each on subjects such as land, short supply chains, commons... These videos were shown on the closing evening, and are now available on the Metabolism of Cities YouTube channel. Supported by the Grand Paris metropolis and the "Circular Economy and Urban Metabolism" research chair founded in September 2019, the summer school will be held for several years. "*The circular economy is a much discussed topic but it is still an emerging field of research so we need to continue to develop the tools and methods to implement it or successfully scale it up*", Corinne Blanquart concludes. ●

"The circular economy is a much discussed topic but it is still an emerging field of research"

LET'S HEAR FROM SOME OF THE PARTICIPANTS

— Agnès Bastin,
doctoral student in sociology and urban studies (Sciences Po Paris)

"A summer school on the theme of circular economy is a rare opportunity in the academic world. It allows projects to have a greater impact and see what can potentially be replicated. I liked the survey and analysis methodology we used for interviews with food chain stakeholders in Montreal. The visit to the Lavallée eco-neighbourhood site in Châtenay-Malabry was also very informative. It's interesting to see how a large developer perceives the circular economy and incorporates the recycling and re-use of building materials into its strategy".

— Sonia Veyssière,
doctoral student in economics (ADEME / Université du Littoral / IFSTTAR)

"During my visit to Montreal I was surprised to find many local stakeholders who were involved in circular economy activities, even in the absence of an institutional strategy on the topic. The workshop on Sankey diagrams and the workshop on the prospective co-design method in Montreal, the bike tour of the Brussels urban farms, making a video documentary based on our meetings, visits and discussions…The summer school encourages you to ask questions, particularly about the role of land in the circular economy".

return to contents

T20 TOKYO

Infrastructure resilience: IFSTTAR makes a contribution to the T20 summit in Tokyo

In May 2019, IFSTTAR and its partners at Université Gustave Eiffel delivered two policy briefs on the infrastructure of the future at the final T20 (Think20) summit in Japan. The aim of these proposals is to provide input for the reflections of the political leaders meeting at the G20.

→ To inform the discussions of the ministers and heads of state meeting at the end of June 2019 during the G20. This is why IFSTTAR, alongside 400 international experts, was asked to take part in the T20 (Think20). This year, under the presidency of Japan, this commitment group of think tanks and research institutes aimed to produce public policy recommendations for the G20 member countries. "*In addition to the Institute's expert appraisal work in the field of transport infrastructure resilience, this invitation is the outcome of numerous collaborations with our international partners,*" recalls Jean-Bernard Kovarik, Managing Director of IFSTTAR and future Vice-President for Public Policy Support at the Université Gustave Eiffel and a contributor to the T20.

Together with other experts from Université Gustave Eiffel's founding institutions and the Cercle Grand Paris de l'Investissement Durable, IFSTTAR researchers helped draft two policy briefs on the theme of infrastructure. The result of a year of discussions and research, their proposals were presented at the final T20 summit organised at the end of May 2019 in Tokyo, before being brought together in the Communiqué submitted to the G20 political leaders who met a month later in Osaka. The aim was to help them redefine the financing and equitable sharing of the economic, social and environmental value of infrastructure for the common good. "*Our work brings together the ideas of engineers, geographers, economists and sociologists in order to better address the complex issue of infrastructure resilience*".

What do these two policy briefs contain? The first, *Building resilient infrastructure systems*, recommends developing resilience strategies at the level of technical systems and services rendered, harmonising methods for measuring resilience and promoting a socio-political approach to resilience that will facilitate project financing and acceptability. "*These topics were addressed from the perspective of climate change, cybersecurity and infrastructure ageing,*" explains Jean-Bernard Kovarik, co-author of the text. The second policy brief, *The infrastructure nexus: from the future of infrastructures to the infrastructures of the future*, focuses on tomorrow's infrastructures in terms of economic growth and social progress. In particular, it details the impacts of urbanisation on biodiversity and ecosystem services and the development of sustainable urban agendas and projects with a focus on critical regions such as the Amazon and the Arctic. "*This brief draws attention to the need for more balanced and sustainable development in the context of resource constraints and urban growth. All these topics will be pursued in 2020 from the perspective of events that are directly or indirectly linked to the Covid-19 crisis.*" These recommendations for a new generation of infrastructure, in line with the major issues discussed at the G20, "*are also of interest to financiers and cooperation and development players such as AFD and IRD,*" Jean-Bernard Kovarik stresses. "*The international network set up in the framework of this research also foreshadows the potential for scientific collaboration at the Université Gustave Eiffel*" he adds. ●

BUILDING THE FUTURE OF QUALITY INFRASTRUCTURE

This open-access book, published by the Asian Development Bank (ADBI), contains almost 100 pages of syntheses, policy briefs and discussions from the Tokyo T20 Summit and related events.

⇨ **FIND OUT MORE**

"Draw attention to the need for more balanced and sustainable development"

Jean-Bernard Kovarik, *Deputy Managing Director of IFSTTAR and future Vice-President for Public Policy Support at the Université Gustave Eiffel*

return to contents

Prizes and distinctions

Find out about all the prizes and awards

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PRIZE

PhDs

COSYS-SII 1

Nicolas LE TOUZ

Albertis Chair: 2019 thesis prize in the category Transport for his work on the design and study of positive energy transport infrastructure: from thermomechanical modelling to the optimisation of such energy systems on the IFSTTAR R5G project.

⇨ FIND OUT MORE

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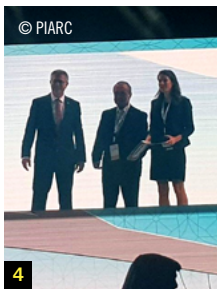

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PRIZE

Innovation / Promotion

COSYS-SII

Nassif BERRABAH received the scientific prize awarded by EDF R&D for his CIFRE-funded thesis "Inverse problems for diagnosis of electric cables from reflectometry measurements".

⇨ FIND OUT MORE

MAST-LAMES 2

Juliette BLANC received the FEREC Foundation prize for the Mine BPL project.

⇨ FIND OUT MORE

MAST-MIT 3

Emmanuel CHAILLEUX received the "*Best Innovation Project*" prize jointly with Dr Davide Lo Presti (University of Nottingham) for "*BIOREPAVATION: Innovation in Bio-Recycling of Old Asphalt Pavements*", which was awarded during the STA 2019 Conference.

⇨ FIND OUT MORE

AME-LVMT 4

• **Anne DE BORTOLI** was placed second in the Charles Parey - Gold medal for innovation which is awarded every four years in the road sector with Adelaïde FERRAILLE and Fabien LEURENT (ENPC) for the study "defining one's road maintenance strategy: a new evaluation method for equitable and sustainable resurfacing programmes".

⇨ 1ST PRIZE

• The PIARC international "Young Professionals Prize" for the best article written by an author of under 35 years of age: "what resurfacing strategies for sustainable development? A case study on a French motorway section".

⇨ 2ND PRIZE

COSYS-ESTAS 5

Mohamed GHAZEL with O. Cazier (Cazier Conseil) received the Charles Parey - Gold medal for innovation which is awarded every four years in the road sector for a study entitled "MORIPAN : a new approach to safety at level crossings" which was submitted at the 26th World Road Congress.

⇨ FIND OUT MORE

COSYS-LICIT 6

Ludovic LECLERQ received the 2019 Lyon University Grand Prix, awarded by the Auvergne-Rhône-Alpes Region.

⇨ FIND OUT MORE

COSYS-LEPSI

Fabrice VIENNE was awarded the "Mix & Match" prize at the "Security & Safety Meetings".

MAST-EMGCU 7

André ORCESI received the AFGC 2019 prize which is awarded to engineers, researchers and academics for work conducted in the scientific and technical spheres.

⇨ FIND OUT MORE

return to contents

PRIZE

Learned societies, associations and foundations

AME-EASE

Daniel DOLIGEZ (6 D Solutions) **Cyrille CHAZALLON, Hervé PELLETIER** (Insa Strasbourg) **Éric GODARD** (COLAS)**, Pierre HORNYCH, Mai-Lan NGUYEN, Armelle CHABOT, Laurence LUMIERE, Maissa GHARBI** (IFSTTAR) were awarded the PIARC French National Committee Silver medal for their paper "A durable technique for strengthening roads with coated fibreglass grids".

AME/TS2 8

The European SaferAfrica consortium won the "Prince Michael International Road Safety Awards for Road Safety Management" for its discussion platform which sets out to strengthen cooperation between governments, research institutes and non-governmental organisations in Africa and Europe.

⇨ FIND OUT MORE

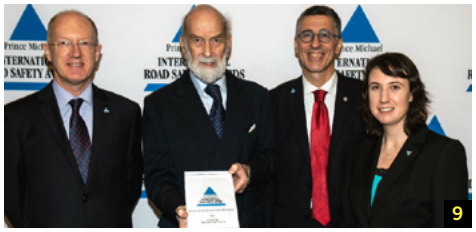
TS2-UMRESTTE 9

The European SafetyCube consortium won the "Prince Michael International Road Safety Awards for Road Safety Management" for its website which was designed to provide players in the political sphere with better scientific information on risk factors and how to measure them.

⇨ FIND OUT MORE

© Road Safety Award

8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10

11

PRIZE

Publications /papers/ conferences

COSYS-LISIS 10

Maria BARRIERA
Jointly-awarded 1st prize for the best doctoral poster at the JTR 2019 for tests conducted on the weigh-in-motion scale developed by the Start up company Altaroad.

⇨ FIND OUT MORE

AME-UMRAE

Simon BIANCHETTI, Pierre AUMOND, Mehdi REGRAGUI with Raphaëlle DUQUESNOY won 1st prize at the Soundscape Hackathon in Ghent (Belgium).

⇨ FIND OUT MORE

AME-UMRAE 11

Marianne BOU LEBA BASSIL won 3rd prize for the best doctoral poster at 2019 Technical Road Days (JTR) for: "Study of the aerodynamic mechanisms responsible for tyre -road contact noise".

⇨ FIND OUT MORE

TS2-LBA

Oscar CHERTA received the 1st prize at the YRS2019 young researchers seminar, which is jointly organised by ECTRI, FEHRL and FERSI for the study "*Protection issues for motorcyclists' airbag protectors: A parametric study based on real accident data*", in the theme of Transport Safety.

GERS-GMG

Jean-François CORTE and Jacques GARNIER, former IFSTTAR researchers have been admitted to the 2019 Hall of Fame for "*Paper 7796 (1995): E.C. Clukey, M.J. Morrison, J. Garnier, and J.F. Corte - The Response of Suction Caissons in Normally Consolidated Clays to Cyclic TLP Loading Conditions*".

⇨ FIND OUT MORE

AME-SPLOTT

Adeline HEITZ received two prizes awarded by the WCTR: :

- *Young Author Best Paper Prize for "Planning urban freight and logistics: duality in the logistics real estate market, the case of the Paris Metropolitan area".*
- *Topic Area B Award For Paper for: "Planning urban freight and logistics: duality in the logistics real estate market, the case of the Paris Metropolitan area".*

⇨ FIND OUT MORE

MAST-CPDM/MIT

Heriberto MARTINEZ
2nd prize in the young researchers competition during the XVth forum on the Bioedeterioration of Materials for a poster and an oral presentation on the bioprecipiation of calcium carbonates.

⇨ FIND OUT MORE

AME-GEOLOC

Johan PERUL received an award for the 3rd best presentation at the doctoral student day at the MathSTIC doctoral school for his presentation of research on Kalman filter based innovative tight fusion for pedestrian navigation.

APPOINTMENTS

High institutions

MAST-DIR

Bruno GODART was appointed Chair of the Scientific and Technical Evaluation Committee for Bridges at MTES.

⇨ FIND OUT MORE

MAST-GPEM

Anne VENTURA
has received the title of Chevalier by the Ordre des Palmes Académiques.

return to contents

Scientific life: research and expert appraisals

FIND IN VIDEO
the research activity of the Institute

Serge Piperno,
scientific director

Antoine Frémont,
assistant scientific director

return to contents

With Université Gustave Eiffel, IFSTTAR's scientific mandates will be continued.

In 2019, IFSTTAR gradually changed the focus of its activities in view of the forthcoming creation of Université Gustave Eiffel on January 1, 2020. While research activities continued normally within a stable setting in the Institute's departments, the conditions necessary for the creation of the university were put in place during 2019.
With the creation of this establishment, IFSTTAR's scientific mandates will be continued, in particular fundamental and applied research that interacts with expert appraisals and public policy support and which is international in scope and open to society. The virtuous continuum formed by training, research and expertise, which already existed at IFSTTAR, should be further consolidated and fostered. The development of the creation in 2019 of the vice-presidencies for Research, International affairs and Public policy support is in line with this vision of scientific roles that are both strengthened and reinvented.

→ The principal mandates of IFSTTAR and Université Gustave Eiffel

In particular the Institute has the following tasks:

- To carry out fundamental and applied research, perform methodological studies and develop tests and prototypes;
- To conduct expert appraisals and advisory work of all types in the fields mentioned in the first paragraph of this article;
- To implement a scientific and technical information policy and disseminate the knowledge gained, in particular through publications, technical regulations and standards;
- To pursue a policy to exploit the results of its scientific and technological research, in particular by means of technical support, technology transfer and certification tests;
- To play a role in training by and for research and both vocational and in-service training;
- To help to export its expertise and the techniques it develops and gain better international exposure for them.

Source: Decree of 30 December 2010 concerning the creation of IFSTTAR

The main tasks of Université Gustave Eiffel:

- Initial and in-service education, with a strong focus on apprenticeship education;
- Careers guidance, social advancement and professional integration that also encourages entrepreneurship;
- Research (fundamental and applied) and innovation;
- Expert appraisals, public policy support and standardisation;
- Openness to society and international cooperation;
- Working with its partners to embody a dynamic outlook;
- Dissemination of humanist culture, in particular through the development of the human and social sciences and scientific, technical and industrial knowledge;
- Openness to society and international cooperation.

Source: Decree of 13 December 2019 concerning the creation of Université Gustave Eiffel

return to contents

The HCERES evaluation of the establishment's departments: what lessons?

In order to be better prepared for their integration within Université Gustave Eiffel, IFSTTAR's departments and the establishment underwent so-called Wave E evaluations by HCERES. These were therefore conducted simultaneously with those of UPEM's laboratories. The evaluations of the departments were completed in 2019 with the release of the evaluation reports written by the inspection committees.
The evaluation of the establishment took place in autumn 2019 and the report was delivered at the end of the same year. All the institutions of the future University (EIVP, ESIEE Paris, ENSG, ENSAVT, UPEM and IFSTTAR) were evaluated at the same time, which made the process highly complex. What general lessons can be drawn from these evaluations from Université Gustave Eiffel's perspective? Clearly, both time and an intense effort are required in order to prepare for and receive the evaluation committees. The value of the process lies as much - and perhaps even more - in the capacity of the scientific teams themselves to take stock of their achievements and the future prospects for their work as in the evaluations themselves, in which the scientific aspect is sometimes pared down to the bare essentials. Nevertheless, the evaluation reports, which are available on line on the HCERES and the institution's website, give a very full picture of scientific activities in the departments and the institution and outline possibilities for the years to come.

An overview of the evaluation of the departments

The Planning, Mobilities and Environment department (AME): maintain the stability of the department

→ The HCERES committee that inspected the AME department acknowledged the value of the department as *«the only major multidisciplinary research structure in France likely to play a major role in decision-making»*, and noted that it runs smoothly and has very good internal unity, fostered by unifying scientific activities. The committee also drew attention to the very high standard of publications (for which efforts to obtain citations from the international community will have to be stepped up), very good relations with the socio-economic world and excellent facilities.
The department's scientific agenda, based on three themes (Mobility and systems of actors; Mobility and technical systems; Mobility and ecosystems) has been validated. For this agenda, the committee pointed out the potential benefits of interdisciplinarity, which can enhance both the questions that are posed and the approaches used to tackle them, without sacrificing a high level of technical expertise in each of the fields the department covers.
The inspection committee made a number of recommendations. The following are particularly relevant in the context of the creation of Université Gustave Eiffel: the need to continue to apply and to intensify an interdisciplinary approach, which is all the more necessary as subjects become more complex; to engage in forward thinking to identify and meet the challenges posed by today's mobility and transport issues; and to become more involved in doctoral training, which will become even more important following the creation of Université Gustave Eiffel.
Finally, one of the inspection committee's recommendations concerned the need to maintain the stability of the AME department in a context of institutional and organisational change. This will be the main focus in the coming months. At the end of 2019 a process of reflection had already been initiated within the department and its laboratories on the best possible way(s) of implementing the department's scientific agenda and the research activities of its laboratories.

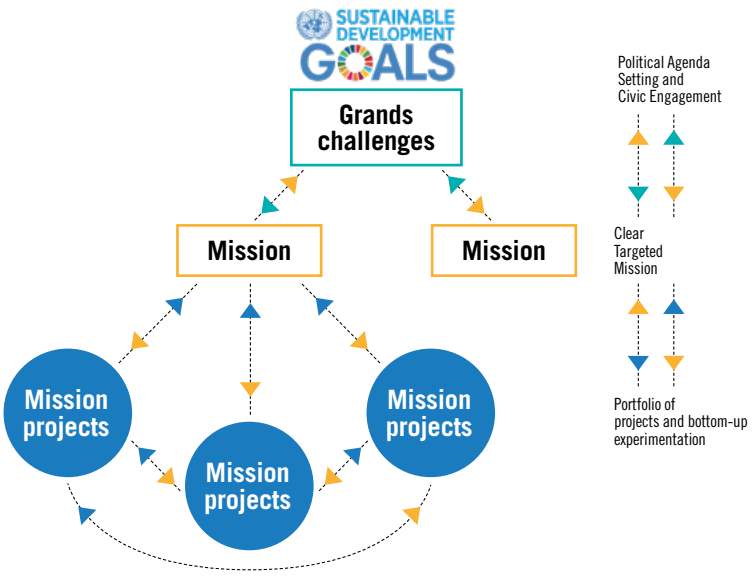
The Components and Systems department (COSYS): concentrating resource on a limited number of critically important topics

→ The inspection committee highlighted many very good aspects of the department's policies during the last few years in terms of its strategy and approaches, ambitious agenda, strong relations with socio-economic players and international action. The report paints a glowing and inspiring picture of the science and innovation carried out within the department and stresses its influence and utility. It is unconditionally positive

return to contents

about the quality of the department's achievements and its links with the socio-economic environment. This evaluation answers most of the department's doubts about its quality and direction, conferring legitimacy. The two-day visit was organised like a congress and provided an opportunity to present a coherent and comprehensive set of results and outstanding achievements. The garnered information has been used on several occasions since. The department has improved the management of its scientific activities in the themes it covers, in particular by creating specific workshops for each theme, mobilising all of the staff and systematically including colleagues from Université Gustave Eiffel, as was done during the department's seminar or the setting up of **FUTURE projects**. Furthermore, in its governance, COSYS has also implemented task- and challenge-based management of its activities in the same spirit as Horizon Europe, in order to focus resources on a very limited number of critically important subjects so as, ultimately, to help the public authorities decide on the social choices they will have to make. The sharing of intelligence between the infrastructure and vehicles, the validation of artificial intelligence (AI) for automated mobility, the roads of the Anthropocene, or monitoring throughout the different scales of the territorial metabolism are examples of topics of this type that address two major challenges: making new types of mobility instruments of carbon neutrality and ensuring that we have breathable air.

Seminar organised by the COSYS department during the visit of the HCERES inspection committee.



From challenges to Missions Image RTD. © Mazzucato (2018)

The Geotechnical Engineering, Environment, Natural Hazards and Earth Sciences department (GERS): consolidating international actions

→ The HCERES evaluation was on the whole very positive. In particular, the committee noted the effort to restructure and refocus the department's research activities. This has made it possible, in the context of a significant reduction in staff numbers and basic support, to increase and diversify budgetary resources and to relaunch a policy of investing in and replacing major facilities. This innovative, cutting-edge scientific equipment is operated by committed and competent technical staff.

The scientific output of GERS has increased during the period under evaluation (452 papers in international journals by the 48 researchers who published during this period), many of them in leading journals. The teams participated in a considerable number of competitive projects (ANR, FUI, European...). Previous efforts to join and lead European networks are beginning to bear fruit. The department's research work is clearly focused on themes that can have an impact on the economy and society. Interactions with the

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return to contents

Perméafor tests developed by the University of New Hampshire (UNH) with the future Université Gustave Eiffel for the New Hampshire Department of Transport (NHDOT).
© Carlos Minatchy - IFSTTAR

socio-economic world are varied and fruitful. Finally, the department's staff play an active role in expert appraisals and standardisation bodies and, more generally, the inspection committee highlighted the efforts made to transmit research results to professionals, through learned societies and the general public. This part of the department's activities is deemed important and should be kept in the future.
The department's agenda, whose roots lie in the creation of Université Gustave Eiffel, was deemed to be clear and realistic. In particular, the committee recommends continuing the effort to increase international publications, paying particular attention to the publication of work by doctoral students. The department should also take advantage of the resources available at the FUTURE I-Site to reinforce its influence and international partnerships, by actively welcoming foreign researchers and encouraging the mobility of its staff.
A more proactive policy should also be implemented to use patents to better exploit its scientific advances.
To conclude, within its remit, GERS appears to be a coherent and valuable research structure. The way the department is organised provides a high-quality working environment and facilitates interaction between the teams which are located at several sites. However, some leadership actions will be required to strengthen the staff's sense of belonging to the department and to position its activities within the Université Gustave Eiffel project, while taking care to maintain and develop the very fruitful local and regional partnerships.

