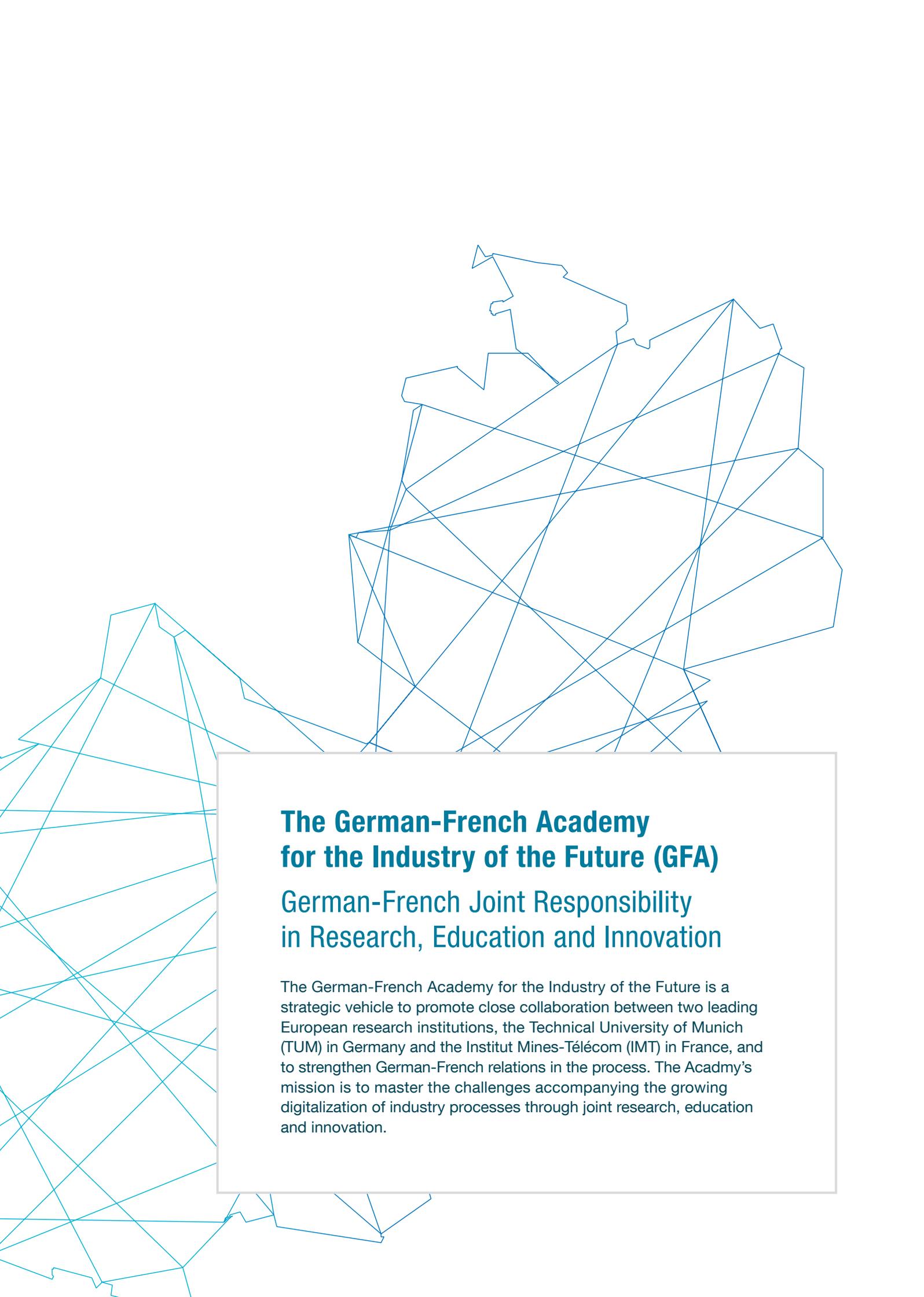




The Transnational Network

for Linking Research, Education,
Industry and Innovation in Industry 4.0



The German-French Academy for the Industry of the Future (GFA)

German-French Joint Responsibility in Research, Education and Innovation

The German-French Academy for the Industry of the Future is a strategic vehicle to promote close collaboration between two leading European research institutions, the Technical University of Munich (TUM) in Germany and the Institut Mines-Télécom (IMT) in France, and to strengthen German-French relations in the process. The Academy's mission is to master the challenges accompanying the growing digitalization of industry processes through joint research, education and innovation.

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EDITORIALS



At this very moment in time, we are experiencing technological leap-frog developments with unprecedented consequences for Europe's economic and innovative strength as well as for our society as a whole. Research and teaching are called upon to break down limiting silos of thought and create new foundations. Not only do we have to bring together knowledge, tools and methods from different disciplines – it is the transnational bridges that are more important than ever. In times of geopolitical shifts, Europe will only be able to remain competitive in an active community with strategic alliances between trusting partners.

This collaborative partnership is the foundation of the “German-French Academy for the Industry of the Future”, established in 2016 by the Institut Mines-Télécom and TUM. Our priority fields are set correctly: artificial intelligence, cyber-physical systems, secure inter-machine communication

and hybrid blockchain architectures in Industry 4.0, as well as additive manufacturing and new approaches to a more sustainable circular economy.

With more than 150 researchers, the Academy carries out joint research projects and promotes cooperation between German-French research institutions and industrial companies. In this way, the Academy makes a decisive contribution to increasing Europe's technological sovereignty. Rather than unilateral action, we believe in strategic collaboration and coordinated teamwork as the basis for future technological innovations.

The foundation of the German-French Academy for the Industry of the Future embodies precisely this collaborative culture of thinking and working: moving forward together with an inquisitive spirit and bundled strength – in order to set decisive innovation impulses and improve the lives of people in France, Germany and around the globe.

I wish all those involved in this partnership a successful and fruitful collaboration.
Yours,



Thomas F. Hofmann, President of TUM

The German-French Academy for the Industry of the Future was born in 2015 out of the strong conviction that encouraging the linking of our complementary skills in research and innovation was necessary for the future of both our industries and societies.

Since then, a global pandemic and new challenges facing industry have only confirmed the pressing need for an increased collaboration between France and Germany to constantly adapt and grow. One thing is for certain: there will be no prosperity without a solid German-French partnership, and without voluntarily directing public research towards strategic technological topics and industrial value chains.

The German-French Academy for the Industry of the Future, founded and piloted by Institut Mines-Télécom and TUM, connects more than 150 researchers and 30 industrial partners both in France and in Germany. This comprehensive community of experts focuses on solving the challenges related to industry's digitalization and its ecological transition. The Academy now acts as a booster to fostering the definition of shared priorities and solutions to ensure tomorrow's European industrial sovereignty. For the last three years, we have been expanding our portfolio of education activities to raise the level of



skills and know-how of more than 1,200 professionals facing the transformation to Industry 4.0. Finally, this joint Academy is also about successfully crafting an innovative and efficient model of international collaboration between academics and industry.

The German-French Academy for the Industry of the Future embodies how far our partnership can go and how much success we can achieve to contribute to the development of a favorable German-French ecosystem that strengthens Europe's technological and digital sovereignty.

A handwritten signature in black ink, appearing to read 'Odile Gauthier'.

Odile Gauthier, Executive President of Institut Mines-Télécom



The German-French Academy for the Industry of the Future is a lighthouse project of cross-border technology collaboration with France.

It gives us particular pleasure to know that the German pillar of the Academy is the Technical University of Munich, which ranks among the 50 best universities worldwide.

The Academy underscores the strong collaborative ties between Bavaria and France in high-tech and innovation. Because one thing is clear: to survive in global competition, Europe must take a leading role in key technologies of the future. To this end, the innovation centers in Europe must cooperate even more closely in the future.

This is where Bavaria and France are ideal cooperation partners. France is a top location in Europe for artificial intelligence and digitalization, and also leads in many classic industrial sectors such as automotive and aerospace.

Bavaria, in turn, is Germany's leading innovation driver, and already launched its High-Tech Agenda back in 2019, an unmatched technology initiative in Germany. With 3.5 billion euros in total, 1,000 new professorships and 13,000 new university places for students, Bavaria is further expanding its frontrunner position in research in Europe and promoting the development of cutting-edge technologies.

Here, again, it is clear that only by working together can we succeed in the global competition for the brightest minds and best technologies. That is why President Macron and I have agreed on a Bavarian-French "Ten Point Agenda" to jointly drive forward future topics and innovation. Strengthening and expanding the German-French Academy for the Industry of the Future plays a key role in this process.

I wish the Academy all the best in continuing its successful work.

Bavarian Minister-President Dr. Markus Söder



M. Bruno Le Maire, French Minister for the Economy, Finances and Recovery, at the launch of the partnership of the German-French Academy for the Industry of the Future with the companies Airbus and ArianeGroup (June 10, 2021 in Bercy, France)

Accelerating the digital and ecological transformation of our industries, improving our capacity for innovation and supporting research are challenges that we must take up.

This means identifying strategic value chains that will create jobs, ensure our sovereignty and finance research and innovation in these areas.

Strengthening cooperation, supporting research, combining our public and private skills to create a more competitive industry is exactly what we must do, as the

German-French Academy for the Industry of the Future is already doing.

I welcome the research projects already under development thanks to the action of your Academy supported by the excellent Technical University of Munich and the Institut Mines-Télécom.

M. Bruno Le Maire, French Minister for the Economy, Finances and Recovery

ABOUT THE ACADEMY

STEERING COMMITTEE



Françoise Preteux
Vice-President for
Research & Economic
Development at IMT



Olivier Boissier
Director of Institut
Henri Fayol at Mines
Saint-Etienne



David Gesbert
Head of Communica-
tion System Depart-
ment at Eurecom



Marc-Oliver Pahl
Chair of
Cybersecurity for
Critical Networked
Infrastructures
(cyberCNI.fr) at
IMT Atlantique



Gerhard Kramer
Senior Vice President
for Research and
Innovation at TUM



Katrin Wudy
Professor for Laser-
based Additive
Manufacturing at TUM



Georg Carle
Chair of Network
Architectures and
Services at TUM



Axel Honsdorf
Director of BayFrance



Hervé Martin
Science and Higher
Education Attaché,
Embassy of France
in Germany

PROJECT MANAGEMENT TEAM

Paul-Guilhem Meunier

Project Manager of the GFA at IMT

For more than ten years, Paul-Guilhem Meunier has been promoting the symbiosis of projects and ambitions of researchers, start-ups and industrialists on an international level. Now in charge of the German-French Academy for the Industry of the Future, within Institut Mines-Télécom (IMT), he encourages cross-fertilization of innovation for the economic development of our two countries.

