Institut Mines-Télécom launches the "Digital Twins for Industrial Systems" Research Chair

The chair's R&D work will cover digital twins from end to end – design, development and maintenance – in a comprehensive approach to production systems and logistics.

> Develop digital twins that are interoperable, data-driven and suitable for use
> Build quick, holistic decision-making models
> Combine artificial intelligence and digital twins

Institut Mines-Télécom (IMT) **is launching the "Digital Twins for Industrial Systems" chair to support industries in their upcoming revolution and increase their competitiveness by focusing on engineering and overcoming technological barriers. The chair aims to design, develop, operate and maintain a digital twin. The world-class research will be tested and applied by the chair's industrial sponsors: Siemens Digital Industries Software, Pierre Fabre and Inoprod. This IMT patronage chair is shared by Mines Saint-Etienne, IMT Mines Albi and IMT Mines Alès, with the support of the Fondation Mines-Télécom.**

Model, analyze and predict system dynamics

Manufacturers have to make quick, complex decisions to optimize logistics flows, reduce activities' carbon footprint, reorganize production, implement new operating and maintenance

strategies, and more. In this context, the digital twin models the real world, using performance indicators to inform decisions. The chair's experts want to increase digital twins' capabilities. Their R&D work will focus on providing a complete view of the systems involved, rather than just component assets, for example. The different models must be able to be assembled to create a simulation of the entire system and interact with it. Different levels will be able to interact and combine, whether digital models, digital shadows or digital twins.

Sponsors and scientific teams are looking to develop digital twins that deal with the dynamics of a production system (for goods or services) and, more generally, the logistics system that accompanies it. In this case, the work will take a step forward by looking at inter-company and intra-company flows to incorporate all of an organization's issues and flows.

This process occurs in time and space and takes into account all critical resources and their contingencies (machines, component life cycles, human resources, energy, data, materials, etc.) and the related value chains, from supplier to customer. Digital twins must therefore be able to be updated in light of data from the field and be readable by all those involved. The chair's teams will also identify and evaluate the main performance indicators for a given production and logistics system.

Digital twins' interoperability

Employees of corporate sponsors Siemens Digital Industries Software, Pierre Fabre and Inoprod alongside teaching and research teams from Mines Saint-Etienne, IMT Mines Albi and IMT Mines Alès will tackle real-life problems. As part of this chair, digital twins are built based on an organized and structured set of digital representations (models and data) that can be updated according to specific time constraints, representing an existing or future complex system (product/service, process, organization). The aim is to meet specific needs such as functional analysis, reconfiguration, maintenance, operational decision making, operator training, dismantling, etc. Digital twins must be agile and adapt to users' needs.

Three thesis topics will be pursued to overcome technological and structural obstacles at Mines Saint-Etienne, IMT Mines Albi and IMT Mines Alès. The work will be tested and optimized with the support of the chair's three major sponsors, who will support experiments in the field.

Mines Saint-Etienne: Create global predictive models that take into account energy and environmental aspects

Today, there are many solutions for long- and medium-term strategic and tactical factory decision making (overall factory sizes, locations, internal and external logistics, etc.) based on detailed models, which are lengthy and complex to build due to the large number of inputs, management rules, etc. These digital twin models are generally based on flow simulation techniques and only cover aspects linked to the production systems themselves. Therefore, they don't offer a global predictive view of energy consumption and CO_2 emissions - which are priority issues for all industrial groups today.

IMT Mines Alès: engineering and maintenance of digital twins

A digital twin of an industrial system is not just a fully standardized digital representation, which has become commonplace and easy to use in manufacturing today. It must be both sufficiently faithful to reproduce how the system being studied actually behaves compared to its intended use case (the aim being realism, to improve future user confidence), and easy to design and maintain over time (the aim being simplicity of design, development and evolution, which is deemed to be difficult and costly). It must also be coherent and easily connect with other digital twins of the same system, responding to other points of view and use cases. For example, a decision about maintenance can influence steering and, therefore, the interaction between the

two digital twins. The aim in this thesis is to develop an approach that will provide a set of interoperable digital twins that can be maintained over time and adapted to different use cases (process, intra- or inter-company organization, data).

IMT Mines Albi: coupling digital twins with artificial intelligence tools

While digital twins can help identify malfunctions and evaluate different scenarios, they do have limitations. The VUCA (Volatile, Uncertain, Complex, Ambiguous) reality to which production systems and supply chains are subjected complicates most of the simulation models that underlie digital twins, sometimes making them impossible to implement (too much data or too many parameters) and/or to use (long calculation times given the replications required and/or decisions to be made). The thesis's ambition is therefore to consider fast, generic techniques for coupling simulation models with complementary, AI-based decision support modules.

