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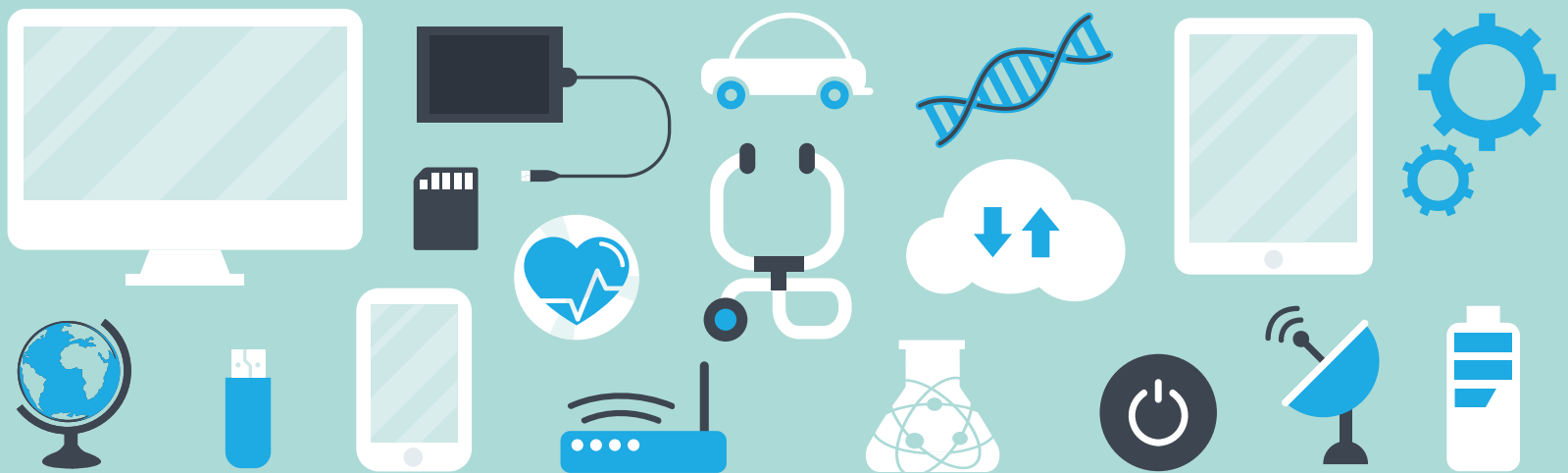


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Interactions in French at <http://interactions.utc.fr>

Donnons un sens à l'innovation

# Interactions



## *The UTC MS2T Labex*

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*A recognised dynamic 'excellence' lab., to be fostered, long-term*



### **Equal Salaries for Men and Women?**

Ms Marlène Schiappa,  
junior Minister  
in charge of Male-Female Equality Issues



Feb.9, 2018 saw the signing of a partnership between the company Canal Seine-Nord Europe and UTC



Xavier Bertrand, Chairman of the Supervisory Board of the Canal Seine-Nord Europe Company and Prof. Philippe Courtier, President and Vice-Chancellor of UTC signed a partnership agreement Feb.9, 2018. The partnership will cover several aspects of this project: land planning, technology-intensive research, sustainability of the future Canal and its societal acceptability, consequent territorial development and project management. During his visit to UTC, Xavier Bertrand was shown a waterway navigation simulator, and a poster display of work carried out jointly by UTC-Cerema on the theme of waterway hydraulics, plus a demonstration of the tactile table units installed in UTC's "digital hall" with worked applications examples about this Canal (participative planning sessions/ worksite progress monitoring). ■

[www.canal-seine-nord-europe.fr](http://www.canal-seine-nord-europe.fr)

### UTC ranked 7<sup>th</sup> by Usine Nouvelle

UTC is therefore the #1 Post Bac engineering school in this list and #2 under the heading "Entrepreneurships". With 38% female students, UTC is one of the best general engineering schools in France. ■

The complete ranking is at:  
[www.usinenouvelle.com/comparatif-des-ecoles-d-ingenieurs-2018-personnalise](http://www.usinenouvelle.com/comparatif-des-ecoles-d-ingenieurs-2018-personnalise)

### A "Best paper" award for UTC-Roberval Laboratory

Abdeljalil Jourani, enseignant-chercheur, Abdeljalil Jourani received a Best paper award at the ICMSE 2018: 20th International Conference on Materials Science and Engineering, in Dubai, for his presentation of the thesis work of Celine Trevisiol, a mechanical engineering PhD graduate (supervisors Dr Abdeljalil Jourani and Prof. Salima Bouvier). The title of the thesis: Effect of Roughness and Microstructure on Friction and Wear Mechanisms. ■

## SEMINAR

# An update on Artificial Intelligence (AI)

January 15, 16, 18 and 19, 2018 saw the GE90 seminar devoted this year to Artificial Intelligence (AI). Throughout the 4 days, the students, whatever their specialty options, attending the conference organized by UTC-Costech Lab were able to address this theme with research scientists, a designer and a lawyer. Interactions spoke with the organizer of this highly stimulating event, Prof. Yann Moulier-Boutang, chair of economic studies, UTC.



## What made you choose AI for this year's theme?

A seminar which counts as a credit course is organized every year. To gain the points, the attendee students must submit a dissertation and a work plan at the end of the semester. For first semester, 2018, the choice of AI seemed self-evident to us. It covers a set of issues that not only are of interest to students in the computer science and applications specialty, but also those who opt for urban system engineering, mechanical engineering, biomedical engineering and many other specialties. It is not a question of being "for" or "against" AI, but to make use of the positive potentialities offered by AI tools and to acquire and develop a critical attitude in doing so. Becoming familiar with AI technologies is as primordial for the public at large as for the future (and today's) engineers. It must be seen as a priority that France regains its self-reliance in the digital world, faced with the American and Chinese giants. If we consider population, France is the first contributor to the digital industrial sector in California! What we need is an Institute for Advanced Studies on the Digital Transition in order not to abandon training to the giants such as Google.

## Are there several forms of AI?

Not only does AI open up marketing prospects inasmuch as the consumer profiles can be better targeted – via social networks, search engines – or service demand can be better channelled – Uber. In the future, a significant fraction of our science and security systems will rely on appropriate use of algorithms. The underlying societal challenges are very important – they run from diagnosis of certain complex illness – notably through fine analysis of X-ray images, to forecasting certain natural phenomena, and even the fight against threats of terrorist acts. Progress in field like these call for algorithmic skills as well as deep statistical analyses, in many specialist areas. The aim will not always be to determine average behavioural patterns or the probability of events occurring, but more to pinpoint possible, rare, events with significant consequences: a patent dying, a terrorist or criminal attacks, natural catastrophes. As far as individuals' behaviour is concerned, social sciences and humanities provide the necessary complement needed to identify the most significant criteria.

### Numerous fears have arisen with the new forms of autonomy conferred on machines. Are they justified?

There are considerably different visions as to the finalities if AI – will it replace Man or assist him for certain complex or repetitive tasks? Some people foresee the possibility of machines gaining a high level of intelligence such that they progressively acquire a conscience or feelings. This transhumanist vision opines that men's health and his mental faculties could be totally modified using computers. In France, Dr Laurent Alexandre supports the idea that our IQ factor can be improved by using computers. But there are, I repeat, many different visions. The ongoing digital revolution represents an opportunity for modern science, for our culture, for our safety and for the creation of more collaborative models that would prove very useful for democracy today and tomorrow.

### Is the pervasive advent of AI modifying the working world and, in particular, will it impact professional engineers?

The entire economy is concerned by the ongoing AI revolution. Added value accrues increasingly to data producers than to industries and the service sectors. The example of aircraft engines is revealing. For a given engine on a commercial jetliner, most of the costs relate to maintenance. Pratt and Whitney, a major US aircraft engine company signed an agreement with IBM to develop real-time engine part control systems, thereby preventing break-downs by using sensors. In this partnership, clearly it is "big blue" who controls the market. This logic can also apply outside the cutting edge technologies. Vinci Public Works is looking at the possibility to replace its worksite supervisors and foremen by digital processes. If this project come to be, some 20 000 jobs could be lost. For big data specialists, evolution is rapid. Thanks to the multitude of data available it is no longer possible just to collect. We must be able also to analyse and use the data. The next few years will see the recruiting of increasing numbers of data analysts. Working conditions will also be changed. Until recently many engineers, experts in data sciences, were employed directly by the major groups. The trend now is to see them

create their own start-ups and offer their services.

### Can UTC offer special skills in this field?

The pluridisciplinary features of UTC's laboratories are strong assets when it comes to AI studies. Work done at the UTC-Heudiasyc laboratory, for example, on self-drive vehicles relies on data received from a multitude of sensors. The concept of system resilience (or robustness) developed at Heudiasyc is a direct application of AI research. Likewise, work at UTC's LMAC (applied maths) Lab in the area of stochastic analysis has proven highly relevant for the creation of probabilistic models. AI also brings together and mobilizes our knowledge about Society and mankind in general. At the UTC Costech lab we have social science and humanities research specialists whose remit is to study several aspects of the ethical, societal and epistemological facets of these issues. ■

**Interview de Yann Moulier-Boutang "L'intelligence artificielle en question" : [webtv.utc.fr](http://webtv.utc.fr)**

**Laboratoire Costech : [webtv.utc.fr](http://webtv.utc.fr) >**

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## SEMINAR

# 'Trompe-l'œil' automation

Artificial intelligence (AI) is often seen as to signing the end of certain jobs and to the development of highly qualified positions. Professor Antonio Casilli (sociology, Telecom ParisTech) addressing the EUROPA GE90 seminar, presented his investigations, a nuanced vision of the work scene that underpins digital automation.

**“In fact, artificial intelligence, does not eliminate work but rather makes it invisible, with a subdivision into micro-tasks”, sums up Prof. Casilli.** The thesis defended by this specialist of digital anthropology contradicts a number of common presuppositions. As it sees it, this idea of AI replacing manpower bears, above all other considerations, the mark of marketing and ideology forces for the purpose of masking free work carried out by consumers themselves and precarious workers thousands of miles away. Comparing corporate communication about the imminent arrival of fully automated services with the reality of technical and human backstage activities, his analysis reveals a major gap. The real operational functioning of applications still depends, to a large extent, on human interventions, but remains hidden by the prevalent discourse on self-reliant machines blatantly served to the public at large. “Accompanying today's scientific and technological challenges, we are witnessing the construction of a specific discourse designed to defend both partisan and economic interests”, he underscores.

## The people behind AI

The students were able to discover - through the presentation of concrete cases such as the Uber platform, the self-drive cars and research engines – a totally new vision of something they use on a

day-to-day basis. The emblematic example is the car booking service of Uber was analysed from various points of view. Normally this service is perceived as a person-to-person portal between potential passengers and the Uber drivers, the application also collects user data without any service in return. “Uber drivers spend more time on their smartphones forwarding information to Uber than they do behind the driving wheel, inasmuch as the trips help build up maps and trip frequencies that are then used to improve the overall efficiency of the Uber system”, explains our research scientist, illustrating his points on the screen. The project of a self-drive taxi, forecast as the next stage of an AI world in progress, was thoroughly debunked. While the self-drive taxi is supposed to operate without any human intervention, in fact the vehicle requires remote operators and even help from the passenger(s) to warn of presence of obstacles ‘en route’.

