Research in laboratories

March 2022

Focus on 2021 - 2022 Signature Projects

GRENOBLE INP - UGA
Graduate Schools of Engineering & Management

Grenoble INP - UGA is taking up the societal challenges represented by the four transitions: energy, environmental, digital and industrial, by combining the expertise in management and technological sciences at its schools and in the laboratories jointly supervised by the engineering and management institute.

This collection turns the spotlight on leading scientists and innovative projects, technologies and products resulting from research carried out in the laboratories over the last two years.

SUMMARY

MATERIALS

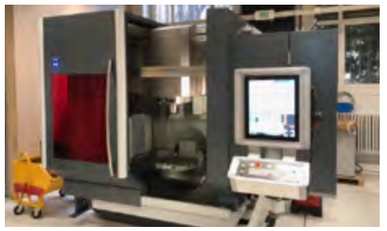
ENERGY / ENVIRONMENT

ELECTRONICS / DIGITAL / ROBOTIQUE

BIOLOGY / HEALTH

03 Feb. 2022

Grenoble: a five-axis machining centre, unparalleled in France



A new piece of equipment, the only of its kind in France, has just joined the GINOVA technological platform at the S.mart Grenoble Alps hub: a five-axis machining centre combining machining and manufacturing of metal additives.

A new piece of equipment, the only of its kind in France, has just joined the GINOVA technological platform at the S.mart Grenoble Alps hub: a five-axis machining centre combining machining and manufacturing of metal additives.

And that is not all. It has also been fitted with a new tool: a wire fusion metal additive manufacturing head. "*This additive manufacturing head is handled like a traditional tool, which makes it possible to program movement trajectories while depositing molten material,*" explains Alain Di Donato, technical manager of the GINOVA platform at the S.mart Grenoble Alps hub. "*This means that material can be added only where needed, with millimetre-level precision by melting metal wire, then finely machining it with 100 times more precision. This combination of technologies provides one-shot manufacturing capabilities that are higher-performing than the former equipment.*" As well as saving considerable time, the ability to go from additive manufacturing to fine machining without changing machine makes it possible to produce parts with complex geometry quickly and with greater agility than with a sequential solution: additive manufacturing machine + machining tool.

Research and pedagogical equipment

First of all, scientists will need to finish developing this machine, unparalleled in France, by trialling steering trajectory strategies. "*The main thing is to check that pre-defined trajectories are followed by the machine, and that the produced parts match their digital model,*" emphasises Alain Di Donato. After a few months of familiarisation with the equipment, it will be used for research and teaching, particularly for scientists at the G-SCOP** laboratory and students at Grenoble INP – Industrial Engineering, UGA.

At a later date, a 3D laser scanner will be installed on the machine, as an additional tool. "*It will be used to check that a part being manufactured matches the digital model, and to proceed with automatic corrections if necessary.*" Lastly, a digital twin development project is currently underway, and will eventually allow the machine's behaviour to be predicted, through digital models.

** Grenoble INP – UGA, UGA, Université Savoie Mont Blanc*
***CNRS, Grenoble INP – UGA, UGA*

Cellulose Valley,
a new chair in industrial excellence

11 Jan. 2022

A new industrial excellence chair has been signed in the framework of the Grenoble INP Foundation. Dedicated to cellulose, the chair is held by Julien Bras, teacher at Grenoble INP – Pagora, UGA, and researcher at LGP2*.

When it comes to cellulose, Julien Bras knows a thing or two! A graduate of ENSIACET, the chemical engineering school at Toulouse INP, he completed his thesis at LCAI**, in collaboration with Ahlstrom, on the development of new bio-sourced packaging made from parchment paper and cellulose derivatives. He was then recruited for the role of innovation manager by Ahlstrom, and was sent to Normandy to develop a specific form of paper for sites in Finland, Italy and France.

In 2006, Julien Bras became a lecturer at Grenoble INP – Pagora, UGA, and researcher at LGP2, where he focused more specifically on developments in the field of biomaterials and functional paper. His research there led to the publication of more than 180 papers and 15 patents. He picked up numerous awards and distinctions in 13 years (junior member of IUF Academic Institute of France, IMT Hope by the French Academy of Science, the International Award from the TAPPI International Nanotechnology Division, etc.), before heading to Switzerland for 2 years with Nestlé Research to take part in the creation of a packaging science institute. Thanks to this new experience in the industrial sector, Julien Bras returned to Grenoble INP brimming with project ideas. Among his projects, the development of the School's international relations and an international Master in biorefinery and biomaterials, in addition to the creation of an Industrial Excellence Chair, led by Grenoble INP and dedicated to cellulose!