The Materials and Structures department (MAST): conserve major facilities

→ The HCERES evaluation of the MAST department has strengthened the focus of its scientific agenda around four themes: the durability of construction materials, the control of ageing and risks in structures and infrastructure, the circular construction economy and innovations in infrastructure and construction.
The inspection committee underlined the potential for synergy between topics linked to urban construction and the infrastructure for urban transport and networks. It encouraged the department's commitment to maintaining its skills and research base at the current level in order to monitor the sustainability and ageing of infrastructures, by further improving its effectiveness and efficiency in the service of public contracting authorities. The committee also recommended increasing the academic and international recognition of the theme of the circular economy.
The department reasserted its strategy with regard to striking a balance between activities and was encouraged to maintain an innovative approach, at the boundary between the academic and industrial spheres, through work based on its major experimental research facilities and through significant involvement in expert appraisal, certification and standardisation, which account for approximately 10% of its time. As part of Université Gustave Eiffel, MAST will therefore stress how important it is for these activities to receive academic recognition. The ways in which beneficiaries are listened to and the nature of partnerships will be revised in this new context in order to effectively manage and finance applied research and expert appraisals.
Finally, the department took careful note of the recommendation to make the creation of Université Gustave Eiffel into an opportunity rather than a threat. In this context, it intends

The HCERES committee's visit to MAST.

return to contents

to modify the existing organisational equilibrium between hierarchical structuring and leadership based on scientific projects in order to encourage synergies, while remaining watchful with regard to operational efficiency in an environment where the way resources will be organised and deployed is still undecided. MAST was encouraged to maintain its strengths in terms of major facilities and the expertise of its research support staff. In this connection, it took note of the encouragement to aim to manage its major experimental research facilities more efficiently. Finally, the department noted the positive reaction to its internal seminars, for which a process of continuous innovation must be maintained so that they support scientific synergy between different areas of the department's work and the links between the different sites.

The Transport, Health, Safety department (TS2): continuing partnerships with universities, in particular via the jointly-managed research units (UMR)

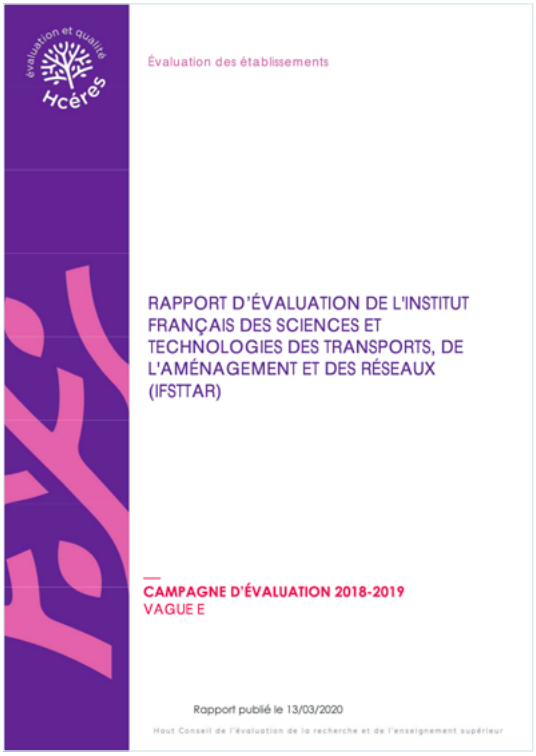
→ The HCERES inspection committee acknowledged the cross-cutting and motivating role of the TS2 department, which has *«a collective vision and a clear scientific identity»*, permits *«cross-fertilisation between interdisciplinary projects in its laboratories»* and increases *«their visibility at international and national levels in terms of research, expert appraisal and decision-making support»*. Concerning the department's agenda, the inspection committee agreed that the envisaged scientific avenues based on the 5 themes (automated driving, new road safety and acceptability issues; new road safety issues; mobility and health for all; modelling the human being; the design, development and operation of digital databases) correspond to major societal issues and that they are coherent, relevant and achievable. This should enable TS2 to consolidate its international standing. The committee also stressed the need, which is all the stronger in an interdisciplinary entity, for researchers and research groups to nurture their links with academia.
In order to consolidate the themes of transport, health and safety within Université Gustave Eiffel, the inspection committee's recommendations included several noteworthy points. The department's policy of strengthening its links with partner universities should be pursued and strengthened, in particular through the creation of a Joint Research Unit (UMR). Efforts made in connection with CIFRE-funded theses should be stepped up, both with industry and local authorities. Finally, more attention should be drawn to its outstanding facilities (testing facilities and databases), particularly on the websites.
The inspection committee took the view that a structure such as TS2 should be maintained within Université Gustave Eiffel, at least in spirit, in order to enable researchers to continue to nurture an effective synergy and structure. This is the key challenge of the Institute's «Transport, Health, Safety and Risks» project which is currently being developed within the department. This aims both to ensure continuity and to extend its scope to include other laboratories and teams at Université Gustave Eiffel.

return to contents

Evaluation of the establishment: consolidating academic ties

As part of the evaluation of the establishment, IFSTTAR performed the challenging task of presenting what it sees as its strengths but also ways of improving its organisation, without forgetting to map out initial avenues for development within the new university. On this basis, the report submitted by the evaluators makes several significant points. It supports a number of the strategic choices, in particular the importance of consolidating academic ties, for example in the form of UMRs, IFSTTAR's duty to contribute to the organisation of scientific life in France on themes related to the city and mobility, and preserving the Institute's international reputation.

→ The evaluators identified a number of points requiring attention and made several recommendations that will be valuable for the future Université Gustave Eiffel. We should ensure that we support the staff in the creation of this new university, bolster our international strategy, build a comprehensive policy concerning scientific facilities and maintain the "very good ratio between the number of administrative staff, engineers and technicians and the number of researchers", which will be an asset for the future university. Some secondary proposals and remarks nevertheless allow us to state principles that seem essential to us. We should not modify our economic model by recruiting permanent staff on contracts. We should guarantee the quality of the opportunities for PhD graduates and the quality of the research methods to be adopted in order to meet our partners' needs. Lastly, we should continue to see public policy support activities as being compatible with high-quality research, helping to guide them in the right direction, exploiting them and maintaining the links with their beneficiaries.



The HCERES report of IFSTTAR.

return to contents

Support for research activities

With the prospect of the Gustave Eiffel University, the scientific momentum of I-Site FUTURE continues

→ The momentum of I-Site FUTURE was maintained in 2019 with the launch for the third consecutive year of a theme-based "Exploratory" call for projects. Much appreciated by the research units, this call is concerned with projects lasting one year, with funding of around €20k and a total budget of €100k, revolving around a specific topic and opening up prospects for further development. A call for expressions of interest for "Impulse" projects has been launched. This relates to a list of themes deemed to be missing from the I-Site's set of scientific challenges, as proposed by the Scientific Committee and the Advisory Board. Three new projects have already been selected and it should be possible to select three more if a fifth year of funding for the I-Site is granted. The "visiting professor" call for projects was relaunched in 2019. The aim is for this to attract 9 new high-level international researchers, for a novel format of visit which involves their presence for about 20% of their time over three years, making it possible to create effective international cooperation in the short term.

FUTURE
INVENTER LES VILLES DE DEMAIN

© Université Paris-Est

A gradual change in the research structures

The appointment of new laboratory management

→ When the laboratory managers within the departments are replaced, this creates an excellent opportunity for the research structures to evolve. Indeed, each new management team prepares a project for the laboratory before it is appointed, and this is discussed collectively with all the laboratory staff but also with the department management and the Scientific Directorate. Changes in the management team therefore very often signal a new start for the laboratories. In 2019, it was necessary to replace 13 management teams whose 5-year terms were about to expire. However, only 5 new management teams took over on 1 January 2020. Indeed, one excessively small laboratory (MACSI) was closed down and another had already changed departments the previous year with a fresh project (GEOLOC). It was also judged advisable to extend the terms of the management teams of four laboratories in the GERS department (GEOEND, EE, SRO and GMG) in order give the department an opportunity to think about changes in their roles. As for the LMA in the TS2 department, the term of its management team has also been extended pending its transformation into a joint research unit through a merger with a laboratory at Université de Marseille. However, new management teams have taken over at the GRETTIA laboratory (COSYS) and the CPDM, GPEM, LAMES and MIT laboratories in the MAST department.

Creation of the PICS-L laboratory (COSYS department)

→ A new laboratory, PICS-L (The Perceptions, Interactions, Behaviors & Simulations Lab for road and street users), was created on 1 January 2020 by the merger of LIVIC and LEPSIS, as recommended in the 2015 HCERES evaluation. The project of the PICS-L laboratory aims to develop tools and knowledge based on multidisciplinary research in order to observe, understand, improve and evaluate the individual mobility of road and street users with various degrees of assistance and automation. The goal is, while remaining within the scope of the existing scientific project, to pool the multidisciplinary skills of the laboratory in order to address all the stages of a scientific approach

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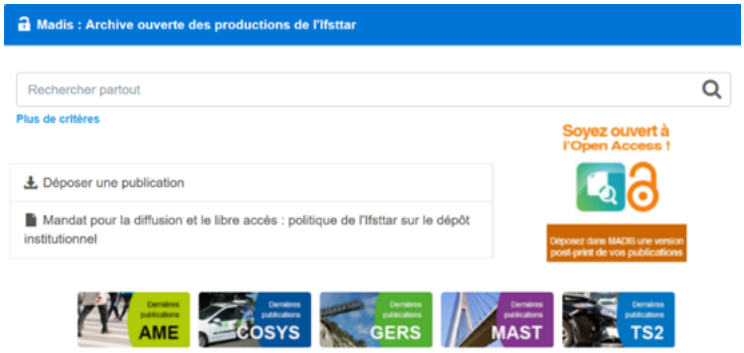
return to contents

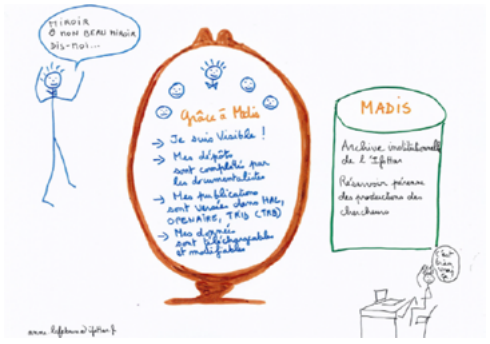
from observation to the evaluation of solutions by way of theory and modelling.
The research in the PICS-L laboratory project is organised according to four cross-disciplinary fields:

- The field of perception and supervision covers the understanding and modelling of perception systems and the main phenomena that disrupt their operation, such as unfavourable geometrical, lighting and meteorological conditions.
- That of behaviours and interactions aims to analyse and model the behaviour of users when interacting with their vehicle, the infrastructure and other users, in different situations on the road or in urban areas.
- That of virtual reality deals with the physical, experiential, ethological and/or psychological validity of hardware and software devices that allow the observation of the interactions between the entities controlling motion (human or robotic) and the travel environment (infrastructure and other users) under various traffic conditions, especially degraded ones.
- Finally, the field of travel assistance contributes to the design and/or evaluation of innovative solutions whose deployment is likely to improve the experience of current and future road and street users.

A scientific and technical information policy serving research

→ In 2019, IFSTTAR continued its policy of disseminating its researchers' publications through green open access, which was formalised in 2017 with the signing of an open access dissemination charter that creates an obligation to deposit publications in its institutional open archive **Madis**, which has an interface with **HAL**, in accordance with the provisions of Article 30 of the Digital Technology Law. Research teams have been targeted by numerous initiatives in the fields of scientific and technical information. The interface of the Madis institutional archive has been upgraded both graphically and functionally, and links are currently being established with the in-house software for monitoring research projects "SI recherche".





Observation has been actively conducted on issues relating to research and scientific publication, in particular on topical matters from the world of publication, the trend towards open access, the evaluation of research and research support tools, supplemented by the feeding of a dedicated Twitter account.
Communication campaigns dealing with the creation of researcher identifiers and updating the corresponding profiles, have been combined with vigorous policies to encourage the updating of researchers' professional pages, which includes the "dynamic" updating of the list of publications deposited in Madis.
Membership of Orcid was ratified at the end of 2019 and more than twenty-five practical workshops dedicated to the creation of researcher identifiers have been offered at IFSTTAR's different sites.
Finally, IFSTTAR took an active part in Open Access Week, choosing a fun theme *"Do you know about open access? Come and play documentation and get to know more!"* during 9 sessions at the various sites.
As a result of this set operations, the rate of open access dissemination of our published articles, estimated at 50%, has reached a stable level, i.e. of the same order of magnitude as the rate of open access publication in all disciplines, as reported by the **Open Science Barometer** (48.5% in 2018; 50.6% in 2017).

return to contents

Research partnerships to engage with the economic world

→ The "Project Development Support" team has responded to more than a hundred enquiries from research units. Nearly half of these involved project development activities, the rest were related to facilitation activities (contract facilitation, participation in seminars, meetings with economic partners, etc.) or specific advice (finding donors, application letters, etc.). 2019 was marked by the continued roll-out of framework contracts. Three new such contracts were signed with ESI Group, OSMOS and INGEROP. To date, a total of 19 framework contracts have been signed with major groups and SMEs. These contracts are designed to build customer loyalty and expedite the signing of agreements. They are also one of the ways of boosting IFSTTAR's own resources, which amount to almost €20 million i.e. about 160 agreements signed every year. IFSTTAR's partners are mainly from three market sectors: road and rail transport, infrastructure and construction, nuclear and offshore energy. They ask IFSTTAR to carry out projects essentially related to four scientific themes that are priorities for the Institute: the circular economy, risk management, new technologies around the 5th Generation Road and, last, the design of the autonomous vehicle from the point of view of ergonomics and new technology. 2019 also provided an opportunity to prepare for the merger of the teams that are responsible for relations with economic partners within the various constituent entities of the Gustave Eiffel University. Thus, the duties of the Office of the Vice-President for Partnerships and Professionalisation were defined in the course of the year. Its remit includes taking over the duties of two IFSTTAR teams: the Project Development Support team and the VITTE team (Promotion, Innovation and Technology Transfer). In 2019, IFSTTAR continued its involvement in Institutes for the Energy Transition (ITE Efficiency and Vedecom) and Institutes of Technological Research (IRT Railenium, System-X, Jules Verne) by continuing to provide the equivalent of about 7 full-time members of staff per year on secondment.

An international initiative to support research that is geared towards the creation of Université Gustave Eiffel

→ IFSTTAR nurtures an extensive network of international and European partnerships. The initiatives undertaken in 2019 focused on two complementary areas: structuring partnerships and the internationalisation of research and training. The initiatives in question all sought to include the prospect of the transition to the Université Gustave Eiffel.
Thus, in terms of the structuring of research or training partnerships, a delegation from several directorates with international relations officers from the founding institutions (IFSTTAR, ENSG, EIVP) accompanied UPEM President Gilles Roussel on a visit to several universities in Quebec (Université Laval, Université de Sherbrooke and Université de Québec in Montreal). This visit served to establish contacts in the field of training as well as to reassert the existing partnership with Université de Sherbrooke, notably within the framework of the ECOMAT LIA.
The visit also provided an opportunity to officially inaugurate the work of the EVASYM International Associative Laboratory (LIA) for a four-year period. The theme of this LIA is the anatomo-functional evaluation of the musculo-skeletal system. It involves the LBMC laboratory in the TS2 department, a joint laboratory that is run with Université Lyon 1 and the École de Technologie Supérieure (ETS) in Montreal, Université de Montréal (UdeM) and the distance university at Université du Québec (TéLUQ).
In connection with the internationalisation of research and training, and in line with the cooperation agreement signed between France and Sweden, IFSTTAR, in association with members of the future Université Gustave Eiffel, organised a Franco-Swedish seminar at ESIEE Paris on 11 and 12 June 2019 on the theme of *"Smart cities and mobility"*. The meeting was opened by the Swedish Ambassador in Paris and welcomed representatives from the European Commission, ADEME, ANR, Vinnova and BPI France to discuss future opportunities for cooperation between France and Sweden. French and Swedish academic and economic partners met each other in a special session held for the purpose. The feedback from these sessions was positive thanks to the networking opportunities they presented. In total, around 110 people took part, a quarter of them Swedish.
IFSTTAR is very active in its research collaborations with Japanese partners in the field of infrastructure and its resilience, and contributed to the final T20 summit under the Japanese presidency in Tokyo. The Institute's delegation was composed of several members of the General Directorate. Parallel meetings of the various task forces provided an opportunity to present the policy briefs (*"Building Resilient Infrastructure Systems"* and *"The Infrastructure Nexus: From the Future of Infrastructures to the Infrastructures of the Future"*) and to continue discussions on the specific topics they addressed.

return to contents

Research
in the service of society

The Ethics Committee and Scientific Integrity: Research that respects society

→ The Ethics Committee, which is shared with IRSTEA, completed its term of office in 2019, and a new ethics committee will be set up with Université Gustave Eiffel as IRSTEA and INRA have merged to form INRAE which will come under the ethics committee of the former INRA.
The work of the ethics committee focused mainly on scientific integrity. How is it possible to conduct honest research, firstly as an individual researcher, but also as a laboratory or an institute? During this epoch of "fake news" and societal mistrust of science, it is essential to produce science that is honest. By drawing on the abundant existing bibliography, by sharing its experience with other institutes (CNRS and INRA in particular) and by inviting the president of OFIS (the French Office for Scientific Integrity), the ethics committee was able to identify the various ways scientific integrity can be compromised. These can be straightforward - for example, simply omitting a citation, but sometimes they can take staggering forms, such as massaging data or plagiarism. One rule is obvious: there is no such thing as a minor breach of scientific integrity.
Based on the recommendations of the Ethics Committee, IFSTTAR has appointed a Scientific Integrity Officer who does not depend on any hierarchy. This officer also performs the same role at UPEM and will continue in this role at Université Gustave Eiffel. He or she can be consulted by both staff and management of the Institute in order to give a completely independent ruling on any breach of scientific integrity. This officer belongs to the network of Scientific Integrity Officers managed by the OFIS, which is a factor which encourages the sharing of experience. Still following the recommendations of the Ethics Committee, the Institute and the future Université Gustave Eiffel would like to implement a policy of scientific integrity based on the triple "prevention, information, rescue" principle. "Prevention" aims to avoid the need for rescue, via briefings to new arrivals and the inclusion of the prevention task among the duties of department and laboratory directors and the provision of a dedicated intranet page.

The PhD: a gateway to employment

→ Between 1 January 2011 and 31 December 2019, 699 theses by IFSTTAR doctoral students were defended. In 2019, the number was 57, with a mean duration of research of 39 months (3.26 years), a standard deviation of 5 months and a median of 38 months (3.15 years). Only 3 theses required more than 3.5 years of research. These good indicator values are the result of a quality approach shared by all those involved in the supervision and monitoring of doctoral students and then that of PhDs.
The excellence of this approach was mentioned by IFSTTAR's HCERES evaluation committee (2018-2019 evaluation campaign - wave E) which drew attention to the *"Specific, high-quality reception and support for doctoral students"* as one of the Institute's strong points.
Our PhDs' progress is monitored for a period of 5 years after they received their degree. The response rate to the survey of the 448 "IFSTTAR Doctors" who graduated between 2014 and 2019 was 97%. As at December 31st, 2019, the employment rate (permanent jobs + fixed-term jobs) varied between 90% after 1 year (2018 PhDs) and 100% after 5 years (2014 PhDs).
On 31 December of the year the PhDs

return to contents

defended their thesis, between 70 and 81% of them had already found a job. To help them through the process, IFSTTAR has developed rules for extending or bridging the gap between a thesis contract - of whatever kind - and their first job:

- Extension of a research contract or hiring on the basis of one: as an exception to the employment charter for fixed-term contracts - no short contracts lasting less than 12 months - when the date of the thesis defence is known before the thesis contract comes to an end, doctoral students receive an extension for between 3 and 6 months, depending on the availability of funds for the research contract and expenses.
- A bridging arrangement that covers the end of the thesis contract and a first job: when the date of the thesis defence is known before the thesis contract comes to an end, if the starting date of a job, in France or abroad, is known, subject to financial availability and the availability of a full-time equivalent grant, the doctoral students in question receive an extension (or are hired) for a period of 3 months.

These provisions make it possible to overcome a number of problems, in particular in the case of doctoral students from outside the EU (due to residence permits), and in the case of doctoral students from the EU who as a result do not have to deal with the Employment Agency, meaning that at the end of their doctoral studies they can devote themselves to writing up their thesis without worrying about their income.
These bridging arrangements are in addition to the legal extensions of the doctoral contract in the event of maternity leave.
As an example, during the period 2018-2019, 9 PhDs were granted an extension or hired on a research contract, and 14 PhDs were awarded a bridging arrangement with a grant. Of these, 20 took up a job directly following their extension or bridging arrangement.
IFSTTAR has therefore set up effective monitoring of doctoral studies. Doctoral students receive support at all levels. This limits the duration of doctoral studies – keeping it below the first MESRI threshold of 40 months - the theses are finished under good conditions and the young IFSTTAR PhDs find work.
At Université Gustave Eiffel, doctoral students working in structures that formerly belonged to IFSTTAR will continue to be monitored in accordance with this quality approach that will continue to operate in this part of the university. It is now planned to extend it to cover the rest of the new university. This will only be possible if everyone involved is aware of how important it is to monitor doctoral students during and after their studies, starting by being vigilant with regard to the actual funding of doctoral students during their studies.