The fundamental theme of machine learning was addressed via an explanation of certain operational modes of research engines. This special capacity – to recognize and reference unending new data inputs - presented as a result of self-learning machine modes, in fact calls on human decisions and interventions. Only the case of seeing thousands of data at

the input could enable machines to be able to handle certain complex situations. “Millions of invisible workers who live outside our Western economies, in the Philippines, in Indonesia, in India and Africa, work on behalf of the GAFA (Google, Apple, Facebook and Amazon)”, the sociologist explains, who based his findings on enquiries carried out in several of the countries mentioned above. There are, spread round the world, tens of millions of micro-task-workers whose jobs it is to name photographs, to rank videograms and music in categories, to associate words or expressions with web-sites, to translate these words and expressions into their native languages. They are recruited via on-line platforms such as Amazon's Mechanical Turk [cf. <https://www.mturk.com/>] at very low pay rates, with these myriad invisible workers omnipresent behind the service offers appearing on the Internet. Amazon is not alone here. In many circumstances, the web surfers are invited to make suggestions to improve a translation or a selection of holiday and leisure sites. “The promises that technological progress implies that machine-based intelligence could become totally independent have been recurrent over the past 70 years, but personally I do not entertain much belief in these prophecies”, concludes Professor Antonio Casilli, with a touch of pessimism notwithstanding. ■

## Elisabeth Brunier receives the insignia of Chevalier de l'Ordre des Arts et des Lettres

Friday Jan. 26, 2018, Elisabeth Brunier, UTC senior lecturer and Delegate General



for the Roberval Prize and head of the Scientific, Technical and Industrial Culture Service of UTC, received the insignia of Chevalier

de l'Ordre des Arts et des Lettres in the presence of Philippe Marini, Mayor of Compiègne and Honorary Senator of the Oise Department, her family, friends and colleagues. The ceremony was conducted by Loïc Depecker, Delegate General for the French language and Languages of France at the ministry in charge of Culture. ■

## The awards ceremony for the Roberval Prize category 'Higher Education' (HE) held at the French Academy of Science

The awards ceremony for the Roberval Prize category 'Higher Education' took place Tuesday Jan. 16, 2018 at the French Academy of Science. Laurent Vulliet, Lyesse Laoui and Jian Zhao were declared laureates of the HE category Prize for their book entitled "Mécanique des sols et des roches - avec écoulements souterrains et transferts de chaleur" [Soil and rock mechanics – with underground flow and heat transfer phenomena], published by Presses polytechniques et universitaires romandes, Switzerland. Alexandre Rojey was awarded a special note of merit by the Roberval Jury for his book "Stockage de l'énergie" [Energy storage], published by Techniques de l'Ingénieur, Paris. ■

## A UTC PhD among the trophy winners at the Engineers of the Future awards ceremony

Mohamed SABBAGH who completed his PhD thesis work at UTC-Heudiasyc Lab., was awarded the General Public Prize, Dec. 5, 2017, at the Engineers of the Future ceremony for work he did on security of Smartphones using cryptography. Mohamed Sabbagh had already been designated laureate at UTC's Guy Deniérou 2017 thesis prizes. His work met with rapid practical recognition inasmuch as he had pinpointed some safety loopholes in two major OS systems, one of which was Android enabling him to join the launch of a start-up. ■



More (in English) at: <https://interactions.utc.fr/thematiques/docteurat/43-les-doc-teurs-acteurs-cles-de-linnovation/son-cheval-de-bataille-la-cybersecurite.html>

## START-UP

# Cognitive sciences and AI

Jean-Baptiste Guignard - an audio-digital engineer with a PhD in cognitive sciences, who did research at the UTC Costech Lab for 10 years – created his start-up, HINS, in 2015. The company implements and commercializes a solution to recognition of hand movements as a concrete application of artificial intelligence (AI) based on biomimetics.

**D**uring his time as Professor at UTC, Jean-Baptiste Guignard came up with an original idea: inventing a system to enable a composer to make real-time changes to a piece of music by moving his/her hands in front of a smartphone's camera. Making use of open source solutions and a signal processing software package, J-B. Guignard was able to assemble and test a prototype which he presented at a general public TV show. This in turn allowed him, albeit fortuitously, to get to know the Renault-Nissan. The automobile manufacturer has shown interest in this gesture recognition technology that does not need any specific hardware to operate and to control certain functions installed on board its cars. Consequently, our "lab. and lecture-hall" specialist decided to try his hand at entrepreneurship. "I have to do loads of work and the risks are quite high, but in France fortunately we can access various portals such as "Jeune Entreprise Innovante" and the Government incentive R&D tax rebate programme, which are unique to the country." After three years, HINS with 31 staff and its home office in Los Angeles now has taken on an international dimension. HINS's customers are French, Americans and Chinese. Possible applications are diverse. The start-up continues to collaborate with the automobile construction sector in France but is also present in California under another corporate name, Clay Inc., who develops technologies specific to virtual and augmented reality devices. Over the past few months, China has become a market target. "The manufacturers and operators of Chinese mobile phones are also interested, inasmuch as their clients will be able to lock their phones with a move of the hand, create and add visual effects round an image of their hand (flames, avatars, etc.). Other "apps" are in the pipeline, such as a system aimed at public works that would allow a site operative to consult his i-pad without having to take off his heavy-duty gloves (to read a map, or a lay-out, for example).

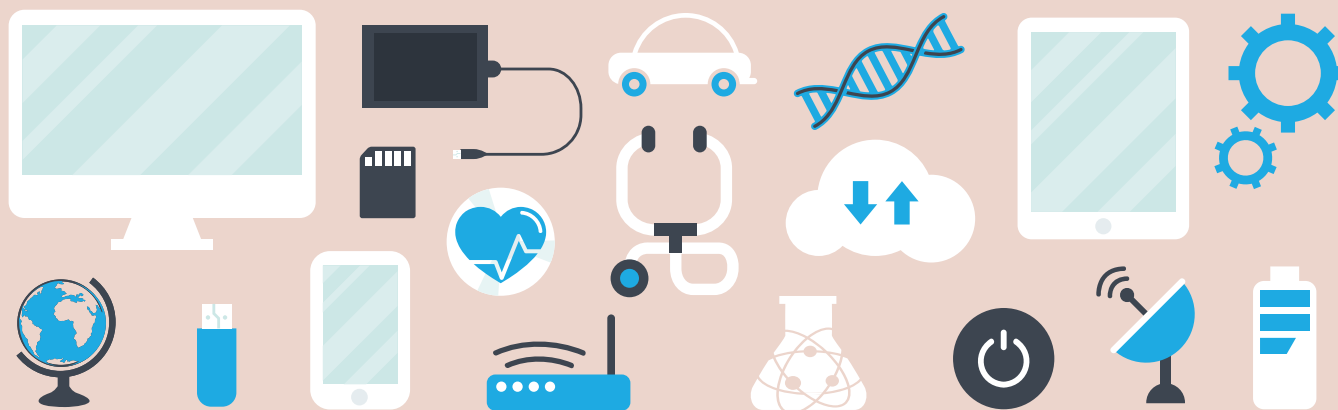
skills in cognition sciences, Jean-Baptiste Guignard was able to develop an original combination of computer vision and artificial intelligence. The main challenge for Clay Inc. when it was launched was to be efficient despite the limited computational power of a classic smartphone: "The demands of our earlier versions of the code exceeded the computing levels available on smartphones at that time; now we only use 6% of their CPU processor power". To go beyond this computational power constraint, our engineering entrepreneur explored some unexplored territory. "Top-heavy" methods that previously relied on so-called 'deep learning' or on self-reinforced learning patterns have simply been abandoned. "Hardliner developers tended to focus only on computer science models and statistics; at Clay Inc., we also seek inspiration in biomimetics", explains our CEO. Among our sources of inspiration, we can cite the theory of auto-poiesis developed by two Chilean biologists, Humberto Maturana Ramecín & Francisco Varela García to describe the self-preservation mechanisms that living organisms have invented and established. For its general structure, Clay Inc. mimes the metabolism of a bacteria. The interpretation of a video stream schematically copies the way a human retina functions. In AI, recognizing shapes, a signature, an ID, a sentence all represent major challenges. The algorithms Clay Inc. implements make good use of discoveries made in cognition psychology, notably in the field of categorizations. In order to satisfactorily solve certain concrete problems such as identifying a hand where a finger or two are missing, for example. Research engineers are currently studying the strategies adopted by humans and their capacity to carry out fuzzy categorization. This approach combining as it does experimental work and industrial applications is, in essence, the DNA of the start-up HINS from its Bordeaux origins to its ambitions to conquer the world. ■



## Innovation beyond the specialties

The success story of HINS, akin to the track-record of its founder, is a direct result of exchanges among biology, psychology, philosophy and engineering sciences. The clinical distance with respect to technology and its forms as introduced by use of social sciences and humanities has proven to be a driving force when it came to proposing innovative products on the market-place. With his dual background as a research scientists and his acquired

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# The UTC MS2T Labex

## A recognised dynamic 'excellence' lab., to be fostered, long-term

UTC is host to and supports one of the 171 so-called Labex (see below) entities certified in the French Government's Investments for the Future incentive Programme (2010). These sites are designated as bridgeheads for "excellence" in French scientific and technological research, HE and valorisation activities, aimed at generally enhancing their international visibility and repute. This issue's Dossier zooms in on the underlying challenges and main positive results and fallout.

**When the French State authorities launched the 'Excellence' Laboratories Programme (acronym Labex), the stated objective was ambitious: to provide and endow the laboratories chosen for having an already proven international reputation, with significant means enabling them to operate on a par with foreign counterparts, to attract the best research scientists and lecturers and to establish new high level research, training and valorisation policies.** In 2011 and 2012, following the assessment conclusion of an international jury, 171 entities whose profiles and project policy statements complied with the above prerequisites, were duly certified as Labex and were accordingly notified that they would receive 1.5 billion euros over a 10 year period (on average this meant close to 9 Meuros for each Labex. "Each entity therefore has a long range perspective as to its finance and can consequently develop a true scientific policy set of objectives and even take risks on some exploratory work and themes", underlines Yves Lecointe, who is in charge of the Labex programmes at the French national research agency (ANR\*). An official assessment took place mid-programme, in 2015, serving to demonstrate how this programme can be of interest. Globally framed, the international jury who did the assessment deemed the Labex programme "on one hand, a really successful operation, focused on excellence in French research and, on the other, offering the

scientific community a flexible tool with enhanced freedom in terms of long-term organization"\*\*\*

The jury also concluded that these certified Labex units had a "restructuring effect on the landscape of French research", underlining in particular the strong interdisciplinary facets and the development of networking which had a « "largely positive impact on the emergence in France of cutting-edge thematics at world class level and on the policies of research topic choices".

### Significant facts & figures

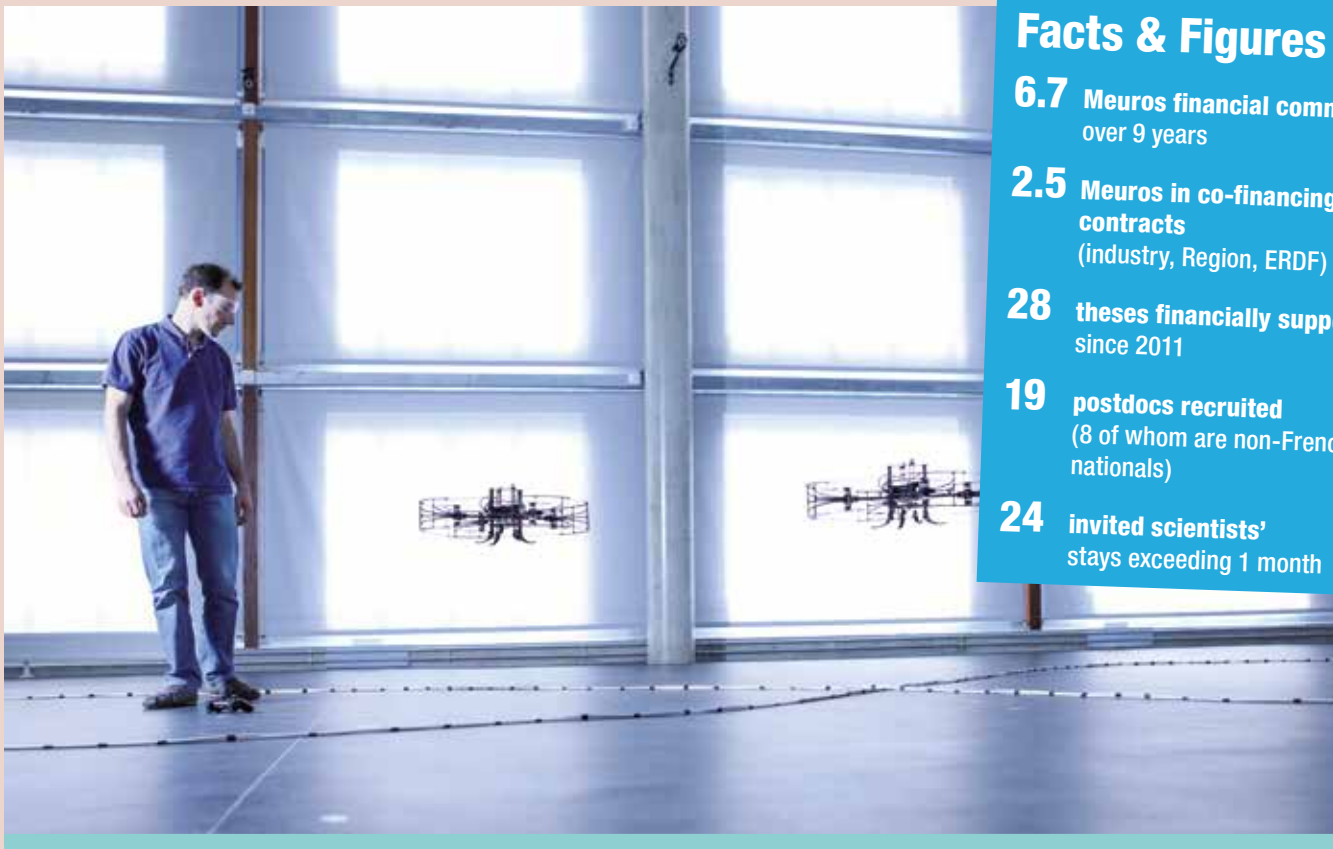
The interim assessment of the indicator value on Labex entities over the period 2011-2016 published end 2017 by ANR confirm the impulse on French research activities, contributing to international reputation and to student training. In just 6 years, the Labex have multiplied the annual number of their publications by a factor 2½ and authorized commencement on nearly 3 400 theses. One signal feature of their intrinsic attractiveness, the number of PhD students registered with the Labex has increased by almost 80% whereas the national population of PhD students continues to decrease. "Attractiveness here can also be measured on an international scale", notes Yves Lecointe. "France traditionally attracts a large contingent of foreign PhD students, but significantly less at Post Doc level. Nearly one half of the post-docs recruited by the Labex entities between 2011 and 2016 were foreigners".