Named "Cellulose Valley", the new chair is supported by several companies: DS Smith (manufacturer of sustainable packaging solutions); Ahlstrom Munksjö (one of the global leading players in sustainable and innovative fiber-based solutions); Alphaform, part of the Guillin Group,(molded cellulose), and CITEO, a mission-driven company working to reduce the environmental impact of packaging and paper. "*The aim is to develop new packaging from cellulose, and thus replace plastic*", says Julien Bras, the holder of the Chair. "*We are already planning to fund two theses, two postdoctorates and some twenty work placements for Master students.*" Watch this space!

**LGP2: Laboratoire Génie des Procédés Papetiers [Engineering laboratory for paper-making processes] (Grenoble INP - UGA, Grenoble INP – Pagora, UGA)*
***LCAI: Laboratoire de Chimie Agro-Industrielle [Agro-Industrial Chemical Laboratory] (INRAE, Toulouse INP)*

19 Oct. 2021

Future engineers cleaning up Nepal

Three students from Grenoble INP – Ense3, UGA, have launched a project to help decontaminate Nepal's highest mountaintops. They have developed a unique solution for handling plastic waste and set off to test it in the field.

If you're a mountain-lover and Grenoble INP – Ense3 student that's been made aware of environmental issues, what's something useful you could do? Why, help clean up Everest! Such was the mindset for students Olivier Robelin, Robin Jager and Valentin Girard when they created the organisation "Tri-Haut pour l'Everest". "We got the idea after watching the documentary Everest Green by Jean-Michel Jorda," explains Olivier Robelin, currently on a leave of absence after his second year at Grenoble INP – Ense3 "We contacted the director to talk about our waste processing project for the region, and he loved the idea!"

Mt Everest is located in the Khumbu region and is a destination for many high-altitude treks that leave behind large amounts of rubbish, like all the high peaks in the area. However, Nepal does not have the infrastructure required to process such waste. "*Despite the efforts made in the past decade to limit pollution in base camps, there is a lot of non-recyclable waste that ends up straight in Nepalese rivers,*" explains the future engineer. "*The aim of our mission is to fill this void by creating infrastructure that could be used to process waste throughout the entire valley.*"

Currently, rubbish is collected at base camp, and some paths have garbage bins. But it is not all collected, far from it, and most of what is picked up is not sorted for recycling. Waste that can be incinerated represents nearly 40% of all rubbish, and the vast majority ends up in garbage pits or as litter, even if there is an undersized incinerator run on fuel oil.

Pyrolysis to the rescue

The future engineers had the idea to fill this void by developing a low-carbon incinerator to burn abandoned, non-recyclable rubbish. For this, they drew on the principle of pyrolysis. "*This principle involves combustion without oxygen, which is low at these altitudes,*" explains Olivier Robelin. "*The reaction produces gas which provides a self-sustaining energy supply, and fuel oil to be reused by the local population.*" Multiple solutions were investigated in collaboration with industrial partners during their first-year project, in order to guarantee optimal performance at a reasonable cost. Prototypes were developed at the school's FabLab and will soon be tested on the ground. "*In the end, we developed a prototype of a pyrolysis tool that transforms plastic waste into fuel oil and gas.*"

The three students recently left for Nepal for 4 months, where they will continue to develop their project in a laboratory in Kathmandu. At the same time, they will work with Nepalese partners to raise awareness among the local population of the importance of collecting and sorting waste. When they return, they will pass on the baton to members of NGO Solidarire, who will send people to continue the project on the ground for at least 2-3 years.

https://trihautpourleverest.go.zd.fr/index.php/le-voyage/

Entroview rides the electric car wave

26 Oct. 2021

Brand new start-up Entroview from GIPSA-Lab* is taking on the huge electric vehicle battery market.

With the market for electric vehicles (EVs) taking off, producing batteries for these cars has become a strategic issue for Europe. And along with it come plenty of challenges in terms of performance and reliability. Brand new start-up Entroview was created in July 2021 after an incubation period at SATT Linksium, and plans to ride this wave.