Public policy support: expanding policy-related dialogue

→ 2019 saw an increase in IFSTTAR's commitment to targeted actions and transfer seminars that involve the public authorities. With the creation of Université Gustave Eiffel on 1 January 2020, public policy support has been given a high profile symbolic role as a result of the creation of the Office of the Vice-President for Public Policy Support whose official status has been confirmed in the university's statutes.
The aim is to broaden the exchange of knowledge concerning public action, in a broad sense, with administrations, local and regional authorities, state operators and agencies and international organisations. The process will also set out to place relevant research-based knowledge at the service of these organisations and the community. This knowledge will take the form, in particular, of studies and expert appraisals, technical recommendations, and support for standardisation and certification.
Transfer actions have increased in 2019. There are now 11 "transfer seminars". Some transfer actions are presented here for the three scientific themes identified in the Goals and Performance Contract (COP).
Theme 1 concerns mobility, innovative technologies, including automated mobility, and transport safety and security.

- Initiatives have been launched with **DRIEA**, **DIR Nord** and **DiRIF** for measuring, modelling, simulating and limiting congestion. The most striking features of this are the development and adjustment of control algorithms for the Île-de-France Region and, for the Lille region, the training provided to the three project managers involved.
- An **important 420 page collective book**, published in 2019 under the direction of IFSTTAR, presents an assessment of French road safety research and proposes avenues for public policy. It was lauded by the DSR (Road Safety Delegation).

Focusing on infrastructure, Theme 2 addresses changes related to the energy transition, climate change and the impact of digital technology.

- Regarding the circular economy, an agreement to create a chair with the Métropole du Grand Paris was signed in June 2019.
- The DRI expressed the wish for IFSTTAR to increase the transfer of its knowledge in the area of

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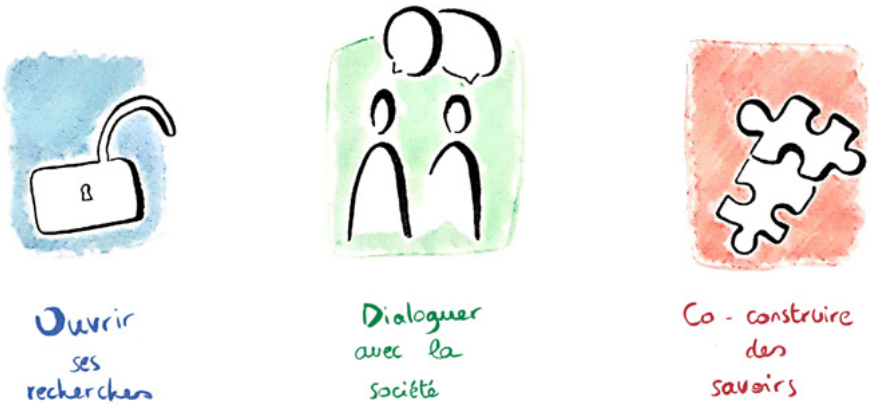
return to contents

infrastructures to ADTech[1]. This transfer was carried out at two events. First, during the meeting of the association's board in Nantes on 13 July, where the most recent results concerning alternative materials and the inspection of road infrastructures were presented then rounded off by a visit to the Institute's major facilities, and second on 16 September in Bron, where the results of the work were presented to all the members during the visit to TRANSPOLIS.

Theme 3 sets out to forestall natural and climatic risks, to reduce sources of pollution and nuisance in order to increase the environmental quality of transport and cities, and to contribute to planning and the policies adopted to protect the population.

- As far as urban environmental quality is concerned, two transfer seminars were organised around the Sense-City climatic chamber: on 20 November, with Météo-France, to consider urban climate scenarios based on the expertise of each organisation in terms of experimentation and simulation; on 26 November, with the partners of the ANR EquipEx Sense-City project, presenting some of the studies carried out (heatwave control, depolluting roads, water purification and thermal diagnosis).
- With regard to natural risks, the transfer seminar held on 11 September in Marne-la-Vallée, on the occasion of the end of the ANR SSHEAR project on the risk of scouring of structures, presented major advances concerning the in-situ monitoring of the scouring mechanisms affecting engineering structures during exceptional floods.

[1]ADTECH: Association of the Engineering Directors of Metropolitan Areas, Départements and Regions



Science that is open to society

→ The research community is being challenged by society and needs to rethink access to scientific results, make scientific procedures more transparent and participate in the emergence of new forms of dissemination and knowledge generation. In order to anticipate and support these changes, IFSTTAR has set up an open science ownership initiative.
How can I open up and share my research and why should I? For researchers who are asking themselves this question or who would like to know more, IFSTTAR has produced a 35-page **vade-mecum.** The aim of this distillation of advice and best practice is to raise their awareness, inform them and support them in their efforts to make their research accessible to different audiences. **12 practical sheets** are provided which cover three areas: opening up your research, dialoguing with society and co-building knowledge.

Research data
→ 2019 saw the launch of a training programme that dealt with the management and opening-up of research data. The courses in question are part of initiatives to support **IFSTTAR's research data policy**.
They are a response to a need among researchers and doctoral students for information on the development of data management plans, good openness practices and regulatory requirements.
The course, entitled "Planning the management of your research data, including your personal data", was co-facilitated by the Institute's Research Data Management Officer and the Data Protection Officer. It was a great success. The participants particularly appreciated the thorough coverage of the subject and the way the two facilitators complemented each other. This course is to be made available again at several sites in 2020.
Two other training courses were also organised for doctoral students at the Université Paris-Est Comue. The result of collaboration with UPEM, they were designed and run in conjunction with the university's open science officer and IFSTTAR's Promotion and Sharing of Knowledge Department (PEPS).

return to contents

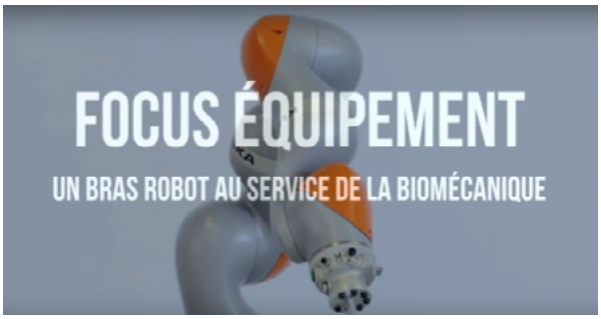
Promoting IFSTTAR's research and facilities

- The science topic **"The railway system: a central role in transport"** proposes a topical and innovative topic which mobilises a variety of disciplines and experimental facilities within IFSTTAR.

- The research focus **(The ageing of reinforced concrete in natural environments)** presents the study of how diseases in reinforced concrete structures evolve in natural environments as a counterpart to accelerated laboratory tests.

- The research focus **"Transpolis, the experimental city for the mobility of the future"** allows you to discover the added value of this experimental site for research through interviews with its main actors and the analysis of tests.

- The facility focus **"A robotic arm at the service of biomechanics"** reveals a new facility at the LBMC.



- IFSTTAR's audio-visual collection is carefully preserved and well showcased. 77 films from the LCPC are now available on the **Internet**.

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return to contents

Science for a young audience

→ With its new **"Petit Campus"**, collection, the Promotion and Sharing of Knowledge Department offers educational resources to make the work of IFSTTAR accessible to secondary school students. The contents, taken from our Science Topics, are presented in a simplified form and accompanied by videos, games and resources for teachers. Produced in collaboration with the **Moulin à étincelles** and validated by researchers, these educational resources are designed to encourage children to ask questions on issues relating to society, technology and innovation. Currently, ten issues of **Petit Campus** are available in the **Science and Society web space**, as well as on scientific and technical portals such as **EchoSciences** and **Pop'Sciences**.

The Petit Campus editions.

To show some of the subjects in the **Petit Campus** collection, 2D animations, made by the audio-visual production company **Visée.A**, feature a small robot, called ELEA. Thus, the **ELEA collection** takes the young public on the 5th Generation Road, in an autonomous vehicle, on the train of the future and behind the scenes of urban logistics.
Twenty-two schoolchildren of about twelve years of age from the Lyon region, were able to take part in workshops and educational visits related to the issue of sustainability of short food supply chains. Organised by IFSTTAR's scientific facilitators, these meetings enabled the students to work with the social geography researcher Gwenaëlle Raton. At the end of this experience, the children and the poet

ELEA robot.

Emanuel Campo created a **collection of poems.** The same topic was the subject of a web documentary entitled ***"Are short supply chains a more sustainable mode of transport?"***, which includes personal accounts from players in the Lyon region and research findings.

Some forty teenagers from the Gérard Philippe youth activity centre and social centre in Bron were sensitised to gender differences in road risk-taking during meetings with the social psychology researcher Marie-Axelle Granié. In particular, the children devised slogans in order to deconstruct gender stereotypes. With a positive and active pedagogical approach, these participatory workshops were designed by the association **Imagineo**, in collaboration with the Promotion and Sharing of Knowledge Department and IFSTTAR researchers, to take the opinions of children into account in the processes of research and innovation.

Granié, Marie-Axelle & Rizzi, Véronique & Revol, Jordan & Assailly, Jean-Pascal. (2019). Sensibilisation à la différence de sexe dans la prise de risque routière : expérience d'un atelier participatif avec des enfants de 9-13 ans.

Sharing science to serve cities

→ The 5 Knowledge Encounters held in Bron (Département N° 69) encouraged interactions between residents and specialists around the "learning area" concept. The debates were organised in two stages: to begin with "actions in the city" based on a presentation of transformational accomplishments, and then a "laboratory of ideas", where science encourages debate and forward-looking thinking. Among the themes addressed in 2019 by the **Bron National Scientific Encounters** were: "Innovative grassroots education", "Education and culture: what levers for the city?", "How will the social and solidarity economy participate in the urban project of tomorrow?".
These concerted approaches are arousing public interest. They are intended to be developed within the Université Gustave Eiffel which plans to be at the forefront in the transmission of research on the city, in connection with existing initiatives in various parts of the country.

return to contents

LA FABRIQUE DES SAVOIRS

The **I-Site FUTURE** Steering Committee made up of the 6 directors of the participating institutions validated the Knowledge Factory project. This initiative is the result of a partnership between IFSTTAR's Scientific Directorate, the Municipality of Champs-sur-Marne and the Paris - Vallée de la Marne Conurbation Committee. It will have taken 6 months of work during the sessions of the I-Site FUTURE Events and Culture workgroup.
The Knowledge Factory intends to combine and coordinate IFSTTAR's cultural and scientific initiatives with those of the local authorities in the vicinity of the Marne-la-Vallée campus. It combines input from research and teaching with input from cultural and social centres, schools and associations. Indeed, the "challenges of the city of tomorrow" can only be met by contributions from everyone, in particular the residents of the areas in question, while at the same time making it easier for them to access the "common fields" of awareness and knowledge about urban issues.
This requires a new approach to communication, in order to meet the needs for information and participation voiced by citizens. The Knowledge Factory will take action to promote equal opportunities (for both studies and employment prospects) based on "resource centres" located in the city's neighbourhoods.
On 27 November 2019, the **Future Days** thus included a conference for the general public entitled "The New City: Urban Legacies and Expectations". The history and future of Champs-sur-Marne were examined and debated with a teacher from the Descartes campus, who is an expert on the subject, and a decision-maker from ÉpaMarne who contextualised the urban development projects that have been carried out. This format of event, open to all, will be repeated in 2020 and developed in the Knowledge Factory, with the support of the local authorities involved.

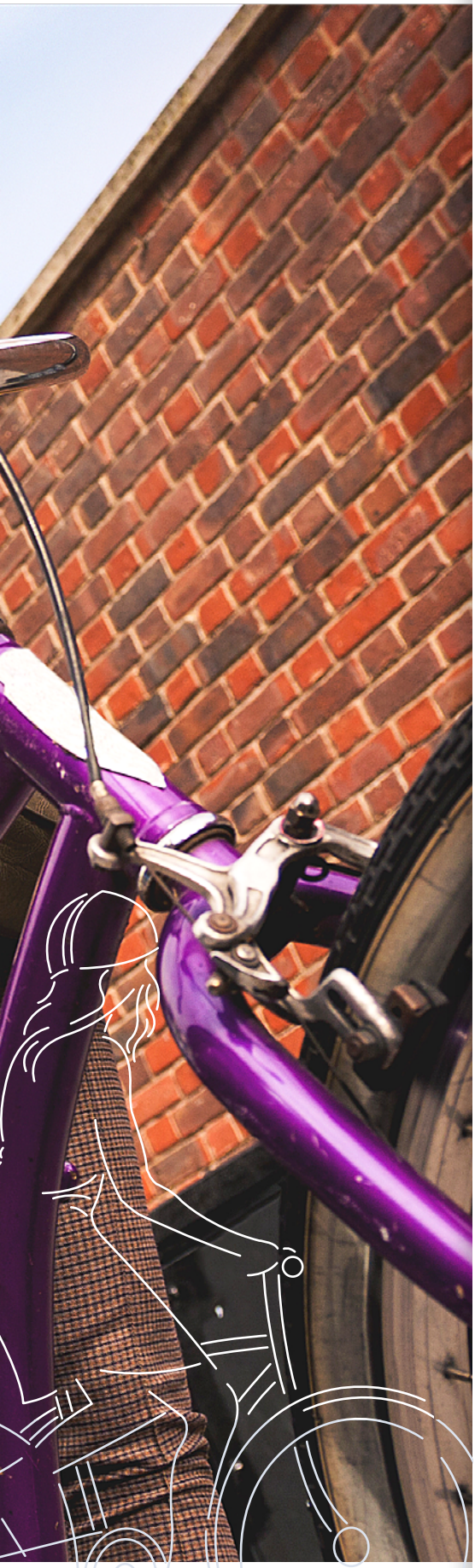
return to contents

THEME 1

Efficient transport and safe travel

Mobility and safety issues, which are central to IFSTTAR's research, are addressed by Theme 1, whose aim is to achieve "efficient transport and safe travel". Mobility systems are crucial for the functioning of modern societies. They must become more energy efficient, more reliable and resilient while integrating technologically innovative components and start to look ahead now in order to grasp the impacts of the changes that are affecting transport systems, in particular their automation.

return to contents



Three of IFSTTAR's five Departments are engaged in work on this theme:

- **COSYS (Components and Systems)** is a multidisciplinary department at the frontier between the physical and digital worlds, with a strong experimental component. Its mission is to develop the concepts and tools needed to add to fundamental knowledge, methods, technologies and operational systems for a new type of intelligence for mobility, infrastructure networks and large urban systems. COSYS thus aims to improve their efficiency, safety, carbon footprint and environmental and health impacts.

- An aspect favoured by **the TS2 (Transport, Health, Safety) department**, which is both unifying and identity-building, relates to the safety of land travel, especially by road. TS2 is a multidisciplinary department, bringing together disciplines from the human and social sciences, science and technology, as well as the life sciences. Research is carried out in five areas: driving automation, new research questions related to the changes in mobility, the links between mobility and health, human modelling, and the design, development and use of databases.

- **The AME (Planning, Mobilities and Environment) department,** which is also multidisciplinary, brings together the human and social sciences and technology. Its research focuses on the mobility of people and the transport of goods and their interrelationship with the natural and built environments. It is particularly interested in analysing the interactions between innovations (digital technology, autonomous vehicles) and mobility practices, as well as peri-urban areas. The department's research allows us to understand mobility practices, to carry out forward studies on mobility, and to assess its social, economic and environmental impacts in order to improve technical systems.

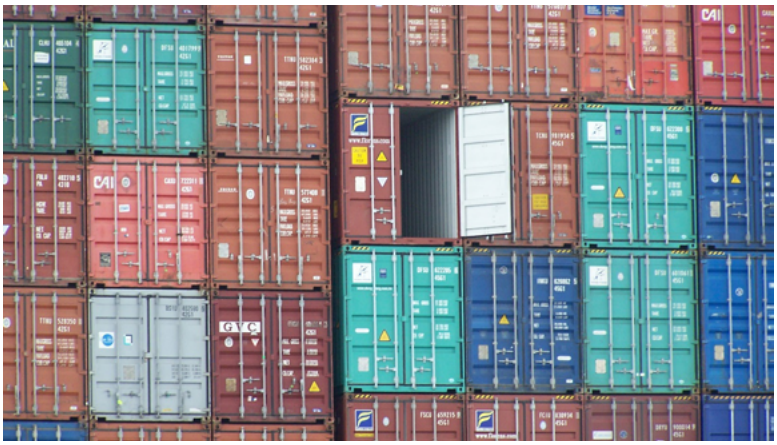
IFSTTAR's researchers thus contribute to the development of energy-efficient, safe and well thought-out proposals to meet society's expectations by helping to design reliable transport systems suitable for all people and all goods. IFSTTAR's teams pursue three objectives: improving the reliability of transport, enhancing travel safety and ergonomics, and promoting multimodal, intelligent, clean and freely-flowing transport.

return to contents

goal 1

Improving the reliability of passenger and freight transport across its different modes and uses, with effectively managed costs and externalities

Research of various types was conducted in 2019 to help design more reliable and resilient transportation systems. Initiatives to transfer knowledge from research to central government directorates have been undertaken to improve our understanding of the logistics and traffic management sector with a view to improving the availability of transport systems and reducing their operating costs.
Research was undertaken to support the upgrading of the rail system to improve its economic, functional and safety performance. A focus study is proposed on Channel Tunnel safety, a topic the Institute has been addressing since 1986.



Container stacking © Guillaume Uster

Towards a logistics observation unit

→ In accordance with its remit from the DGITM (Directorate General for Infrastructure, Transport and the Sea) and the DGE (Directorate General for Firms), IFSTTAR has drawn up a preliminary dashboard for logistics and its performance. On 16 September 2019, the Prime Minister announced the creation of an Interministerial Logistics Commission to supervise this sector at a strategic level. In this connection, it is advisable to provide some sort of framework and draw lessons from the quantitative and qualitative data regularly produced by public administrations, professional organisations and scientific bodies. In this context, the DGITM and the DGE have entrusted IFSTTAR with the task of evaluating the performance of the logistics sector. A dashboard has been developed, based on a set of key indicators relating to the economic, social, environmental and energy performance of the sector. Several criteria were used to select the indicators for this dashboard:

- The reliability of the data and the frequency of its production, so the trends affecting the indicators can be monitored;
- The comprehensibility of the dashboard, which means avoiding too many indicators;
- The dashboard should be helpful to both public and private stakeholders.

In addition to the development of this dashboard, the remit also includes the coordination of a logistics observation network, bringing together the stakeholders in the sector. The first meeting was held on 21 January 2020 at Université Gustave Eiffel. In 2020, Université Gustave Eiffel will continue this work by producing summary documents for decision-makers.

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return to contents

Mixing data, expertise and approaches to provide better tools for traffic management and the dynamic modelling of travel

→ Sharing urban space better between modes, reducing congestion and pollution, increasing road safety... Optimising the use of existing transport infrastructure is a goal for every manager. This requires better tools, that are better used. The Messigéo research initiative aimed to make better use of the large amount of data available and to develop effective tools to meet current transport challenges. It took advantage of the long-term partnership that has been built between the Centre d'Expertise sur les Risques, l'Environnement, la Mobilité et l'Aménagement (CEREMA) and IFSTTAR. This has permitted a fruitful exchange of ideas between the researchers at CEREMA, who work closely with public and private transport infrastructure managers, and those at IFSTTAR, who are able to propose new methods in this area, while also providing their knowledge of the international state of the art. Some findings are given below:

- Dynamic modelling and evaluation of the traffic control strategies deployed on peri-urban motorways, in some cases with a degree of connectivity between certain vehicles and the infrastructure. We now offer solutions that overcome two shortcomings of the existing technologies as they provide shorter computation times and the ability to accurately reproduce the effects of control measures;
- Optimum route planning, covering all the possible modes: walking; cycling (including shared bikes); urban or interurban public transport, track-guided or not; cars, shared or not. This inclusion of all modes means accessibility can be approached in a genuinely multimodal way;
- Joint analysis of data on pollution and traffic and a multi-scalar traffic-emission modelling chain. This means we have instruments that highlight the effect of speed and the proportion of heavy goods vehicles on oxides of nitrogen (NOx).

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Map of traffic-related emissions, at segment level © Traps, Cerema Licit, D. Lejri, A. Burianne

MORIPAN (Models of Risk for Level Crossings)

→ MORIPAN is a project supported by the **IRT Railenium**, with the involvement of ESTAS (Evaluation of Automated Transport Systems and their Safety Laboratory) in the COSYS department and SNCF Réseau. Its aim is to develop risk models in order to identify and describe safety issues on level crossings, which is a subject of government concern, and take action to deal with them.
The MORIPAN project aims to identify the main risk factors, assess their respective contributions in order to guide safety improvements at level crossings and allocate resources efficiently.
An in-depth statistical analysis of accidents in France has highlighted three main road-related causes: driver inattention, the inability to clear level crossings quickly enough, and a serious offence resulting from careless behaviour.
An experimental phase made it possible to observe the behaviour of road users at 12 level crossings over a period of 3 months. Bayesian network models were then developed. These revealed and described the causal relationships between the various factors, risk scenarios and the occurrence of accidents.
This type of mathematical model allows us to quantify how each of the identified factors contributes to the overall level of risk. It can provide a basis for forecasting how different solutions could improve level crossing safety. This detailed knowledge will enable the infrastructure manager and other stakeholders to efficiently allocate available resources to improve level crossing safety.
The results obtained within the framework of MORIPAN were presented at a transfer seminar organised in the framework of the parliamentary commission on level crossing safety, coordinated by the deputy Mme Laurence Gayte.