In terms of training activities, the impact of the Labex exceeds that for the PhD students. The number of Master's degree students that benefit from Labex training packages (lectures, external initiations, internships ..., remained limited and variable up to 2015. But in 2016, the figure literally took off, increasing from 15 000 to over 54 700, i.e., 10% of the total number of students in Master degree courses in France. Final point of note: between 2011 and 2016, the Labex entities registered 1 042 patent claims and created 2 390 start-ups, 80% of which are already engaged in business activities.

The initial plan was to support financially the Labex up to termination date, December 2019 with the provision that any outstanding sums not used by that date would be recovered by the issuing authorities. A recent decision has extended the deadline date to Dec.31, 2022. This was important for the recruitment of PhD students – a flow that would have dwindled as of end 2016 since thesis work classically runs for 3 years. But in addition to this, various arrangements will ensure financial support for those Labex that perform well beyond 2019 and this will enable the "dynamics" of the system to be upheld. ■

\* Investissements d'avenir - Laboratoires d'excellence [investments for the future] synthetic assessment reports 2011-2016, ANR, December 2017.

\*\* Source: Laboratoires d'excellence - Synthèse des rapports des 15 sous-jurys du point d'étape de juin 2015 [French 'Excellence' Laboratories synthetic mid-term assessments by 15 sub-juries], ANR, October 2015



## The MS2T Labex Facts & Figures

- 6.7** Meuros financial commitment over 9 years
- 2.5** Meuros in co-financing contracts (Industry, Region, ERDF)
- 28** theses financially supported since 2011
- 19** postdocs recruited (8 of whom are non-French nationals)
- 24** invited scientists' stays exceeding 1 month

# The UTC 'MS2T' Labex: a highly positive interim assessment for the UTC Labex 'MS2T'

MS2T is the acronym in French for 'Control of technology-intensive systems of systems'. UTC, in a partnership with the CNRS entertains the ambition to rank among the international reference bench-marks in this innovative research field. This is the challenge facing UTC's Labex MS2T, one of the 15 "excellence" certified laboratories of the Idex SUPER (the Sorbonne Universities Cluster). MS2T was designated 'excellent', with the highest possible rating A+, in the first round of Labex entity certification that took place in 2011. 7 years later, the Labex' track record is deemed significantly positive.

**The whole represents more than the sum of the parts. This basic principle applies to a system of systems (SoS), viz., a set of autonomous, generally heterogeneous, systems the interaction of which generate new properties and/or functions that the component parts did not possess separately.** To illustrate, we note that

self-drive cars can exchange information about what they perceive on a given road section, gaining in collective intelligence and able to drive in much safer conditions than with 'non-cooperating vehicles. "In order to better understand and control the behaviour of a metasystem like this, and with the aim to guarantee operational safety and maximize the added value, it is not enough to reason system by system or seek to optimise the design of each system component", underlines Prof. Ali Charara, Director of the

UCX Labex MS2T. "We must necessarily adopt a global approach, one that takes into account interactions among systems. This is a key challenge we face in our research activities: to develop concepts and scientific methods that enable us to control a system of systems in its entirety".

In France, as elsewhere in Europe in 2011, when the Labex programme began, SoS represented an almost unexplored field in academic research. And yet the concept underlying systems of systems (SoS) can also be advantageously applied to numerous other domains, all the more so that progress in TICs, EDP and interconnected systems will certainly multiply and be at the heart of future digital revolutions: in energy with the advantage of "smart" power grids, in transportation with driverless cars, in e-health, in "Industrie 4.0"...

## The strength of interdisciplinarity

In order to bolster its position among the bench-mark entities in this field, UTC has adopted a unique approach. A first specific feature is that of an integrated approach. "Our objective consists of designing generic, interdisciplinary science-based methodologies that can be used in several applications", explains Prof. Ali Charara. "But it is a goal that does prove difficult if you do not do some research on certain precise socio-economic areas. We tackle both the theoretical and the private questions and issues without restraint: we mould and fire the technological bricks that help demonstrate the "applicability" of our theoretical tools to real problems and at the same time they also help us to cross various scientific hurdles".

“But above all other considerations, the strength of the Labex lies in its multidisciplinary components”, underscores Prof. Marie-Christine Ho Ba Tho, Head of research (Biomechanics and Bioengineering Lab, UTC). The Labex was created jointly by research scientists from 3 UTC laboratories associate with the CNRS who, as early as 2009 had founded a federation of research units (certified by the CNRS) on interacting heterogeneous systems: UTC-Heudiasyc Lab. (sciences & technologies in computer sciences and applications and digital technologies, UTC-Roberval Lab. (mechanical engineering, material sciences and engineering and acoustics) and UTC-BMBI (biomechanics and bioengineering). Making the most of the strong input from this triple paternity, the MS2T Labex devised a concept of systems of systems (SoS) to be found in very varied settings. A high proportion of the Labex research work relates to the control of interconnected systems (drones cooperating in flight, likewise driverless vehicles, etc.), hence a set of network, robotics, artificial intelligence ... issues to be solved. But the research also relates to more unexpected areas and subjects, such as future therapeutic devices, with the problem of controlling the interactions between blood flow and microcapsules injected into the vascular stream for the purpose of releasing a dosed medicinal drug at a precise location (organ) in the receiver's body. How, for instance, can we assemble a bio-artificial organ imitating as best we can a native organ in a transplant replacement operation? “Even if living organisms represent par excellence a system of systems, it is, a priori, not self-evident to envisage assembling our bio-artificial devices from this point of view”, notes Dr Cécile Legallais, research director, CNRS, director of the UTC-BMBI Lab. “It derives from all our exchanges with colleagues located in other laboratories our Labex”. Another advantage here that by federating the research scientists of UTC's Heudiasyc, BMBI and Roberval Laboratories, the MS2T Labex has enabled a multiplication of transverse projects that lead to some truly significant scientific

breakthroughs, because the control of complex metasystems that integrate heterogeneous component parts requires largely diverse skills. “The UTC Labex is clearly a tool that helps break down the walls separating scientific and technological specialties, and has lent a real collective dynamic thrust to our work together,” underlines Prof. Philippe Bonnifait, Director of the UTC-Heudiasyc Lab. The Labex programme has now incorporated a 4th partner, viz., the UTC-COSTECH Lab. which specializes in technology-intensive research in both humanities and social sciences (cf. p.12).

## An international network of experts

In order to establish a quality of research recognized as ‘excellent’ outside France, the UTC Labex has managed to attract some high level scientists to join the teams. For good measure, the Labex appointed on invitation an international scientific advisory committee with the best possible experts, to help the Labex executives define their scientific strategy and to assess results of the research, one notable member being one of the world's most renowned specialists in systems of systems, viz., professor Mo Jamshidi, University of Texas at San Antonio (cf. [www.utsa.edu](http://www.utsa.edu)) (Electrical and Computer Engineering). In order to develop long term international collaboration, the Labex has also organized a programme for invited scientists to come to UTC campus for one to three month stays while Labex scientists can also carry out ‘mobility’ stays abroad. Likewise, to feed its creativity and ensure international visibility, the Labex organized regular interdisciplinary seminars and workshops,

open to UTC students and established research scientists, plus invited external auditors and during these events, the audience hears from well-known systems of systems experts, French and non-French, notably academic professors invited by the Labex, but also experts from the industrial world. “This is a specific feature of UTC (hence also of the Labex), we do not indulge in ethereal blue-sky research”,

From the very beginning, we built up our technological roadmap in close liaison with industrial partners to jointly identify the challenges related to system of systems”. These intercultural blends and mixes have borne their fruit: the Labex is now engaged in cutting edge research, the progress and results of which are echoed more and more in the scientific communities.

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These intercultural blends and mixes have borne their fruit: the Labex is now engaged in cutting edge research, the progress and results of which are echoed more and more in the scientific communities. To give one example: in June 2018, the Labex will organize the 13th edition of a major international venue on Systems of Systems: the IEEE System of Systems Engineering (SoSE 2018), founded by Prof. Jamshidi, and this will be a first in France, in Paris. “This forthcoming event will bolster even further our visibility”, adds Franck Davoine, research officer, CNRS and international coordinator for MS2T. “It will notably allow us to promote in-house research activities and, hopefully, bring us closer to other international teams and industrialists with whom we could make tenders and proposals in the framework of future European (EC) calls for projects”.

## Positive leverage

Thanks to this inherent dynamics, the UTC Labex has also been able to benefit from numerous sources of financial support, from various institutions and industrial partners for its ongoing projects. As of the start of the academic year 2017, three PhD theses were financed by the Regional Authorities (Hauts de France). In like manner in 2016, with the support of the Region and the European Regional Development Fund (ERDF), UTC instated an “Excellence” chair for Systems of Systems – Cooperating and Interacting Mobile Systems” which is open for talented young research scientists. The first titular holder of the Chair is Eliseo Ferrante- Catholic University of Leuven (Belgium) and who has brought to the UTC MS2T Labex his precious skills in the field of squadron in-flight robotic drones (cf. p.11). “Clearly, the Labex has enabled us to build up an original “excellence” reputation internationally on the topic of systems of systems and this benefits as a whole to UTC”, sums up Marie-Christine Ho Ba Tho. “It has contributed to the institution's visibility and attractiveness for both scientists and industrialists and has a definitely positive leverage effect on the ‘excellent’ research work carried out by the laboratory teams.” The Labex has registered 3 patent claims, developed three software packages under licence, and has a project to create a start-up company. It is also starting to see valorisation of its work. Last but not least, the Labex has had a structuring effect on the training offer by UTC, e.g., the opening of a Master's degree based on the MS2T context (cf. p.13). The international jury invited to make the mid-programme assessment, in 2015, returned a more than positive opinion, in regard to governance, to research achievements, to the growing international vista created, to valorisation and to training. ■

## “The MS2T Labex is definitely becoming an international benchmark”



**Dominique Luzeaux, one of the key French (and international) experts in Systems of Systems (SoS), Deputy Director of a French Armed Forces unit, viz., the Inter-army Directorate for Infrastructure Networks and Defence-oriented Information Systems, is a member of the MS2T international scientific advisory committee.**

### How would you sum up the work done, seven years after its creation, by the Labex?

Apart from its multidisciplinary feature, one of the strong points of this Labex is that it was ‘assembled’ via contributions of laboratories with decades of experience in each unit's specialist fields. By their skills, by their research themes, by the scientific cooperation with laboratories outside France or via the seminars they organize, the Labex partners have done everything needed to justify a claim to a position of “excellence” in the field of systems of systems. Indeed, the Labex is gaining in impetus: it entertains some ambitious research projects, it attracts increasing numbers of postdocs from outside France ... The MS2T Labex is definitely becoming an international benchmark in the specialist field of systems of systems.

### As you see it, what should the next stage be?

The objective as of now consists in amplifying the dynamics of the Labex, to make it last in time, notably by tightening even further the links with industrialists to ensure technology transfer of the research findings. UTC is all the better positioned to do so that it is already close to the industrial world.

### Why is it so important that the international IEEE SoSE 2018 be held for the first time in France?

The fact that this event will be convened in Paris and organised by the MS2T Labex demonstrates that the country has a trump card to play in research on systems of systems.