“ I believe in the meeting between academic and industrial experts from our two countries and in the complementarity of our knowledge and expertise in order to support and develop research of excellence for the benefit of our technological sovereignty. ”



Olivia Pahl

Coordinator for the Education of the GFA at IMT

Olivia Pahl worked for several years in the field of science marketing, being the head of the communications department at the institute for societal development (FGW) in Düsseldorf, Germany. After moving to France, she is now in charge of the educational strategy and projects of the GFA.

“ I'm proud to be part of the ecosystem of the GFA that is fostering the intercultural relations between France and Germany, as well as pushing research and education with highly relevant topics. It is my strong motivation to help society shape its future, which is becoming more digital every day. I am happy to work together with a great team that is shaping our future. ”

Cosima Stocker

Head of Industry Relations of the GFA at TUM

A manufacturing engineer with a German-French double degree, Cosima Stocker worked for six years as a researcher at the TUM Institute for Machine Tools and Industrial Management. Being part of the GFA's team at TUM as Head of Industry Relations, she is now responsible for strengthening and expanding the German-French science and industry network of the GFA.

“ I have always been fascinated by the European idea, which manifests itself especially in the German-French partnership. I am proud to actively contribute to this as part of the GFA. The collaboration with my French colleagues inspires me every day to think outside the box on the path towards the Industry of the Future. ”



Marc-Oliver Pahl

Educational Advisor of the GFA

Prof. Dr. Marc-Oliver Pahl heads the Chair of Cybersecurity for Critical Networked Infrastructures (cyberCNI.fr) at IMT Atlantique in Rennes, France. He is an adjunct professor at Carleton University in Canada. Marc-Oliver's research focus is on a holistic approach to cybersecurity. He is an experienced teacher and an eLearning pioneer, holding several teaching awards.

“ I see intercultural work as a strong enrichment of my life. It is one of my motivations for working in academia. I like the goals of GFA and education. Therefore, I want to contribute to their achievement. In addition, the GFA has a wonderful team, which makes the collaboration a pleasure. ”

OUR VISION, OUR MISSION AND OUR GOALS

In line with the TUM mission statement of a global knowledge exchange and IMT's aim to train the key stakeholders of a sustainable future, the vision of the GFA is German-French excellence and joint responsibility in research, education and innovation for the Industry of the Future.

Our strategic goals are

- To expand our academic, scientific and industrial network in France and Germany, initiating new partnerships dedicated to mastering the challenges for the Industry of the Future.
- To diversify our thematic portfolio through interdisciplinary projects involving societal and socio-technical issues, answering urgent questions on sustainability, resilience, digital and technological sovereignty and digital governance.
- To increase the visibility of the GFA as an essential strategic lever in the European ecosystem.
- To support European technology sovereignty by crafting disruptive technological solutions and improving the competitiveness of industry.

Key facts

The GFA's strategic objective is to strengthen the competitiveness of French and German industries. Its success is due to the fact that it improves the competitiveness of the entire ecosystem. Since its creation, one euro invested in the project by the industrial and academic partners has been transformed into six euros. This success shows the GFA's agility and efficiency in research and education for the economic and scientific development of both IMT and TUM, but also of France and Germany.



Our goal is to support and improve the competitiveness of the industry, by meeting the needs of businesses



Return on investment on research projects



Created by Sigmar Gabriel and Emmanuel Macron in Oct. 2015



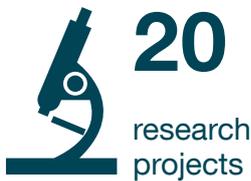
To foster and extend the German-French relations



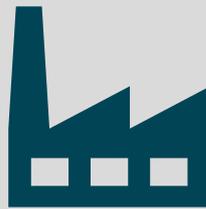
Building a platform to bring together French & German expertise



A German-French virtual Academy to accelerate the digital transformation of the industry



20 research projects



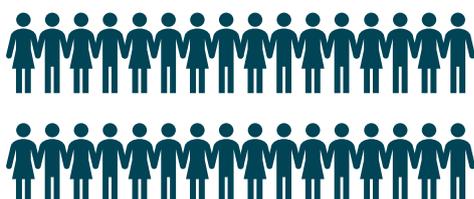
30+ partners in industry



150+ researchers, PhD students, engineers



1st joint technological platform for AI & data



1,200+

people trained in our summer and winter schools



7 recurrent annual summer and winter schools

FOSTERING GERMAN-FRENCH RELATIONS

The German-French Academy for the Industry of the Future (GFA) was created in 2015 to enhance the complementary skills of France and Germany in research, education and innovation in the fields of Industry 4.0. Its creation was announced on October 27, 2015, during the first German-French Digital Conference.

It was President Emmanuel Macron, then Minister of the Economy, and Sigmar Gabriel, German Federal Minister of the Economy, who entrusted the Institut Mines-Télécom (IMT) and its schools and the Technical University of Munich (TUM) with the management of the GFA.

This academy of excellence “without walls” is intended to fulfill two major strategic objectives identified by the government: first to strengthen German-French relations, and second to help make France and Germany disruptive technological economies by reinforcing public research and the orientation towards industrial development around strategic value chains.

Since its operational launch in June 2017, the activities of the GFA for the Industry of the Future have expanded to meet this dual objective through research, training and innovation.

The Academy is recognized as a driving force in German-French cooperation in research and innovation on Industry 4.0 technologies.



Odile Gauthier, Executive President of Institut Mines-Télécom and Thomas F. Hofmann, President of TUM



First German-French Digital Conference, October 2015

First of all, the Academy supports the development of the German-French technology roadmaps set out in the framework of the Treaty of Aachen (January 22, 2019) by addressing the strategic topics decided by our two governments or by sharing its assets available in the joint European Sovereign Cloud initiative: Gaia-X.

The Academy is at the heart of the German-French Industry 4.0 ecosystem by bringing together and collaborating with many governmental (French Ministry for the Economy, Finances and Recovery, Bpifrance, German Bundesministerium für Wirtschaft und Energie, Bavarian Chancellery), institutional (UFA-DFH, AHK-CFACI, Invest in Bavaria, BayFrance), academic (University of Nuremberg, TU Dortmund, University of Saint-Gallen and others) and industrial partners in order to foster the development of the German-French relations and Industry 4.0 solutions and knowledge.

It also contributes to the visibility of German-French technological cooperation by co-organizing and participating in international trade fairs in order to present its research results to the community and encourage meetings between experts, in Paris such as at the Viva Technology innovation fair with its German-French Space for the Industry of the Future.

The German-French Academy supports cross-border business development initiatives such as being a founding member of the French Tech Hub Munich in 2021.

In 2020, the Academy team was awarded the German-French Friendship Prize by the German Embassy in France.

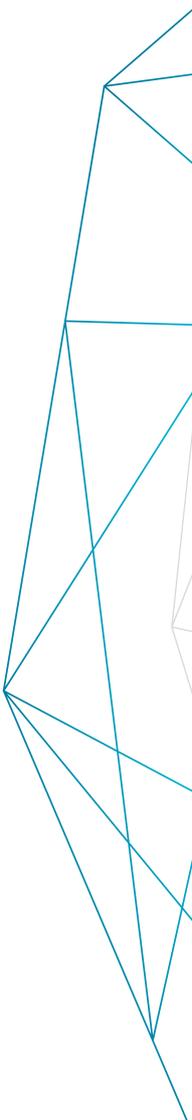
A PLATFORM TO BRING TOGETHER ACADEMIC AND INDUSTRY EXPERTS

“It is a pleasure to see the joy and the fruits of the collaborative work happening under the umbrella of the GFA.”

Marc-Oliver Pahl, member of the steering committee of the GFA

Our mission is to act as a platform and booster to bring together the right partners in both countries in order to initiate long-term collaborations and actively shape change through the digitalization of industry. We address scientists, students, industrial companies, start-ups and institutions in the academic and industrial ecosystem.

The Institut Mines-Télécom (IMT) in France, leader in the field of the Industry of the Future combined with excellence in teaching and innovation, and the Technical University of Munich (TUM) in Germany, globally known as one of the world's best universities and renowned for its entrepreneurial spirit, are the ideal partners for our ambitious activities. Together, IMT and TUM are committed to jointly building the Industry of the Future but also crafting the University of the Future.