An urban level crossing
© Mohamed Ghazel

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return to contents

Channel Tunnel safety

The entrance to the Channel Tunnel © Eurotunne

→ For INRETS (French National Institute for Transport and Safety Research) then for IFSTTAR, Gérard Couvreur, former deputy director of IFSTTAR site at Villeneuve d'Ascq,has been following the Channel Tunnel since its inception, helping to make the operation of this unique transport system safe and efficient. His retirement will mark the end of this involvement for the new Université Gustave Eiffel. This last IFSTTAR activity report provides an opportunity to review the main features of this work.

Since 1986, when the Treaty of Canterbury and the quadripartite concession agreement were signed, the "Cross-Channel Fixed Link" has been supervised by the Intergovernmental Commission (IGC) appointed by the French and British governments to monitor its construction and operation.

One of the IGC's areas of competence is safety, for which the Treaty set up a Safety Committee. During the construction phase, this committee examined the 23 "Preliminary Projects", each dealing with a specific technical subsystem (rolling stock, signalling, railways, ventilation, power supply, etc.) as well as engineering structures and buildings (terminals, civil engineering works, etc.). In 1994, this work enabled the fixed link to be brought into commercial operation.

In spite of a few incidents, some of which, notably the fires of 1996 and 2008, had significant material consequences the initial safety concepts have proven to be robust. No fatalities or serious injuries have occurred.

Twenty-five years after its commissioning, the Channel Tunnel is reaching a period in its life cycle where the obsolescence of its systems needs to be addressed. For example, the time for the mid-life overhaul of the shuttles, which is required for all rolling stock, has come. The highly unusual nature of these trains makes this operation both complex and sensitive. In addition, the TVM 430 Track-to-train transmission system will soon be replaced by the ERTMS (European Rail Traffic Management System), a rail signalling system which, in theory, will ensure interoperability across all European networks.

ERSAT-GGC (ERTMS on Satellite Galileo Game Changer)

→ ERSAT-GGC is a **European H2020 project** whose goal is to speed up the certification process for a positioning system based on satellite technology (GNSS) to be used on regional railway lines equipped with the European Rail Traffic Management System (ERTMS). In the European ERTMS/ETCS railway standard, the absolute position of a train is ascertained when it passes a trackside beacon. Between beacons, the position of the train is calculated by odometry. For level 3 ETCS (European Train Control System), the position of the train should be computed on board the train. The use of GNSS is now recognised as a good way of replacing the trackside equipment with virtual beacons. However, the performance of the technologies depends on that of GNSS, which is itself affected by multipaths, signal attenuation or obstruction by obstacles near the train. With RFI in the leadership role, ERSAT-GGC has contributed to the development of a methodology and tools that classify lines according to the anticipated performance of the satellite system. This classification is based on a series of tests aimed at detecting masking, multipaths and interference based on measurements collected by on-board COTS (Component On The Shelf) equipment and the analysis of parameters such as CN0, pseudo-distances, AGC, images, etc. These tests are used to identify the areas where the virtual beacons can be deployed. The procedures and tools thus developed have been tested and evaluated on several railway lines in Italy and Spain. An analysis of the operational security of the technological architecture was also carried out as part of the project.

Equipment (PREDISSAT) developed by IFSTTAR and installed on a train for a campaign to detect the reception of indirect GNSS signals © Juliette Marais

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return to contents

goal 2

Enhancing the safety and ergonomics of travel, for worry-free mobility that safeguards human life

Mobility is constantly changing, with consequences for safety and ergonomics. New ways of reducing transport accidents have been identified that take account of changes in travel practices.
With regard to the safety of motorised two-wheelers, work has been carried out to improve the modelling of human phenomena. A model and a tool for assessing motorcyclists' behaviour and injury risk have been developed and validated by comparing them with real data. This has made it possible to improve our understanding of what occurs both before and after an accident. Based on the study of motorcyclists' behaviour and their accidents, new knowledge has been shared and innovative prevention and protection systems have been designed.

Risks related to new forms of mobility

→ Urban policies for sustainable mobility, which are justified in view of the need for an environmental transition, lead to new malfunctions and risks to which little attention is paid. These issues are linked to new forms of planning, the development of new practices and the spatially selective approach to development.
The RED project aimed to increase our understanding of these risks and identify the organisational and political factors that hinder their consideration in the context of land-use management.
The research shows the continued survival of the automotive system despite measures to support sustainable mobility. Planning often seems to focus on improving the living environment and economic attractiveness.
The spaces created for exclusive right-of-way public transport generate new types of accident. Nevertheless, in streets with tramlines, the number of accidents is falling, mainly due to the drop in car traffic. However, no improvement has been observed at conurbation level.

The increased use of motorised two-wheeled vehicles, encouraged by the reduced role of the car, generally has a negative impact on safety.

Spatial ergonomics studies show that the socio-spatial characteristics of the place of residence have a strong influence on access to resources and the ability of residents to change the transport modes they use.
This project, funded by the ANR and led by the LIEU laboratory at Aix-Marseille Université, brought together teams from IFSTTAR (Laboratory of Accident Mechanism Analysis (LMA) in department TS2) and the Universities of Strasbourg and Caen from 2014 to 2019. It will lead to the publication of a book in 2020.

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The project logo Illustration © F. Hernandez, B. Romeyer

return to contents

The vulnerability of passengers on motorised two-wheelers

→ It is now recognised that the risk exposure of motorised two wheeler users is extremely high compared to other groups of road users. So far, epidemiological studies and accident analysis in this field have focused mainly on the drivers of motorised two-wheeler users. This is also the case for normative aspects and for the technological development of protective equipment.

An initial parametric numerical study conducted at the LBA (Laboratory of Biomechanics and Applications - UMR IFSTTAR/Aix Marseille University) on driver and passenger kinematics, for the most frequently observed impact scenario, provided some very unexpected results. After evaluating the performance of the model, based on data from the literature, it was observed that the driver's presence increases the distance the passenger is projected, acting as a launching pad. Head-to-ground impact speeds are on average higher for the passenger than the driver. The driver's kinematics are also modified by the presence of a passenger. These results raise many questions: for a given accident situation, what difference will there be in injury risk exposure between the driver and a passenger, or between a driver with or without a passenger? How effective are protective devices for passengers? What is the influence of the vehicle and the occupants' posture on risk exposure?

Full-scale tests have been conducted which allowed to determine the kinematics of the driver and the passenger in a motorcycle crash. Likewise, it was possible to assess the levels of acceleration experienced by the passenger.

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COSMOS symposium © Thierry Serre

Scientific Knowledge for Motorcycles (COSMOS)

→ Faced with the scale of the road safety impacts of motorised two-wheeler accidents, the objective of the COSMOS project was to bring together and promote the dissemination of scientific and technical knowledge on all issues relating to motorised two-wheelers and their safety. This project was jointly led by IFSTTAR/TS2/LMA (Laboratory of Accident Mechanism Analysis) and CEREMA with the support of the DSR (Délégation à la sécurité routière) with the aim of providing public policy support.

Five multidisciplinary seminars have been organised since 2016 in Paris (June 2016), Lyon (November 2016), Marne-la-Vallée (October 2017), Paris (March 2018) and Aix-en-Provence (November 2018). They have provided an opportunity to showcase a variety of ongoing or completed research projects. These events provided a forum for discussions between the participants and an opportunity for experts to state their research needs. A final symposium brought together more than 110 participants on 4 and 5 November 2019 in Marne-la-Vallée. This French-speaking symposium, which was closed by Mrs Manuelle Salathé from the DSR, provided an opportunity to present 20 oral papers and 10 poster papers by researchers, manufacturers, insurance companies, experts, local and regional authorities, or ministries, on various topics such as accident analysis, protective equipment, training, perception, safety policies, use of infrastructures, vehicles, user behaviour, etc. The conference proceedings will be published in 2020.

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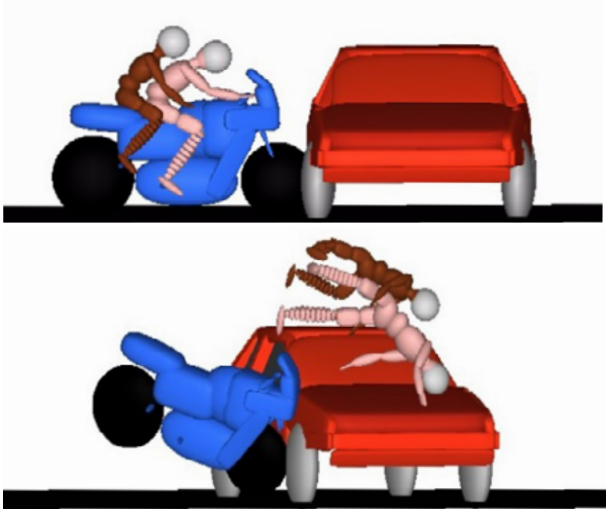


Kinematics of two occupants of a motorised two-wheeler during a head-on collision © Catherine Masson

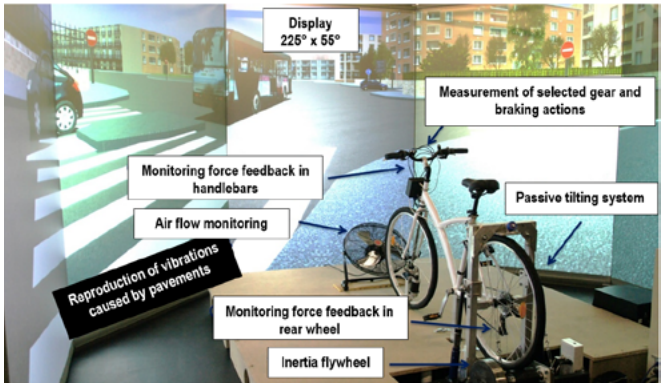
return to contents

goal 3

Making progress in the areas of systems and services for multimodal, intelligent, clean and seamless mobility

Simulation platforms are used for system prototyping and evaluation. With the increasing use of two-wheeled vehicles, IFSTTAR has developed a bicycle simulator and equipped it with new functions and sensors. The implementation of a virtual systems approach to cycling use under the most realistic conditions possible allows to foresee future travel scenarios and to begin to study a number of issues. Connected cars, the delegated driving car and shared cars are overturning traditional representations of car use. Research conducted in 2019 has studied the actions and responses of humans when interacting with these new environments, as well as their ability to use them. Work on the design of a man-machine interface has been proposed, as well as a forward-looking study on robotic mobility.

Studying cyclist behaviour and evaluating virtual reality innovations



The bicycle simulator and its main functionalities
© Stéphane Caro

→ IFSTTAR has developed a bicycle simulator in addition to its other immersive simulators to study the behaviour of cyclists and evaluate travel aids. It has been used in several projects, including two completed in 2019.

Built in 2013-2014 as part of incentive funding from the Scientific Directorate and in partnership with LaPEA (Laboratory of Applied Psychology and Ergonomics; UMR Université Paris Descartes/IFSTTAR), IFSTTAR's bicycle simulator was the sixth in the world to be built for research purposes. It was upgraded in the years that followed, notably as part of the Vibrasimu project (2017-2019) in partnership with the EASE laboratory ((Environment, Planning, Safety and Eco-design Laboratory; AME department)). Today, the simulator has two force feedback systems, producing an airstream that depends on the speed, and is the only simulator of this type in the world that reproduces the vibrations caused by pavement irregularities. Five experiments have been conducted on the simulator since its creation. For example, one was conducted as part of the ANR CYCLOPE project (2016-2019) which focused on the development and evaluation of an innovative low-cost warning system for cyclists in the context of interactions with buses.

Two other experiments were conducted as part of a thesis funded by the European Marie Curie SaferUp project. The objective was to study the effects of pavement characteristics (geometry, skid resistance) on cyclist safety.

Finally, the bicycle simulator is one of the nine immersive travel simulators that make up the facilities managed by the PICS-L SimTeam. A steering committee and a roadmap have been created for this facility in order to best meet the needs of users attached to five laboratories of the new Université Gustave Eiffel, of which IFSTTAR is a part.

⇨ **FIND OUT MORE**
Thematic file

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return to contents

Proposed human-machine interface (HMI) specifications for buses with automatic docking
Illustration © ADAS&ME

Design and development of driver assistance systems

→ The ADAS&ME project focuses on the design and development of advanced driver assistance systems (based, where appropriate, on the partial or total automation of driving) for 4 different types of vehicle: cars, trucks, buses and motorcycles.
The challenge is to design real-time monitoring functions for drivers (some of which are shared and cross-functional), with a view to assessing their physiological state (fatigue, or "heat stroke" in the case of motorcyclists), their distraction (visual and cognitive), their stress level or their emotional feelings (anxiety, joy, anger or fear). In the context of this project, the IFSTTAR research team was particularly involved in two related activities:

- Setting up a pre-pilot study aimed at collecting empirical data for the development of monitoring functions.
- Participating in the survey to assess acceptability and user needs.

As part of the transcultural European approach pursued in this project, this work resulted in the design, dissemination and processing of the French part of the survey. A proposal for human-machine interface (HMI) specifications for buses with automated docking was drawn up, together with some ergonomic recommendations.

⇨ FIND OUT MORE

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Imagining humans to prepare for robomobility

→ This forward-looking research work sets out to imagine what our society and lifestyles will be like when all transport systems have become autonomous, by providing input for reflection and debate with both public authorities and citizens.
In the coming years, land vehicles will be increasingly automated, whether in case of public transport, goods transport or private vehicles. The term "robomobility" describes this paradigm shift that will disrupt our society. In order to imagine the impacts of disruption of this kind, an approach that relies on a forward-looking workshop "the robomobile life" has been initiated by the Ministry for an Ecological and Solidary Transition. In this context, ESTAS (Evaluation of Automated Transport Systems and their Safety Laboratory; COSYS department) and LBMC (Biomechanics and Impact Mechanics Laboratory; TS2 department) suggested imagining human beings in this new environment, in collaboration with the WT2I agency. A creative process was thus undertaken on the basis of a new hybrid mobility concept combining the horse, which was mankind's first means of transport, and the VAL, the Lille driverless metro. It is this so-called "ch'VAL" that was given centre stage allowing to imagine it in different environments: MEDIACITY, a city controlled by digital technology, AUTARCITY, an ephemeral city on the fringes of megalopolises, rebellious and "under the radar", and TRANSCITY, a doomsday city where collapsology and transhumanism reign.
The aim of this highly future-oriented research project is to provide the public authorities with a basis for analysis and reflection about acceptable technological developments and a liveable society that has yet to be built. Only a scenario that includes the best of each seems desirable for our planet.

The "ch'VAL" in the digital city © Agence What time is I.T.

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return to contents

International activities

IFSTTAR's Directorate for European and International Affairs implements incentivising tools to support European and international partnerships. They are designed to facilitate the launch of European and international initiatives. In addition to encouraging the outgoing and incoming mobility of permanent researchers and students, this funding is used to organise symposia, conferences and seminars, and to set up or perpetuate bilateral partnerships and major academic and technological partnerships.

→ A first French-Swedish workshop on smart cities and mobility was held on 11 and 12 June 2019 at ESIEE - Cité Descartes. The strengthening of partnerships involves the setting up of International Associative Laboratories (LIAs). A LIA provides a structure for scientific cooperation between two (or more) research teams from two (or more) laboratories. It is a laboratory "without walls". Researchers are supported by the institute when setting up these LIAs. At the end of 2019 there were five LIAs and the creation of a sixth is currently on the table.

- The COSYS (Components and Systems) department is in the final phase of setting up the ASTI (Advanced Sensing for Transport Infrastructures) LIA which brings together IFSTTAR, INRIA, IREA (CNR) in Naples and Milan and the IMAA in Potenza. This LIA is founded on the success of the FP7 ISTIMES project (merging data from multiple INSAR and Sentinel satellite sources, images from drone-borne radar interferometry, and radar or fibre optics on the ground) for infrastructure monitoring.
- A second project to set up a LIA with the University of Bologna, nextRIM (Next Generation Road Infrastructure and Mobility), has been approved by COSYS following an extensive appraisal process. The project has also been approved by the University of Bologna (Italia) and will be assessed by Université Gustave Eiffel with a view to signature of the agreement in the near future. This LIA focuses on improving mobility by simulating the behaviour of road and street users who are interacting with the infrastructure. An extension of the project is being considered with the DICAM department at the University of Bologna with regard to executive training.
- The third LIA on ITS (Intelligent Transport Systems) and smart cities will seal IFSTTAR's long-standing collaboration on these topics with Queensland University of Technology (a letter of intent was signed by the two partners in February 2019). Extending the LIA to the University of Queensland (Australia's leading university) appeared timely given the many convergences in research, particularly on the aspects of the blue economy and smart cities, in connection with Sense-City and more broadly with Université Gustave Eiffel.

>>>

return to contents

- For the TS2 (Transport, Health and Safety) department, 2019 was marked by the signing, during the Jacques Cartier meetings in November in Montreal, of the agreement for the EVASYM LIA between IFSTTAR, Université Claude Bernard Lyon 1, the Ecole de Technologie Supérieure, Université de Montréal and Université TELUQ, involving researchers from the LBMC, LESCOT and LEPSIS in France and the LIO and S2M in Montreal. The EVASYM LIA's scientific project consists in combining the complementary expertise of the laboratories involved to conduct an anatomo-functional assessment of the musculoskeletal system with regard to the two themes of ageing and disability (movement, balance, autonomy and rehabilitation) and orthopaedics and traumatology (deformities, injuries and implants).
- The iLab-Spine LIA is a unifying research project focused on the modelling and biomechanics of the spine. This year, all the partners have supported the extension of the LIA (an agreement is currently being signed). Activities in 2019 made it possible to organise a scientific event during the Jacques Cartier meetings, to permit the mobility of doctoral students who are co-supervised at international level, and to organise the iLab's annual scientific days in Montreal. The research themes that marked the activities in 2019 relate to the mechanical characterisation of spinal cord structures, protection of the spine and optimisation of surgical strategies.
- In the medium term, IFSTTAR, UPEM and ESIEE Paris are expected to sign an agreement for a LIA with Milan Polytechnic on smart structures for the city and transport. A meeting to establish the broad outlines of the scientific project was held in November 2019 in Milan.

The AME (Planning, Mobilities and Environment department) has implemented a cooperation programme known as Innomob. All the department's laboratories will take part in this programme. Among the activities launched in 2019, the following are particularly noteworthy:

- Organisation of a workshop in Berlin on the challenges associated with robomobility in May;
- Organisation of a seminar in Paris on models linking transport and land use in July;
- Organisation of a workshop in Paris in September on the eco-design of road infrastructures;
- Cross-supervision of trainees on the issues of electric vehicles and geolocation;
- Reception of DLR staff at GEOLOC (Geolocation laboratory, AME department) in November;
- Finalisation of publications on freight transport.

Alongside this programme, links with Canada were also strengthened in 2019. Thus, the AME department jointly organised a summer school with Université de Montréal from 16 to 30 June on the theme "Cities, Regions and the Circular Economy".

return to contents

Transfer activities

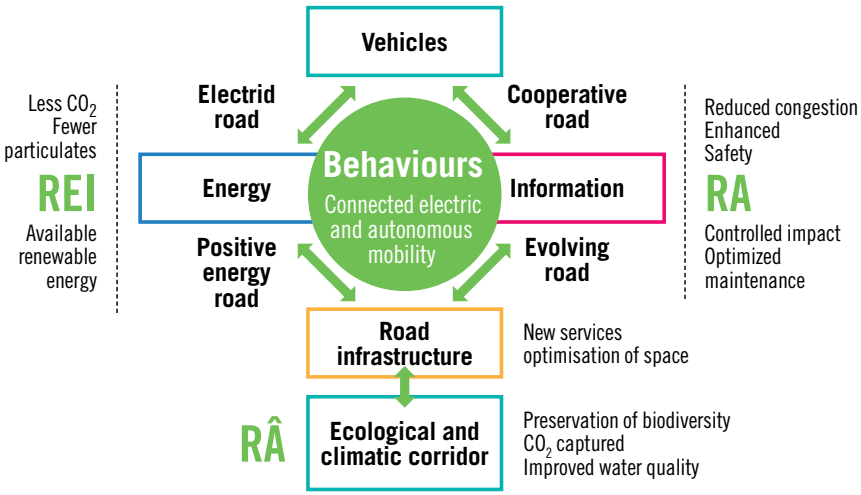
IFSTTAR has always pursued a policy of exploiting the results of its scientific and technological research, particularly for the purposes of technical support, technology transfer, testing and certification. These activities are carried out primarily for the benefit of the departments of the Institute's supervisory ministries and the other administrations and bodies attached to them.

Various transfer activities have been devised in order to encourage mutual awareness of the needs of the scientific community and those in charge of public decision-making, and to put in place the transfer of knowledge to public policy makers, central government departments and institutional partners. Briefs are produced in order to compare views about scientific issues and issues relating to public policy support. This makes it possible to show the utility of our research and to promote it. These activities also help to convert scientific results into decision-making aids. Transfer seminars are also organised to present research results to the Institute's supervisory authorities.