Its founder, Sohaïb El Outmani, is putting the research from his thesis at GIPSA-Lab into practice, after an all-important meeting with Rachid Yazami, co-inventor of the rechargeable lithium battery and winner of the 2014 Draper Prize. In concrete terms, he has developed and patented a technique allowing the condition of a rechargeable battery to be monitored in real-time, by measuring electrical and thermodynamic parameters such as entropy. "*We are able to measure the entropy of a battery in real-time thanks to model identification algorithms and machine learning,*" explains Sohaïb El Outmani, whose thesis was supervised by Olivier Sename and Pierre Granjon, professors at Grenoble INP – Ense3, UGA, and researchers at GIPSA-Lab. "*With the classic tools, it takes several days to measure this variable. But this method gives a very good idea of the level of charge and condition of a battery, and it's a lot more accurate than other kinds of tests.*"

Potential applications at different levels of the value chain

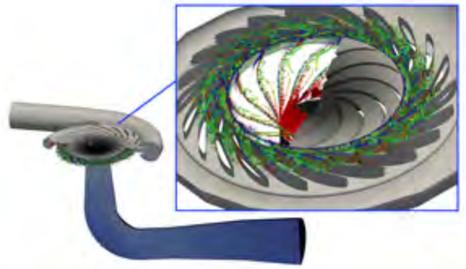
Beyond improving management of battery charging and use cycles, and therefore extending battery lifespan over time, this technology opens up extremely promising possibilities.
With the fast-arriving need to mass-produce EV batteries, we are currently seeing the creation of huge battery factories, known as gigafactories. These facilities will manufacture billions of cells, which have to undergo quality tests that sometimes take over a week before being sold. Entroview is developing a method that will allow this testing time to be reduced or even eliminated. Initial results are encouraging.

The start-up's technology can also be used at other stages of the value chain. They are working with a huge international industrial group at the moment, in negotiations for a partnership, to assess the condition of battery farms used to regulate the production of intermittent renewable energy. "*It should make it possible to avoid the weekly shutdowns needed to recalibrate the batteries.*" And lastly, Entroview is also in contact with gigafactories, who are extremely interested in the start-up's activities.

**CNRS, Grenoble INP – UGA, UGA*

08 March 2022

A better design for the turbines of the future



An Industrial Chair between General Electric and the LEGI* is going to put the YALES2HYDRO turbulence simulation code, developed at the laboratory, to good use in designing new generations of hydro turbines that are better adapted to the current demands of the power grids.

In Etruscan mythology, Nethuns was the god of water. At the LEGI, it's the name of the ANR's** new Industrial Chair which has been signed for a four-year term with General Electric Hydro France. The Chair for the 'New Development of Hydro Turbines Using a New Simulation Tool' (NETHUNS, in French) aims to promote the development of new turbine designs that are tailored to the networks' current demands.

Hydroelectric turbines are now the most versatile way to balance the needs of the electrical network, which has to accommodate an increasingly large share of intermittent energy sources (such as wind and solar power).
"At all times, it must be possible to balance production and consumption quickly, either by opening the dams' floodgates in order to produce energy, or by pumping water from the downstream basin to the upstream basin in order to store surplus energy," explains Guillaume Balarac, professor at Grenoble INP - Ense3, UGA, researcher at the LEGI and holder of the Chair. "*This demand for flexibility imposes operating speeds on the turbines for which they were not originally designed. To allow them to operate over a wider rev range, their design must be reviewed so as to adapt them to the turbulence generated by these new speeds.*"

But in order to do that, you have to be able to simulate this turbulence - and that's where the LEGI researchers come in. "*The rotational speeds at which the turbines now have to operate are a lot more unstable than the rated speeds, and the simulation strategies conventionally used are incapable of predicting them,*" the researcher explains. "*That is why we have developed more advanced turbulence simulation strategies that are capable of anticipating hydrodynamic instability. As we do not have the necessary computing power to predict turbulence of all levels, we are compromising by seeking to accurately simulate only the most influential eddies.*"

This project is part of the national YALES2 project, coordinated by the CNRS, which helped to simulate the transport of SARS-Cov 2 in the air a few months ago. YALES2 will be implemented in its 'hydro' form at General Electric to help the engineers design more robust turbines. At the same time, the researchers at the LEGI will further develop the code in order to make the computing time compatible with industrial requirements. The NETHUNS Chair has received a total of 1 million euros in funding.

**CNRS, Grenoble INP - UGA, UGA, Ministry of Higher Education and Research*
***French National Research Agency*
Photo credits: Illustration of turbulent structures in an instantaneous simulation of a Francis turbine wheel: ***F. Doussot, LEGI, 2019.***
Illustration of turbulent structures in an instantaneous simulation of an entire Turbine-Pump: ***G. Balarac, LEGI, 2021.***

Monitoring machine operations 24/7 with ASTRIIS

28 Sept. 2021

An offshoot of GIPSA-lab*, ASTRIIS has created a tool for automatic, continuous monitoring of gears and other rotating machinery. Testing of an initial prototype on a wind turbine has met with success.