# A start-up project supported by MS2T

Ahmed Lounis defended his PhD thesis at UTC-Heudiasyc Lab on a subject that relates to research carried out in the remit of MS2T: "security in cloud computing".

**W**ith his PhD supervisor, Prof. Abdelmadjid Bouabdallah, plus support from the MS2T Labex, Ahmed finds himself busy today creating a start-up based on his research. "Cloud computing mobilizes various, different systems that inter-communicate (forming, consequently, a system of systems) to provide data storage and/or processing, as desired. For a business company that is a more economical alternative to investing in a home EDP equipment, but it can at the same time raise security issues. The solution we provide offers two advantages. One: the control of the data stored in the

cloud and their processing remain in the hands of the data owner, i.e., it is not the service supplier that offers protection but the client who can, if he/she so wishes encrypt that data or mask it partly. Two: it is efficient in terms of computation and consumes less energy, for a lower cost". The solution Ahmad Lounis proposes has been embodied in a demonstrator. From this point on, the aim is to identify potential industrial partners and to develop commercial products tailor-made for specific applications. For this purpose, Ahmed Lounis is accompanied by the SATT (a technology transfer accelerator company) of which UTC is a member, by Lutech and also has a pre-

incubator contract on the Heudiasyc lab. premises co-financed by the Labex, by the Region (Hauts-de-France) and by the ERDF (European Regional Development Fund). "The objective is to create a start-up in our Hauts-de-France Region as it is important to remain physically close to the UTC. The latter serves as the scientific guarantor for the project and offers an environment conducive to innovation later on. The Cloud should be viewed only as the start-up's market entry-point. In the long term, our company will be able to position itself on other promising segments generated by the cybersecurity theme". ■

## Two guest professors ... two Best Paper Awards!

Prof. Michal Pioro, University of Technology, Warsaw, Poland and University of Lund, Sweden and Dritan Nace, senior lecturer and research scientist at the UTC-Heudiasyc Lab. started collaborating on the theme "optimizing communication networks" in 2003, with a very rapid acceleration when MS2T was created.



**A**s Prof. Pioro recalls: "In 2013 I spent 3 months as a guest professor at the MS2T Labex.

With Dritan Nace and two other Heudiasyc researcher scientists, we developed a solution to make FSO (Free Space Optics) optical networks more resilient when ambient weather conditions became degraded. We called

the approach Flow Thinning". FSO is a recent technology enabling optical communications in free space, i.e., light beams can carry large amounts of data over long distances. Naturally, rain, snow and even fog lead to sharp deterioration of transmission quality. Thus the concept presented, 'Flow Thinning' was immediately welcomed by peers. It was presented at a Conference

in 2013, the International Workshop on Reliable Networks Design and Modelling (RNDM), where the team received a Best Paper Award, following which it was published as an article in *Operations Research*, a front line scientific journal with a strong editorial focus on optimization issues.

Since then, Michal Pioro and Dritan Nace have continued to analyse in depth their concept and today they are co-supervising a PhD thesis financially supported by the Labex. Its objective is to design more robust, less expensive, hybrid solutions, in a combination of FSO techniques and other technologies, such as terrestrial optical fibres. In 2017, Prof. Pioro

spent a month at the Labex, and the local team made the most of his stay, studying realistic, hybrid networks, one of which is operational in the Ile-de-France Region (round Paris). And yet again, this work was rewarded by a Best Paper Award, at the International Workshop RNDM 2017 (9th International Workshop on Resilient Networks Design and Modelling September 4-6, 2017 Alghero, Sardinia, Italy).

“As I see it”, notes Prof Pioro, “it is certainly important to receive funding from the Labex for network optimization research. But more importantly, it allows for a truly exceptional working milieu where experienced and junior research scientists can exchange. The Labex

upholds a philosophy that brings science and technologies closer and this bears fruit: when, for instance, you apply a basic science such as optimization theory to today’s new technologies, FSO, for example, you can identify the strong points before the systems are implemented and deployed. The vision Labex has of telecommunications networks is also rich in its implications: dealing with all the layers of a network as a system of systems - and not as an addition of separate networks- leads us to discovering more efficient concepts, in terms of costs, quality and resilience”. ■

## *From the Labex programme to an ERC grant*

Anne-Virginie Salsac, a CNRS research officer and her team at the UTC-BMBI (biomechanics & bio-engineering) Lab are investigating use of microcapsules (fluid droplets encapsulated in a fine, elastic membrane) to deliver medicinal drugs to a target zone (or organ) via the body’s bloodstream: the question is to determine how the envelope of the microcapsules is deformed due to the local forces of the blood stream, to determine also the mechanical properties needed for a capsule to rupture and release its active ingredient where desired, etc.? In other words, to see how the microcapsule membrane interacts with the internal and external fluids? Questions like these require that we compare and confront digital modelling and experimental work.

**W**ithin the remit of the MS2T framework, research scientist Salsac has co-supervised two projects centred on this theme avec other research colleague at the UTC Roberval Lab.: firstly, a PhD thesis that enable the team to certify new digital modelling paradigms using the principle of model reduction and, secondly, postdoc work as a follow-on to the PhD. To complete this research, another thesis is under way on modelling of microcapsule damage phenomena and membrane rupture and soon a request will be addressed to the scientists at the UTC- LMAC Lab (applied maths), Compiegne. “Without these skills and this collaboration, we simply would not be able to carry out such advanced research in digital modelling”, underscores Anne-Virginie Salsac. “The strength of the Labex configuration is that it enabled us to develop our interdisciplinary dynamics. Indeed, its existence and work are structuring also for UTC, as are the programmes financially supported by the Hauts-de-Fran Regional authorities, inasmuch as it forced us to collaborate with other research centres

and with industrialist located on the Region. Moreover, the various projects on microcapsules financially supported by the Labex and by the Region have provided leverage to help us advance even further”.

In 2017, Anne-Virginie Salsac was the first UTC research officer to receive a grant from the European Research Council (ERC), where the unique criterion for the grant is the scientific “excellence” of the projects proposed. The financing takes the form of a 5 year package and in this instance will serve to pursue research on microcapsules initiated not only within the MS2T framework but also in a thesis on encapsulated antioxidants, financed by the Hauts-de-France Region and co-supervised between the UTC-BMBI Lab. (biomechanics and bio-engineering) and the UTC-GEC Lab (enzyme and cell engineering). “Thanks to these ongoing research investigations, we have been able to bring to maturity a totally interdisciplinary project compliant with the prerequisites of the ERC programme, which presupposes that the research team goes beyond the frontiers of science and proposes



some very innovative, yet realistic, ideas”. It is indeed a project that involves – over and above external collaborative agreements – five UTC laboratories: UTC-BMBI (biomechanics and bio-engineering), UTC-Roberval and UTC-LMAC (applied maths), to pursue and extend basic research on microencapsulation, and also UTC-GEC (enzyme and cell engineering) and UTC-TIMR (integrated transformation of renewable matter) with the objective of attaining encapsulation of naturally anticancer substances, viz., the antioxidants, in the form of a food supplement. ■



# An increasingly ambitious programme

The key asset of a Labex is to have access to financial sources that enables the scientists to take the risk of committing themselves to truly novel upstream research topics that may lead on to scientific and/or technological breakthroughs. To illustrate this here are some of the ongoing MS2T projects.

**L**aunching the MS2T project, UTC identified three directions for its investigations – Interacting and Cooperating systems, Management of Uncertainty in Metasystem Operations and Optimised Design for Systems of Systems (SoS), plus four socio-economic domains, viz., Mobility (cooperating autonomous vehicles, guided transportation...), Health Engineering (remote health monitoring, therapeutic devices ...), Security (cybersecurity, drone fleet surveillance...) and the Environment (smart electric power grids, management of natural risks ...).

Subsequently, the scientists involved – under the scientific supervision of Prof. Thierry Denoeux, UTC-Heudiasyc – had identified a number of scientific and technological hurdles to be addressed over a four to ten year span. As a first

stage, they defined some ‘building bricks’ as levers to overcome the mid-term obstacles. As of 2015, they shifted gear to progress faster. Currently the Labex is rolling out its roadmap, concentrating the major part of its resources to several very ambitious, interdisciplinary projects and, in particular has taken on 3 major challenges, code-named: ‘Dapad’, ‘Divina’ and ‘Interfaces’.

## Co-operating autonomous vehicles

Dapad\* is the code name for co-operating autonomous vehicles. This is one of the key features of these vehicles, enabling them to take to the open road safely, alongside other human drivers. It is also a strategic issue for UT-Heudiasyc who have been studying smart transportation modes for a long time. “An autonomous

vehicle, with on-board sensors (cameras, radars, lidars, GPS...), is unable to position itself very accurately alone and, above all other considerations, only has a limited vision”, explains Franck Davoine, one of the two project managers. “By exchanging data with other vehicles and the roadside infrastructure equipment, the vehicle can ascertain its position better, can “see” further ahead and consequently can better anticipate on decisions: for example, it can receive information “detecting” a car masked by the bus just ahead; likewise if an oncoming vehicle has activated its traffic indicator signalling a turn that could potentially cross the path of the vehicle progressing, or again that a traffic jam is forming at the next roundabout”. But before we reach this level of performance, a great many questions remain; what data should be exchanged?

How are we to compound data coming from various sensors in a set of vehicles? How are we to guarantee the reliability and robust nature of decisions made by the auto-pilot of self-drive vehicles when the data exchanged is at faulty or partly lacking, for example when a sensor fails or if there are local communication problems? As a consequence, what algorithms need to be designed in order to analyse considerably complex and dynamic road-scenes, if we are to integrate the aforementioned parameters? To overcome these obstacles, the Dapad Project team concentrates various Heudiasyc specialties (robotics, automation and control, computer vision, telecommunications) and carries out experiments with the self-drive cars assigned to the Equipex Robotex research team\*\*.

## Robotics for drone swarms



The Divina\*\*\* challenge consists of making small drones cooperate in order to explore and map (3D) zones where the GPS cover is not available: for example, a disaster struck area where rescue teams are needed on the ground. A mini-drone, lacking the possibility to localize itself, with limited flight range and computational capacity, cannot fulfil this mission alone. Hence the idea of associating several drones, all equipped with cameras and inter-drone communications equipment enabling them to localize themselves with respect to each other, to navigate, to individually map parts of the assigned terrain below and to exchange data with the fleet.

In this project, the issues addressed relate both to the spatial representation the drones have and 'build' from their camera inputs, the data exchanges made to improve their exploration of the target zone and what is called 'distributed control' of the swarm, for example, how to enlarge, i.e., maximize, the scope their vision, while ensuring they stay close enough to each other to communicate? The answer these problems, the scientists are notably exploring a new field, swarm robotics. "When they interact, the constituent parts of a system of systems generate emergent behavioural patterns that are either not always predictable, or desired", explains Vincent Frémont, who coordinates the Divina Project. "The drones, for example, can 'decide' to stay in a group in order to better communicate with each other, but in this case, the site exploration task proves slow, or they may decide to head off in all directions and in this case the exploration will only be part completed as planned. The objective is to arrange for the swarm to become self-organised and to prove themselves efficient. For this purpose, we try to make the most of swarm robotic principles, which draw their inspiration from "social" insects: ants, for example, who release pheromones to

communicate with others in the colony. But, in doing so, we twist the concept somewhat given that in a robot swarm all the members are identical and very simple: the overall intelligence of the system stems from their multiplicity. And in the case of our drone fleet, there are not many in flight at one time, but each with a certain form of intelligence and they are heterogeneous (larger or smaller models, equipped with one or two cameras, depending on the precise operation...".

The Divina research team makes best use of several UTC-Heudiasyc specialties. The team is registered with the French single interministerial fund (FUI), participating on an infrastructure surveillance project using a fleet of heterogeneous drones, alongside several industrial companies (Eurogiciel, SNCF, EDF, Aero Surveillance).

## A bio-artificial system of systems

The third major challenge, code-named Interfaces\*\*\*\* relates to tissue engineering, i.e.,

development of bio-hybrid substitutes used to regenerate or replace damaged human tissue. The UTC-BMBI Lab, at the cutting edge in this area, for example, has been working on bone reconstruction by cultivating cells on a bio-material matrix, stimulating their in vivo environment and serving as a support-for-growth until such times as the natural bone tissue reforms.