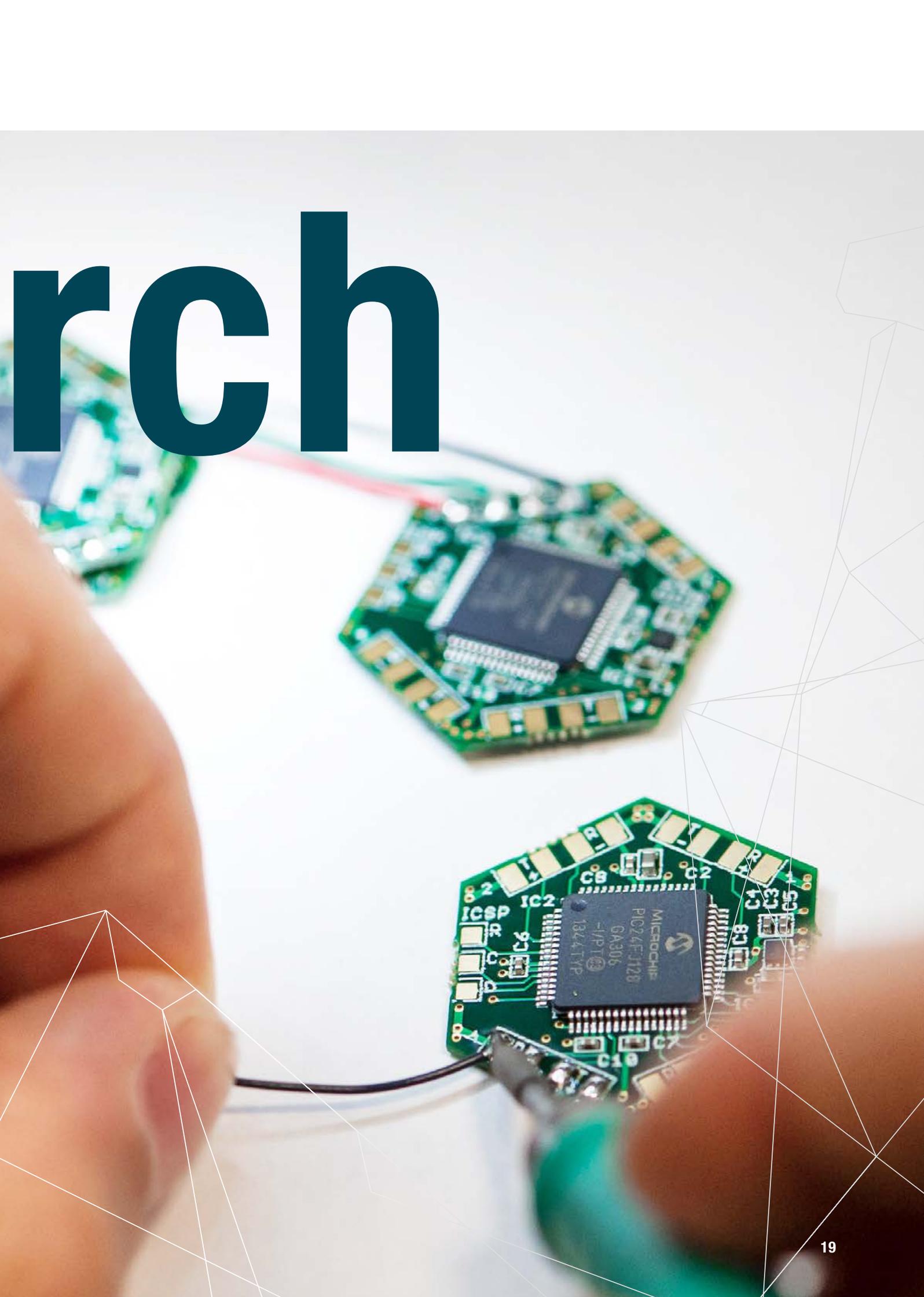
Resea

- 20 **Effective Research for the Industry of the Future**
- 22 **Our Success Stories in Research**
- 30 **Outlook on Future Research**

The GFA brings together interdisciplinary teams of outstanding researchers and scientists from Germany and France. These experts work together on highly relevant topics, advancing economic and industrial development and generating innovations for the Industry of the Future.



rch



EFFECTIVE RESEARCH FOR THE INDUSTRY OF THE FUTURE

After matching the experts during one of our networking events and by connecting them within the TUM and IMT community and with industry experts (stage 1), the GFA provides initial seed-phase funding to launch research activities. Over six months, the interdisciplinary teams develop a deeper understanding of their counterpart's research and how to continue working together in following projects (stage 2).

Finally, selected projects get subsequent maturation-phase funding in order to deepen their scientific collaboration and deliver scientific breakthroughs (stage 3). During the next twelve months, they have the opportunity to develop ideas, solutions and publications together and to aim for technological transfer to industry or third-party funding for larger-scale projects (stage 4).

The GFA already has several subsequent research projects (such as European projects, bilateral German-French projects) with a volume of tens of millions of euros that have flourished out of GFA funding.

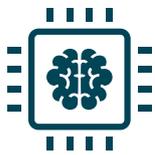




TUM and IMT's Academy for the Industry of the Future is the ideal basis to foster collaborative research and joint education to tackle the digital transformation and to prepare our countries successfully for a sustainable future."

Axel Honsdorf, member of the steering committee of the GFA

To serve as an effective technology accelerator, the research projects cover the whole Industry 4.0 scope in order to respond to industry needs:



Applied AI & Data



Cybersecurity



Industrial IoT



Production Systems



Advanced Manufacturing



New Materials



Supply Chain & Logistics



Decarbonization of Industry



Future Energy



Social and Economic Sciences

In recent years, the GFA launched three waves of calls for proposals on highly relevant and strategic topics:

2017

Challenges around the digitalization of industry

2018

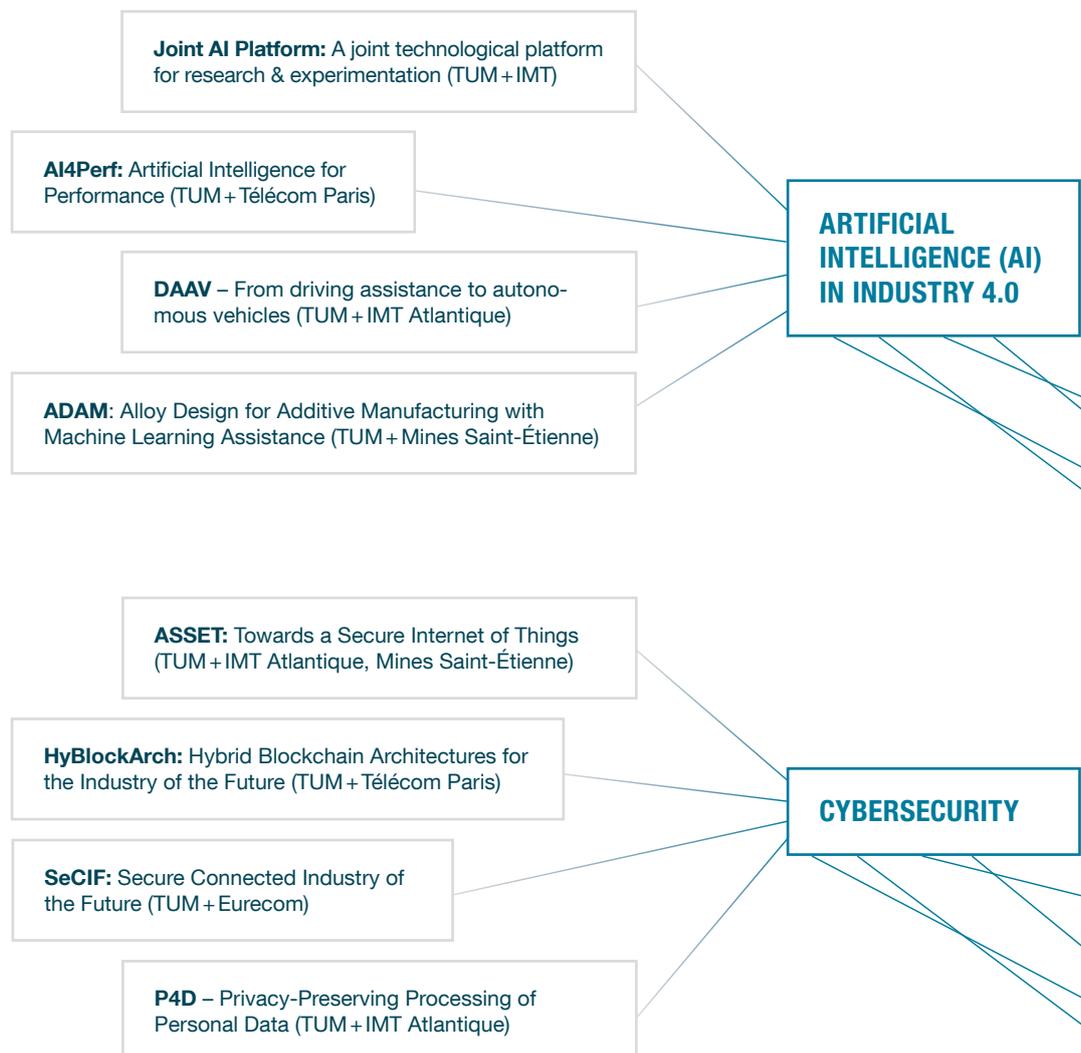
AI for the Industry of the Future

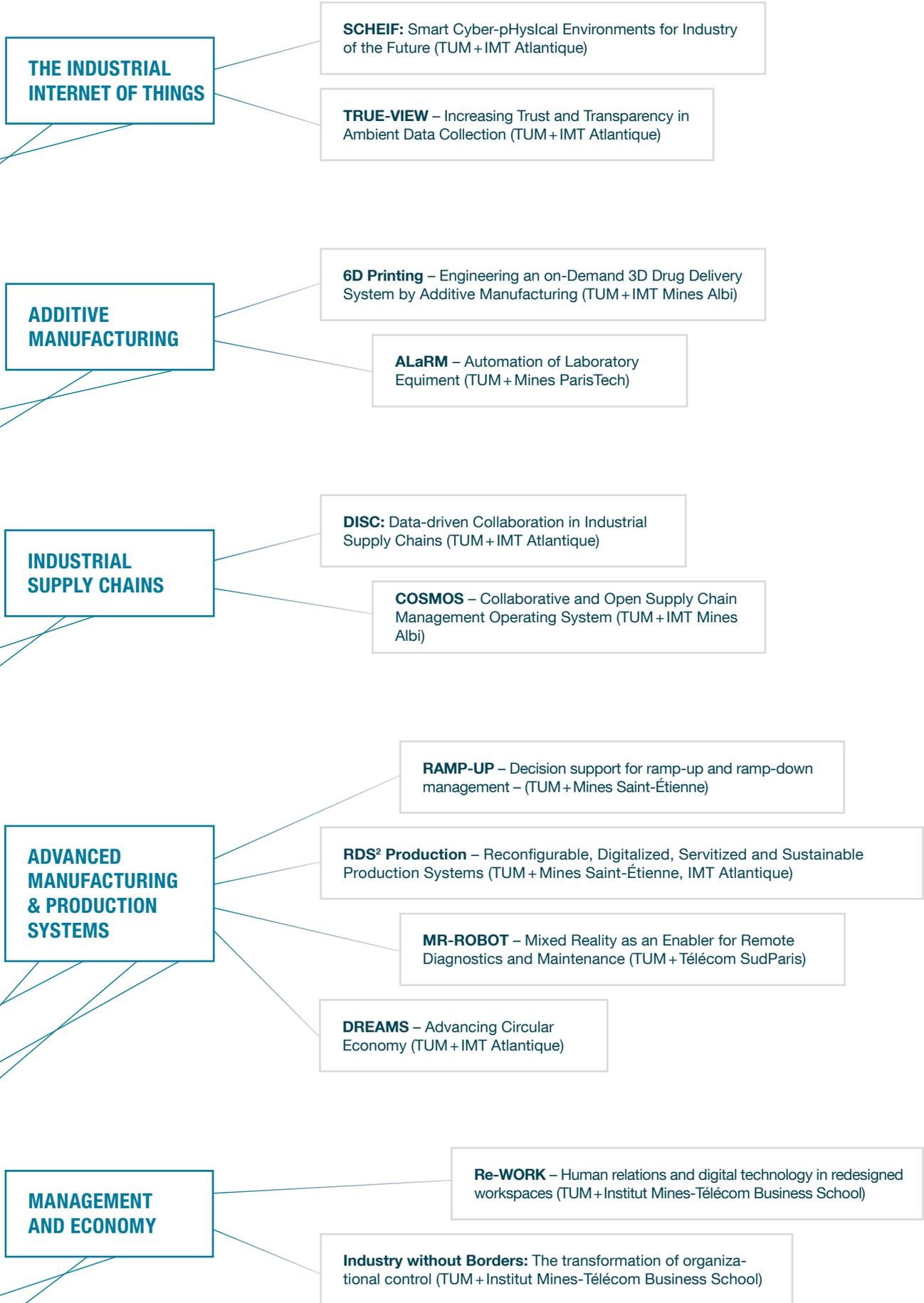
2020

Resilience & sustainability for the Industry of the Future

OUR SUCCESS STORIES IN RESEARCH

Our interdisciplinary German-French research teams create innovations for the challenges of the Industry of the Future. In the following, some of the flagship research projects launched within the framework of the GFA are presented.