Anticipating issues rather than correcting them, to save time and money - this could be the slogan for ASTRIIS, the start-up from GIPSA-lab currently in the SATT Linksium incubator. "*Everything that rotates, moves or vibrates emits vibration signals that can be recorded and analysed in real time,*" explains Nadine Martin, CNRS research director at the laboratory.

Drawing on 30 years of research in analysing signals with applications in preventive maintenance, she has combined her results in one piece of software, AStrion. It's a program for automatic signal processing, capable of detecting all frequencies representing the condition of different parts for each kind of signal. "*This kind of autonomous super scanner has been designed to assist with maintenance operations for machines,*" specifies the researcher. "*By tracking changes over time for indicators associated with an individual frequency or a physically relevant group of frequencies, the software can identify any abnormal signal changes thanks to learning algorithms based only on the data base being monitored.*" The software can monitor each part of a system remotely and analyse large data bases. The intuitive interface means that the analysis can be understood by operators and facilitates the work of experts by allowing them to access all results in detail.

Demonstrated by proof of concept in the wind sector, AStrion is ready for deployment on industrial machinery to test its performance in real conditions.

**CNRS, Grenoble INP – UGA, UGA*

IMEP-LAHC
launches a joint laboratory with the industrialist LYNRED

05 Oct. 2021

A joint laboratory between the French infrared sensor specialist LYNRED and IMEP-LAHC* has just been created for a period of five years.

To better understand the physics of cooled infrared sensor components, LYNRED, a world-class French player in this field, has joined forces with the IMEP-LAHC* laboratory. After two years of discussions, the project has taken shape with the recent creation of a joint laboratory between the partners for a period of five years. "*This is the first joint laboratory that we have created with an industrial company,*" says Quentin Rafhay, a lecturer at Grenoble INP - Phelma and a researcher at IMEP-LaHC, who has taken up the management of the new entity. "*We are also the first academic partner with which LYNRED has signed such a contract. We knew them because we had already conducted two theses with them.*"

In concrete terms, the laboratory will use its experience in the electrical characterisation of components to better understand what is happening at the physical level. To do this, the scientists will use advanced characterisation methods (DLTS**, low frequency noise, etc.), the development of new characterisation methods and modelling. "*The electrical characterisation of components, such as photodiodes, will enable a precise diagnosis of their operation and knowledge-based action to improve their performance.*"

The main markets for the infrared sensors developed by LYNRED are aerospace, defence, industrial and the general public. Currently, the cooled infrared sensors must be lowered in temperature by an integrated cryostat in order to be operational. "*If we could better understand the mechanisms at play in these components and thus increase their operating temperature, we could reduce the size, weight and power consumption of the entire system,*" says Laurent Rubaldo, a senior expert and head of the joint laboratory at LYNRED.
While waiting to reach the Holy Grail of the cooled infrared industry, this joint laboratory is a great recognition of IMEP-LAHC's skills, and a new way of collaborating with industry.

**CNRS, UGA, Grenoble INP – UGA, Savoie Mont-Blanc University*
**Deep-level transient spectroscopy*

Etienne Gheeraert
awarded the Etoile de l'Europe prize

02 Dec. 2021

Crédits photos: © Musée dauphinois – Isere Department

Etienne Gheeraert, researcher at the Néel Institute and teacher at Polytech Grenoble – INP, UGA was presented with the Etoile de l'Europe prize by Frédérique Vidal, Minister for Higher Education, Research and Innovation, on 2 December 2021, for the European project, GreenDiamond.

While silicon still largely dominates the semiconductor market, carbon could soon create a place for itself with graphene, carbon nanowires and... diamond!

Funded by the EU and coordinated by the French National Centre for Scientific Research (CNRS), the aim of the GreenDiamond project was to develop a diamond-based converter to transport the electricity produced by offshore wind farms. The latter use two high-voltage converters which traditionally contain silicon-based electronic devices. Although an inexpensive material, silicon's ability to conduct high-voltage electricity remains mediocre, and leads to significant losses during transfer. Diamond, in comparison, presents numerous advantages. *"For an equivalent thickness, diamond withstands a voltage which is around 30 times higher than silicon"*, Etienne Gheeraert, researcher at the Néel Institute and teacher at Polytech Grenoble – INP UGA, explains. *"At a constant voltage, therefore, the diamond component can be 30 times finer than a silicon component. This refinement also increases its conductivity and further reduces losses."*

In small power converters, such as those used in telephones, losses exist but are not critical. In larger converters, however, alternatives to silicon are being explored. Such is the case of GaN for low-voltage consumer use, and SiC, which is gaining ground in upmarket hybrid vehicles and certain industrial converters. Diamond will represent a competitive alternative for high-power applications, such as the transfer of electrical energy produced by offshore wind farms.