With the Interfaces Project, the ambition of UTC-BMBI goes even further. The BMBI scientists aim is to rebuild the bone-tendon-muscle continuum, i.e., reforming the interfaces between these there components (between bone and tendons and between muscles and tendons). "In stem cells on various supporting matrices, which would allow the stem cells

– depending on specific composition, structure and mechanical constraints applied at cell level - to differentiate into bone, tendon or muscle cells", the long run, the idea would be to rebuild all the tissues involves simultaneously, by cultivating explains Cécile Legallais, CNRS senior research officer and Director of UTC-BMBI who is the project coordinator. "But this is a formidable challenge!"



## The 'Labex' certification guarantees "excellence" in research activities

The company Plastic Omnium financially supports a thesis on Industry of the Future, co-supervised by UTC-Roberval and UTC-Heudiasyc laboratories and is also among the sponsors of the of the forthcoming Systems of Systems Engineering Conference 2018 (SoSE18) managed by the Labex MS2T. Interactions interviewed the company's scientific director, Ronan Stephan, who we recall was President and Vice-Chancellor of UTC from 2005 to 2009.

### What interest is there for industrialists like Plastic Omnium in the Labex programmes?

"There is an increasingly mandatory relationship between innovative enterprises and public research activities. On one hand, even the major corporate groups no longer possess the means to maintain basic, upstream research capacities to cover the spectrum that leads to the generation of all the building bricks that underpin their technologies. On the other hand, the industrialists cannot content themselves in contemplating remotely how research is evolving in their respective domains and then proceed to apply the results that appear most relevant to their business sectors. To act like this would be tantamount to taking the risk of being surprised by some new, breakthrough technology. Hence the importance of keeping good and continued liaison with public sector laboratories and, in certain cases, to develop truly collaborative and strategic research with public scientists. Today, innovation relies on partnerships and, taken in a wider connotation, on ecosystems and actor complementarities, in order to attain joint objectives faster and better. And this proves all the more verifiable that 'excellence' is a quality shared by the partners too. We really need to build and use links with research teams whose intrinsic academic quality is at the forefront of international competition".

### Does this mean that the Labex certificate is seen as a label of guaranteed quality?

"Yes indeed, it is a recognition of the high level of "excellence" of a research team".

### What MS2T work is of special interest to you?

"Our immediate interest focuses on 'Industrie 4.0' as it is called, with real-time, automated analysis of data collected via the manufacturing production lines, so as to anticipate drifts in production quality level and to adapt the planning of maintenance sequences to the real need of the equipment. The issues addressed in 'industrie 4.0' are close – from an algorithmic point of view – to those found in auto-pilot systems for drones or autonomous vehicles, these being examples of topics explored currently by the Labex scientists. Let me recall that Plastic Omnium is the world leader in plastic car parts which – if and when autonomous transportation modes develops - will necessarily be fitted with sensors, antennae... The research carried out by UTC teams on vehicles of the future is also of interest to us, for this very reason".



Among the obstacles ahead, we can cite: the characterization of the mechanical properties of the bio-material matrices and, especially, that of the bio-artificial tissue as it is forming (via stem cell growth on the matrices). If, on one hand, we are fairly well acquainted with the behaviour of materials, this is not true for materials that serve as substrates on which a living tissue can be grown. In order to decipher these phenomena, the UTC-BMBI research scientists are working hand in hand with experts in mechanical engineering and material sciences and engineering at the UTC-Roberval Lab.

A second obstacle is underlined by Cécile Legallais: "Our current knowledge base on the bon-tendon-muscle ensemble is insufficient to allow us to assemble directly an implantable replacement to be grafted on a human patient. Nonetheless our Interface Project will serve to enrich our knowledge here. To begin with – and this is the objective of the team – we are seeking to avail of a bio-artificial system of systems that allow us to both model living organisms and to better understand how they operate".

## Unpredictability, a source of innovation

Early 2018, the Labex took a major stride into interdisciplinarity when it integrated research scientists at UTC-COSTECH Lab who carry out technology-

For example, we could imagine 'connected' car glass windscreens, with the capacity to communicate and display information for the driver or vehicle body arts that directly incorporates micro-sensors. These are some the topics we would lie to develop in a context of our interdisciplinary research programmes.

intensive research into social sciences and humanities. The stakes here are to see the "social-humanities" specialties interact with engineering sciences to produce an even more novel impulse to the MS2T programme. With this aim in mind, the Labex introduced and defined a 4th axis, entitled "Dynamics of Systems of Systems: Emergence and Agility" the purpose of which is to study other ways to consider and design systems of systems. "We know that these very complex metasystems can show unpredictable behaviours", explains Hugues Choplin, Deputy Director UTC-Costech. "The bet we are taking is that we can envisage such emergent features, not as uncertain factor carrying risks, but as opportunities we can exploit usefully. This approach illustrates what is called 'agile methodology' in software design, editing and engineering: it is never possible to foresee every outcome and this is all to the good, inasmuch as adapting to unforeseen situations in conducive to innovation. We see this as highly relevant for investigating systems of systems".

To experiment the 4th axis, the Labex has notably defined two applications. The first has a direct connection, with the Interface Project, bringing together Cécile Legallais, UTC-BMBI, and Xavier Guchet, whose field is philosophy in technology. The objective: to explore a new vision of how a bio-artificial organ can be rebuilt, and which, potentially, could move the frontiers of bio-engineering. The vision does not consist of assembling hitherto separate components, for the purpose of trying to predict the overall behaviour of an organ, but rather to draw inspiration from living organisms as they are and function. In other words, we should favour emergent behaviours that mime successive transformations, i.e., close to

the way a living organism develops spontaneously, without a special assembly of the component parts.

The second application brings together a UTC-Roberval Lab scientist, Matthieu Bricogne, and Isabelle Cailleau, a specialist in ITC at UTC-COSTECH. They

are investigating an increasingly strategic subject for UTC- the digital revolution of design and production processes in the 'industry of the future'. "The base-line of 'Industrie 4.0' is agility and adaptability to unpredictability", explains Jérôme Favereon, senior research officer and director of UTC-Roberval Lab.: "For instance, the capacity to tailor-make mass production goods to suit the specific demands of clients is still a challenge for manufacturers". But here again, we are invited to imagine the mechanisms that would favour and enhance inventive solutions faced with an 'uncontrollable' (hence impossible) and dynamic setting.

## Communicating materials

Another evolution that lies ahead, the enlargement of the axis on optimized design of systems of systems to incorporate a new dimension, viz. to consider interconnected physical systems as a whole as communicating objects (e.g., autonomous vehicles). "Today, the materials chosen for a given system depend on their expected mechanical behaviours and, where relevant, other specific properties (electric, thermal, magnetic...)", underlines Jérôme Favereon. "In

the future, these objects will necessarily need to transmit information if we wish to avoid having to systematically add a communication layer to the physical system. For example, we could imagine 'connected' car glass windscreens, with the capacity to communicate and display information for the driver or vehicle body arts that directly incorporates micro-sensors. These are some the topics we would lie to develop in a context of our interdisciplinary research programmes". ■

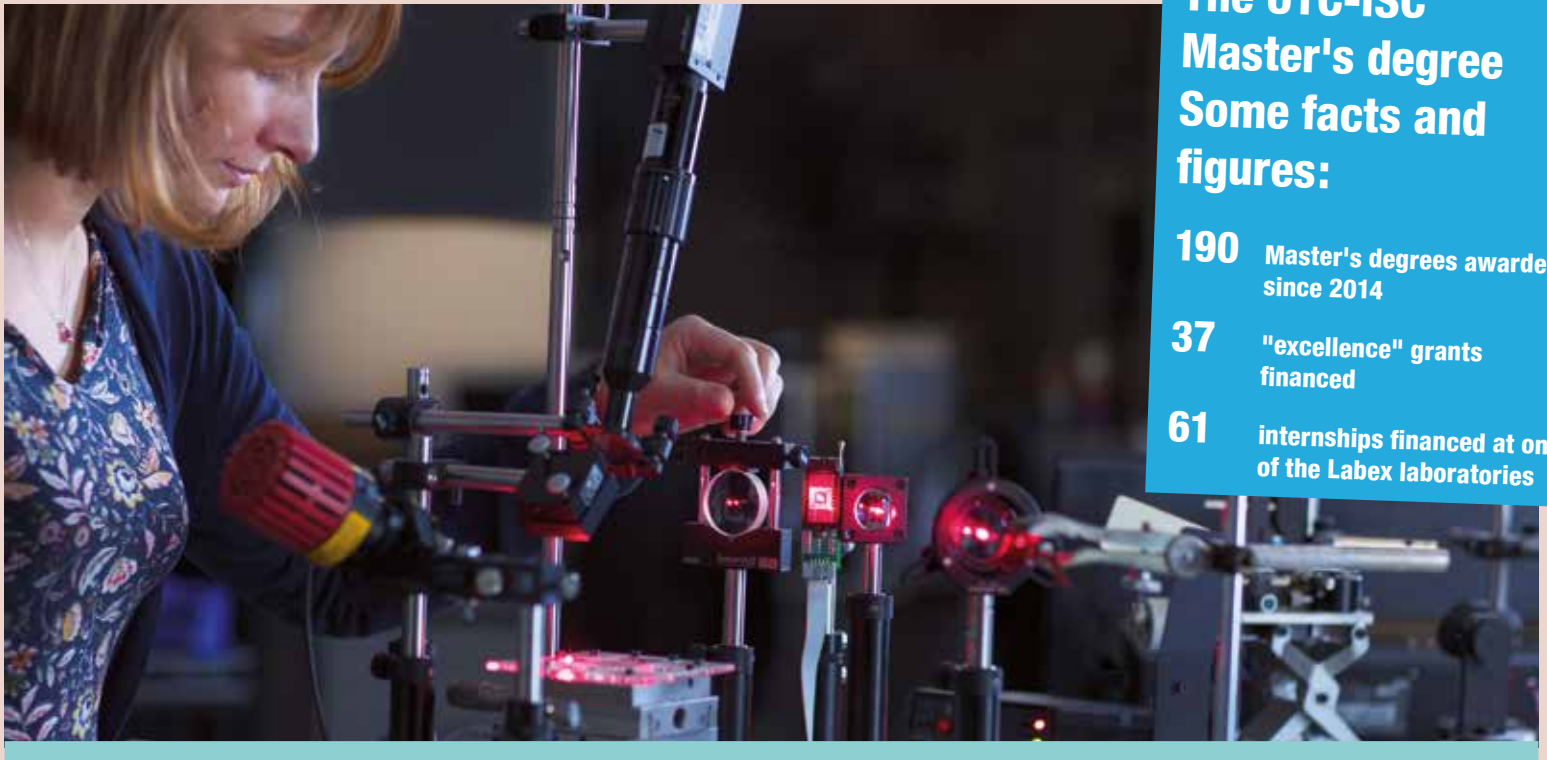
\* Dapad : Distributed and Augmented vehicle Perception to support Autonomous Driving

\*\* MS2T makes use of several high level technological platforms, such as the Equipex Robotex: a national network of robotics experimental platforms, administered by the CNRS, where UTC-Heudiasyc coordinates the field of "Mobile terrestrial and airborne robots" (autonomous vehicles and mini-drones).

\*\*\* Divina : Distributed cooperative Visual Navigation for multi-UAV systems

\*\*\*\* Interfaces - Tissues and cell interfaces in muscle-skeleton system: application to the design of bio-artificial SoS.





## The UTC-ISC Master's degree Some facts and figures:

- 190** Master's degrees awarded since 2014
- 37** "excellence" grants financed
- 61** internships financed at one of the Labex laboratories

# Training for and via research: a major challenge for the MS2T Programme

The Labex MS2T programme has committed itself deeply to training aspects, creating a Master's degree that had a direct connexion with its research programme. The plan envisaged today is to open up a University Engineering School of Research on Systems of Systems (SoS).