Transfer activities concerning the management of public space

→ As major contributors to the carbon footprint of most countries in the world, the mobility and urban sectors are becoming increasingly critical. They influence not only the attractiveness of countries but also the quality of life and health of their inhabitants. The growth of mobility requires leaders to rethink the management of public space. The transformation of motorways into urban boulevards, the development of hybrid spaces or the increase in the functionalities provided by infrastructures to accommodate mobility that is shared, electric, bicycle-based, autonomous, focused more on accessibility and less on flow are all responses to this urgent need to support the transformation of the sector. Today, smart cities are recognised as helping to improve sustainable development indicators by facilitating more efficient, flexible and environment-friendly mobility that consumes less space, on condition that overall behaviour is properly managed. The national strategy for the development of automated vehicles is a response not only to the challenge of industrial sovereignty, but also to the need to open up regions. France's uniqueness in this area lies in its decision to require the infrastructure to play a major role in automation. Thus, new needs are emerging in terms of new generation infrastructures, known as 5th Generation Road (R5G), which also have virtues from the point of view of their carbon footprint and ability to adapt to climate change, given that today's climate is already placing heavy demands on network capacity. Relying on technologies with a high transformative potential to address a range of transport and urban challenges is a promising way forward. This is the path chosen by the COSYS department. The Internet of Things, the intelligent collection of reliable data at all scales (from satellites to embedded sensors and drones), flexible and reliable communications, massive data processing, perception, geolocation, modelling and regulation at all scales, safe systems engineering, cybersecurity and energy management are the scientific mainstays on which the department has decided to invest, in response to the challenges posed by the automated vehicle and the sustainable city. Overall, the aim is to offer the opportunities provided by digitised areas to all citizens at the level they require.

Diagrammatic representation of R5G © Nicolas Hautière



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return to contents

Transfer activities for road safety

→ A collective book was published under the direction of IFSTTAR researchers by Harmattan in 2019 with the title, *La sécurité routière en France : quand la recherche fait son bilan et trace des perspectives*. Readers will discover four main sections: road safety issues and the consequences of accidents, road safety policy, the infrastructure-vehicle-use triad, as well as risk and vulnerability factors. Each contribution describes the current state of scientific knowledge on the subject and suggests possible courses of action to improve safety.
Four IFSTTAR researchers are on the committee of experts consulted by the National Road Safety Council (CNSR). These road safety specialists use their scientific and technical expertise to inform the actions of the public authorities. In 2019, they met every month at the Ministry of the Interior to discuss various subjects considered important in the light of the questions raised by the CNSR and the social context. Their work involved, for example, issuing advice on planned measures, producing thematic reports, suggesting courses of action or conducting forward-looking monitoring of the impact of new technologies. The committee thus provided a technical, scientific and professional study of the draft recommendations of the four CNSR commissions: vulnerable users; road education and occupational road risk; vehicles, innovative technologies and infrastructure; health and road travel. Their reports can be consulted on the **CNSR** website. They deal with electric personal mobility devices (scooters, rollerblades, gyropods, hoverboards), the rules that may be applied for the use and sharing of public space, the safety equipment that may be made compulsory, analysis of pedestrian accidents, the road safety issues related to automated driving and the exemption from the maximum authorised speed of 80km/h on two-way roads outside built-up areas.
These recommendations were a major source of inspiration for the Mobility Policy Bill (Projet de Loi d'Orientation des Mobilités (LOM)).
The Transport, Health, Safety department (TS2) also organised six symposiums or study days in 2019.

- At the symposium on the emerging risks of sustainable mobility (organised by the LMA in July), an analysis of policies in favour of sustainable mobility was presented, identifying the consequences of policies and planning measures, as well as the transformation of spaces and practices;
- TS2 jointly organised with ENTPE the 2019 conference of the ERSA (European Regional Science Association) in Lyon at the end of August, which was attended by more than 900 researchers in the field of the regional sciences;
- The LMA (Laboratory of Accident Mechanism Analysis) organised a study day on "detailed accident studies" (October). After a brief historical survey of their origin and the reasons behind them, the meeting provided examples of how to understand accident occurrence mechanisms and make road design and protection recommendations;
- TS2 was co-organiser with the University of Sherbrooke and the Agence Wallonne Pour la Sécurité Routière of the "1st French-speaking road safety study days" in Quebec City (October) which focused on vulnerable road users;
- The "Accidental Trauma: The Ain Observatory and Rhône Register" workshop (November), jointly organised by UMRESTTE (Epidemiological Research and Surveillance Unit in Transport, Occupation and Environment; IFSTTAR/Université Claude Bernard Lyon 1 - UCBL) and networks of doctors and emergency physicians (Arvac, RESUVal – RESCUe), made it possible for the first time to produce results on everyday accidents in general and to see road accidents in the broader context of accidents of all kinds.

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Transfer actions conducted in 2019 in the sphere of road safety

return to contents

France Mobilités Master Class: **find out more**

Transfer actions relating to mobility management and the environment

→ The Planning, Mobilities and Environment department (AME) has undertaken transfer activities on issues relating to changes in mobility practices (goods and passengers):

- Hearing at the National Assembly on Sections 2 and 4 of the Mobility Policy Act;
- Contribution to one of the policy briefs of the T20: "the Infrastructure Nexus: from the Future of Infrastructures to the Infrastructures of the Future", presented in Tokyo in May 2019;
- Contribution to the "zero emission urban freight" white paper produced by the Transport Decarbonation Alliance (TDA);
- Contribution to the international seminar on 28 June 2019 of the forward-looking workshop on robomobile life;
- Contribution to the final seminar of the OBAMO Structural Research Collaboration on the observation and analysis of mobility on 26 September 2019, attended by representatives of the MTES and the European Metropolis of Lille;
- At the request of the MTES, implementation of **Master Classes** accredited by France Mobilités on all aspects of the governance of innovation. AME also chairs the France Mobilités scientific committee.
- Founding of an urban logistics chair funded by SOGARIS. The programme of the Logistics City Chair focuses on logistics real estate and new trends in urban logistics;
- Work on dense transport services carried out in conjunction with the Normandy Region. The regions are in fact in great need of criteria and methods that will enable them to prioritise their future investments on small lines.

The AME department has also contributed to transfer actions on environmental issues:

- From 16 to 30 June, a summer school bringing together some 50 participants was jointly organised by the department with Université de Montréal and Université Libre de Bruxelles;
- A chair has also been created with the Métropole du Grand Paris in order to help it implement and promote its policy on the circular economy;
- The results of the European CNOSSOS project on the method for characterising the acoustic emissions of medium-heavy vehicles were presented to the Noise Commission and the DGITM (Directorate General for Infrastructure, Transport and the Sea) during a feedback meeting held in April 2019.

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return to contents

THEME 2

More efficient and resilient infrastructure

The scientific activities of Theme 2, "More resilient and efficient infrastructure", were marked in 2019 by current events which pointed up the importance of monitoring and maintaining existing, sometimes ageing, infrastructures and how they are used. The appraisal of roads, which took the form of the parliamentary report on French engineering structures and the report of the National Roads Observation Unit (Observatoire National des Routes), highlighted a need for large-scale investment to upgrade and maintain the quality of roads, which are subjected to ever-increasing demand and greater stresses due to traffic and climate change.

return to contents

Results have been obtained on adapting infrastructure

The National Low Carbon Strategy (SNBC), as part of the ecological and solidarity transition, is leading to a search for materials that consume less energy and are more environmentally friendly, in particular through increased recycling and re-utilisation, without compromising their mechanical properties and durability. The development of a circular construction economy is outlined in this annual report. The infrastructure must not only be energy-efficient for its own sake but also help to reduce the environmental impact of mobility. Finally, research has been carried out on new infrastructure that will play a role in the environmental and energy transition, in the context of the 5th Generation Road, the transport of the future and the production of renewable energy, particularly in the marine environment.

goal 1 Adapting infrastructure

Adapting to the challenges posed by new forms of mobility involves increasing the lifespan of existing infrastructure by guaranteeing its strength and resilience. Examples of research that contributes to the durability of engineering structures and pavements, the optimisation of their use or their monitoring are given below.
Monitoring and detection methods using sensors are being developed and tested under real conditions (the use of fibre optics for underground structures). Adaptation also involves optimising road traffic, developing multimodal solutions and optimising heavy vehicles on the basis of performance criteria (more efficient and environmentally-friendly), as in the FALCON project. In the case of pavements, which account for a large share of the maintenance budget, research seeks to make them more robust and durable in situations where they are subjected to greater stresses.

return to contents

The ANR SolDuGri Project – A durable technique for pavement strengthening with fibreglass grids

→ The ANR SolDuGri project aimed to gain a better understanding of the mechanical behaviour of fibreglass-reinforced bituminous pavements from when they are laid to the end of their service life, including their performance under loads. Laboratory studies were supplemented by full-scale trials on the fatigue carousel and by modelling of the fatigue behaviour of the strengthened pavements.
Usually, fibreglass grids provide a high-performance reinforcement method for delaying reflective cracking in bituminous pavements in order to increase their service life. Currently, the profession is trying to use this solution to reinforce upper pavement layers. Their evaluation is still based on empirical rules. This project, combining laboratory studies, experimental observations and modelling, has made it possible to:

- Evaluate the performance of the different components (strands and resins) of the grids used in the project 40x40mm²;
- Characterize by means of laboratory tests the mechanical performance of the grids in terms of their tensile strength, creep, strength during laying, fatigue and cracking of reinforced bituminous mixes;
- Gain a better understanding, through laboratory and full-scale tests, of the impact of laying conditions on damage to the grids, the impact of grids on the bonding of bituminous layers, and their mode of operation in the pavement;
- Estimate the service life of reinforced pavements by performing fatigue tests and calculations using the Alizé software;
- Verify that full recycling of these materials is possible;
- Evaluate the environmental impacts of such reinforcement by conducting life-cycle analysis.

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A bituminous structure that has been strengthened with the fibreglass grid used in the ANR SolDuGri project

return to contents

The CEDR FALCON Project

Multimodal platform seen from the sky

→ The objectives of the FALCON project (Freight And Logistics in a Multimodal Context) were to identify the factors that influence modal choices for freight transport and to propose efficiency criteria for HGVs in terms of safety, manoeuvrability, impact on the infrastructure and responses to logistics needs. Four IFSTTAR teams were involved: SPLOTT (Production Systems, Logistics, Transport Organization and Work Laboratory in the AME department (Planning, Mobilities and Environment), EMGCU (Experimentation and Modelling Laboratory for Civil and Urban Engineering; Materials and Structures department), LAMES (LAboratory for Modelling, Experimentation and Survey of transport infrastructures; Materials and Structures department) and the Scientific Directorate.
In order to develop vehicle performance criteria, a population of heavy goods vehicles that is representative of those on European roads was selected. At the same time, a catalogue of the infrastructures commonly used in Europe (roads, bridges) was drawn up, with their geometric and mechanical characteristics. The behaviour and aggressiveness of the various HGV silhouettes were evaluated on these infrastructures, making it possible to propose performance criteria (PBS: Performance Based Standards). These are aimed at designing more efficient trucks that respect the environment (emissions and consumption) and the existing infrastructure.
This project paved the way for Europe's Smart Infrastructure Access Policies (SIAP), along the lines of those introduced in Australia (IAP), and showed the attendant benefits.

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OA13 (line 15 of the Grand Paris Express) – installation of fibre optic cables in the reinforcement cage of a diaphragm wall

Monitoring and designing intersections in underground works

→ IFSTTAR used fibre optics to instrument four diaphragm walls forming the protective enclosure of the OA13 structure on the Ile de Monsieur, in Sèvres on the banks of the Seine. This structure is one of the access shafts for the tunnel boring machines working on line 15 of the Grand Paris express. As each of its walls is 60m high, more than 1,000m of fibre was needed for the instrumentation. Twelve fibre optic cables were fixed to the reinforcement cages of the diaphragm walls under study. The deformations experienced by the structure during earthworks inside the enclosure were measured by these fibres over a period of 10 months.
Robust and original data processing methods were developed to adapt to site constraints, particularly vibrations. This experimental campaign showed that fibre-optic instrumentation was able to provide a continuous deformation profile that reflected the progress of the construction works and allowed an evaluation of the orthoradial compression of the wall.

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return to contents

goal 2

Developing the circular economy

2019's completed research projects highlight IFSTTAR's work on bio-deterioration mechanisms affecting wastewater systems. This work is helping us to propose materials that are less sensitive to bio-deterioration and has defined a pre-normative accelerated test. During 2019, research was also carried out to identify processes or solutions that will meet the requirements of the National Low Carbon Strategy (SNBC). Among these, the national **FastCarb**, project is evaluating solutions for the recarbonation of recycled concrete aggregates. In particular, a workshop was organised to exchange international knowledge on CO_2 sequestration.

DURANET: durable drainage networks

→ The patrimonial management of wastewater systems is of crucial importance, both economically and technically, for communities and their delegated managers. The DURANET FUI project (2014-2019) aimed to develop tools to limit and forestall the risks of bio-deterioration in wastewater networks in the presence of hydrogen sulphide, as this is a very common problem. The project brought together a consortium made up of Saint-Gobain PAM, Veolia Water, Imerys Aluminates, Dralam Technologies, Optomesures, INSA Toulouse, IFSTTAR and Université Paris-Est Marne-la-Vallée (UPEM). In the framework of DURANET, significant advances have been made in understanding bio-deterioration mechanisms on the basis of laboratory tests and modelling. The latter has in particular provided a better understanding of the behaviour of certain cementitious materials, with, in particular, the important role of the nature of the initially formed hydrates and their thermodynamic stability. An important part of the project was carried out at the Division for Physical-chemical behaviour and durability of materials Laboratory (CPDM) and involved the development of an accelerated bio-deterioration test, which is now proposed for European standardisation. At the same time, in situ tests have enabled a significant amount of data to be gathered, which has, for example, contributed to revising the FD P18-011 standard on media that are aggressive for concrete in order to redefine the various exposure limits and propose appropriate cementitious materials.

In-situ ageing of various cementitious materials

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The CO_2 Sto2019 Workshop

→ The CO2 Sto2019 (CO_2 storage in concrete) workshop organised by IFSTTAR and the FastCarb National Project was held on 24 and 25 June 2019 in Marne-la-Vallée under the aegis of the FIB, RILEM, AUGC and EFB. The conference brought together around 80 experts on the subject to listen to just over 30 presentations including ones by Professor Valérie Masson-Delmotte from the IPCC (Cities and Climate Change Science), Professor Chi Sun Poon from Hong Kong University (Enhancement of properties of recycled aggregate concrete by accelerated CO_2 curing), Professor Carmen Andrade from the Polytechnic University of Catalonia (Substantial global carbon uptake by cement carbonation) and Sandrine Mansoutre from the École Française du Béton (Concrete Recycling: Research and Practice). In addition to the results of approaches aimed at storing CO_2 in different cementitious materials, the workshop confirmed the emergence of a consensus on storage by natural carbonation: about 10% of the CO_2 emitted by cement manufacture is recovered during the service life and another 15% during the deconstruction and recycling phase. All of the papers given at the workshop can be downloaded from the **RILEM**.

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return to contents

goal
3

New transport and energy production infrastructure

This objective of the COP and Theme 2 is still being very actively pursued and is focused on innovative transport infrastructures, in particular to meet the vital need to limit climate change and reduce CO_2 emissions, but also to meet requirements for energy production, storage and transport infrastructures. The 5th Generation Road also includes solutions combining both approaches. In 2019, in view of the growing concerns of network managers regarding the maintenance, evaluation and sustainability of their infrastructure, the MIRE study presented below was conducted for IDRRIM (Institute of Roads, Streets and Infrastructures for Mobility). Proposals aimed at facilitating the construction of underground railways, particularly for the Grand Paris express railway, were studied, such as those aimed at reducing the total thickness of the tracks. Finally, two projects are presented that deal with the production of renewable energy in marine environments.

The MIRE study: the impact of the revolution in Mobility practices on Roads and Road Equipment

Presentation of the MIRE study at the *Biennales des Territoires*, March 2019

→ The MIRE study has identified a series of challenges facing road network managers. Roads have a use value and a patrimonial value, and they have the potential to offer progress to users if they are managed on the basis of a strategy underpinned by a shared forward-looking vision:

- Maintain the road network in its state of optimal performance at the service of mobility for all, promote recognition of the central role of roads in the architecture of mobility systems, generalise the patrimonial approach and ensure the universality of the road network;
- To meet the need to regulate the use of roads as a public space with a variety of uses, to ensure the diversity and effectiveness of the legislative and regulatory tools proposed to the various project owners and network managers, to promote the coherence and complementarity of the policies implemented by different managers in a given area, for the benefit of both users and areas, and to anticipate changes, transformations or disruptions in the medium and long term in order to guarantee the proper management of the different types of use;
- Revise the foundations of the economic model for the road, optimise public expenditure on roads and modify financing methods to take into account the role of road traffic in the overall system of mobility and freight transport.

Each of the associations that initiated the study promoted MIRE in 2019: a parliamentary breakfast for the TDIE think tank (Transport Development Intermodality Environment), the "Biennale des territoires" ATEC ITS France's after-work meeting, a special session at the IDRRIM congress...

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return to contents

Behaviour of a bituminous mix under loading from continuously supported rails - a summary of Octavio Lopez-Polanco's thesis

The SISYPHE platform used to test the railway structure in the REVES project

→ Part of the FUI REVES project (Reduction of Track Thickness in Underground Environments), this thesis was supervised by Thomas Gabet (Advanced Materials for Transport Infrastructures Laboratory (MIT); department of Materials and Structures (MAST)) and Nicolas Calon (SNCF), supervised by Pierre Hornych (Laboratory for Modelling, Experimentation and Survey of Transport Infrastructures (LAMES), Materials and Structures department (MAST)). Its objective was to create a very thin railway track, without ballast or sleepers, in order to increase the headrooom in tunnels. The chosen solution is a structure in which the rails are continuously supported by a layer of bituminous mix.
The main deterioration modes of bituminous mixes are fatigue cracking due to the passage of rapid repeated loads, and the accumulation of permanent deformations resulting from heavy static loads. The thesis focused on the creep behaviour of bituminous mixes under static loading. In the REVES project, a class 4 gravel stabilised with bitumen was chosen for the support. A programme of triaxial creep tests was carried out on this material. Based on the results, a viscoplastic behaviour model was developed to simulate the creep behaviour of the bituminous mixes. A simple method for identifying the model parameters was also developed. The viscoplastic constitutive model was then implemented in the Cast3m finite element calculation software and the behaviour of a railway structure corresponding to the specifications of the REVES project was simulated under different loading conditions. These simulations showed that the behaviour of the bituminous mixes was stable over time under the effect of railway loading and that the levels of permanent consolidation in the structure complied with SNCF specifications. The use of bituminous mixes as a structural layer for railway tracks therefore appears to be a viable option for increasing tunnel headroom.

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REDENV-EOL Project (WEAMEC 2017-19): Reducing the Environmental & Geometrical Impact of Floating Wind Turbines by using Pile Foundations

→ The geometrical footprint of the anchor lines for floating wind turbines is an important issue for the overall acceptability of the technology (because of its impact on navigation). In addition, the movements of the wind turbine are transmitted to the foundations as non-permanent "cyclic" stresses. The purpose of this project is to better understand the operation under repeated loads (tension) of some innovative deep foundation anchors with different geometries (driven pile, helix pile, suction pile, depending on the nature of the seabed (sand or normally consolidated clay)) allowing a reduction in the geometrical footprint of the anchor lines. To this end, a targeted campaign of centrifuge experiments on physical models was carried out in order to observe and understand the behaviour of this type of structure and to build up an experimental database. The results can be compared with existing design methods.
This project was coordinated by IFSTTAR, carried out with the Ecole Centrale de Nantes and financed by WEAMEC (West Atlantic Marine Energy Community) which brings together academic and industrial players involved in research, innovation and training in the field of marine renewable energy in the Pays de la Loire.

Examples of the scale models used; a shaft with a diameter of 10mm instrumented with 1:10 scale force sensors
© Ifsttar, extrait de « Schiavon J.A. 2018. Effect of the helix to shaft diameter ratio on the behaviour of single helix anchors subjected to cyclic loading. Scientific mission report. IFSTTAR USP Partenariat structurant international HELICAL PILE. 108p »

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return to contents

EMODI project: Offshore Energy Grids Monitoring and Diagnosis

→ Coordinated by RTE, EMODI is an ANR research project (The safe clean and efficient energy challenge – *Défi énergie sûre, propre et efficace*) involving Nexans, IFSTTAR, CEA, the University of Nantes and the Ecole Centrale de Nantes. Launched at the beginning of 2015 with a duration of 48 months and a total budget of €2.3M, it deals with export power cables (either laid on the seabed or buried). These are of strategic importance for connecting MRE (marine renewable energy) generating units to electricity transmission and distribution networks. The aim is to manage the operation of the cables over a 20-year operating period, to guarantee the transmission of electricity and limit maintenance. Work focused on sizing and new monitoring methods (preventive and predictive cable maintenance). The Components and Systems department (COSYS) has developed multi-physical models of cable use (Copper conductor and XPLE insulation). Stressing the copper conductor beyond its elasticity limits, which can occur during manufacture, routing and immersion, leads to mechanical - and consequently electrical and thermal - damage. The link between the mechanical, electrical and thermal behaviour has been demonstrated by multiphysical numerical models and prompted the creation of a decision support method for the immersion process. It is based on tensioning the phases at the end of the manufacturing process and verifying the absence of temperature peaks (related to damage) in the conductor. A model for the ageing of XPLE insulation has been developed to replace long experimental test campaigns. It shows how nano-bubbles of residual moisture attack the insulation under the combined action of mechanical stress and tension in the conductor.