ELECTRONICS / DIGITAL / ROBOTICS

Diamonds are surprisingly affordable

Contrary to what one might think, diamonds can be produced industrially at affordable costs. The technique for producing diamonds by chemical vapour deposition has been around since the 1970s. This industrial process was picked up on by jewellers a few years ago.

For the purposes of the project, researchers used diamond wafers, on which they placed layers of diamonds with appropriate electronic properties. This work led to the creation, in 2019, of Diamfab, a start-up hosted by the Néel Institute, whose core activity is to supply ready-to-use diamond panels for clean rooms in the silicon sector.

From this starting point, the various bricks of a power converter were produced. Initial assessments suggest that the resulting diamond-based supply devices are four times more effective than standard silicon converters, leading to a potential 75% reduction in electricity losses. *"All high-voltage electrical systems can save energy by using diamond devices,"* Etienne Gheeraert points out. *"Applications might include long-distance power lines, aeronautics and industrial converters, or even hydrogen production, which requires a large amount of electrical power."*

The aim at present is to spark the interest of industrial companies, as diamonds are still synonymous with luxury and expensive prices. Yet the diamond market, which is currently conditioned by the prices jewellers are willing to pay, could be shaken up by the upcoming separation of diamond markets for industry and for jewellery. *"This separation will automatically lower the cost of diamonds for industry, thus offering great prospects for their use as semi-conductors."*

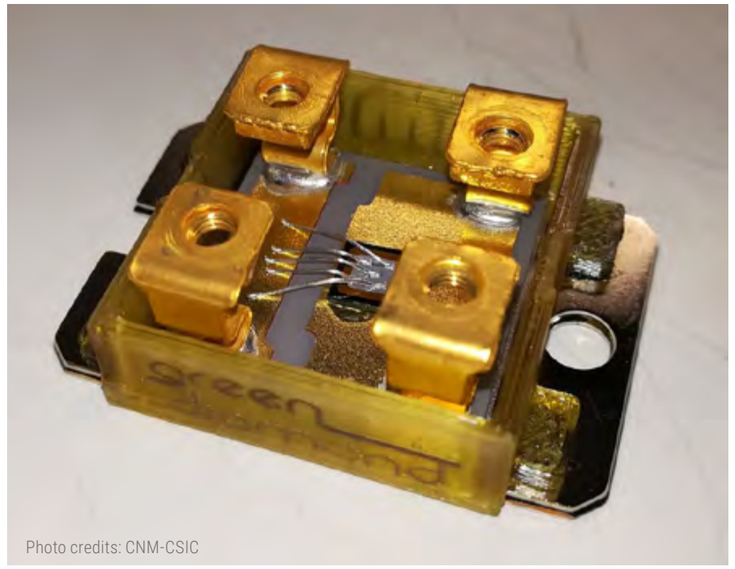


Photo credits: CNM-CSIC

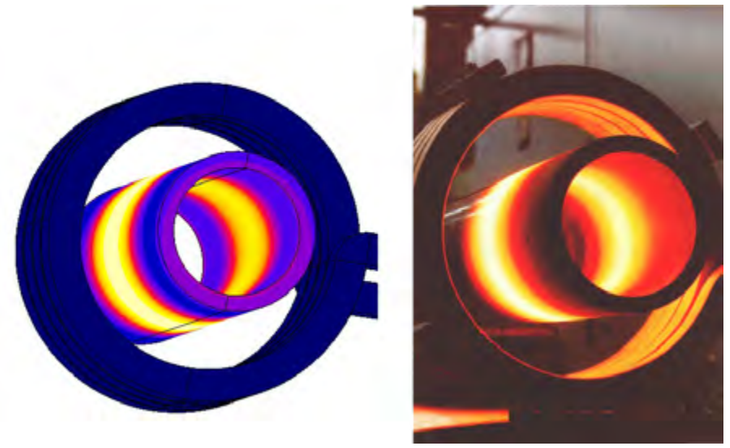
Grenoble-born software Flux celebrates its 40th birthday

11 Jan. 2022

The joint laboratory between Altair Engineering and G2Elab was created in 2017 and is working on developing the Flux software suite. It has been used in industry to simulate electromagnetic fields and help design all kinds of electrical machines.