**A**s is the case for all certified « Excellence » laboratories, MS2T trains PhD students. Ever since it was created, 28 PhD theses have been financed, often with co-supervisors from two different specialties and increasingly now 'followed' or even co-supervised by a foreign academic, for the purpose of enriching the PhD students' international vistas. More unusual: as of 2012, UTC launched a Master's degree based on the Labex, entitled 'Master of Complex System Engineering (UTC-ISC)'. This course, based on the same model as in the composition of the MS2T teams, i.e., pluridisciplinary, with students admitted from different majors (computer sciences and applications, mechanical engineering, biology...) who first follow a core programme and then have a choice among 5 specialties with a direct link to ongoing Labex research activities: "Learning and Optimization in Complex Systems", "Automation and control, Robotics and Smart Systems", "Biomechanics and Bio-engineering", "Mechatronic Systems" and "Complex Mechanical Structures and Systems". "Bearing in mind the fact that UTC does not deliver a first degree (Bachelor or 'licence')", recalls Dritan Nace, Head of the ISC Master's degree,

"the first year (M1) student intake, no more than 15 to 20 per year, come from other universities. But in contradistinction, in second year (M2), there are between 50 and 60 direct admissions, given that graduates from the French engineering school system (the grandes écoles and some universities), or again students who have another Master's degree can apply, this representing the majority of the applications we receive for our ISC course. Our aim is to increase even more the number of admissions to year M2". Every year, the Labex financially supports some 10 "excellence" grants and internships in one of its laboratories, addressing ISC Master's degree students. "The challenge we faced when we launched this course was to attract the best possible candidates and, above all, students interested in research activities", recalls Prof. Philippe Bonnifait, Director of the UTC-Heudiasyc Lab. and former Head of the Master's degree, adding "Indeed this is the situation today: approximately one half of the graduates of a given class opt to pursue a PhD." Another specific feature of this degree is its open vista for international affairs. The students from the Lebanese University have been authorized to follow some of the course specialties: lectures can be viewed by visio-conference or given by UTC

visiting lecturers in Beirut, Lebanon. Moreover, since 2016, UTC and the University of Genoa (Italy) co-organize a European Master's degree, entitled European Master Engineering for Complex and Interacting Systems (Emecis), that brings together students of the French ISC Master's degree and its Genoan counterpart (see box).

## The next target

laboratoires ou à l'extérieur. En outre, pour développer ses recherches, elle entend étoffer son vivier de doctorants. Le label d'école universitaire de recherche et les financements qui vont de pair contribueraient à UTC entretiens the ambition today – given the elements already in place – to access a new provision of the Government's "Investments for the Future" incentive, viz., the European Universities of Research (EUR), designed to promote the international visibility of French universities. The model that inspires this drive is that of the well-known and highly reputed Graduate Schools and these EURs must interweave teaching and research, proposing both Master's degree and PhD level training with the support of (one or



several high level laboratories, with a high international reputation and, as far as possible, with close links to external socio-economic, business agents. "With this Labex and its technology-intensive research, UTC is genetically equipped to set up an EUR on Systems of Systems (SoS), which would not only integrate students taking the ISC Master's degree but also a fair fraction of our student-engineers", stresses Prof. Bonnifait, "the reason being that a systemic approach can be applied largely to the specialties we offer at UTC".

In 2017, the French National Research Agency (ANR) launched a call for projects to certify the first EURs created. UTC, in responding to the call, proposed an "excellence" curriculum linked to the 4 scientific priorities of MS2T, with an open international vista, common to both students registered for the Master's degree and to student engineers in 3 of the UTC majors: computer sciences and their applications, bio-engineering and mechanical engineering. "Out of 195 establishments candidates registered in that call, only 25 were classified A+", explains Professor Ali Charara, Director of the Labex. "Our proposal was not among the 25, but nonetheless qualified with an A assessment, which we found most encouraging and we had the only A in our Region, Hauts-de-France. We shall consequently restudy, reframe our proposal for the next round. Prof. Philippe Courtier, President and Vice-Chancellor of UTC and the UTC Executive Board have expressed their full support for this institutional project".

The challenge is all the more important that UTC – for the purpose of better forearming

## The Labex attracts PhD students

**Siqi Qiu, a Chinese national, carried out her PhD investigations at the UTC-Heudiasyc Lab. with financial support from the MS2T Labex. She defended her thesis in 2014, which won recognition (2<sup>nd</sup> Prize) by the French association for systems engineering (Afis).**



**Your thesis focused on operational safety considerations for Systems of Systems (SoS) applied to the railroads: can you explain this for our readers?**

"Modelling and assessing operational safety factors are key steps in ensuring safe design protocols for complex systems. They allow you to analyse the associated risks as of the initial design processes and not a posteriori. I proposed to model the "level 2" European ERTMS railroad signalling system, by considering it as a System of Systems. This led to a better overall picture, taking into account the various components and their interactions. I made good use of the principles that underpin operational safety to assess signal performance."

**What is the interest of the MS2T Labex for a PhD student?**

"This Labex offers an international academic platform for PhD students who come from different countries. On a personal level, the exchanges of ideas I enjoyed with research scientists from very diverse countries was a great source of inspiration for me. Secondly, the Labex carries out research on cutting edge subjects and technologies, such as autonomous vehicles, and this proves highly attractive for the students. These – as I saw it – were the two most important assets."

**Today you are a lecturer/research scientist at a prestigious Chinese university, Shanghai Jiao Tong University. Are you still investigating Systems of Systems?**

"Exact. I am currently working on operational safety factors for complex systems and preventive maintenance. And I continue to collaborate with my PhD thesis supervisors\*. Since I was awarded my PhD, I have published three papers in scientific peer reviews and presented two at international conferences."

*\* Walter Schön and Mohamed Sallak.*

its student engineers faced with the increasing need for innovation expressed by the corporate world – wishes to make them more aware of research possibilities and to increase the numbers of those who decide to pursue to PhD level in one of UTC's labs

or elsewhere. Moreover, in order to develop in-house research, UTC intends to build up its stock of PhD students. This label: EUR 'European University of Research' and the associated funding, would contribute to attaining the objectives. ■

# A joint Master's degree with the University of Genoa (Italy)

**P**rofessor Roberto Sacile, from the Dept. of Computer Sciences, Bio-Engineering, Robotics and Systems Engineering (DIBRIS) at the University of Genoa (UNIGE), has been invited by the Labex 3 times and is most happy about this privilege: "spending several months alongside research scientists from another university is far more efficient than exchanging remotely. Furthermore, it is the best way to learn to speak the same language and to develop lasting forms of collaboration." To support this, we can note that his stays in Compiègne not only led to joint project work with colleagues at UTC-Heudiasyc on modelling of risks in the transportation of hazardous goods, but also to the creation of the European Master's degree "Emecis", open to students registered for two of the specialties in the Labex Master's degree, viz., "Learning

and Optimization in Complex Systems" and "Automation and control, Robotics and Smart Systems", and likewise to their Genoan counterparts. "The contents of the UTC Master's degree are close to those taught at my Department at the University of Genoa. Consequently, it was deemed of interest that we offer our respective students the opportunity of enjoying an international experience different from an Erasmus stay and enabling them to work with research scientists from another country", underlines Prof. Sacile. The students are invited to follow part of their course in Compiègne (UTC), and part in Genoa (UNIGE), carrying out their internship under a co-supervision of two lecturer-cum-research scientists from both establishments, defend their Master's dissertation at both universities and are duly awarded, if all goes well, a double diploma –

the ISC Master's degree from UTC and the Laurea magistrale in ingegneria informatica from the University of Genoa. Launched in 2016, this double degree training course has proven to be highly relevant. Several graduates from the first class have indeed chosen to pursue their international experience: two Italians are registered for a PhD in France, one of whom is at UTC, Compiègne and one French graduate is likewise doing a PhD in Italy. "For the moment, the Emecis Master's degree only has 5 students per class", explains Roberto Sacile. "Our priority is now to open the scheme to include other European universities working on the same theme, viz., systems of Systems (SoS) and thereby offer, more choices, in terms of mobility, to more and more students". ■



## A new look on Equal Salaries for Men and Women?

**Marlène Schiappa**, junior Minister in charge of Male-Female Equality Issues [reporting directly to the French Prime Minister].

**C**ontrary to common misbeliefs, the male-female salary gap actually widens as salary levels rise. Is this something specifically French?

Whether you are a woman or a man and are paid the Minimum National Salary (set by law), you both are paid the same amount, viz., the minimum. Above this base level, as salaries rise the wage gap widens, from 9% to 27%. This is a situation we can observe in many countries, including Sweden often quoted as the “social example to follow”. Although Sweden has made considerable advances in terms of parental leave and the place men occupy in the household and family life, it nonetheless shows similar wage discrepancies (and maybe more) as in France.

**How can we enhance the attractiveness of executive, management-level jobs for women? In particular, in technology and innovation-intensive sectors?**

An international survey conducted in a partnership with Unesco and some international associations – about women employed in scientific and technical positions, Gender Scan ([www.data.gouv.fr/fr/datasets/gender-scan](http://www.data.gouv.fr/fr/datasets/gender-scan)) showed that between 2012 and 2015, less and less young women were choosing a professional orientation in new technologies. With my colleague Mounir Mahjoubi, Junior Minister for Digital Affairs, likewise in the French Government, we launched an appeal in favour of such an orientation – seen by tens of thousands of young Internet surfers, notably via the social networks where we underline the advantages of seeking this kind of job. And as of the start of the coming academic year - in collaboration, with our colleague Minister in charge of Education, we shall launch an even more vigorous campaign addressing young women in France.

**Are enterprises the only culprits in creating wage discrepancies?**

There are, as I see it, three types of responsibility here. Firstly there is the work-place: employers, enterprises, trade unions, social partners ... But there are also the public authorities, i.e., we the Government. We shoulder a high degree of responsibility and for this reason there will be a priority thrust of the Government’s Labour Force Inspectorate to carry out more spot checks. Notwithstanding, upstream of the authorities, individuals have themselves to blame too. Young women who graduate from France’s engineering and business schools (the grandes écoles) demand salaries lower than their male counterparts. There definitely is a real effort to be made in terms of the individuals concerned.

**Does ‘maternity’ play an important role here?**

I presided for nearly ten years over a social network called “Mum’s at work” which I created and yes, indeed, we did observe that the maternity factor acts as a first major stumbling block for women’s careers. As of the second child’s arrival, career gaps widen even more in heterosexual couples. I called this phenomenon the ‘Mother’s Glass Ceiling’ where the career maternity interruptions lead to the salary gaps running from 9 to 27%. It is for this very reason that we would like to see a better balanced maternity leave, including women in liberal professions, entrepreneurs and in agriculture. I have commissioned a female MP to carry out a parliamentary investigation to thus end. Likewise, we would like to bolster the conditions for ‘paternity leave’. A mission was entrusted to the French Social Services Inspectorate General (Igas) and their findings and conclusions will be made known next Spring.

**Does the choice of a career specialty have an impact on women’s professions and lives?**

Yes, the courses one chooses have a strong impact given that stereotypes do exist. That is why we must take down the “glass walls” that have led to a distinction between so-called female and male oriented specialties. In your own engineering school you no doubt can observe a more or less clear demarcation depending on the majors and specialties offered, even though I have noted with pleasure that UTC is proud to count 38% young women

among its undergraduates.

**Are the professional areas driven by science and technology more impacted by this male-female discrimination? How do you see things evolving?**

Let us observe, firstly, that there are less women than men in start-ups. The latter have a direct relationship to money and also to risk acceptance. It is patent that when you innovate you assume taking risks, but this is a culture that is not encouraged with girls. That is why my colleague in charge of Digital Affairs is seeking to induce a real culture change and he will be making his Department’s proposals in this field known over the coming months. ■

**Minister Schiappa answers 6 questions relating to salary equality issues, at [webtv.utc.fr](http://webtv.utc.fr)**

### DID YOU KNOW THIS ?



Atteindre l'égalité  
femmes-hommes.  
Un combat difficile.  
[Aiming for male-  
female equality. Uphill  
all the way]  
Édition OCDE (2017)  
[Edited by OECD, 2017]

RESEARCH

# Virtual reality (VR) immersion

The Translife CAVE at the UTC-Heudiasyc Laboratory has been operational for just over a year now. This is a research-intensive area, where 3D images are projected on 3 walls and the floor, providing a more realistic, more natural, effect than wearing a virtual reality (VR) helmet. This experimental set-up allows the scientists to observe and analyses the interactions taking place in a virtual environment, leading to numerous applications, especially in the domain of professional training drills.



analysing the mistakes, conferring on the trainee the freedom to progress and improve ad libitum. This system, called EBAGG, is a virtual sphere materializes space in 3D in which the trainee will carry out his gestures. 'Particles' appear dynamically when the trainee's movement deviates from the optimal line. The number of 'particles' indicates the amount of trajectory correction needed. And yet another example of VR training applications in the industrial sector, is the LEON Project (acceptability of Emerging technologies in aeronautics) currently under development with UPJV (Jules Verne University of Picardie, Amiens) studies the level of acceptability of VR tools used in aeronautics, depending on whether you use a CAVE type or a VR helmet environment. For instance, learning how to rivet aircraft fuselage sections as a support to compare these two environments and protocols.