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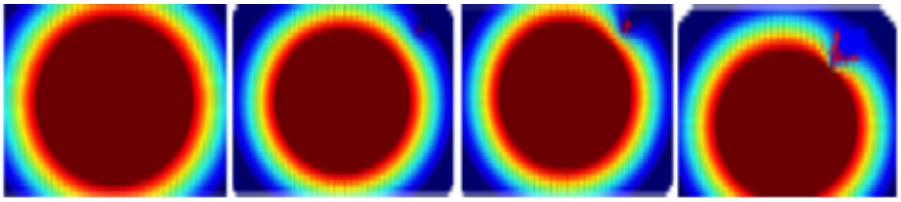

Modelling of the initiation of an insulation defect and its propagation towards the conductor in an extra high voltage cable (Thèse RJ DAS)

return to contents

THEME 3

Planning and protecting regions

IFSTTAR has been dealing for many years with issues related to the environment, natural and climatic events, as well as the risks posed to property, people and infrastructure. The upsurge in climatic and natural events that are deemed to be exceptional prompts IFSTTAR to seek innovative ways of adapting and planning for these risks, but also taking account of new forms of mobility. IFSTTAR's research topics therefore cover these themes - with a particular focus on the development of urban areas - and aim to reconcile the growing needs for space, mobility, supply or energy with the need to protect populations and the environment from pollution and natural or malicious threats.

return to contents

goal
1

Foreseeing natural and climatic risks

Two focuses have been chosen to illustrate this objective. They relate to the transfer themes in the COP 2017-2021 with, on the one hand, the forecasting of floods and the associated risks to infrastructures (7.1) and, on the other hand, seismic risk and ground movements (7.2).

Transfer Theme 7.1 deals with the prediction of high water and flooding and the risks they pose to infrastructure. The ANR-SSHEAR project (Soils, Structures and Hydraulics: Expert Appraisal and Applied Research) on scouring processes and attempts at in-situ instrumentation has brought together a large number of researchers from multiple disciplines who complement one another.

The ANR SSHEAR project

→ Scouring processes are a major cause of the destruction of constructions (engineering structures, earthworks and buildings), especially during major floods, but the way they are addressed is still too empirical. The **SSHEAR project** has improved our understanding of scouring mechanisms and led to the development of innovative observation and modelling tools at the scales of both experimental models and real structures with a view to proposing optimised methods for diagnosis, warning and management. This project has also made it possible to acquire scientific and technical expertise that was almost non-existent in France, but also international expertise focused on issues that differ from those affecting France. The team managing the SSHEAR project had to create the conditions for this national expertise to emerge. In order to enhance our knowledge and propose optimised methods for diagnosis, warning and management, the SSHEAR project was based on a multi-scale multidisciplinary approach. This focused on:

- the physical processes of flow and erosion in the vicinity of structures (bridges, banks, etc.);
- three laboratory experiments offering multi-scale observation;
- a truly innovative approach to two-phase modelling;
- field observations and measurements as well as the development of equipment. A one-day feedback meeting to present the main results of this project was held at IFSTTAR on September 11, 2019 and brought together more than 70 researchers.

⇨ **FIND OUT MORE**

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Instrumentation of engineering structures to identify the risk of scouring by vibration analysis

→ In the framework of this project, the thesis "Vulnerability of engineering structures to the risk of scouring" by N. Boujia (2018), dealt with the **instrumentation of engineering structures to identify the risk of scouring by vibration analysis**. Two avenues were explored: direct monitoring of the behaviour of bridge piers and a feasibility study for a scour sensor. The dynamic behaviour of the piles was studied by modelling, validated by hydraulic channel experiments at the LHSV (Saint-Venant Hydraulics Laboratory) in Chatou and the instrumentation of a bridge on the A71 motorway. This work is currently continuing with inverse modelling and identification of scouring in the context of M. Belmokhtar's doctoral research.

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return to contents

Transfer theme 7.2 deals with seismic risk and ground movements through findings on soil liquefaction and the *in-situ* characterisation of this phenomenon.

Seismic response of soils and the phenomenon of liquefaction

→ Recent changes in earthquake-proofing regulations in France (Decrees n°2010-1254 and n°2010-1255 of 22 October 2010) mean a reassessment of the seismic risk is required for a very large number of structures. At the research level, major advances have been made in understanding the phenomena linked to severe earthquakes, particularly since the exceptional Tohoku event (Japan, 2011). The **seismic response of soils and the phenomenon of liquefaction** explain the devastating effects leading to the loss of bearing capacity in the foundation soils, large-scale flow slides, the collapse of structures and significant damage to urban networks (e.g. Port of Nice, 1979; Tohoku, 2011). However, there is still a need to improve the understanding and modelling of these phenomena on the basis of appropriate tests at the scale of the material (laboratory behaviour tests) and at the scale of the foundation soil (physical modelling). IFSTTAR has proposed to develop advanced experimental devices in each of these fields, the objective being to better characterise the non-linear seismic response of soils (including liquefaction) and the dynamic soil-foundation soil-structure interaction in the laboratory at different scales, and thus to limit damage to urban structures and networks. Since seismic action is characterised by the appearance of shear stresses alternately and repeatedly at different frequencies and amplitudes, the rotations of the imposed stresses can only be simulated in experimental devices allowing the application of cyclic simple shear deformation up to several hertz. A platform containing complementary devices capable of observing these phenomena from the intermediate scale of the material to that of the structure has been set up. Thus, the soil tested under a full-scale model structure in the largest case, can be tested at the scale of the soil-structure interface in the intermediate size material and at the scale of its representative elementary volume in the laboratory test.
To meet these objectives, regular financial support from the DGPR at the MTES has been put in place over the last three years to move these actions forward with funding that is earmarked to support ongoing doctoral research and the preparation of methodological documents. The ANR ISOLATE project as well as the CSR EGIDE project have also contributed and profited from this transfer theme dedicated to the understanding of soil liquefaction.

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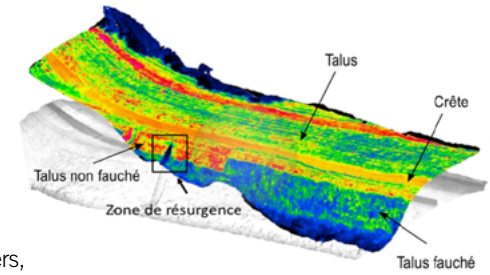
The DIDRO FUI project

→ The DIDRO FUI project explored the various possibilities offered by drones for the surveillance of dikes: preventive surveillance and surveillance during floods.
As the French dyke system is generally in an unsatisfactory condition, new regulations have been introduced (Decree n°2007-1735) in order to bolster not only its management but also its effectiveness and safety. Faced with these new requirements, dike managers lacked any means of carrying out high-speed monitoring at an affordable cost. The DIDRO project "Monitoring dikes with Drones" (2015-2019, an FUI project approved by the SAFE Cluster and ASTech competitiveness clusters) was thus set up, bringing together the companies Geomatys (the project leader), SURVEY Copter, Atechsys Engineering, the public establishments IFSTTAR, IRSTEA, CEREMA, IGN, Entente Valabre CEREN, DREAL Centre, together with the subcontractors L'avion Jaune and CEEMA and dyke managers, represented in particular by France Digues. The aim of the project was to develop an operational solution based on instrumented drones to support surveillance and reconnaissance missions for all types of dykes. The observation instruments - remote sensing cameras and sensors (operating in the visible, near infrared, thermal infrared domains, and LiDAR), aquatic measurement tools and ground-based geophysical methods - provide a set of data which, when used alone or in combination, make it possible to detect disorders that are visible on the surface of structures, but also to obtain information on some of their internal characteristics. The drone-borne technology is able to carry out high-speed data acquisition, both in the context of so-called routine surveillance missions and surveillance during hydro-meteorological crisis situations. The project has made it possible to bring several innovative technological bricks to maturity, then to integrate and validate them. Various restitution phases and a demonstrator were deployed to present the solution to end users (managers), financiers and SAFE Cluster. In addition to the numerous technical deliverables, a methodological guide was produced and the partners also looked into the economic model for operating the future "DIDRO" service proposed to dike managers.



3D surface models, in the thermal infrared and visible domains, produced during the rendering of a dyke on the Loire (at Bou, Département 45) with a zone of artificial resurgence
© consortium DIDRO

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return to contents

goal 2

Understanding, evaluating and improving the interactions between infrastructures, transport services and planning policies and their effects on the environment and populations

Human activities in the sphere of transport or energy production have an impact on the environment and populations that should be assessed in the first instance. IFSTTAR is working on the different forms this pollution takes, whether it is the pollution of aquatic environments by caesium and mercury (Continuum de la Loire project), or noise pollution in the vicinity of wind turbines (Cibelius project). In both cases, the aim is to assess the exposure of populations. This assessment requires the use of complex sensors and metrology for physical characterisation, as well as the consideration of human feelings in the case of noise, or the involvement of the population through a participative approach in the case of mercury pollution.

Road verges play an important role in limiting the impact of linear transport infrastructures on biodiversity. Their management and maintenance is complex due to the large number of local stakeholders and the multiplicity of factors involved, be they legal, technical, economic, social or ecological. IFSTTAR is helping to analyse this complexity and to propose solutions to increase the effectiveness of management partnerships (Gedev project).

The DGT-DET River Loire Continuum Project - Development of passive sensors for understanding the mobility of caesium (Cs) and mercury (Hg)

→ The project, funded by the Observatory of the Sciences of the Universe in Nantes (OSUNA) and carried out in partnership with the University of Angers (LPG-BIAF), IMT Atlantique (Subatech) and IRSN (LSE and LER-Nord), aimed to develop tools to study the spatial distribution and environmental mobility of two chemical elements: caesium (Cs) and mercury (Hg). These highly toxic metals are chiefly associated with human activities, the first coming from fallout and discharges related to nuclear activities, the second from industrial emissions (incinerators, coal-fired power plants, refineries, cement works) and diffuse sources (transport, heating, electrical and electronic appliances).

The research has led to the development of a set of functional tools for investigating the environmental dynamics of mobile forms of Cs and Hg. These consist of devices using diffusive equilibration [DET] and diffusive gradients in thin films [DGT] which are based on the pollutant diffusion mechanism. The work has enabled these sensors

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return to contents

to be tested in the laboratory and then under real conditions. The results showed that they are able to measure the bioavailability of Hg in soils and sediments as well as Cs ceiling levels in water. In practical terms, the DGT and DET devices were tested along the continuum of the river Loire from leaching areas to estuarine or coastal deposits. Finally, a participatory approach was initiated to assess the levels of Hg pollution in the indoor air of dwellings in the Nantes region (see Figure).

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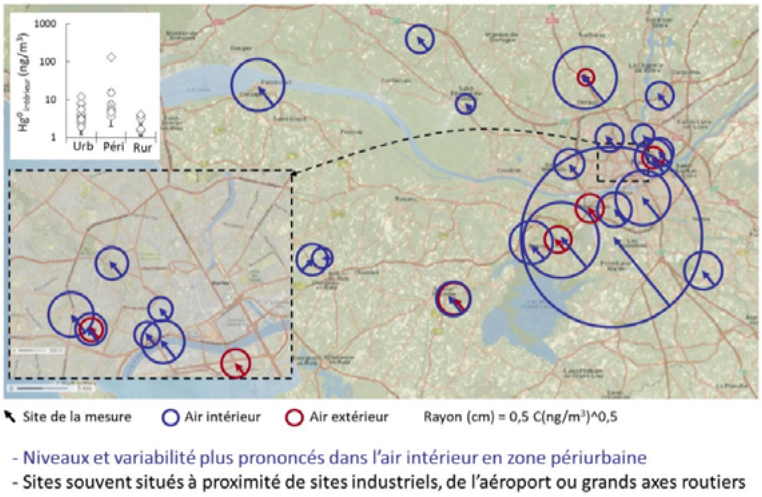
Indoor and outdoor measurement of elementary mercury – Application to the river Loire continuum © B. Muresan



CIBELIUS Project

→ The WHO Environmental Noise Guidelines point out that the evidence on the health effects of noise from wind turbines is either non-existent or of low quality. In this context, a feasibility study for an epidemiological study called Cibelius (*Connaître l'Impact du Bruit des ÉoLiennes sUr la Santé, 2017-2019*) was conducted in France. This study, funded by Anses, was coordinated by UMRESTTE (Epidemiological Research and Surveillance Unit in Transport, Occupation and Environment, IFSTTAR/Université Claude Bernard Lyon 1) and conducted in collaboration with DCM and UMRAE (Environmental Acoustics Laboratory which is jointly managed by CEREMA and IFSTTAR). The objective was to propose a wind noise calculation methodology to identify the number of local residents exposed to different levels of wind turbine noise. The Harmonoise model was finally selected on the basis of a literature review. Overall, the levels recorded for the contribution of a wind farm vary from 35dB(A) to 45dB(A) for distances of 500m to 1,500m, depending on the meteorological conditions. These levels are fairly moderate compared to other sources of noise (e.g. transport) and the total number of people exposed is very low: approximately 0.4% and 0.5% of the French population in 2017. Nearly 85% of the population exposed to wind noise is exposed to levels below 40dB(A), day and night. These results constitute the first ever assessment of population exposure to wind turbine noise in mainland France.

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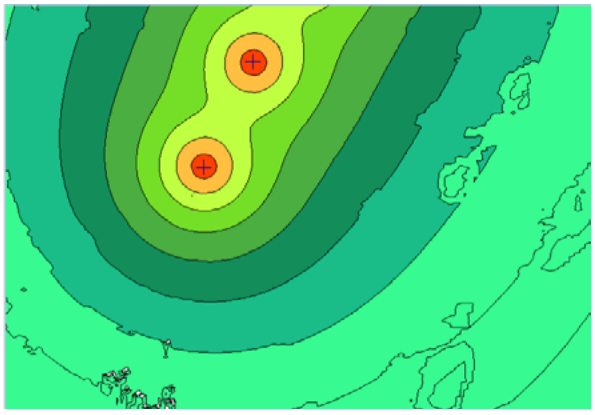
Wind turbines and a microphone
© D. Ecotière



Noise levels from wind turbines
© Cerema, UMRAE

return to contents

Maintenance of the banks of the navigation canal from Roanne to Digoin by the itinerant grazing of a herd of sheep © Claire Etrillard (Inrae)

GEDEV Project on the partnership-based management of road verges: a feasibility study

→ The GEDEV project, led by INRAE, aims to assess the possibilities of involving local players in road verges. In addition to crucial legal factors due to the purpose of roads and the regulatory powers of their managers, factors of a social, economic, ecological and/or technical nature have been identified, whether they are explicitly taken into account in the agreements that were have examined, whether they result from failings experienced by the actors, or whether they result from more general difficulties linked to the overall context. Proposals have been made to address some of these issues and increase the effectiveness of future management partnerships for the observed practices. They relate to the negotiation of specific points between the actors and their formalisation when partnership agreements are drawn up. They also deal with the clauses that can be inserted in all partnership agreements, without being limited to the practices we have detailed in this project. Finally, they are concerned with developing measures that would help to create a more favourable general framework for the extension of grassland along canals and improve recognition of the ecological benefits of some alternative methods of road verge management. These are thus modular elements that can be taken into account (or not) by the actors according to the linear transport infrastructures in question and the local contexts.

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return to contents

goal 3

Contributing to sustainable development

Urban areas both generate and experience multiple problems that interact with each other. Urban land use planning therefore requires collective thinking, with multi-domain approaches based on a large amount of varied data. IFSTTAR is actively engaged in addressing this challenge through its involvement in networks and the production of tools that are tailored to address this complexity. So, whether it is for stormwater management, the maintenance of their road network, or the management of mobility and logistics within their area, local authorities need knowledge and tools to inform and facilitate their decision-making. IFSTTAR is committed to actively responding to these needs by developing tools and knowledge that will enable local and regional authorities to respond to the major challenges of the ongoing energy, ecological, climate and demographic transitions.

The Veolia VEDIF2 Water Meter Project

→ The new concept of smart water and electricity grids offers the possibility of better management of these resources by means of advanced information and communication technologies. The aim is to optimise the availability and reliability of the supply of these resources and to improve the economic performance of the relevant networks. With this in mind, programmes to equip homes with communicating meters are being introduced by cities and water and electricity companies. For example, in the Île-de-France Region, the Téléo programme, managed by Veolia Eau d'Île-de-France (VEDIF) which has been delegated by the Syndicat des Eaux d'Île-de-France (SEDIF), plans to install around 600,000 communicating meters before the end of 2015. Whereas consumption was previously measured once a month, communicating meters now allow hourly or daily consumption readings. Within the framework of the project, the operators have provided the researchers with huge amounts of data from the communicating water meters. The use of advanced statistical methods to exploit these data reveals drinking water consumption habits on an individual and collective scale, and in particular opens up the possibility of reliable predictions of demand.

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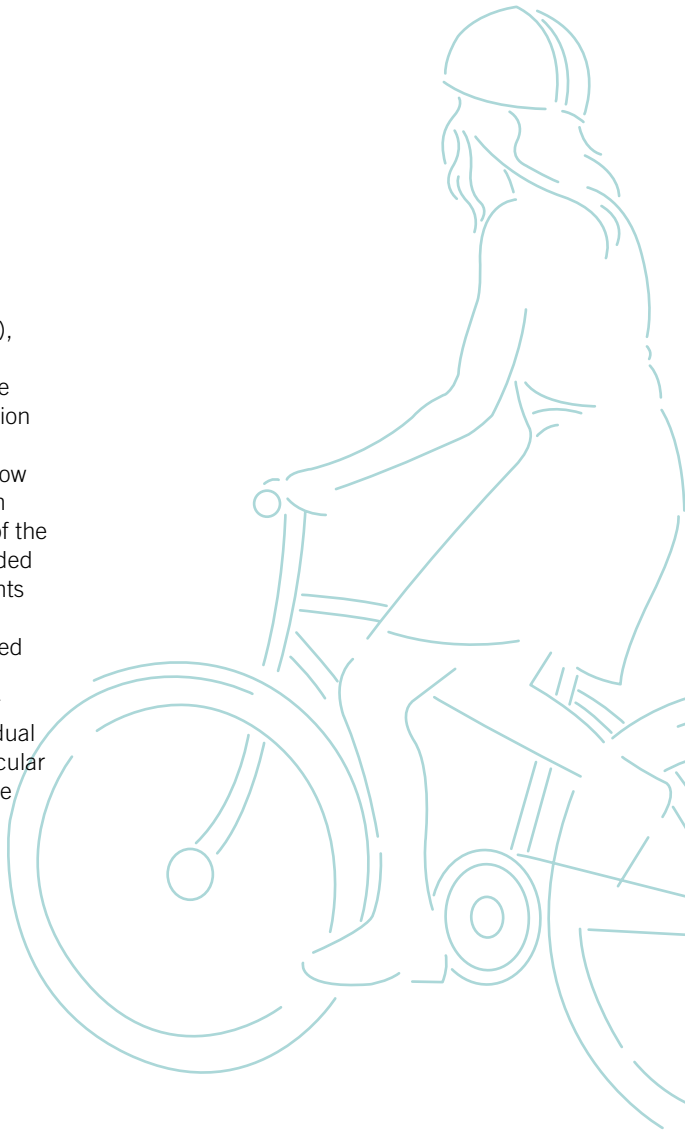

return to contents

Urban Europe Research Alliance – the EXPAND Project

→ The Joint Programming Initiative (JPI) Urban Europe and its associated scientific network, the Urban Europe Research Alliance (UERA), were set up in 2010 with the aim of imposing a framework on the field of urban research in Europe. IFSTTAR is coordinating the EBU scientific network and leading one of its 4 thematic working groups, dealing with urban accessibility and connectivity. Aimed at supporting the scientific activities of this network, the first phase of the EXPAND project, completed in 2019, has led to the organisation of numerous scientific activities and events. In particular, in 2019 the network organised a seminar on the *humanification* of cities and another on urban research to address the challenges of the mobility transition.

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JPI Urban Europe Uberisation of road freight transport, a DGITM study

Uber is a company which connects VTC service providers with customers. It has paved the way for the trend towards "*uberisation*", which also affects freight transport. The project focuses on three transport segments that have witnessed the advent of digital intermediation platforms: parcel carpooling, digital freight exchanges and food delivery. For each segment, the characteristics of the players involved, the business model and the legal status are identified. Thus, parcel carpooling consists of very small entities sometimes managed by non-professionals. With an ethos close to that of the collaborative economy, these small entities struggle to survive and acquire enough users to exceed their break-even point. Digital freight exchanges are larger players that bring shippers and carriers together. In this respect, they differ from traditional freight exchanges, and have, in fact, ended up with the same status as a freight forwarder. The report concentrates mainly on a survey of 130 couriers who deliver food for Deliveroo, Foodora or Uber Eats. The survey shows the high economic dependency of these delivery workers - although they are considered as self-employed - due to a specific type of algorithmic management. It also examines their decreasing remuneration and the economic model of food delivery platforms.