In late November 2021, the CNRS organised a communication event based around its joint laboratories, at Palais Brogniart in Paris. Minister for Higher Education, Research & Innovation Frédérique Vidal cited the exemplary success of the Flux software suite, a result of the work of G2Elab (CNRS, Grenoble INP – UGA, UGA). 40 years ago, this software entered the industrial world, and it is now marketed by Altair Engineering, an international leader in engineering simulators with a joint laboratory with G2Elab.

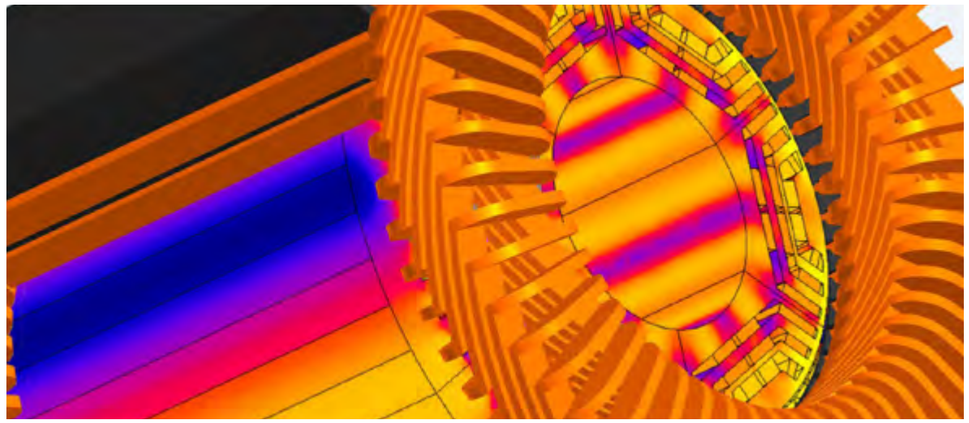
With 2,000 users across 750 industrial sites, Flux is currently the third biggest program in the world for simulating low-frequency electromagnetic fields. Engineers use it to simulate electromagnetic fields produced by all kinds of electrical devices. "*Electrical machines convert electric energy into mechanical energy,*" explains Olivier Chadebec, CNRS researcher at G2Elab. "*This conversion relies on a kind of intermediate energy, electromagnetic energy, which is important to quantify in order to evaluate the performance of the machine. The simulation software makes it possible to construct a digital copy of the machine and calculate the low-frequency electromagnetic fields that it generates, without having to actually build it. This makes it possible to make as many adjustments to the parameters as needed, before making the machine in real life.*"



Simulation of the induction heating process. Altair Flux™ ©1983-2021, held by Altair Engineering Inc

This kind of software is useful for everything related to converting electrical energy - particularly in the transport sector (planes, trains, cars, etc.) but also for all kinds of sensors and actuators, power plant generators, etc. The market is very rich!

ELECTRONICS / DIGITAL / ROBOTICS

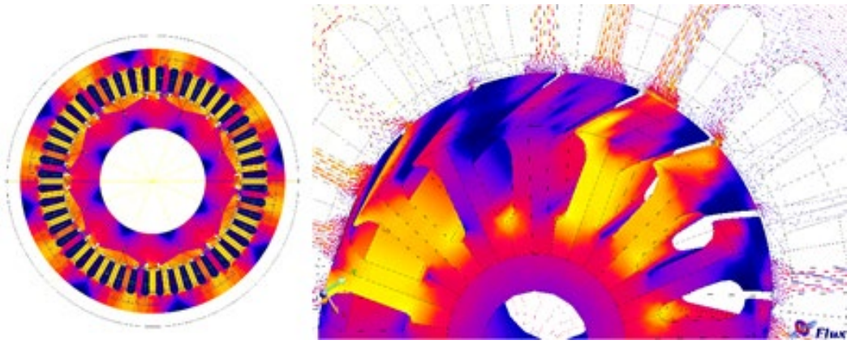


Altair Flux™ ©1983-2021, held by Altair Engineering Inc

Software in perpetual evolution

Far from resting on its laurels, the Flux software (which uses finite element method) is constantly the subject of multiple theses at the laboratory. The devices to be simulated are increasingly complex and use increasingly elaborate materials. Furthermore, it is important to be able to obtain ever-more precise and fast results (high-performance calculation). In recent years, innovations have notably made it possible to optimise 3D calculations, to speed things up while maintaining optimal precision. "*Currently, at the laboratory, we are working on models for magnetic materials, which are especially hard to model,*" indicates Olivier Chadebec. "*We are also optimising topologies, to guide engineers in creating new, more adapted kinds of motors. Lastly, we are working on original modelling methods, such as the integral equation method, and performing parallel calculations.*"

The collaboration between Altair Engineering and G2Elab has also given rise to the program FluxMotor, which is used to build electrical machines as well, but functions more simply than Flux.