ALLOY DESIGN FOR ADDITIVE MANUFACTURING (ADAM)

Details

Time period

January 1, 2020 –
June 30, 2021

Principal Investigator at TUM

**Prof. M. Zaeh,
A. Bachmann,
A. Wimmer,
M. Wittemer**

Institute for Machine Tools
and Industrial Management
(IWB)

Principal Investigator at IMT

J. Favre
Mines Saint-Étienne

www.future-industry.org/research/advanced-manufacturing/alloy-design-for-additive-manufacturing/



Motivation

Additive manufacturing offers excellent possibilities for the fabrication of functional parts with complex geometries. Powder bed fusion of metals using a laser beam (PBF-LB/M) has become popular to manufacture parts with an innovative design using tailored materials to gain defined properties. However, the companies working on cutting-edge 3D technologies have access to less than 50 commercially available powder alloys. Common powder alloys were initially developed for conventional processing techniques and the adaptation to PBF-LB/M processing is costly and difficult. Consequently, there is an urgent need for new alloy compositions dedicated to PBF-LB/M allowing for a better control of the microstructure, in order to improve the mechanical performance and the competitiveness of the additively manufactured products.

Goal

ADAM aims at investigating the capability to produce larger parts with custom alloys, in order to understand and to evaluate their performance for the PBF-LB/M process. In this stage, experimental and theoretical tools will be developed to be capable of estimating rapidly the relevance of powder compositions with a minimal amount of powder.



Challenges

Chemical heterogeneities after melting:

Despite a suitable mixing of the powders, there are some chemical heterogeneities after melting. The change of laser scanning parameters could help to decrease these heterogeneities. In addition, mechanical testing would reveal important information about the positive or negative impact of heterogeneities on the mechanical strength.

Modeling and understanding the thermal field of the melt pool:

The thermal field of the melt pool and its surroundings has relevant effects on emerging hot cracks and spatters. Monitoring of the thermal field is very informative; however, an improvement of the accessibility of the process zone is required to obtain further information about the melt pool dynamics. Especially the coupling with numerical models is a relevant track for understanding the underlying physics.

Hot cracking, distortions, and understanding the physical phenomena associated:

The seed phase has shown that some compositions are sensitive to hot cracking. The reasons for this phenomenon are not well known, and it is an important industrial issue for laser additive manufacturing. The determination of cracking conditions would help to design better alloys that are less sensitive to this problem. It would be necessary to determine the physical parameters, which are responsible for hot cracking and distortions. The thermal

conductivity, thermal expansion and solidification range are expected to be of considerable importance. Their variation by changing the chemical composition will be evaluated, and their respective effects will be quantified.

Cooperation

Mines Saint-Étienne (IMT) works on the development of new alloys for mechanical engineering applications, with specific skills in computational materials science and materials characterization. Specific tasks were conducted in the Laboratoire Georges Friedel of Mines Saint-Étienne on the prediction of compositions by thermodynamic modeling and statistical learning, and on the characterization of the built materials.

The iwv (TUM) focuses on manufacturing processes of metallic materials, with specific skills in PBF-LB/M. They have longstanding experience in the optimization of this process and in real-time monitoring to understand the phenomena during PBF-LB/M. The design and use of an experimental test bench allows the measurement of thermal fields on the melt pool scale by means of e.g. high-speed thermographic imaging, requiring only a small amount of powder.

The results have been published in 2020 in a joint paper in the Journal for Laser Applications.

RDS² PRODUCTION

Details

Time period

January 1, 2020 –
June 30, 2021

Principal Investigator at TUM

**Prof. G. Reinhart, D. Leiber,
M. Paul, L. Heuss,
F. Dillinger**

Industrial Management and
Assembly Technologies

Prof. M. Zäh

Machine Tools and
Manufacturing Technology

Principal Investigator at IMT

**Prof. X. Delorme, Prof. X.
Boucher, Dr. A. Cerqueus,
Dr.-Ing. D. Lamy**
Mines Saint-Étienne

**Prof. A. Dolgui,
Dr. H. Haddou Benderbal,
Dr. S. Thévenin**
IMT Atlantique

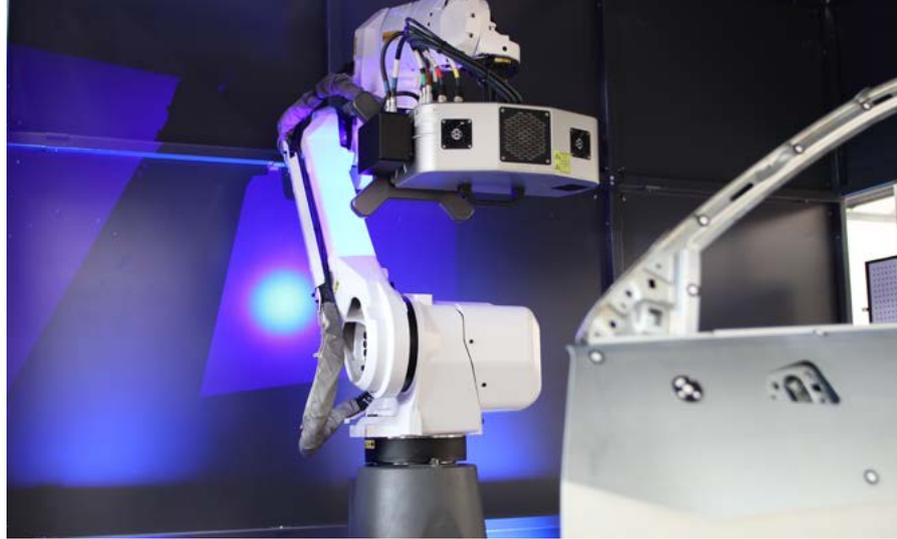
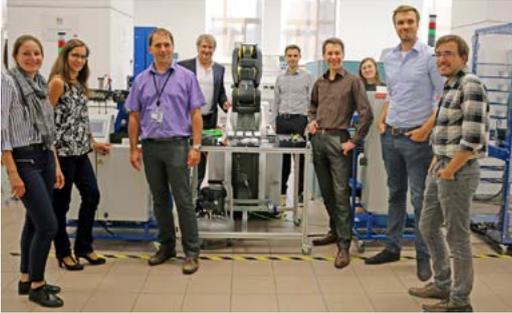
[www.future-industry.org/
research/ai/rds-production/](http://www.future-industry.org/research/ai/rds-production/)



Motivation

Increasing product diversity, volatile markets and a dynamic production environment are significant challenges for manufacturing companies. Reconfigurable production systems can help companies to face these challenges and adapt their production processes quickly and cost-effectively to constantly changing requirements. Particularly in combination with the current trends of digitalization, servitization and sustainability, companies have great potential to increase their productivity sustainably. Introducing and implementing such reconfigurable, digitized, servitized and sustainable production systems (RDS² Production Systems) is highly complex and requires industry and research expertise.

In the RDS² Production research project, researchers from TUM, IMT-Mines Saint-Étienne, and IMT-Mines Atlantique worked together on a holistic framework that guides companies in describing and categorizing decision-making situations in the context of RDS² Production Systems and supports them in subsequently finding solutions.



Challenges

The focus was on modeling the interrelationships between reconfiguration, digitalization, servitization and sustainability. For example, digitalization offers opportunities to support the planning and control of reconfigurable production systems, while sustainable resource utilization reduces the operating costs of production systems. After analyzing the current challenges and potentials of RDS² production systems in cooperation with industrial companies, the RDS² framework was developed to design and manage serviced reconfigurable manufacturing systems. The conceptual proposal was transformed into a detailed definition, specification and integration of the first set of decision-making methods and tools. Afterward, the framework and tools were validated by industrial partners and have been published in various international conferences and journals. A special session in a conference and a thematic workshop have been organized to disseminate the results obtained among academics and industrials and build future collaborative projects.

Therefore, the overall objective was to define and further develop a reference architecture and framework for an innovative methodology that improves the reconfigurability of connected and servitized production systems.

Cooperation

One of the most critical research results with French academic partners was to enable companies to make their production more flexible and sustainable. This is the purpose of the jointly developed framework, which is intended to support industrial users in decision-making processes. Therefore, the project participants' different experiences, working methods and cultural backgrounds positively impacted the results. Moreover, problems and challenges could be investigated from different perspectives and holistic solutions could be found. This was particularly beneficial during the development of the framework.

Future work

A key finding of the collaboration is that digital changes have a significant impact on the industry and our collaboration: The regular and spontaneous digital meetings with French colleagues bear witness to this. This digitalization was further accelerated, not least by the Covid-19 pandemic. This shows once again that innovative, digital solutions can be used to counter the challenges of the pandemic. For the future, we would like to further strengthen and expand the cooperation with our French colleagues, and we would also like to work together again on site. The networking activities have thus led to the submission and funding of two projects.



Presentation of the ASSET Demonstrator at the 2nd CoC Industry Day 2019 at TUM

OUR SUCCESS STORIES IN RESEARCH

TOWARDS A SECURE INTERNET OF THINGS (ASSET)

Details

Time period

March 1, 2018 –
October 31, 2019

Principal Investigator at TUM

Prof. G. Carle
Prof. G. Sigl

Principal Investigator at IMT

Prof. N. Montavont,
Prof. L. Toutain,
IMT Atlantique
Prof. F. Cuppens,
Prof. N. Cuppens,
Mines Saint-Étienne



www.future-industry.org/research/cybersecurity/towards-a-secure-internet-of-things/



Abstract

Over the past decade, devices have become more and more connected, now forming the Internet of Things (IoT). This continuing trend offers opportunities in all aspects of our daily lives. Medical devices integrated in smart clothes send data to the doctor to simplify diagnostics, smart home devices make our lives easier, and cars communicating in critical situations make our lives safer. However, what if an adversary were able to access or manipulate data? The IoT's benefits would immediately turn into a risk to life and property.

Against this backdrop the German-French project “Towards a Secure Internet of Thing”, ASSET, researched solutions to enhance the IoT's security and strengthen its resilience against cyber-attacks.