Research into the interactions that take place in virtual environments for the purpose of designing more convivial and more intuitive interactive systems represents a novel experimental research thrust for CAVE scientists. To illustrate this, we can cite the rather original Special Touch programme which explores "touch". The device allows a virtual character to touch a human being in various set-ups and scenes. The reciprocal gesture will also be enabled. What we are studying is to see if a physical contact changes an individual's behaviour faced with a computer system and you can rest assured; we will tell your readers what our conclusions are, once we have conducted the research planned this promising field. ■

**What looks like a simple cube at first sight is, in fact, a cutting edge piece of equipment used to digitally model situations and environments with a high degree of precision and perfection.** The user - wearing a pair of 3D glasses that rebuild the surrounding profile from the images projected on the walls and floor - is fully immersed in a coherent virtual environment. Infrared cameras accurately detect the user's movements, enabling a real-time adaptation of the scenery and sequences as a function of the user's movements and behaviour. In the professional training drills, the data analysed using algorithms which assess the mental and physical state of the 'apprentice'. Consequently, the exercises can be adapted as a function of the level attained, the stress and fatigue factors. When the training officer is absent, the errors the trainee makes are never self-evident. The Heudiasyc scientists therefore try to go further in designing new models to help visualize the mistakes in a given gesture. "Virtual reality offers numerous possibilities to improve the pedagogy of digital training modules", sums up Indira Thouvenin, lecturer and research

scientist, specialist of this field and Director of the UTC-VR unit.

## Making learning easier

Numerous sectors of the economy could be affected by the potentialities of this technique. The Kiva Programme (Knowledge and Informed Virtual environment for gesture cApitalization) was conducted with the Montupet Group, one of the world's leading manufacturers of cast aluminium cylinder heads for automobiles, so as to improve the learning-acquisition of the technical gestures needed when a new cylinder head is moulded. REVIATECH, a company specialized in VR training programmes, built up the virtual environment and integrated the results of research to make a better use of the system. Several options were tested in the CAVE, e.g., using arrows to indicate the direction to follow, or reproduction of a correct move by a tick mark. However, all the feedback here does not tell you where the errors lie. The most efficient solution finally consisted of

volletResearch into the interactions that take place in virtual environments for the purpose of designing more convivial and more intuitive interactive systems represents a novel experimental research thrust for CAVE scientists.



# Energy management: a promising sector in the future

Schneider Electric, a world leader in the field of energy management, offers numerous career opportunities for young qualified engineers. Philippe Vollet, who has been the Group's Standardisation Director for almost 30 years now, talks about his personal track-record and describes the professional perspectives opening up for today's and tomorrow's engineers.

## How and when did you join Schneider Electric?

The electric power industrial sector is very present in the Grenoble area, notably with Merlin Gerin, acquired by the Schneider Electric Group in 1992. Joining Schneider Electric was fairly logical for me inasmuch as I had just completed my engineering studies, majoring in electrical engineering, at the Institut polytechnique de Grenoble (IPG). In 1989, I was first recruited as a reliability engineer in their Low Voltage Switchboards Department.

## Apparently, you have held some very varied postings, haven't you?

I didn't want to do the same routine job all my career. I started with purely technical, engineering positions, followed by a Master's degree in corporate management from IAE-Grenoble in 1998 which allowed me gradually to open up the scope of my activities learning new skills close to marketing functions. I then became head of Architectures, Innovation and Expertise for the Low and Medium Voltage Switchboards, Panelboards and Busways Department, where my job consisted in foreseeing and preparing for coming market trends and emerging technologies, with new architectures for our offers and associate business plans. In 2009, I took the responsibility of Strategic Marketing Director for the Final Distribution Department and, in parallel, I was a pioneer of our Electric Vehicle business. Finally I came to my present position as Group's Standardisation Director, responsible for deploying 'influence' actions and standards for the Buildings Division – indeed I now find myself at the core of medium and long range policy framing for the Group as a whole.

If you can prove curious and open minded, there are numerous possibilities open to you. We need highly skilled specialists in certain technical domains but also more 'general purpose' engineers with the capacity to adapt to changing, new situations. This is a feature I appreciate with UTC students; together with their willingness to get 'dug in' to work. If you want to enjoy a bright career, then you must also be mobile. For example, I only learned to work with the Chinese when I became an 'expat', in China. And my dozens of round trips to China only gave me a superficial

understanding of that country.

## How does one become a Standardization Director?

The way I see things, when you wish to work in the field of international standards, you need to have experience. You represent your company, your industrial sector at the standards agencies, at professional trade organizations and government institutions (both national and regional as is the case for the European Commission).

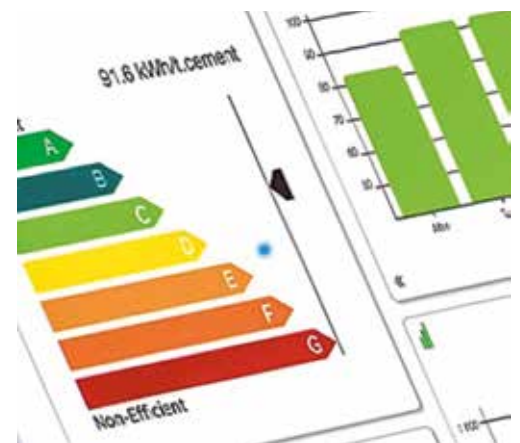
When you defend your company's interests, you also need to have a solid technology-intensive base, to know your company's products well and to possess an excellent knowledge of your strategies and market positions. Most of my colleagues are like myself – it takes about 15 years with the company to properly acquire these skills and the knowledge base. On top of this, if I can add that the pay-off for our actions only becomes visible some 5 to 10 years later, then you can readily understand that a certain degree of stability is needed in my position.

## What are the observable changes emerging today in the standards field?

System gaps are decreasing, even if certain user particularities still remain. In the electric domain, it is the IEC standards that are largely implemented in Europe, North America and Asia (China, Japan and South Korea). The relevant standards here are drawn up by the best experts in the world. They contribute notably to defining safety levels, performance expectations and interoperability of electric and electronic technologies, and also they form the reference base for equipment testing and system certification. Over and above serving to protect consumers, these standards facilitate access to new markets for our enterprises.

## How did you personally contribute here?

Well, I am a member of several IEC (International Electrotechnical Commissions) Technical Committees. In the IEC framework, I took part notably in the setting up of international standards related to electric vehicle recharge posts. (IEC TC69, IEC TC64, IEC SC23H, IEC SCX23E ...). The aim here is to guarantee a maximum safety level for persons and goods and to ensure complete coherency between vehicles (whatever the brand), the recharge posts and the building electric



installation – the other main aim is to seek total interoperability of the recharge stations, whatever the type of electric vehicle (plug outlets, with industrial plugs, socket-outlets and couplers).

I was also active in establishing product related standards for active energy management in buildings (IEC SC23K, IEC TC64, CEN TC247). This reference framework allows you to have access to efficient electric plant and energy management systems as well as being able to manage sources and electric recharge facilities.

## What are the most promising sectors in the field of energy management?

My company has always kept abreast with change. In the 19<sup>th</sup> Century we were specialized in cast iron products, then in electromechanical devices in the 20<sup>th</sup> and today we have a global reputation as leaders of the ongoing digital transformation of energy management and automation, illustrated by our solutions to obtaining better energy-related efficiency. Here we have a field that is developing rapidly, faced as it is with coming energy issues and carbon reduction. Cities today represent 75% of total energy consumption and 80% of the associated carbon emissions. We expect the world's population to double by horizon 2050. At the same time, today's system of centralized electric power production will gradually evolve towards a multitude of local producers/ storage facilities/ consumers. Such ultra-rapid development requires that we secure and offer cleaner energy, a « smarter » grid and especially a more efficient network, with a more active energy management scheme – tariff modulation, by the hour, as is already the case in certain countries. We shall no doubt see more recruitments in this field. ■

## AGENDA

interactions.utc.fr • www.utc.fr

### The UTC Guy Deniélou thesis Prizes

April 6, 2018

The 13th edition of the UTC Guy Deniélou thesis Prizes will be organized Friday, April 6, 2018, with the patronage of Plastic Omnium, along with support from Airbus Safran Launchers and the Greater Compiègne authorities.

Cf. our WebTV series "Theses that change our lives" : [webtv.utc.fr](http://webtv.utc.fr)

### 7th international Symposium on Aircraft Materials (ACMA2018)

April 24-26, 2018

ACMA2018 will aim at providing a comprehensive forum for discussing current state of the art in the wide field of aircraft materials as well as generating inspiration for future ideas specifically on a multidisciplinary level. Special sessions, project forums, poles or networks and mini-lectures will be offered on recent research findings and other topical industrial subjects.

<https://acma2018.sciencesconf.org/>

### Final round of the "Fleur d'Eloquence competition,

Wednesday May 2 2018

Some 30 students (out of 80 candidates) were invited to take part in the oratory skills competition "Fleurs d'Elkoquence" organised by the Sorbonne Universities Cluster. The final round - open to the public - will take place May 2, 6:30pm in the 'small' lecture-hall of the Bibliothèque Nationale de France. The remaining candidates will be asked to develop their arguments before the audience, in a set time.

[www.fleursdeloquence.com](http://www.fleursdeloquence.com) • [webtv.utc.fr](http://webtv.utc.fr)

### Conference on "system of systems engineering" IEEE SOSE 2018

June 19-22, 2018

The 13th international conference on "System of Systems Engineering", organized by UTC will take place on the Paris Jussieu-Sorbonne Universities campus with as the central theme this year "Systems of systems Management and Control: Frontiers between cyber, physical, and social systems".

<http://sosengineering.org/2018/>

### 9th UTC conference on powder science and technologies

July 3-5, 2018

Powders are at the core of numerous industrial applications such as pharmaceuticals, cosmetics, chemistry, agro-food products, materials, energy and the environment. The 9th Conference on Powder Science and Technologies aims at allowing the attendees - whether they are academics, industrialists and/or equipment makers to meet, exchange and update their knowledge and also be informed of the latest scientific and technological progress in the field.

[www.utc.fr/colloque-stp.html](http://www.utc.fr/colloque-stp.html)

## AERONAUTICS

# Aeronautics progresses to lower pollution turbine-engines

The challenging target set by the EU European programme E-BREAK (Engine BREAKthrough Components and Subsystems), viz., to lower aircraft and helicopter engine CO<sub>2</sub> emissions levels by 30% ended last year. This ambitious programme, bringing together 41 partners from 10 different countries, was awarded a French "Stars of Europe" Prize, under the heading "Innovation" for the technological excellence displayed and the high quality of scientific cooperation generated during the programme.



**This Prize for "Stars of Europe" was launched by the French ministry in charge of Higher Education and Research in 2013 to underscore the merits of research projects coordinated by French companies (or structures) in partnerships on a European scale.**

The laureates were chosen from among initiatives supported by the EU in the Horizon 2020 Programme, the European pluriennial Framework programme to finance and encourage research and innovation – with a budget of 80 billion euros for the period 2014-2020. The EU Programme E-BREAK (Engine BREAKthrough and subsystems) brings together academic laboratories, private research centres, SMEs and world-scale aircraft engine manufacturers. The EU has provided some 18 Meuros of the total 30 Meuros invested. The project leader is Safran Helicopter Engines whose HQ is near Pau, south France, and the target set to the participants was to find technological solutions to a number of block-points (over the time scale 2013-2017) by sharing their skills and experimental set-ups ; as Manuel Silva, project manager and a graduate from UTC, majoring in Mechanical Engineering, put it "a partnership on this sort of scale was hitherto unknown territory for us at Safran Helicopter Engines – cooperating with competitors and academics was an unusual step for us but it proved very rewarding and a rich experience". Several months after the close of the

programme, the results in terms of competitiveness and economies made are visible. Seven patent claims have been lodged. Numerous promising longer-term returns on experience (RE) have been noted. Several professional jobs were created. Engineering schools such as ENIT(Tarbes) or ISAE-SupAERO, Toulouse have gained in international visibility with respect to the industrial world, notably though the excellence of their experimental rigs and their specific skills in digital modelling.