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ELECTRONICS / DIGITAL / ROBOTICS

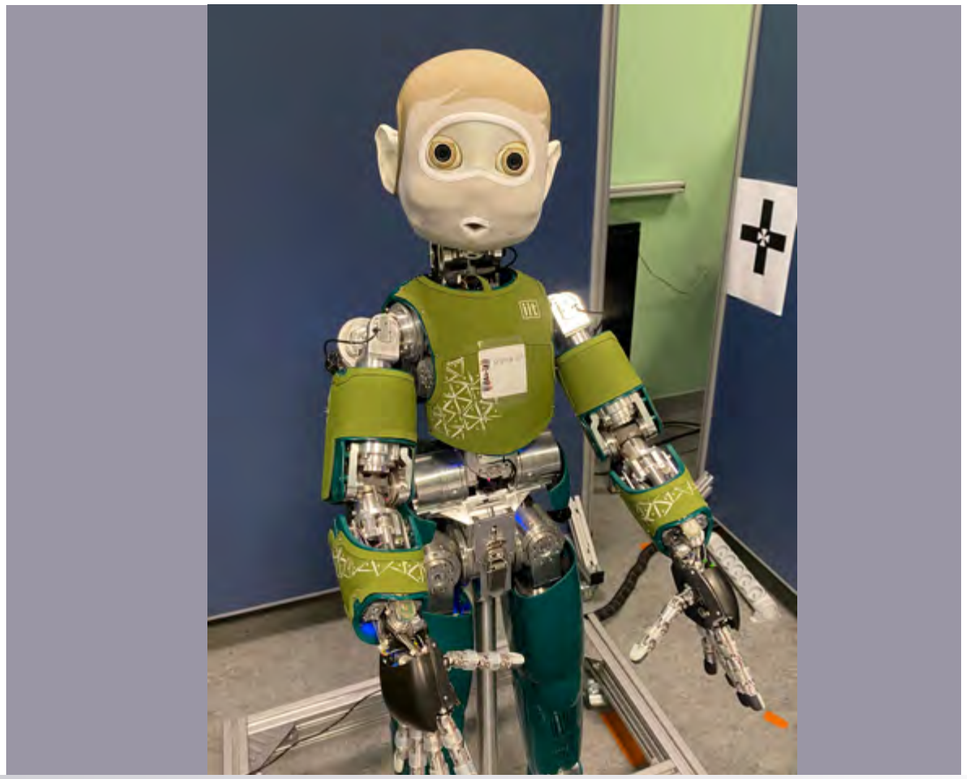
Robotics: Pooling for greater efficiency

02 March 2022

Under the latest calls for project proposals from the Investments for the Future Programme, a budget of €12 million has been allocated to the French robotics community for the purchase of targeted equipment. Led by Nicolas Marchand, CNRS researcher at the GIPSA-Lab* and teacher at Grenoble INP - UGA, the TIRREX project was officially launched in December 2021 for an 8-year period, and has just obtained National Research Infrastructure certification from the Ministry for Higher Education, Research and Innovation.

There is strength in unity. This is especially the case for multidisciplinary sciences like robotics - the ultimate complex science which requires the pooling of both knowledge and equipment. With that in mind, the TIRREX project (Technological Infrastructure for Robotics Research of Excellence) intends to finance the development of new, easily accessible sharing platforms.

Coordinated by the GIPSA-Lab, this project brings together 18 national partners who will share the development of platforms and basic technological building blocks, which will then be made available to the whole community.



The national platforms are structured around 6 key areas:

- **XXL robotics** - a relatively new field of research which focuses on very large robots, particularly for3D printing buildings, and includes exploring the issues surrounding the flexing of the arms.
- **Humanoid robotics** and interaction, which studies the problems relating to the locomotion of a humanoid robot and its interaction with humans. For the first time, the whole community will share a single robot, thereby concentrating all the developments carried out across the whole of France.
- **Aerial robotics**, one of the two platforms of which is in Grenoble and offers an outdoor testing ground, combining navigation in the forest and in the natural environment. The GIPSA-Lab is also working on the piloting of drone fleets which requires compliance with strict standards and a sufficient number of authorised pilots. Moreover, the drones will become generic, which will further simplify the procedures for requesting administrative authorisation.
- **Land-based mobile robotics**, which focuses on vehicle development and the development of autonomous agricultural vehicles.
- **Medical robotics**, in which Grenoble's TIMC** laboratory plays an important role. The equipment in this sector is designed to provide realistic data for an adaptive design and control, especially in the presence of soft tissue.
- **Micro and nano robotics**, which aim to develop automated methods for the manipulation and characterisation of objects smaller than 10 microns, including biological cells. One of the potential applications of this area concerns cell therapy.