Challenges and results

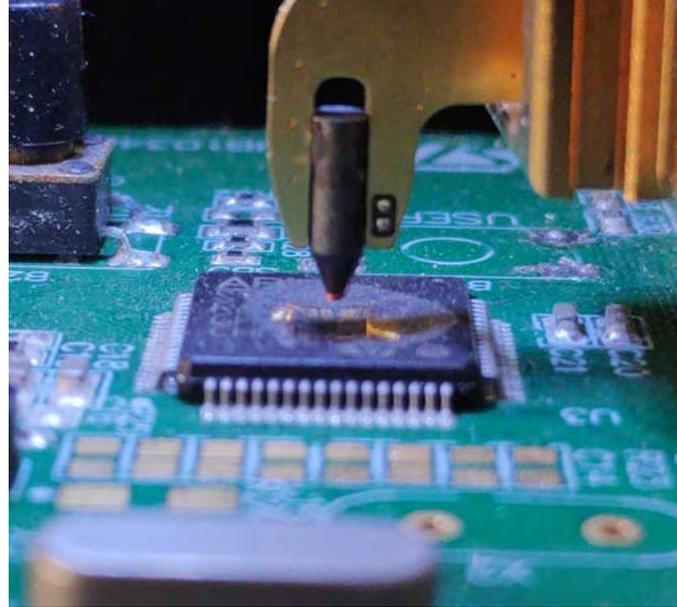
One risk to the future IoT lies in quantum computers capable of breaking currently used cryptographic algorithms for key exchange and authentication. Post-quantum secure algorithms solve this problem. However, their implementation in resource-constrained devices must be possible for most IoT applications. ASSET evolved the state of the art here by researching the design of new algorithms. Further, ASSET developed solutions on software and system level. This included methods for secure and resilient software update, defense and response in depth, and moving target defense. A demonstrator on secure protocols developed by German and French partners now forms the basis for a lab at TUM.

Security challenges in the IoT also include attacks on hardware like side channel attacks (SCA) and fault injection attacks (FIA). Research on SCA and FIA in ASSET pointed out the common interests of TUM, École des Mines de Saint-Étienne (EMSE), and Télécom ParisTech. A different focus allowed researchers to join forces, boosting their endeavor to increase security, resulting in a new consortium for the APRIORI project.

APRIORI

APRIORI (Advanced Privacy of IoT Devices through Robust Hardware Implementations) focuses on data privacy, strongly resource-constrained devices and protection against FIA. Dr. Pehl (TUM) and Prof. Danger (Télécom ParisTech) lead this project, to which EMSE, Fraunhofer AISEC, Mixed Mode GmbH, Secure-IC S.A.S., and Siemens AG also contribute. APRIORI is funded by the German Federal Ministry of Education and Research (BMBF) and the French Agence Nationale de la Recherche (ANR).

The challenge in APRIORI arises from the absence of existing highly secure but expensive security solutions in lowcost



Fault injection probe as will be used in APRIORI over IoT microcontroller

IoT devices. APRIORI compensates for this by developing components for a trust anchor in the form of a resource-saving secure chip. This Secure Element enables unique identification by means of Physical Unclonable Functions (PUFs) generating a digital fingerprint. APRIORI benefits from the collaboration of German and French partners. EMSE, Télécom ParisTech and TUM work together on three aspects: They jointly (i) develop sensors to detect FIAs and protection mechanisms for PUFs, (ii) develop a joint ASIC, and (iii) practically evaluate the efficacy of the protection.

Summary

ASSET, funded by the German-French Academy for the Industry of the Future, provided German and French researchers with the opportunity to carry out joint research. On top of this its workshops and exchange opportunities contributed to the qualification of young talents in IT security and facilitated knowledge exchange. Moreover, it has become a seed for subsequent collaboration, as the joint APRIORI project shows. This makes ASSET a success story of funding by the German-French Academy.

OUTLOOK ON FUTURE RESEARCH

“*The GFA is a hub for innovation, research and education between France and Germany and I am glad to be part of the team.*”

Katrin Wudy, member of the steering committee of the GFA

In the future, the GFA will keep using well-proven and reliable tools. In line with the goal of enhancing the GFA network, new partners at TUM, IMT, other scientific institutions and industry will be acquired and integrated. Especially addressing new relevant topics will be essential.

Following the joint HighTech Agenda of Germany and France, most notably the Aachen Treaty on Artificial Intelligence, the

Bavarian High-Tech Agenda, the program of Horizon Europe and the European Green Deal, the GFA envisages important fields of research for the next calls for proposals.

Additionally, the thematic direction will be diversified by integrating social and socio-technical aspects like Ethics in Machine Intelligence, Digital Law and Data Governance and Sovereignty.



Digitalization for Sustainability



Circular Economy and Remanufacturing



Digital Twins

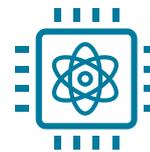


Data Sharing and Analytics

OUR FUTURE TOPICS



Hydrogen



Quantum Computing

SPOTLIGHT ON AI RESEARCH

GFA – A DRIVING FORCE IN AI

Even before the launch of the Aachen Treaty (January 22, 2019) making German-French cooperation in artificial intelligence a priority, the Academy took up this strategic subject for the competitiveness of our two countries' businesses and technological sovereignty.

In 2018, the Academy launched a wave of research projects on the subject of AI applied to industry: 6 large-scale projects have been funded on the subjects of automatic reconfigurability of production systems, autonomous cars, data-driven collaboration in industrial supply chains, artificial intelligence based automation of networked systems, and finally, the setting up of the first joint technological and experimental platform allowing academic and industrial researchers to innovate on real industrial data sets.

The construction of a community of excellence of German-French experts, in symbiosis with industrial partners and equipped with shared collaboration tools such as a common technological platform for research and innovation, thus allows the GFA to be a singular operational player today in AI. In 2020, the GFA joined the official German-French Network for Innovation on AI.

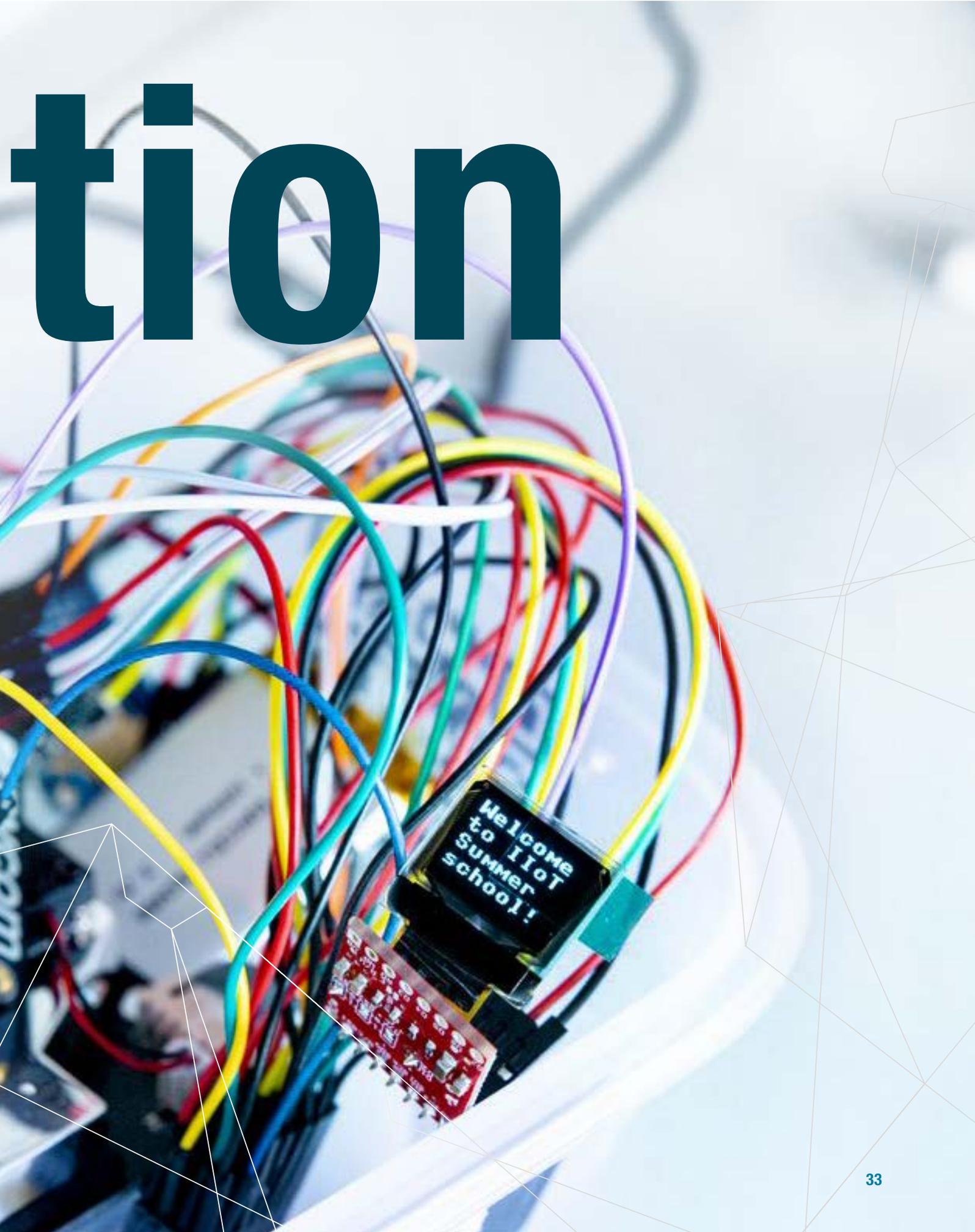
Educa

- 34 **Education for the Industry of the Future**
- 35 **Excellent Formats for Excellent Education**
- 44 **Outlook on Future Education**

Education is one of the core missions of the GFA. Not only during the pandemic of 2020/21 but also before this, we were establishing and refining digital teaching formats to attract audiences from different contexts and places, in France, Germany, and the world. Our goals are to bring Industry 4.0 topics to the spotlight, as our world is becoming more digital every day, and to raise discussions about the Industry of the Future.



tion



EDUCATION FOR THE INDUSTRY OF THE FUTURE

“*The GFA enables lifelong learning around the Industry 4.0. From pupils to students to professionals and even retired people: everyone can benefit from the GFA’s blended learning courses. Join us today!*” Marc-Oliver Pahl, educational advisor of the GFA

In recent years, our funding members TUM and IMT have developed new tools to support the digital transformation in the field of Higher Education and lifelong learning for students, future students, employees, professionals and executives. These two institutions have proven expertise and diverse competencies in media and higher education pedagogy, linking research in teaching and the innovative teaching techniques afforded by educational technology and digitalization.