## Innovative progress towards 'greener' aeronautics

The E-BREAK programme was set up in a context that encouraged industrialists and research scientists to design lower pollution, more economical aircraft in terms of energy consumption and emissions. Aircraft companies foresee a doubling up of their fleets by 2035, while ACARE (the Advisory Council for Aviation Research and innovation in Europe), the European body in charge of drafting air transportation policies and strategies, has set objectives in terms of lower greenhouse gas (GHGs) emissions and fuel consumption. E-BREAK analysed various technologies enabling design of more compact, lighter engines that burn less fuel. Higher pressure and temperatures in turbopropulsion engines (but providing the same power thrust) have indeed brought to light some novel technology-intensive challenges. The ACARE objective was to see new sub-systems and materials capable of resisting the new constraints. No less than 6 research areas and some 50 technologies were studied during the programme's 4 ½ years. The objectives were reached or exceeded in 90% of the cases. Numerous test-bed experiments were conducted to validate and certify the results. Better gas tight conditions were achieved with new generation carbon seals; tip clearance control between turbine and stator was reduced by addition of higher performance (thermal and mechanical) wall cladding; new and lighter alloys (e.g., titanium-aluminides) were developed, compliant with the extreme temperatures; improved parts inspections, using various, mechanical and thermal tests, involving artificial intelligence (AI) tools and Big Data analyses and techniques ... were among the research facets explored over the E-BREAK Programme years. ■

[www.e-break.eu](http://www.e-break.eu)



# SD data at a glance

Claire Behar, a UTC graduate who majored in Urban Systems Engineering (GSU), won second place in the Dataviz SDG\* competition organised by the French ministry in charge of Ecological Transition and Solidarity. It is an event that rewards the best digital projects that set out the 17 United Nations goals for sustainable development, to which end France is an active party.

**C**laire Behar, currently in charge of the development for a Data Analytics department of WorkIT Software, is a specialist in big data applications in e-commerce, but has also been interested in the thematics of sustainable development ever since she studied at UTC. In 2012, she also won a second place - with two other UTC undergraduates - at the ADEME competition: "The SD Generation". This is an annual event that addresses undergraduates in higher education, who come up with concrete applicable solutions to day-to-day problems aimed at reduced consumption of resources and decreased greenhouse gas (GHG) emission levels. What these students propose to the ADEME Jury was an, "app" to facilitate choice of personal routing when several transport modes co-exist. The "app" automatically calculates the route and mode that emits least CO2 and proposes group booking. The overall aim was to set up a general public web-site to facilitate public transport and co-sharing rides. Our then undergraduate was inoculated with a combined ecology/new technology virus, enabling her to face new challenges.

## The 'state' of the planet Earth

In 2017, and thanks to the eSteem social network that favours and enhances humanitarian charity based activities and aims, Claire discovered the "Dataviz SDG competition" (in French Dataviz ODD). She also met her two future team-mates on this associative and professional alternative network, both employed by the French Electricity Operator, now called Engie, who were as impassioned as Claire was about sustainable development objected. When Claire took up this challenge, she had already heard about the UN Horizon 2030 global action plan and its 17 Sustainable Development Goals (SDG). However, at the time she ignored quite a lot of the pointers used to set up this "volontaristic" program. The 17 goals set out in the UN document rely on statistics and diagnostics from all round the world. Now it is no easy matter to draw international comparisons when there are many themes involved. Depending on the countries assessed, the criteria used came defined in largely different ways hence the difficulty of offering a coherent overview. Dataviz SDG has the objective to make the information for this complex set-up accessible and to better situate France's contributions and actions. The aim was to make

244 data inputs attractive and easily understood, using animated images and graphics, for domains as distinct as agriculture, poverty levels and terrestrial biodiversity. "The indicators for social status are relatively familiar, but in contradistinction, when we look at "artificialisation" of soils or biodiversity we must know how to be pedagogical", analyses Claire Behar. Despite the scale of the task, and with just two months to finalize a proposal "At UTC, we learned how to implement projects in very short time spans and that was very helpful here". Her professional experience in the development of "apps" and also that as a user helped her also to acquire a good overview and to prioritize problems. Putting the work together was a remote set up using collaborative tools. "All three of us were professionally very busy, living in different towns in the Ile-de-France Region but this also turned out to be a highly ecological way to work together", adds Claire to sum up. The end-result was a very attractive interactive website where the objectives of SD can be addressed from 4 different angles: generalities, comparison of French territorial departments, parallel comparisons country-by-country and finally an assessment of any personal project in terms of the UN's 17 SDGs. ■

## START-UP

## 'Soundsuit', providing tailor-made music at 'points of sale' (POS)



At UTC, there is "life after" class. And what may seem, at first sight, a pastime can lead to creation of start-up. Mikaël Bourdon, who graduated from UTC (majoring in Mechanical Engineering) is a perfect illustration. Mikaël is both a great music fan, and also involved in several musical associations, being MC and DJ for student soirées at UTC. In 2004, he created Soundsuit\*, a streaming service specialized in serving points of sale (POS).

### How did you get the idea to propose a music distribution system for shop outlets?

When I used to go into a shop, I was always somewhat amazed at the gap between the music background, the decoration the clients' styles and time of day. Those systems were not adapted and no doubt frustrating for the employees who had to endure listening to the same music all day long, every day. Moreover, the shop manager (or restaurant) simply does not have the time to select new pieces and organize them logically in a play-list to last for the 8 opening hours. What I realized was that there was a real demand from POS outlet-owners/managers for a system that would enable them simply (and at low cost) to put on some adapted choices of music at their POS. When I first had this idea, AI (Artificial Intelligence) and Cloud technologies were neither reasonably priced nor easy to implement. I waited till 2014 before I presented my idea at a start-up creation competition, and then only launched Soundsuit in 2016.

### What was the biggest challenge you had to face in this project?

In our case, the interest did not consist of having access

to all music but to have the right song at the right moment using a digital solution requiring minimum effort from the professional who uses it. Consequently, our solution embodies only very few functions. To achieve this, we did a lot of work on system ergonomics, implementing the principles of "design thinking" and "user-centred design". The real challenge was to build a musical data base adapted to given professional markets (hotels, gastronomic places, luxury goods outlets, fashion catwalks and shops, events, etc.) and to develop a form of AI that could contextualize or "think" like a DJ in real-time. Upstream of our algorithm, there was a fingerprinting phase where each preselected piece of music in our base is scanned, analysed and the categorized (quantity and quality-wise), thanks to use made of Digital Signal Processing (DSP) techniques. We also make good use of our in-house team of music lovers to check that the automated categorization of the parts is satisfactory.

### How does it work, from the user's point of view?

When a user-subscriber logs in, he/she can notify several criteria (not related to music): clientele, the kind of POS (shop outlet, restaurant, hair-dresser salon ...), decoration of POS ... and acting as a real DJ, our algorithm will

use these data to select the music and adapt the musical ambiance throughout the day. The user can also skip pieces, "like" a given song, request a more rhythmic (or calmer) atmosphere and this enables the algorithm to learn and tailor the musical ambiance accordingly.

### What are your objectives for 2018?

We launched our solution in Germany a year ago today, in a collaboration with the Bo Concept furniture chain of outlets. Our sales target for 2018 is to generate business in new sectors (fitness clubs, social areas in corporate surroundings) and to spread our idea and product through European countries.

The future of Soundsuit, as we see it in the long term will lie in the Internet of Things (IoT). Integrating platforms such as Nest, Netatmo, etc., will allow Soundsuit - via information collected at POS sensors, plus real-time data such as temperature, number of clients present, sound level, etc., and adapt the musical ambiance accordingly. And when we add some "vocal aids", an employee at the POS will be able to adjust the output even more simply - similar to the way a shop-manager previously dialogued with a shop floor DJ. It's all new stuff and yet all old and familiar at the same time! ■



## Technically-minded with an innate gift for negotiating

Eric Schindler, who graduated from UTC in 1986 (majoring in Computer sciences and their applications), is today Global Project Manager for Procter and Gamble. Network Infrastructure Project manager (Europe) and in charge of projects in 5 regions (North America, Latin America, Asia and Pacific countries, Western Europe and CEEMEA (Central & Eastern Europe, Middle East and Africa). His professional track record, plus his commitment to associations and citizen issues underpin his combination of technical skills, open-vista and an acute sense of human relationships.

**With a passion for biology, our young French 'Bachelier' first chose the major Bio-engineering. But given the low attractiveness he felt for the chemistry-intensive CCs, he changed his orientation and moved to Computer sciences and their applications.** At the end of his UTC training, he simultaneously carried out two special internships in the Compiègne area. For 4 week-days he was posted at Saint-Gobain, contributing to the making of wind-shield prototypes for Renault's future R21 car. And on Fridays and Saturdays, he managed a team of 40 at the perfume company Yves Saint Laurent. This dual experience revealed his propensity for both industrial and human questions: "On one hand, I was deeply involved in industrial process automation, using computers to control glass smelting furnaces and, on the other hand, I discovered the world of luxury goods with its management and quality control functions". Six months later, to start his professional career, he applied – not at all sure of the outcome – for a job with Procter & Gamble. And although the recruitment process was arduous and demanding, he was given his first job. He began in the field of industrial computing at the P&G factory in Amiens. Three years later, he was appointed to the Home Office at Neuilly-sur-Seine to execute analytic missions in EDP management: "I wanted to change locations and to get out of the purely industrial world". It was a point in time when P&G was acquiring numerous French companies with a variety of products; the corporate policy aim was to integrate the activities of these production units by making the supply chain and the logistics system uniform. Later, we saw that harmonized European accounting and financial management practices called for the methods of the units to be brought into compliance. From 1996 to 1998, Eric Schindler worked on the SAP\* professional software package with fiscal and financial system experts. These years of collaboration with other specialties provided Eric with an excellent knowledge of how the various Group activities worked in France.

### From computer science to commercial business relationships

With his now extensive expertise and acquired multiple skills, he left the field of EDP to join the P&G Sales Department: "Over

and above promoting our products to the supermarket shopping outlets of Leclerc and Auchan, I was able to use my skills to develop order placement, billing and payment automation". His first sorties in this function were not self-evident but it did help him develop his personal sense for human relationships and for negotiations. But his ease in communication and his innate sense for manpower team organization led to him being appointed EDP Director for the pharmaceutical factory unit owned by the America giant P&G. It is a sector that is demanding in terms of ingredient and product inspection and control and was a rich experience for Eric. "Every time we changed the factory computer system, we had to attest and justify in writing that the changes would not impact the quality of the medicinal drugs produced". As a member of the factory's executive directorate committee, Eric also held more transverse responsibilities. When P&G sold this sector's activities, Eric rejoined the EDP Division and in his new capacity as IT Purchasing it was his job to select the suppliers in charge of setting up new logistics and sales systems for Europe. Since 2011, his responsibility extends to cover P&G EDP projects on a global scale: "What I am seeking are solutions that will improve productivity and well-being of some 100 000 P&G personnel, no matter the site to which they have been assigned." Despite an already very business diary of professional commitments, Eric also finds time to commit some energy to the "city" and to his alma mater, UTC. Since 2001 he has become an elected and prominent Town Council Officer at Neuilly-sur-Seine: "My engineering training background proves very useful when it comes to understanding some highly technical dossiers, such as road-works and associate infrastructures". Eric has now presided over the UTC alumni association Tremplin, for the past 4 years and he has thoroughly

enjoyed the convivial atmosphere and the feeling that he has been useful in this role. "We plan to launch lots of new services for the UTC students and graduates, such as a personal loan". Tremplin will be celebrating its 40th anniversary this year and can rest assured that Eric will bring his dynamic nature and his organizational qualities to bear. In short, Eric Schindler has enjoyed a challenging career combined with his personal commitment to serve others. ■

### BIO EXPRESS

**1986** Graduated from UTC (majoring in Computer science and their applications)

**1987** Doctoral level qualification from the Institut d'administration des entreprises (IAE)

**Joined Procter & Gamble in 1987**

**1998 - 2001** P&G Sales Department

**2001 - 2007** Director EDP in the P&G Pharmaceutical Division

**2007 - 2011** IT Purchasing Executive for Europe (53 countries)

**2011** Appointed Network Infrastructure Project manager (Europe)

**Elected Town council officer at Neuilly-sur-Seine (first term of office)**

**2014** Elected President of the UTC alumni association, Tremplin.



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Director of publication  
**Philippe Courtier**  
Editor-in-chief  
**Nadine Luft**  
Editors  
**Marilyne Berthaud**  
**Bénédicte Haquin**  
**Olivier Moulargues**  
Design/Realization  
**L'agence**  
**& Dorothée Tombini-Prot**  
**Antonella Vaudru**  
Assistant  
**Corinne Delair**  
Photos p. 6 et 13  
**Eric Nocher**  
Translation by  
**Alan Rodney, BABEL TWO**  
Printing  
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