Frédéric Grimaud, Associate professor at Mines Saint-Etienne and holder of the "Digital Twins for Industrial System" chair: "*Digital twins are shaking up manufacturers' operational and organizational models. Our sponsors, Siemens* Digital Industries Software*, Pierre Fabre Group and Inoprod offer us crucial experience from the field, and we want to speed up this revolution by endowing digital twins with a more comprehensive dimension that will turn them into a decision-making tool. Changing demand, tensions in procurement chains, energy crises: risks are multiplying, and companies need to be able to anticipate and model them with new tools that must be easy to handle. To meet our users' different needs, our work will respect the three "S" rule: Simplicity of design, Simplicity of maintenance, and Simplicity of use.*"

Guillaume Cordonatto, Digital Enterprise Technical Fellow at Siemens Digital Industries Software: "*I'm delighted to be launching this industrial chair with the prestigious Institut Mines-Télécom and our partners Pierre Fabre Group and Inoprod. I'm convinced that this will accelerate our ability to meet the challenges faced by our customers and those encountered in our own Siemens plants. The three research topics go to the heart of the digital twin's value streams, both to make it accessible to all the roles in a plant and to broaden the scope of application to cover aspects related to energy and sustainability.*
Siemens is in a unique position as a provider of digital solutions and as a manufacturing group with hundreds of production sites. We can't wait to contribute our experience and real-life use cases so that these research projects can quickly lead to tangible results."

Pascal Dubuis, Founder and Chairman of Inoprod: "*I'm very proud to be able to take part in this research chair on digital twins for industrial systems, alongside Institut Mines-Télécom*

and our partners Pierre Fabre Group and Siemens Digital Industries Software. Digital twins for industrial systems are part of Inoprod's DNA, and the lines of research proposed in these first three theses are pillars for deployment in all our industries. Today, these industries are faced with new challenges – to their resilience, environmental impact or even simply their human resources – that could find answers and ways to anticipate them thanks to digital twins. This chair should be a keystone in the response to the needs of our small, medium and large manufacturing groups. The partners' complementarity and respective experience will guarantee the research work's success. This contribution to the research chair is a testament to our commitment to innovation and working together across disciplines. By combining our skills with those of these prestigious partners, we can shape the industry's future and play a decisive role in the development of revolutionary technologies."

Vincent Huraux, Director of Laboratory Operations, Pierre Fabre Group: "*For many years, we have built very strong ties with Les Mines engineer school, and we are thrilled to be patrons of such an innovative project as the Digital Twins chair, alongside our partners Inoprod and Siemens Digital Industries Software. This project is part of the evolution of our French industrial base, where digital technology, data and artificial intelligence work together to become more agile and efficient. 90 % of Pierre Fabre Laboratories' production is carried out in France at six sites, including five in the Occitanie region, and 100% of medical research takes place in France. Our mission is to take care of our patients and consumers. Using digital twins combined with AI is an essential part of our mission while helping us to anticipate future challenges.*"

The chair was created with the support of Fondation Mines-Telecom for a duration of three years.

A video presentation in French is available:
https://www.youtube.com/playlist?list=PLnCDDu6cujOxp3_gbq20BbjHes8VxuzpR

About Institut Mines-Télécom - http://www.imt.fr/en

Institut Mines-Telecom is the leading public group of French engineering and management schools to be placed under the supervisory authority of the Ministry of the Economy, Finances and Industrial and Digital Sovereignty. It is a public research and higher education institution made up of eight public graduate schools: IMT Atlantique, IMT Mines Albi, IMT Mines Alès, IMT Nord Europe, Institut Mines-Telecom Business School, Mines Saint-Étienne, Telecom Paris and Telecom SudParis as well as two subsidiary schools: EURECOM and InSIC. It leads and develops a rich ecosystem of partner schools and economic, academic and institutional partners and players in training, research and economic development. Created to meet France's needs in economic and industrial development since the 19th century, Institut MinesTelecom's graduate schools have supported all the communications and industrial revolutions. Through its research and its training of engineers, managers and PhD students, Institut Mines-Telecom tackles the major industrial, digital, energy and environmental challenges in France, Europe and around the world. Today, Institut Mines-Telecom and its 10 schools are imagining and building

a world that combines science, technology and economic development with a respect for the planet and the people who live on it. It is double Carnot certified and trains 13,600 students every year.

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About Fondation Mines-Telecom – www.fondation-mines-telecom.org

The Fondation Mines-Telecom, a foundation recognized as being of public interest, supports the development of IMT and its eight graduate schools in their training, research and innovation missions. It boasts over 280 corporate sponsors and 4,200 individual donors who are committed to supporting substantial projects with a strong technological, industrial and societal impact, based on digital technology, energy and the industry of the future, as well as charitable initiatives for students. Thanks to the support of companies, including its founding partners (BNP Paribas and Orange), graduates and parents, the Fondation Mines-Telecom finances a dozen programs in training (scholarships, promoting women in engineering professions, open-innovation program for students, MOOCs), research (theses, awards of excellence, the Franco-German Academy and teaching-research chairs), innovation (interest-free loans for start-ups and support for incubation) and forward studies (intelligence and monitoring reports), as well as initiatives to develop IMT graduate schools (grants, social openness, state-of-the-art equipment, support for international mobility).

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