The commitment of two experienced institutions is a major asset for the GFA. Interacting on a regular basis, the teams already exchange their progress and good practices on the projects.

Our educational strategy targets continuous learning along three axes: (1) Online courses, (2) PhD school and workshop series, as well as (3) short webinars and interview series.

With a focus on topics around the Industry of the Future, our educational formats guide the way to our digital future.



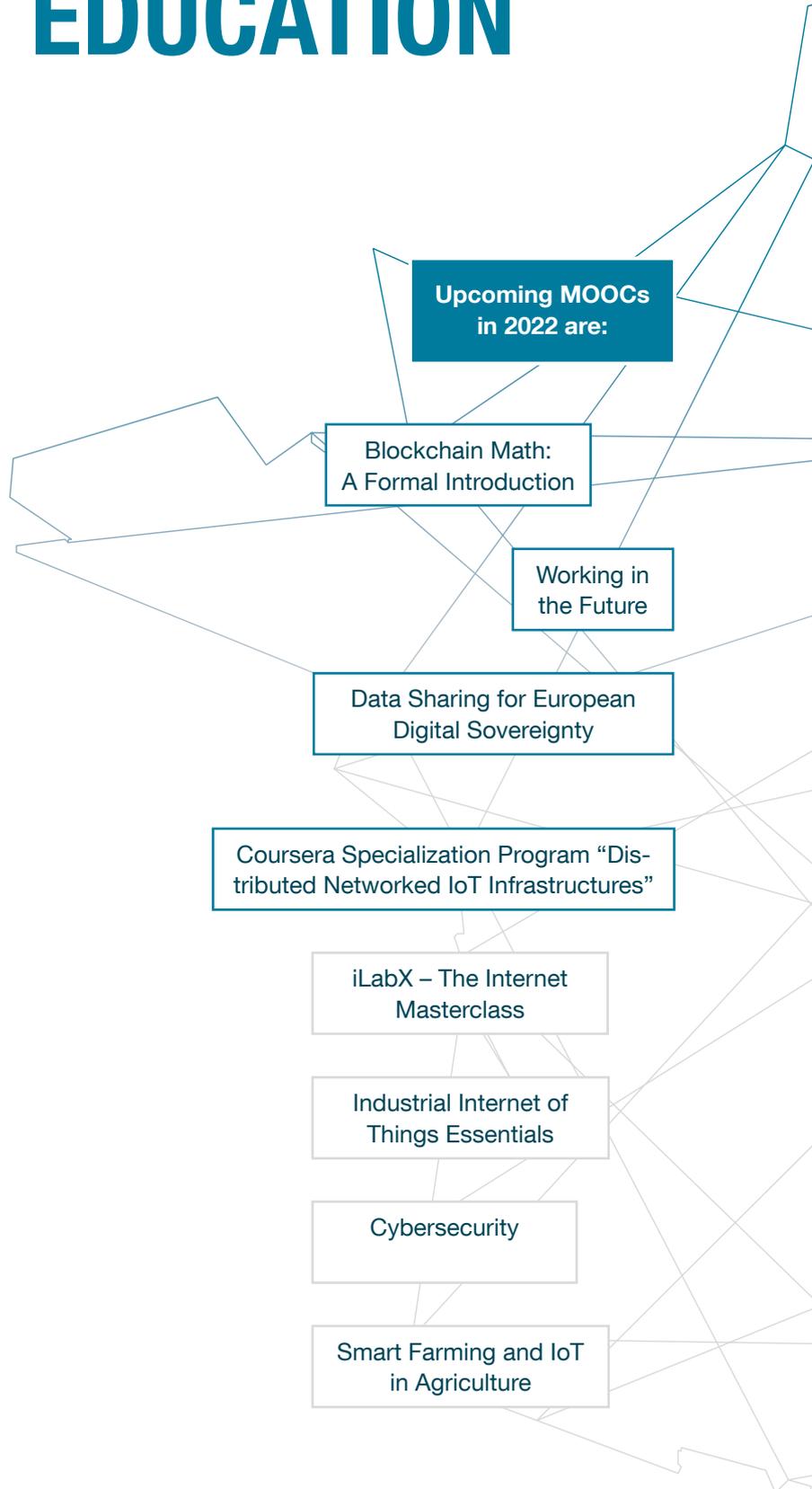
EXCELLENT FORMATS FOR EXCELLENT EDUCATION

Online and blended learning courses

The GFA benefits from the strong expertise of TUM and IMT in the field of online courses. TUM has been at the forefront of the Massive Open Online Courses (MOOCs) wave from its earliest use in Europe.

The IMT is one of the French leaders in online and blended learning courses. Nearly 30 online courses are open to people who wish to acquire specific professional skills in continuing education.

The GFA is collaborating with one of the biggest platforms for online education and courses “Coursera” and now has an official partner presence on the platform. Currently, 3 MOOCs and a Specialization Program with 4 MOOCs are being developed within the framework of the GFA. The design of the MOOCs is carried out by experts from TUM and IMT who constitute the editorial committee of the GFA.



The existing PhD schools and workshop series are:

Intelligent Cars on Digital Roads

Ai4industry – AI technologies for trust, interoperability and autonomy for Industry 4.0

Future-IoT: IoT meets ...

Data Sharing

Human Factors Aspects in Cooperative System Design

RoAMing – A Roadmap for Industrializing Additive Manufacturing

German-French Industry of the Future Workshop

Reconfigurable production in the era of Industry 4.0

PhD schools and workshops

The GFA offers a portfolio of thematic schools and workshops in cooperation with industry and provides additional support for the organization. Students, PhD students, researchers, as well as industry experts are invited to take part in these thematic schools. They have the opportunity to dive deeper into the state-of-the-art research through lectures and talks. Also, they have the possibility to get engaged in challenges and hackathons to develop innovative solutions in the field of the Industry of the Future.

Those events serve as a think tank where young researchers meet professionals and experts to discuss specific topics. This helps them to exploit their potential for innovation, creativity and entrepreneurship. Also, it helps students to apply theoretical knowledge to practical use cases.

For researchers, the schools and workshops are a platform for networking and giving intensive tuition on very special topics. This format, well known among academics, tends to be very popular among professionals as well in the context of lifelong learning and engaging in education.

Between 2018 and 2021 we had around 15 PhD schools and workshops within the GFA ecosystem. That adds up to more than 1,200 participants in the last 4 years.

Some of the schools operate a live stream format allowing the organizers to overcome the cancellation of many events following the coronavirus crisis and to reach a huge number of attendees.

Webinars, interviews

Recently we expanded our educational portfolio with a new format: webinars and interviews.

These shorter formats range between 1–2 hours and are online based. This has the advantage of attracting bigger audiences, from students and researchers to professionals and even the interested general public. We expect this to raise awareness for our topics around Industry 4.0 even more.

To jump-start the new format, we became co-organizer of the cybersecurity speaker series “talk.cybercni.fr”. That format aims to raise awareness on a core pillar of the GFA, cybersecurity. Every last Wednesday of the month, another live episode is broadcasted over YouTube and LinkedIn. More information and the videos of the previous editions can be found at

<https://talk.cyberCNI.fr/>



Digital workshop: "How Machine Learning can push the boundaries of Digital Twins?" organized by AKKA and GFA, June 24, 2021



SUMMER SCHOOL ON AI FOR INDUSTRY 4.0

Summer School on AI Technologies for Trust, Interoperability and Autonomy in Industry 4.0 (ai4industry)

Background

In April 2019, Mines-Saint Étienne, Université Jean Monnet, Universität Bonn, and Fraunhofer IAIS organized a German-French workshop on Challenges of Trust, Interoperability and Autonomy in Industry 4.0 to which Prof. Andreas Harth (from FAU Erlangen-Nürnberg) was invited. During the event, the researchers acknowledged their mutual interest in bringing web agents to the industrial sector. A collaboration emerged towards organizing a summer school on the topic of AI for Industry 4.0.

At the time, the organizing committee included Mines Saint-Étienne and Université Jean Monnet on the French side, and FAU Erlangen-Nürnberg and Fraunhofer IIS on the German side. Mines Saint-Étienne and Université Jean Monnet had several years of experience through the French-speaking “Web intelligence” series of summer schools. They proposed a general structure for the new German-French summer school based on three pillars: Web of Things, Semantic Web and Multi-Agent Systems, which are all important sub-fields of AI. The German partners quickly agreed on the structure and everyone started working on integrating software modules into a common technical framework that would become the baseline for a hackathon.

Format

Since the beginning, there had been the dual idea of bringing three research communities together and showing their significant overlap by practical means, through a hackathon. The domain of Industry 4.0 lent itself to such integration work. After several months, an industrial scenario was drafted and a working prototype involving all three pillar technologies was developed. The organizers were ready to create the summer school program, which took place in July 2020 over one week and attracted 40 participants. The program covered Web of Things, Semantic Web and Multi-Agent Systems (one day each), as well as Trust and Ethics (one day). Every day includes a keynote, a lecture and a hackathon session.

Supported by  Institut Mines-Télécom   FRIEDRICH-ALEXANDER UNIVERSITÄT ERLANGEN-NÜRNBERG   UNIVERSITÉ JEAN MONNET SAINT-ÉTIENNE  Universität St. Gallen	Summer school 2020 1 week, 40 participants <hr/> Summer school 2021 1 week, 55 participants <hr/> https://ai4-industry.wp.imt.fr/ 
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From the first editions to the future

The industrial scenario developed for ai4industry in 2020 helps to drive an integration effort across research communities that includes other formats (a German-French doctoral college, international research projects). The summer school was held again in 2021, with the same scenario but on an improved technical framework, and with new invited speakers. Fraunhofer left but KIT, TUM (Germany) and Universität St. Gallen (Switzerland) joined the organizing committee. In the end, the 2021 edition of ai4industry attracted significantly more participants (55 participants). Future ai4industry editions are already planned. In the future, the ambition is to strengthen the topics of trust and ethics, as they are particularly relevant in Industry 4.0. In 2020 and 2021, keynote speakers were invited to cover the question of

cybersecurity (2020) and trustworthiness in AI (2021). Future editions shall extend the covered topics and introduce practical work associated with trust and ethics.

So far, the majority of ai4industry participants attended online due to the Covid-19 pandemic. However, the organizing committee has the ambition to settle on a decentralized organization, where participants have the choice of attending physically in Saint-Étienne, Nuremberg or St. Gallen. The GFA for the Industry of the Future is thus an important sponsor, to lower as much as possible the travel expenses and accommodation caused by a physical presence. Despite the growing importance of dematerialized processes in Industry 4.0, physical interactions do make for a better learning experience and much more productive hackathon sessions.