All of these areas will also be supplemented by a prototyping and design area focused on the use of advanced means of mechanical execution, a manipulation area (which constitutes a general problem in robotics), and an open infrastructure area. The latter proposes the pooling of access methods to the platforms and the sharing of data delegated to GRICAD***. In time, the development of digital twins of the various platforms will allow for virtual fine-tuning of the experimentation phases.

** CNRS, Grenoble INP – UGA, UGA*
***CNRS, Grenoble INP – UGA, UGA, VetAgro Sup*
****Grenoble Alps Research - Scientific Computing and Data Infrastructure*

Thingsat is ready to take off

18 June 2021

Barely a year after Amicalsat, the CSUG is preparing to launch a second device into orbit aboard the Stork nanosatellite.

After the successful launch of Amicalsat in September 2020, the CSUG is preparing to launch another object into space. In June this year, a communication device for the Internet of Things developed in Grenoble will be launched aboard a Space X rocket from Cape Canaveral. "*Instead of making a satellite for this project, we bought a place on the Stork nanosatellite, developed by Polish company SatRevolution, which will transport several other devices besides our own,*" explains Mathieu Barthélémy, Director of CSUG. "*This offers the advantage of being much less expensive than if we had developed a full nanosatellite*". The device, which will be launched in late June, is a radio communication module based on a low-speed and low-power wireless communication protocol developed in Grenoble (LoRa by Semtech). Its total volume is 300cm^3 including its aerial. The device, called Thingsat, provides communication with isolated objects on Earth's surface such as buoys at sea fitted with sensors to measure water level or temperature. "*The solution offered by Thingsat involves a device that receives information when the satellite passes over the buoy and then transmits the collected data when it passes over the research centre concerned*".

The CSUG developed the electronic module and ensured it was compatible with the conditions encountered in space in collaboration with LIG**, l'IMEP-LAHC***, Institut Paul Emile Victor and Université de Polynésie. Several industrialists have joined the project, including Air Liquide which is interested in Thingsat for recording the positions and pressure levels in gas containers on ships at sea.

The project in the midst of the health crisis

The project was carried out entirely remotely and involves several students and staff from Grenoble INP. Despite the restrictions due to the health crisis, it was completed on schedule in the space of 18 months: the flight model was delivered and the device was subjected to vibration testing before being integrated into the nanosatellite, which will be sent to the launcher in the coming days. To start with, tests will be carried out to check the functionality of the device before concrete collaborations with industrialists are set up.

Other projects are already in the pipeline. In 2022, the QlevEr Sat nanosatellite, developed thanks to the support of Teledyne e2v, will allow deforestation to be monitored thanks to an imaging device and on-board image processing system using artificial intelligence. In 2023, ATISE will be launched into orbit with a spectrometer for studying aurora borealis.

Project partners:
Academic: CSUG, LIG, IMEP-LAHC, IPEV, Université de Polynésie
Industrial: Air Liquide, SpaceAble

**Grenoble INP – UGA, UGA ; **CNRS, Grenoble INP – UGA, UGA, Inria ;*
****CNRS, Grenoble INP - UGA, UGA, université Savoie Mont Blanc*

Graduate Schools of Engineering & Management

8 schools at Grenoble and Valence

Energy and Environment • Geomaterials and Civil Engineering • Biosourced Materials and Processes • Micro Nanotechnologies Digital & Usage • Production, Management & Organization

8 schools of engineering and management
Grenoble IAE - INP, UGA
Grenoble INP - Ense³, UGA
Grenoble INP - Ensimag, UGA
Grenoble INP - Esisar, UGA
Grenoble INP - Génie industriel, UGA
Grenoble INP - Pagora, UGA
Grenoble INP - Phelma, UGA
Polytech Grenoble - INP, UGA

2 préparatory classes
La Prépa des INP (Grenoble and Valence)
PeiP (réseau Polytech)

1 partner school:
SeaTech

1 lifelong training department

Member of Groupe INP
+35 engineering schools

8 500 students

70 000 graduates since the creation of the institute

39 laboratories
which 8 international

21 Technology Platforms et Fablabs

360 preferred partner companies
including about 90 directly involved in governance
Grenoble INP - UGA

24 industrial chairs

1 foundation

1 valuation subsidiary

Vice - president Research : **Valerie Perrier**
Vice - President Enterprise and Development : **Gaëlle Calvary**

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www.grenoble - inp.fr/en

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