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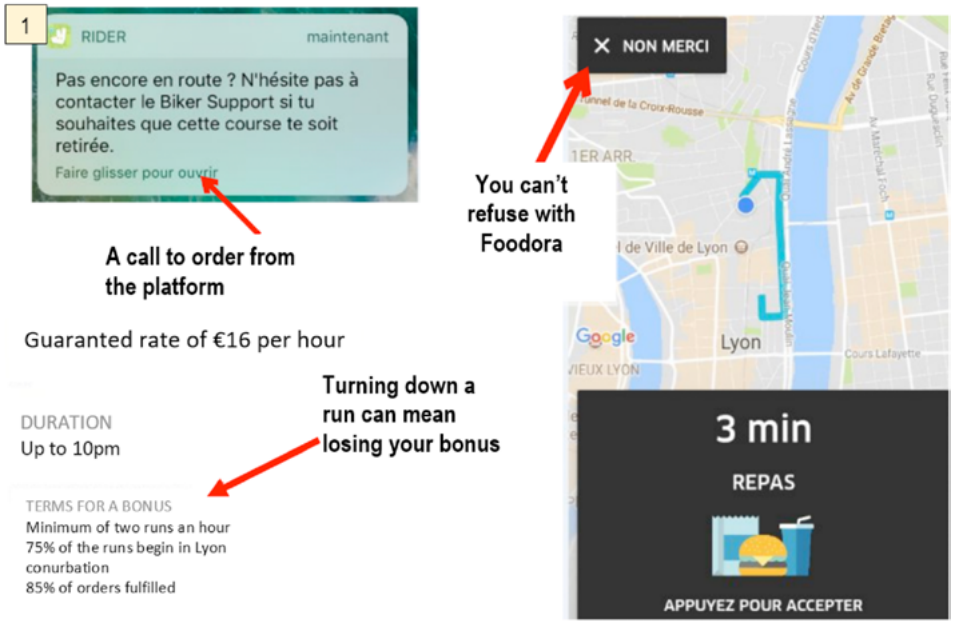
Screen captures from several food delivery couriers working for Deliveroo, Ubereats and Foodora in 2017 and 2018



return to contents

Some key figures

FIND OUT ABOUT ALL THE HIGHLIGHTS

return to contents

Contracts 2019

18.32 M€

Revenue in 2019 from research contracts
(including 432 k€ from Sense-City and 4.5 M€ from TRANSPOLIS)

18.36 M€

Total amount
from notified orders in 2019

171

Notified orders
in 2019

172
Contracts completed

21
Contracts in 2019
which received more than 200k€ in aid

390
Ongoing contracts

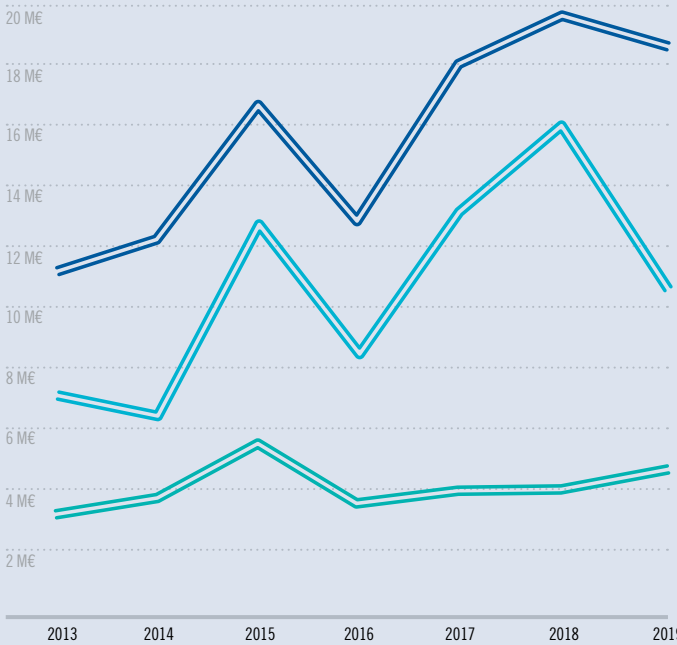
GOALS FOR RESEARCH CONTRACTS

as 31/12/2019

GOAL 1
Increasing internal resources by means of research contracts

GOAL 2
Giving priority to research contracts that generate profit margins

GOAL 3
Developing ties with the world of industry



RESULT
18.36 M€
A high level maintained for all types of contract

RESULT
10.67 M€
A marked decrease for contracts

RESULT
4.65 M€
A slight increase for contracts

return to contents

PhD activities

THEME 1

Efficient transport and safe travel

14
defences

THEME 2

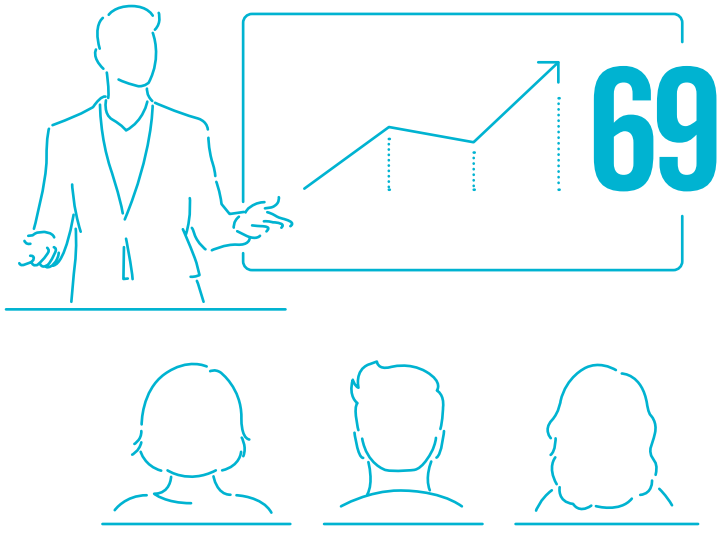
More efficient and resilient infrastructure

29
defences

THEME 3

Planning and protecting regions

14
defences



699
theses defended
since the creation of IFSTTAR

which include:

58
theses defended
in 2019 with a median research duration of 3.15 years

9
accreditations to direct research awarded
in 2019

return to contents

THE DOCTORAL STUDENTS

1 **teaching assignment**

18 **doctoral students under contract** in the academic year 2018-2019

17 **vacation sessions**

2 **fixed-term contracts** (co-funding ADEME, Université de Bourgogne)

10 **doctorates with research contracts**

62 **incoming IFSTTAR doctoral students in 2019**

24 **subsidised doctoral contracts** (7 with joint funding from a region)

4 **theses jointly managed** with the Universities of Sherbrooke and Montréal (Canada) and Tsinghua (Chine)

22 **theses with funding from other sources of which:**

2 civil servants (ITPE4A)

9 CIFRE-funded contracts with IFSTTAR assistance contract

6 doctoral contracts with an external employer

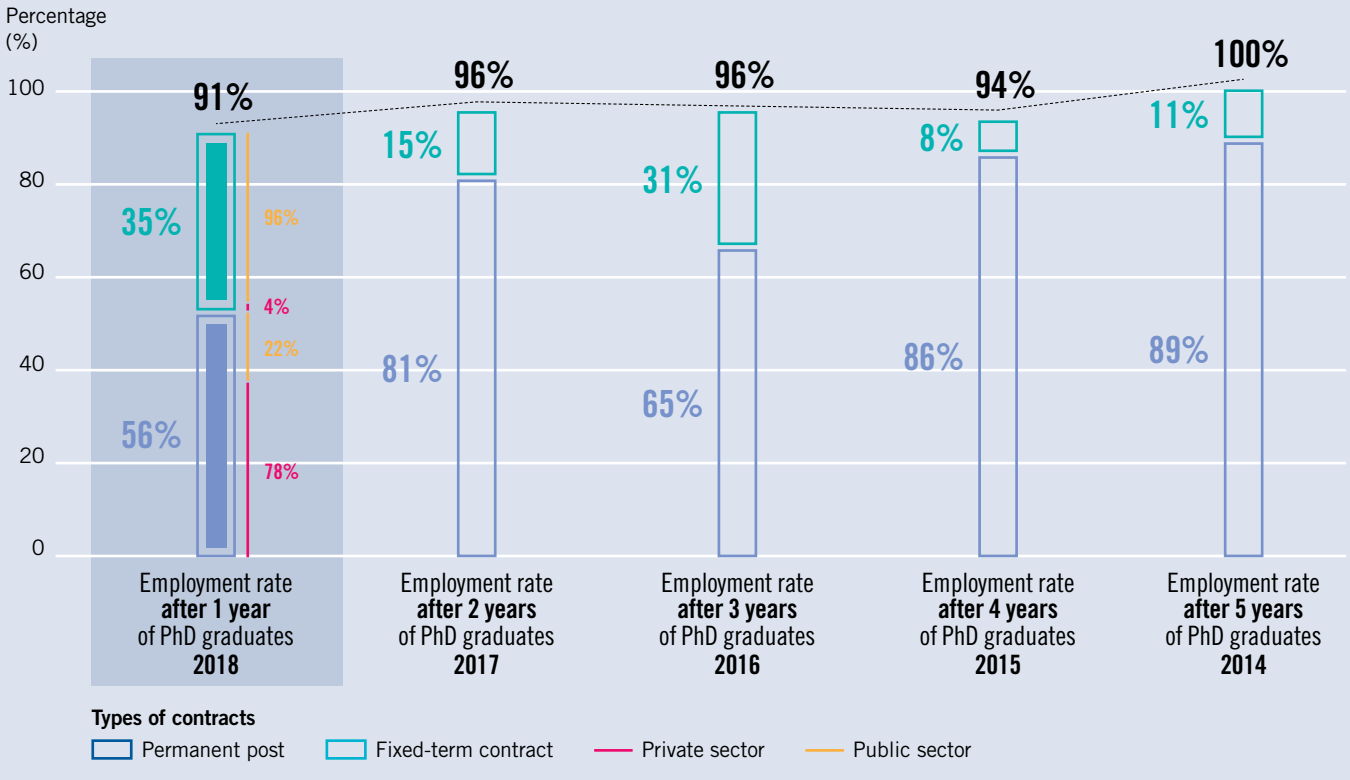
1 CIFRE-funded contract with an assistance contract from outside IFSTTAR

2 fixed-term contracts

2 grant-holders

EMPLOYMENT RATE OF PHDS AFTER 5 YEARS, ACCORDING TO TYPE OF CONTRACT AND SECTOR

as 31/12/2019



return to contents

Human resources

1,035

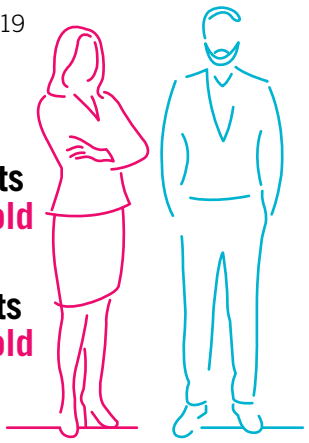
IFSTTAR staff
Amounting to 1,011.3 full-time equivalent posts of which 779.5 are permanent

411 women

624 men

DISTRIBUTION OF STAFF BY AVERAGE AGE

as at 31/12/2019



WOMEN

Permanents
48 years old

Non-permanents
29 years old

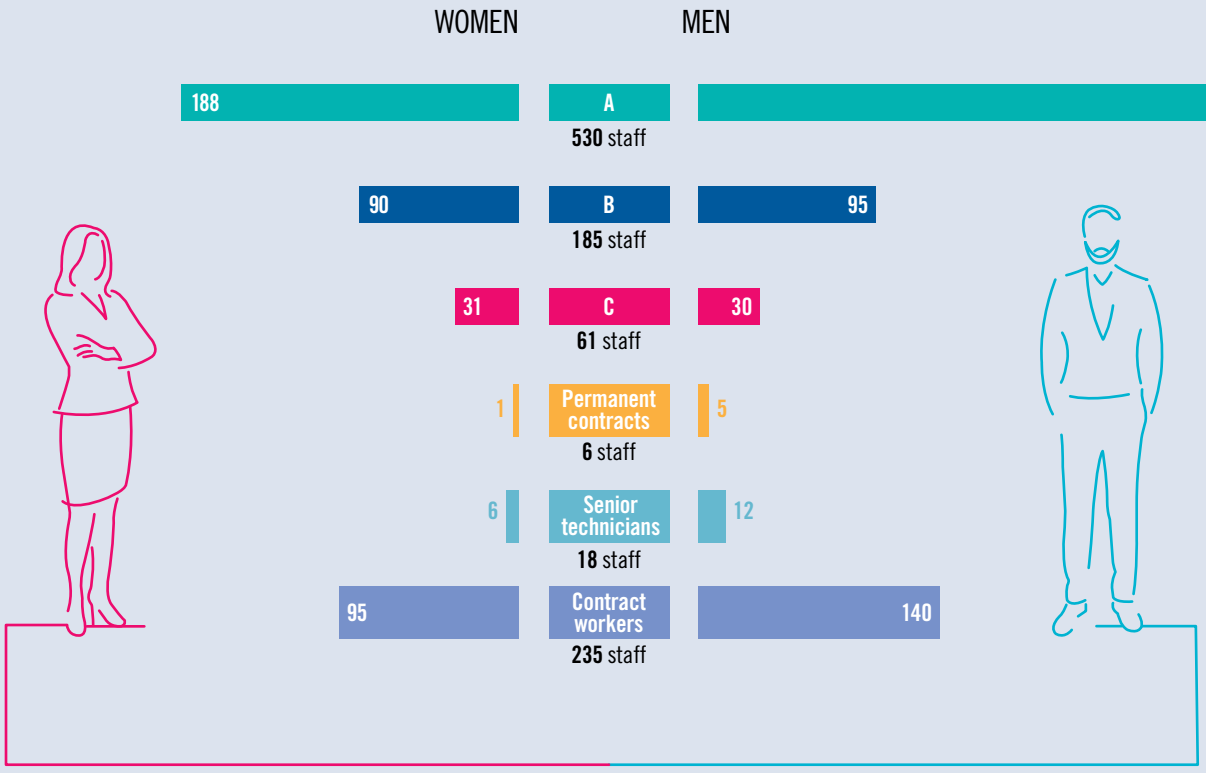
MEN

Permanents
48 years old

Non-permanents
28 years old

GENDER DISTRIBUTION OF STAFF BY CATEGORY

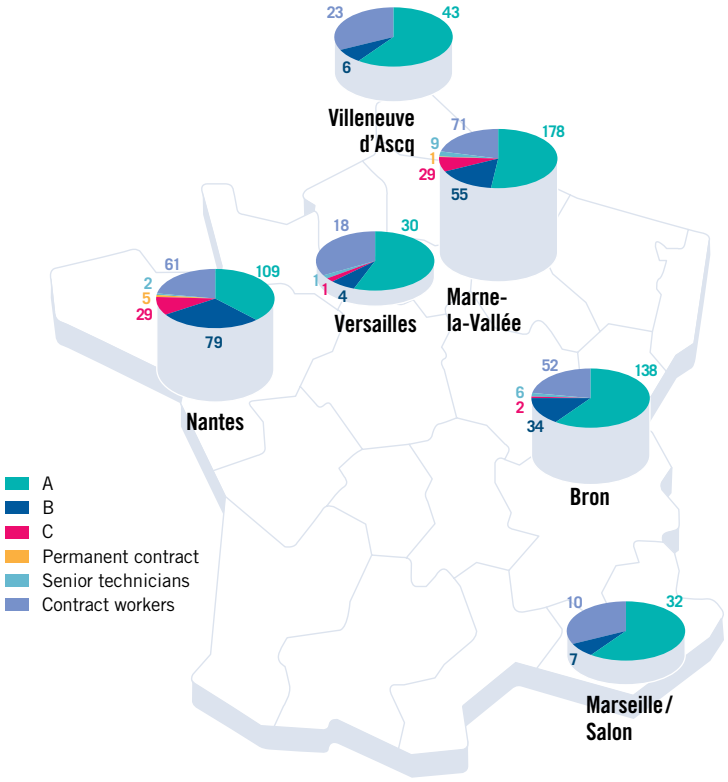
as at 31/12/2019



return to contents

DISTRIBUTION OF STAFF BY SITE

as at 31/12/2019



NUMBER OF PHYSICAL EMPLOYEES AND FULL-TIME EQUIVALENTS

as at 31/12/2019

	Physical staff	Full-time equivalents
Researchers	291	285.7
Technicial staff	278	271
Administrative staff	231	222.8
TOTAL	800	779.5

4,167,197 €

Action for the entire institution

including the promotion of research

14,783,438 €

Support functions

EXPENDITURE ON STAFF BY RESEARCH THEME

as at 31/12/2019

Expenditure on staff	Subsidy	Own resources
Theme 1 - Efficient transport and safe travel	18,513,395 €	2,762,728 €
Theme 2 - More efficient and resilient infrastructure	15,224,511 €	1,475,408 €
Theme 3 - Planning and protecting regions	22,306,959 €	937,180 €
Total for research	56,044,865 €	5,175,316 €

return to contents

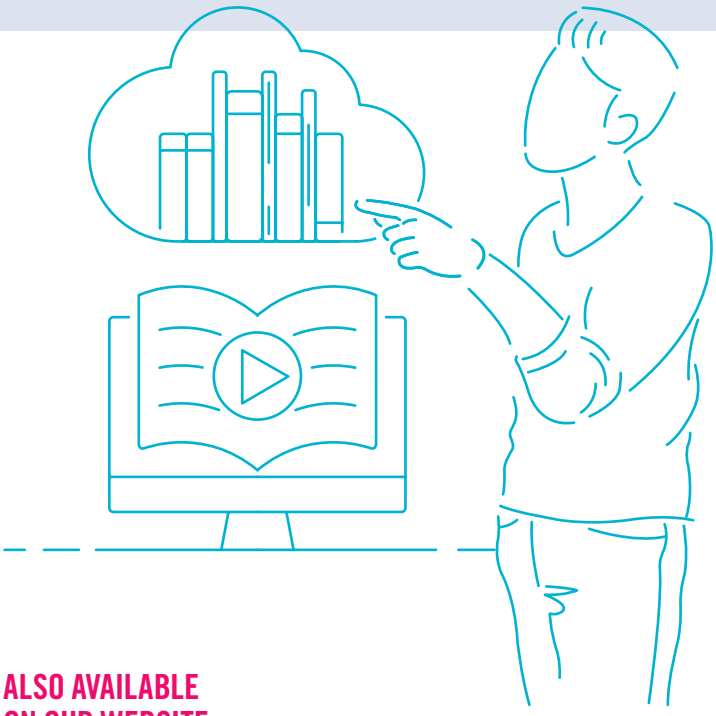
Publications

PAPERS IN PEER-REVIEWED JOURNALS

2017-2019

MADIS institutional archive

48,696
records
of which 11,020
are with the full text



ALSO AVAILABLE ON OUR WEBSITE:

REVIEW OF PUBLICATIONS

SUMMARY OF PUBLICATIONS

return to contents

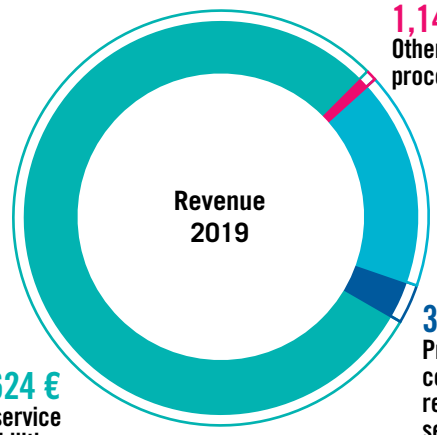
Revenue and expenditure

Financial resources and expenditure exclusive of depreciation

108,509,619 €

Total revenue 2019

BREAKDOWN OF REVENUE (EXECUTED BUDGET)



1,148,225 €
Other subsidies and proceeds (1 %)

18,324,063 €
Contracts and support for research activities (16.9 %)

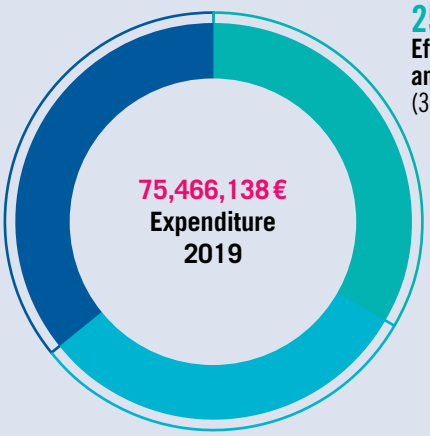
3,505,708 €
Product of the commercialisation of research activities and service provision (3.2 %)

85,531,624 €
Subsidy for public service responsibilities (78.9 %)

106,166,101 €

Total expenditures 2019

BREAKDOWN OF EXPENDITURE BY RESEARCH THEME

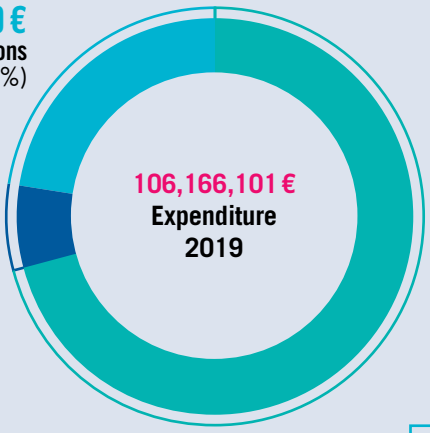


26,903,040 €
Planning and protecting regions (35.6 %)

25,119,659 €
Efficient transport and safe travel (33.4 %)

23,443,439 €
More efficient and resilient infrastructure (31 %)