“*The ai4industry2021 summer school brought 55 participants from 7 countries together in a novel format. All 4 teams developed intelligent web agents to control arbitrary manufacturing equipment and adapt to changes, as envisioned in Industry 4.0.*”

Victor Charpenay, École des Mines de Saint-Étienne

SUMMER SCHOOL ON FUTURE IoT

Background

The series is organized by Marc-Oliver Pahl and Nicolas Montavont from IMT Atlantique and Technical University of Munich as a flagship event of the German-French Academy for the Industry of the Future (GFA). The series is kindly supported by the Deutsch-Französische Hochschule (DFH)/ Université Franco-Allemande (UFA).

The “Future IoT: IoT meets ...” series began in 2018. The previous editions are:

- 2021: 4th IoT meets **Cyber** (Rennes)
- 2020: 3rd IoT meets **Security** (online)
- 2019: 2nd IoT meets **AI** (Munich)
- 2018: 1st IoT meets **Industry** (St. Malo)

<https://school.future-iot.org/>



Format

Behind Future IoT is the didactical concept of connecting industry and academia through keynotes, hands-on sessions, poster presentations and hackathon challenges. The week ends with a pitch by the students in front of a jury where the best hackathon team wins a prize. There is also a lot of room for getting to know each other, networking and exploring our host city, which alternates between Germany and France.

Partners and topics

Following the spirit of the German-French Academy for the Industry of the Future, the summer school is not only co-organized by German-French teams, it also happens in close collaboration with the most relevant industrial partners including Airbus, ArianeGroup, Atos, AWS, elm.leblanc, Siemens, and several others. They provide experts for the keynotes and the challenges, jury members, information about the company, and gifts for the participants.

As the name says, the school covers topics around the Internet of Things – the connection of the cyberspace with the physical world. It is one of the biggest challenges in our digitally transforming world. It brings many fascinating challenges and opportunities but also risks. All this is covered in the events.



This year's school

This year's edition is happening from November 29th to December 3rd in Rennes, France. The title “**IoT meets Cyber**” expresses the idea that software drives the critical infrastructures around us. Examples are water or energy supply, communication, transportation, banking, production, or health care. “IoT meets Cyber” focuses on different aspects of the software cyberspace, including cybersecurity.

Future IoT is being held as a hybrid event on-site and online. While the on-site experience is the richest, there is also the possibility to comfortably join parts of the program as a free live stream over YouTube and LinkedIn. The registration and the previous editions, as well as their recordings can be found online.

“ Without the GFA, the Future IoT PhD school series would not exist. Thank you for such strong support in so many areas, from speakers to financial support to participants.”

Marc-Oliver Pahl, organizer of the “Future IoT: IoT meets...” PhD school series

Supported by



BMW SUMMER SCHOOL: FRONTIERS IN MACHINE LEARNING

Background

Mobility is currently dominated by a number of powerful trends. Urbanization and decarbonization are calling for new concepts. Autonomous driving, electromobility, car sharing and ride hailing business models, and digital information and communication technologies have begun to fundamentally change the landscape.

Beyond sustainability, competition is increasingly focusing on all-encompassing service, maximized use of drive time, digital real-time economy and deep integration within the Internet of Things.

Here, artificial intelligence is finding some exciting and challenging application areas – under the hood and quite visibly on the surface alike. Beyond industrialization of state-of-the-art sensor technologies, advances in machine learning and computer vision are behind a great many breakthroughs in autonomous driving. The means to organize personal mobility and intelligently deliver a wealth of digital services along the way are increasingly based on automated algorithms. And cognitive capabilities are promising to let the robots in our cars interact with humans in a natural, intuitive way.

At the same time, cities have started to organize procedures, let alone traffic management, with the help of big data analytics and predictive algorithms. And artificial intelligence is poised to touch almost every aspect of future societies.

Summer school

2022

<https://www.summerschool.bmw/en.html>



- Trust and safety in AI
- What is trust?
- How do we extend concepts of product quality and safety when introducing machine learning algorithms?
- What is SafeAI?
- How can we prove algorithmic behavior in safety-critical systems?
- What challenges are to be expected in governance?

Format

The BMW Summer School format comprises keynote presentations from executive-level speakers, ideation workshops, technical expert presentations from industry and academia, moderated panel discussions and PhD poster presentations. During moderated PhD challenge group discussions and idea creation workshops, innovative visions and applications, conceptual, sociological and business changes shall be discussed



that are to be expected with the rise of fully-connected vehicles in the Internet of Things. The BMW Summer School may be complemented by social events in the beautiful area around the venue or a trip to downtown Munich with a visit to BMW Welt & BMW Museum. Awards for the best PhD posters and outstanding proposals from idea creation workshops or challenge group discussions will be presented during the closing ceremony.

Next summer school in 2022

In 2022, the summer school will turn the spotlight onto the topic of trust and safety in artificial intelligence, a broad field of discussion and growing relevance at the crossroads of technology, psychology, product safety, law, economics and ethics. We will look into it with a special emphasis on challenges and opportunities for applications of AI in mobility.

What is trust? What creates and influences trust in a system? How must a technical system or product be designed to be

trustworthy? How do we extend concepts of product quality and safety when introducing machine learning algorithms? What is SafeAI after all and how do we verify and validate reliable performance of neural networks? How can we prove algorithmic behavior in safety-critical systems? What measures need to be taken in corporate processes to ensure trust and safety in AI-powered approaches? What challenges need to be expected in governance and oversight?

Join us for a week of technical deep dives and multi-disciplinary debate.



OUTLOOK ON FUTURE EDUCATION

In 2021 we launched our first “Call for Proposals – Education & Knowledge”.

With it, we gave German-French teams the opportunity to propose innovative ideas for education projects. The call was a great success, resulting in many high-quality proposals.

As a result, 12 innovative teaching projects will be realized under the umbrella of the GFA. For the future, we plan to repeat the call for proposals on education projects annually, to continuously strengthen our portfolio of high-quality learning resources for students, professionals, and lifelong learners in the field of Industry 4.0.

In addition to PhD schools, workshops and online courses, we will continue experimenting with new formats. This includes a Makeathon and a three-day hackathon “Green Hack IT” in 2022. Likewise, there will be a database of physical flow experiments, called SPINEL. The goal with this resource is to facilitate the study of Fluid Mechanics.

To enable an even broader audience to benefit from the GFA creations, future workshops and PhD schools will be recorded and published on our new GFA YouTube channel.

“*France and Germany are truly proud of their engineering excellence, which is the result of world-class higher education. In order to remain successful, we have to train a new generation of European engineers with skills in Industry 4.0 technologies.*”

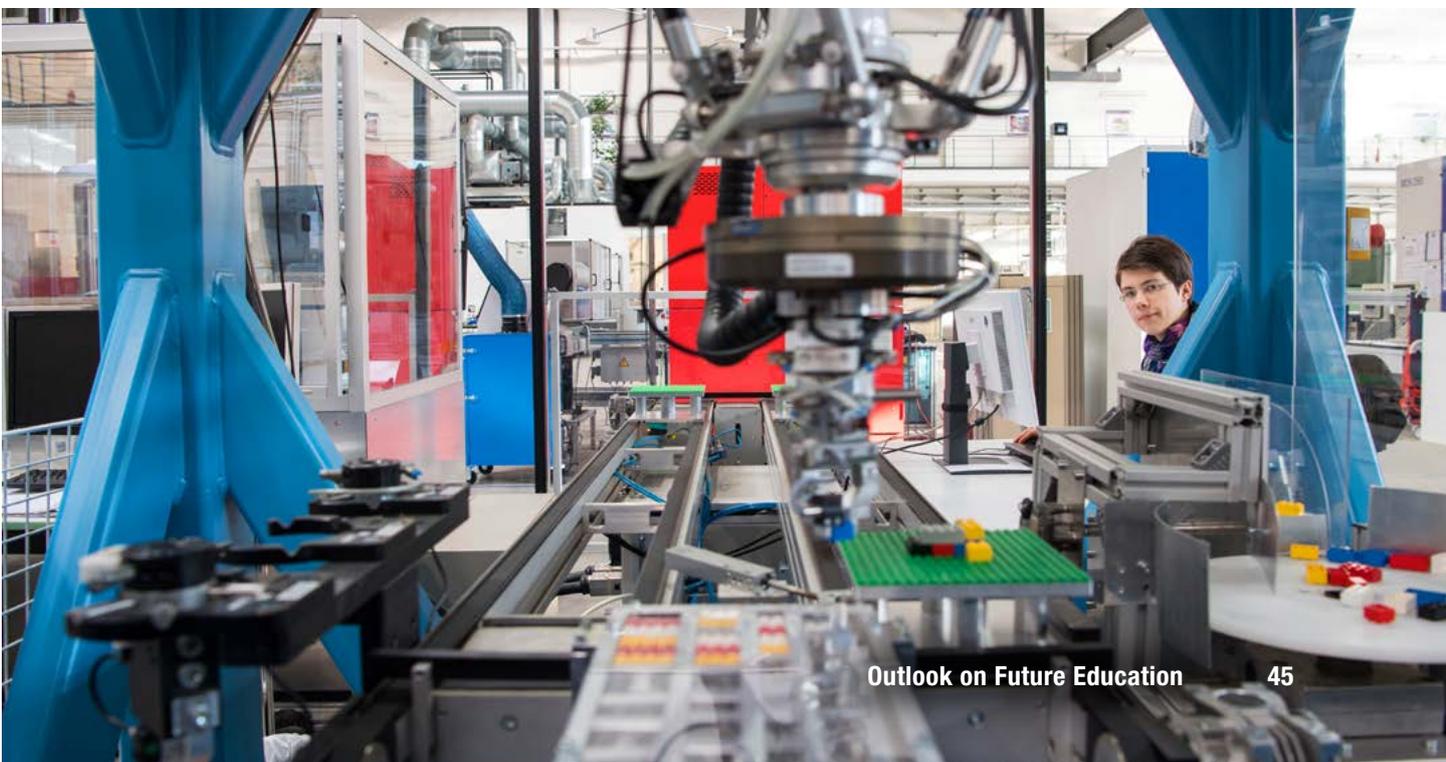
Axel Honsdorf, member of the steering committee of the GFA

Green Hack IT

Green Hack IT is a three-day hackathon for about 60 French and German students. The hackathon will provide a hands-on experience for students and allow them to unleash their creativity by tackling a significant industrial problem. The first edition is planned for Nov/Dec 2022.

SPINEL (Smartphone for Practical Imagery: a New Educational Library)

SPINEL is a new educational tool for Fluid Mechanics students. As the subject is quite theoretical, this database leads the students through a variety of imaging experiments that allow them to explore flow properties and bring visual elements to their understanding. Best of all, these experiments can be done at home. The library will be launched in autumn 2022.



Industry & Innovation

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The GFA aims to boost a framework for partnerships with French and German industrial companies and start-ups including research, innovation, continuous and lifelong training, prospective cooperation, and their involvement in the strategy and orientation of the GFA activities.



ery ation





INDUSTRY & INNOVATION

INDUSTRY & INNOVATION OF THE FUTURE

An innovative partnership at the service of industry

To support and improve the competitiveness of industry and to serve as an effective Industry 4.0 tech accelerator, the GFA focuses on meeting the needs of businesses. The GFA relies on partnerships with industrial companies to bring industrial expertise in the steering of the research and the training activities and to share their visions of the trends in various fields, technological roadmaps and needs. In addition to direct access to the precompetitive research results of the Academy, industrial partners are given the opportunity to support more focused and advanced research activities linked to their future business in various ways including industrial chairs and research programs linked to their own technological challenges.

The Academy also provides partner companies with a unique venue to link with students, to develop internships and to recruit young talents with high-value skills in the Industry of the Future and a German-French culture.

Entrepreneurial spirit

The Academy provides a unique ecosystem for founders and start-ups that builds on the entrepreneurial culture of its two founding institutions. This high-profile platform gives start-ups the opportunities and tools they need, including the chance to present their businesses at tech conventions, fairs and start-up events.

IMT and TUM offer start-ups in-depth support every step of the way – from defining a business model and legal formalities to technology development to financing.

The two institutions additionally provide entrepreneurs with office facilities, maker spaces and incubators.

Every year, IMT and TUM act as a launch pad for around 170 spin-off companies.

“Thanks to the different collaboration formats of the GFA, numerous fruitful collaborations between top level researchers, young talents and experts from leading European industries emerged.”

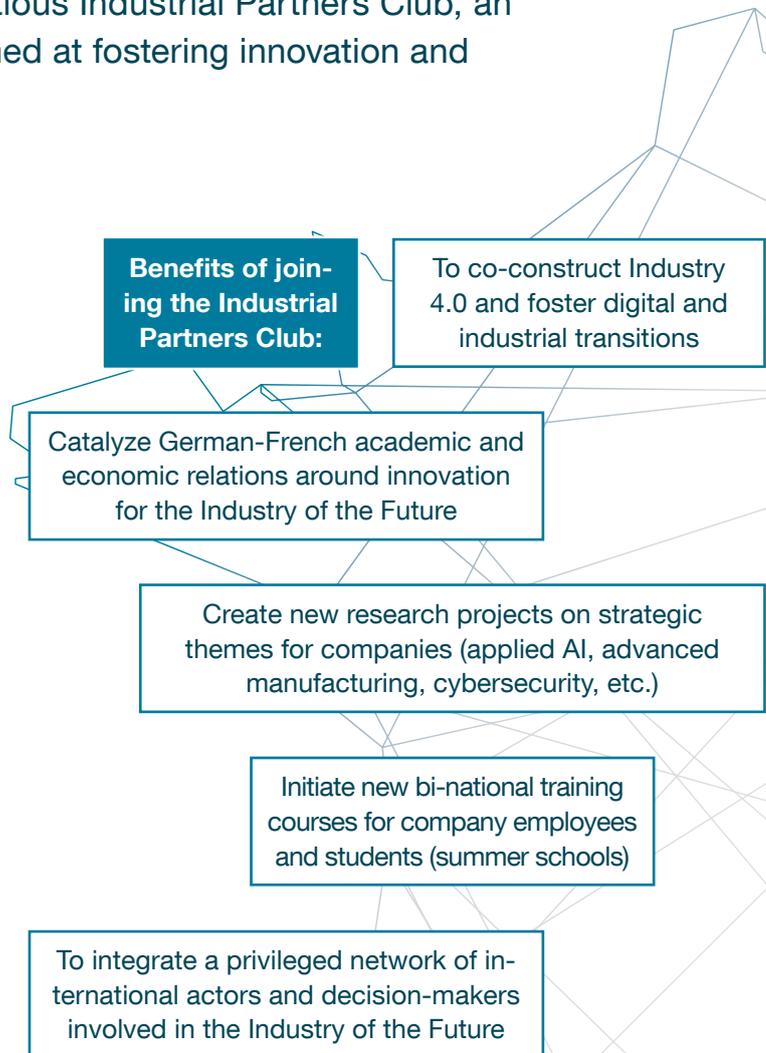
Georg Carle, holder of the Network Architectures and Services Chair at TUM and co-director of Teralab

INDUSTRIAL PARTNERS CLUB

IMT and TUM are putting companies at the heart of their partnership with the creation of an ambitious Industrial Partners Club, an innovative cooperation model aimed at fostering innovation and digital transformation.

The GFA founded the Industrial Partners Club, through which major stakeholders gain access to an ecosystem pursuing excellence in research and innovation unique in Europe. Thanks to this partnership with leading academic institutions in the field of Industry 4.0, members will benefit from an exceptional growth lever around research, education and innovation.

On June 10, 2021, ArianeGroup and Airbus joined the Industrial Partners Club of the Academy. The aerospace and aeronautics sectors are currently tackling major technological challenges related to artificial intelligence, cybersecurity, advanced manufacturing, and hydrogen propulsion systems. In this context, Airbus and ArianeGroup, the two European leaders in these fields, recently became the first official members of the Academy's Partners Club, with the aim of sharpening their forward-looking strategies. Founded on the experience and expertise of IMT and TUM's relations with industry, the Partners Club was designed to facilitate interactions and technology transfer between the industrial and academic worlds. From the Academy's perspective, the entry of Airbus



and ArianeGroup in the club opens new horizons for future research and training initiatives, while also developing a pool of French and German experts in Industry 4.0.

“ ArianeGroup is the fruit of a joint German-French venture in 2015 for Ariane 6, which sought to guarantee Europe’s sovereign access to space. It is therefore both an obvious choice and a source of pride to have our most innovative teams participate in the German-French Academy. With the support of our academic partners, we will be inspired to encourage and back new joint ventures that will promote Europe’s access to space. These new ventures promise to be increasingly innovative, competitive, and respectful of the environment, for the benefit of all.”

André Hubert-Roussel, CEO of ArianeGroup

Supported by



AIRBUS

Atos

Fostered by



From left to right: Michel Combet (Fondation Mines-Télécom) – Karl Heinz-Servos (ArianeGroup) – André Hubert-Roussel (ArianeGroup) – Bruno Le Maire (French Minister for the Economy, Finances and Recovery) – Sabine Klauke (Airbus) – Antoine Bouvier (Airbus) – Odile Gauthier (Institut Mines-Télécom)



OUTLOOK ON FUTURE INDUSTRY & INNOVATION

EXCELLENT NETWORKING

An important focus of the GFA in the future will be increased business relations and networking activities. More industrial companies and for the first time also start-ups are to be won as strategic partners and integrated into the GFA Industrial Partners Club. Furthermore, conferences and event series with various partners, both internal and external to TUM and IMT, are planned as regular and high-profile networking activities.



Here · We · Go
The Future Industry Forum

As a flagship event, “Here. We. Go – The Future Industry Forum” will be organized on a recurring basis to present results from the research projects and to connect existing and new partners from science, business and politics. In order to intensively link the various partners within the GFA, the networking portfolio will be supplemented by joint exchange and mentoring programs for researchers, students and professionals.



“*Digital transformation, artificial intelligence, and cybersecurity are all central to the industrial technology and processes of the future that are shaping the development of Airbus. Given our Group’s deep roots in German-French cooperation, we are proud to become members of the German-French Academy’s Partners Club, and to join forces with engineers from the industrial world, research professors, and students from IMT and TUM, which are among Europe’s most prestigious schools and universities.*”

Sabine Klauke, group CTO at Airbus.

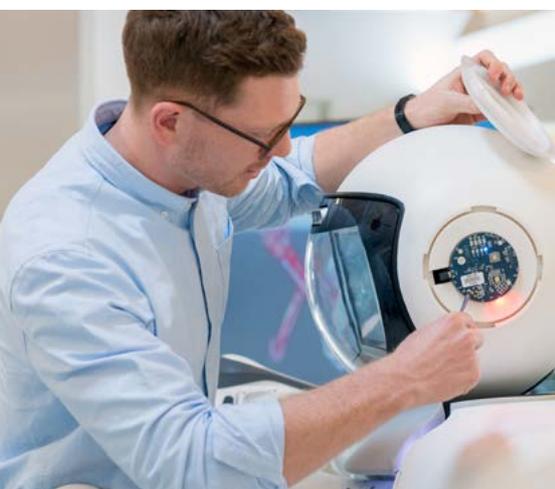
EUROPEAN DIGITAL SOVEREIGNTY

In the future, the GFA will continue to address the burning questions and issues of current and innovative research topics. In particular, the topic of European digital sovereignty is becoming increasingly important. In particular, supporting companies in their digital transformation, securing their data and at the same time strengthening exchange and cooperation on a transnational level, is a special goal and challenge at the same time.

Building on the achievements of the GFA from the past years, such as Teralab, the joint German-French data platform

for AI research, initiatives and projects will be launched to advance the topic on a transnational as well as European level. As a major advantage, the GFA can build on IMT's experience, being a founding member of GAIA-X, the European cloud initiative for data sovereignty and interoperability.

In order to achieve these goals, the GFA will initiate various projects in the future, from a Data Sharing Winter School to the coordination of workshops, in order to bring the most important stakeholders together and to give the right impulses on a research, political and social level.



“The primary aim is to support artificial intelligence research projects between France and Germany. One of the major risks for AI researchers is presenting their work to academic peers or industry stakeholders and having it stolen.”

Anne-Sophie Taillandier, director of Teralab at IMT



“ *The joint AI platform makes it possible to improve the reproducibility of results. This leads to higher-quality results, with a bigger impact for the industry stakeholders.*”

Georg Carle, holder of the Network Architectures and Services Chair at TUM and co-director of Teralab

“ *The use of data is a strategic economic and social issue in a European approach such as the GDPR. IMT is an academic player committed to the economic world and we support companies in their digital transformation. Thus, our commitment to GAIA-X is an extension of our involvement in these issues.*”

Odile Gauthier, Executive President of IMT



**GET IN TOUCH,
BECOME A
PARTNER OF
THE GFA!**

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