BREAKDOWN OF EXPENDITURE ALLOCATION



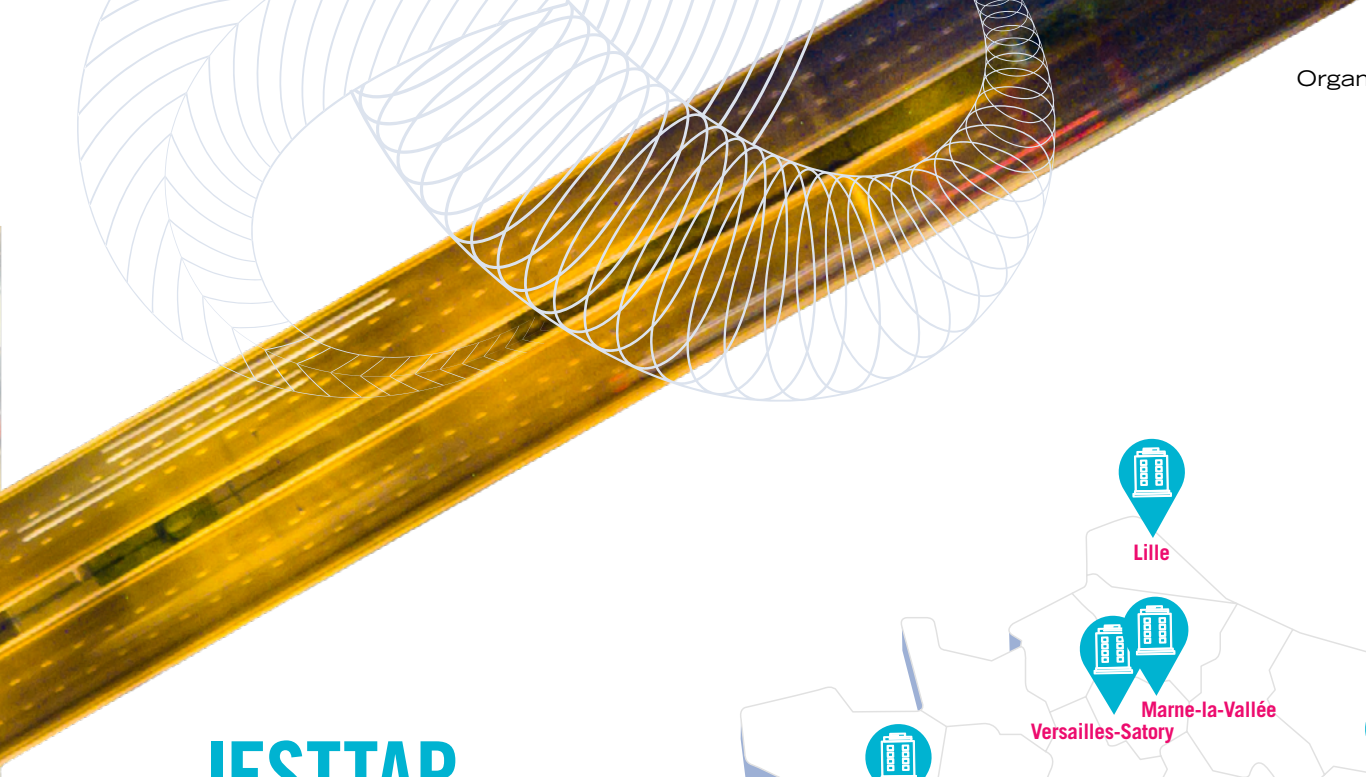
23,767,859 €
Support functions (22.5 %)

6,932,104 €
Action for institute as a whole (6.5 %)

75,466,138 €
Activities of research units (71 %)

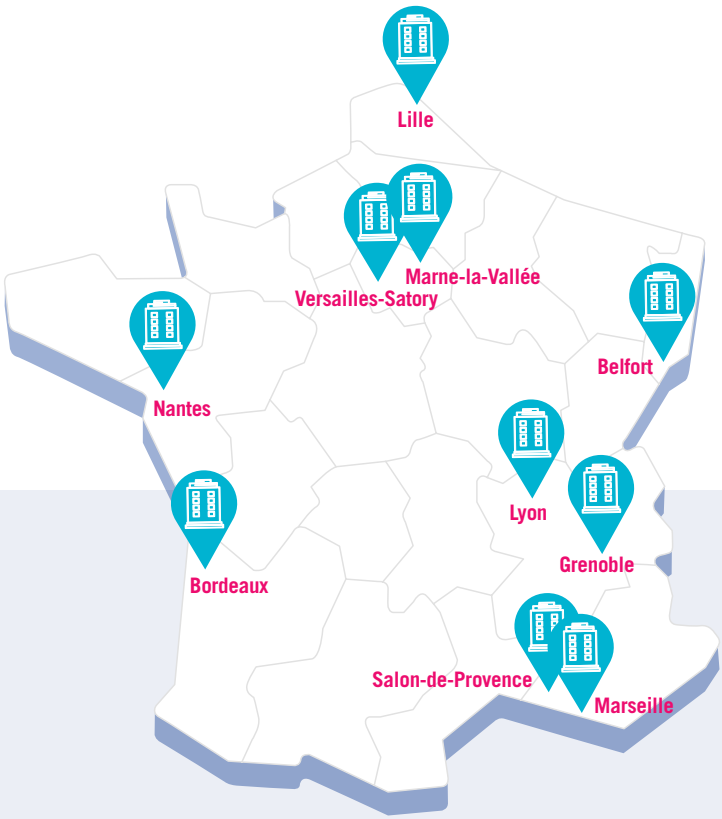
return to contents

return to contents



IFSTTAR SITES

RESEARCH LABORATORIES IN FRANCE



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IFSTTAR Headquarters

14-20 Boulevard Newton
Cité Descartes, Champs-sur-Marne
F-77447 Marne-la-Vallée Cedex 2
Tel.: +33 (0)1 81 66 80 00

Research laboratories:
CPDM, EMGCU, FM2D, SRO, SV, GRETTIA, LEPSIS, LISIS, DEST, LVMT, SPLOTT, Simu&Moto, Navier

Belfort

Fédération FCLAB
Rue Thierry Mieg
F-90010 Belfort
Tel.: +33 (0)3 84 58 36 00

Research laboratory:
Fédération FCLAB

Bordeaux

Cerema DETER Sud-Ouest
Rue Pierre Ramond - CS 60013
F-33166 Saint-Médard-en-Jalles Cedex

Research laboratory:
ERENA

Grenoble

Maison des Géosciences
1381, rue de la Piscine
F-38400 Saint-Martin-d'Hères

Research laboratory:
ISTerre

Lille - Villeneuve d'Ascq

20, rue Élisée Reclus
BP 70317
F-59666 Villeneuve d'Ascq Cedex
Tel.: + 33 (0)3 20 43 83 43

Research laboratories:
ESTAS, LEOST

Lyon - Bron

25, avenue François Mitterrand
Case 24
Cité des mobilités
F-69675 Bron Cedex
Tel.: +33 (0)4 72 14 23 00

Research laboratories:
RRO, LICIT, LBMC, LESCOT, UMRESTTE, LEPSIS, UMRAE, DCM, ECO7

Marseille

Faculté de médecine secteur Nord
Boulevard Pierre Dramard
F-13916 Marseille Cedex 20
Tel.: +33 (0)4 91 65 80 00

Research laboratories:
LBA, EMGCU

Nantes - Bouguenais

Allée des Ponts et Chaussées
CS 5004
F-44344 Bouguenais Cedex
Tel.: +33 (0)2 40 84 58 00

Research laboratories:
GéoEND, GMG, MIT, LAMES, GPEM, SMC, EE, GEOLOC, MACSI, SII, EASE, UMRAE

Salon-de-Provence

304, Chemin de la Croix Blanche
F-13300 Salon de Provence
Tel.: +33 (0)4 90 56 86 30

Research laboratories:
LEPSIS, LMA, Simu&Moto

Versailles - Satory

25, Allée des Marronniers
F-78000 Versailles
Tel.: +33 (0)1 30 84 40 00

Research laboratories:
GRETTIA, LPC, LIVIC, LEPSIS, TEMA

return to contents

Governance

BOARD OF DIRECTORS

31 DECEMBER 2019

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Jacques TAVERNIER

Vice-chair
currently being replaced

Representatives of the State

Ministry for an Ecological and Solidary Transition:
- **Thierry COURTINE** (full member), *Ministry for an Ecological and Solidary Transition*
- **Claire SALLENAVE** (deputy member), *Ministry for an Ecological and Solidary Transition*

Secretary of State for Transport:
- **Jean LE DALL** (full member), *Ministry for an Ecological and Solidary Transition*
- **Nicolas PATIN** (deputy member), *Ministry for an Ecological and Solidary Transition*

Ministry for an Ecological and Solidary Transition:
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- **Thierry HUBERT** (deputy member), *Ministry for an Ecological and Solidary Transition*

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- **Frédéric RAVEL** (full member), *Ministry of Higher Education, Research and Innovation*
- **Pierre PACAUD** (deputy member), *Ministry of Higher Education, Research and Innovation*

Ministry of Higher Education, Research and Innovation:
- **Alain BERNARD** (full member), *Ministry of Higher Education, Research and Innovation*
- **Éric CHARRON** (deputy member), *Ministry of Higher Education, Research and Innovation*

Ministry for Action and Public Accounts:
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- **Pierre VAISS** (deputy member), *Ministry of the Interior*

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- **Christophe RAMAEN** (deputy member), *Ministry of the Armed Forces*

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- **Valérie DAVID,** *Eiffage*
- **Marie-Claude DUPUIS,** *RATP*
- **Anne-Marie HERBOURG,** *ADTech*
- **Pierre IZARD,** *SNCF*
- **Muriel JOUGLEUX,** *Upem*
- **Yves METZ,** *Ingerop*
- **Guy SIDOS,** *Vicat*
- **Jacques TAVERNIER,** *Usirf*

Representatives of the Staff

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.

return to contents

SCIENTIFIC BOARD

31 DECEMBER 2019

Chair of the Scientific Board
Corinne GENDRON

Vice-Chair
currently being replaced

Scientific and technical dignitaries

– **Sylvain ALLANO**
The Daffodils Company
– **Brigitte BARIOL-MATHAIS**
FNAU
– **Bénédicte BUCHER**
IGN
– **Pierre-Étienne GAUTIER**
SNCF
– **Corinne GENDRON**
Université du Québec à Montréal (Canada)
– **Antonio GOMES CORREIA**
Universidade do Minho (Portugal)
– **Catherine JACQUARD**
Fondasol
– **Corinne LARRUE**
Université Paris-Est Créteil
– **Barbara LENZ**
DLR (Germany)
– **Lucie LAFLAMME**
Karolinska institute (Sweden)
– **Stephen PERKINS**
OCDE
– **Jean-Éric POIRIER**
Colas
– **Souheil SOUBRA**
CSTB
– **Catherine TRUFFERT**
Iris Instruments – BRGM
– **Anne VARET**
ADEME

Representatives of the staff

CFDT
– **Alexandre de BERNARDINIS** (full member),
– **Fabrice VIENNE** (deputy member)
– **Pierre-Olivier VANDANJON** (full member)
– **Étienne LEMAIRE** (deputy member)

CGT
– **Divitha SEETHARAMDOO** (full member),
– **Jean-Michel FOURNIAU** (deputy member)

Sud Recherche EPST-Solidaires
– **Karine BRUYERE** (full member),
– **Neila BHOURI** (deputy member)
– **Sébastien AMBELLOUIS** (full member),
– **Juliette KAUV** (deputy member)

Unsa
– **Lamine DIENG** (full member),
– **Malal KANE** (deputy member)

Discover on line
THE ORGANISATIONAL CHART

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return to contents

Acronyms

A

- **ADEME** ..... Agence de l'environnement et de la maîtrise de l'énergie
- **Anses** ..... Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail
- **ANR** ..... Agence nationale de la recherche
- **AUGC** ..... Association universitaire de génie civil

B

- **BRGM** ..... Bureau de recherches géologiques et minières

C

- **CEA** ..... Commissariat à l'énergie atomique et aux énergies alternatives
- **Cerema** ..... Centre d'études et d'expertise sur les risques, l'environnement, la mobilité et l'aménagement
- **Cifre** ..... Convention industrielle de formation par la recherche CIG commission intergouvernementale
- **CIG** ..... Commission intergouvernementale
- **CNRS** ..... Centre national de la recherche scientifique
- **CNSR** ..... Conseil national de la sécurité routière
- **Comue** ..... Communauté d'universités
- **CO2 Sto2019** .... *CO_2 storage in concrete*
- **COP** ..... Contrat d'objectifs et de performance
- **CSTB** ..... Centre scientifique et technique du bâtiment

D

- **DGITM** ..... Direction générale des infrastructures, des transports et de la mer
- **DGPR** ..... Direction générale de la prévention des risques
- **DGRI** ..... Direction générale de la recherche et de l'innovation
- **DIRIF** ..... Direction des routes Île-de-France
- **DGE** ..... Direction générale des entreprises
- **DLR** ..... *Deutsches Zentrum für Luft- und Raumfahrt* (German Research Center for Aeronautics and Astronautics)
- **DRI** ..... Direction de la recherche et de l'innovation
- **DRIEA** ..... Direction générale et interdépartementale de l'équipement et de l'aménagement d'Île-de-France
- **DSR** ..... Délégation à la sécurité routière

E

- **EAVT** ..... École d'architecture de la ville et des territoires Paris-Est
- **ECTRI** ..... *European conference of transport research institutes*
- **EDF** ..... Électricité de France
- **EIVP** ..... École des ingénieurs de la Ville de Paris
- **ENTPE** ..... École de l'aménagement durable des territoires
- **ENSG** ..... École nationale des sciences géographiques
- **Equipex** ..... Équipement d'excellence
- **ERSA** ..... *European regional science association*
- **ERTMS** ..... *European rail traffic management system*
- **ESIEE Paris** ..... École de l'innovation technologique de la chambre de commerce et d'industrie de région Paris Île-de-France
- **ETCS** ..... *European train control system*
- **ETP** ..... Équivalent temps plein

F

- **FEHRL** ..... Forum européen des laboratoires nationaux de recherche routière
- **FERSI** ..... Forum des instituts européens de recherche en sécurité routière
- **FIB** ..... Fédération de l'industrie du béton

G

- **GIEC** ..... *Cities and climate change science*
- **GNSS** ..... *Global navigation satellite system*

H

- **H2020** ..... Programme européen Horizon 2020
- **HCERES** ..... Haut conseil de l'évaluation de la recherche et de l'enseignement supérieur

return to contents

I

- **IDRRIM** — Institut des routes, des rues et des infrastructures pour la mobilité
- **IRT Railenium** — Institut de recherche technologique de la filière ferroviaire
- **IGN** — Institut national de l'information géographique et forestière
- **INNOMOB** — Institut de recherche franco-allemand *Innovation for mobility*
- **INSA** — Institut national des sciences appliquées
- **INRAE** — Institut national de recherche pour l'agriculture, l'alimentation et l'environnement
- **INRETS** — Institut national de recherche sur les transports et leur sécurité
- **IRSTEA** — Institut national de recherche en sciences et technologies pour l'environnement et l'agriculture
- **I-Site** — Label « initiatives - science - innovation - territoires - économie »
- **ITE** — Infrastructures de transition énergétique
- **ITS** — *Intelligent transportation system*

J

- **JPI** — *Joint programming initiative*
- **JTR** — Journées techniques route

L

- **Labex** — Laboratoire d'excellence
- **LaPEA** — Laboratoire de psychologie et d'ergonomie appliquée
- **LCPC** — Laboratoire central des ponts et chaussées
- **LIA** — Laboratoire international associé
- **LIO** — Laboratoire de recherche en imagerie et orthopédie
- **LPG** — Laboratoire de planétologie et géodynamique

M

- **MESRI** — Ministère de l'enseignement supérieur, de la recherche et de l'innovation
- **MTES** — Ministère de la transition écologique et solidaire

O

- **OCDE** — Organisation de coopération et de développement économiques
- **OMS** — Organisation mondiale de la santé
- **OFIS** — Office français de l'intégrité scientifique
- **OSUNA** — Observatoire des sciences de l'univers de Nantes

P

- **PME** — Petite et moyenne entreprise

R

- **R5G** — Route de 5e génération
- **RILEM** — *International union of laboratories and experts in construction materials, systems and structures*
- **RIS** — Référent à l'intégrité scientifique
- **ROA** — Rencontres ouvrages d'art
- **RSNB** — Rencontres scientifiques nationales de Bron
- **RST** — Réseau scientifique et technique
- **RTRI** — *Railway technical research institute*

S

- **SafetyCube** — *Safety causation, benefits and efficiency*
- **SNBC** — Stratégie nationale bas carbone
- **SNCF** — Société nationale des chemins de fer français

T

- **T20** — *Think Tanks (T20)* dans le cadre du G20
- **TDIE** — Transport développement intermodalité environnement
- **TVM** — Transmission voie machine
- **TRB2019** — *Transportation research board 2019*

U

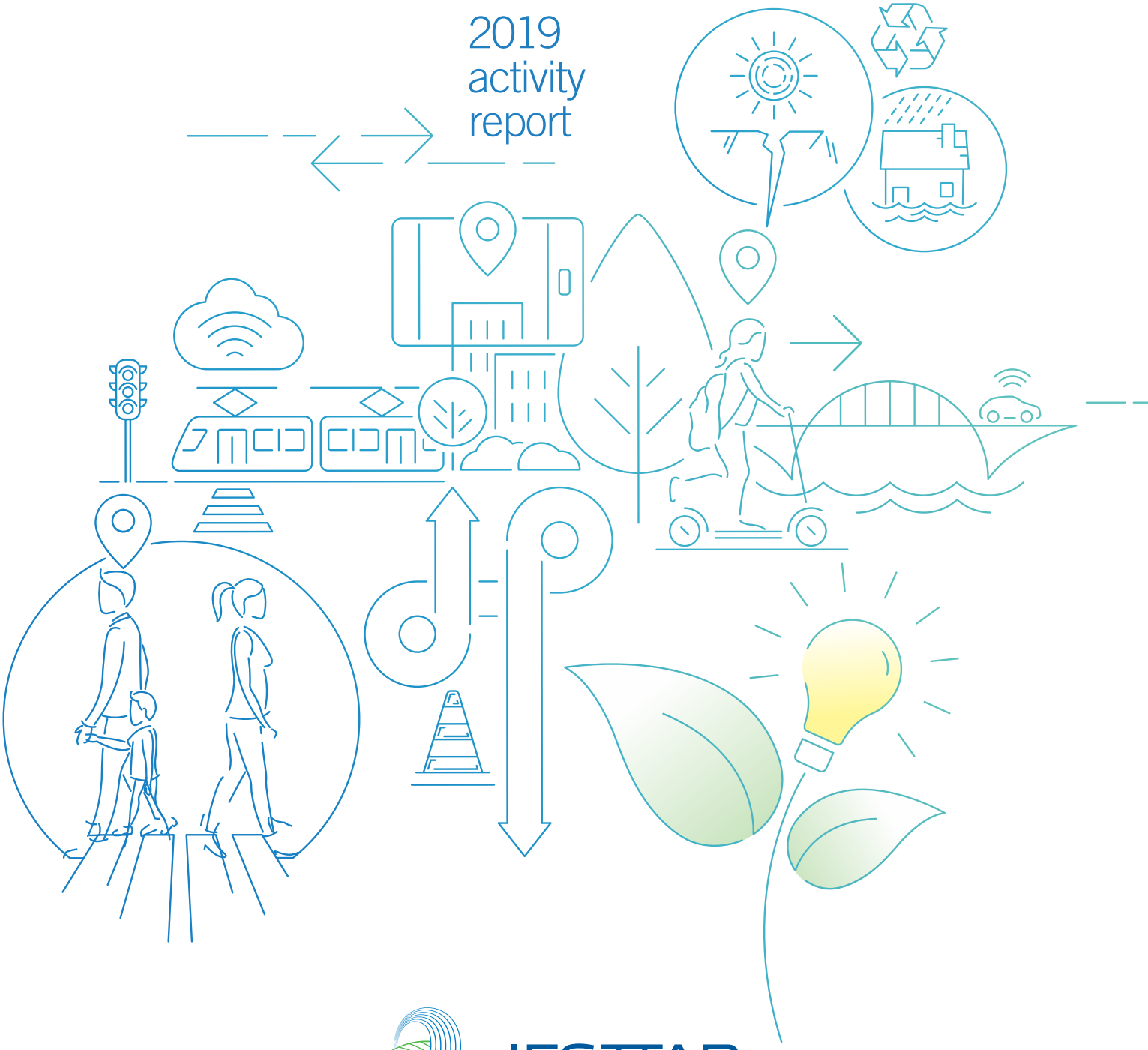
- **UERA** — *Urban europe research alliance*
- **UMR** — Unité mixte de recherche
- **UPE** — Université Paris-Est
- **UPEM** — Université Paris-Est Marne-la-Vallée
- **URSI** — Union radio-scientifique internationale

V

- **Vedecom** — Institut du véhicule décarboné et communicant et de sa mobilité

return to contents

2019 activity report



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This document is the outcome of a collective process. We would like to warmly thank all the contributors.
Published by Université Gustave Eiffel • Legal submission: ISSN: 2285-9902 • Director of publication: Hélène Jacquot-Guimbal • Director of communication: Philippe Tamagny • Coordination: Farida Laval et Insaf Ben Cheikh • Photocredits: IFSTTAR, MTES / B. Suard, Fondation des Ponts, Université Paris-Est, STA, PIARC, AAUL, Veolia, ADAS&ME, AFGC, Road Safety Award, Consortium DIDRO, Sogaris, EpaMarne, IREX, Centre Jacques Cartier, Société du Grand Paris / G. Rollando, ORCID, Métropole du Grand Paris, Ville de Bron / M. Ridde, EIVP, OSUNA, SHM-France, IRT SystemX, DR, Traps, Cerema, Inrae / Claire Etrillard, EuroTunnel, Getty Image • Graphic Design: EFIL - www.efil.fr • Text: IFSTTAR and Kogito - www.kogito.fr • June 2020

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