UNIMORE
UNIVERSITÀ DEGLI STUDI DI
MODENA E REGGIO EMILIA

30°

Department of Engineering
"Enzo Ferrari"

Introduction – Head of Department

2020 marks **30 years of Engineering in Modena**. The "Enzo Ferrari" Engineering Department (DIEF), which was so called after the faculty of the same name, is an active part of UNIMORE's Engineering School and is comprised of **110 professors and researchers**, besides **more than 5000 students**. The teaching portfolio includes **7 Bachelor courses**, **10 Master courses**, and **3 Ph.D. schools**, covering all the most relevant and cutting-edge topics in engineering: from mechanics to automotive, from materials to electronics, from computer science to civil engineering, from telecommunications to environment.

By acknowledging the solid intertwining between **high-quality research and teaching activities** that bring knowledge and innovation to the society as a whole, in recent years DIEF actuated policies aimed at favouring interconnections among different areas, strengthening its presence in international and EU networks and research projects. This, in turn, led to the **influx of new high profile professors and researchers** active in strategic high-innovation fields, with the aim of triggering a **continuous renewal of key competences** through high-quality research. As a result, the number and the quality of both national and international competitive funded projects in which DIEF participates remarkably increased.

In the long-term vision of strengthening ties with local entities, institutions, and industrial partners, recently DIEF contributed to the creation of the so-called **Motorvehicle**

University of Emilia-Romagna (MUNER), a synergistic association among many Universities, Emilia-Romagna Region, and automotive industries that represent worldwide **the excellence of the "Made in Italy" automotive** that is rooted in the same territory in which DIEF is present.

Therefore, in recent years the teaching portfolio expanded by including **new international and interuniversity Master courses in automotive engineering**, which represent one of DIEF's main hallmarks. Lecture courses therefore benefit from ever renewed contents that trigger and motivate students, giving them a **long-lasting and robust higher education**, highly valued in the job market.

A significant contribution to applied research comes from **Interdepartmental Centres**, specifically those housed in DIEF such as AIRI (Artificial Intelligence Research and Innovation Centre), CRIS (Interdepartmental Research Centre for Safety and Risk Prevention), CRICT (Interdepartmental Research and Service Centre for Buildings and Territory), and INTERMECH-MORE (Interdepartmental Applied Research and Service Centre for Advanced Mechanics and Motor vehicles), all located on DIEF's campus.

In this pamphlet the research topics characterized by a high degree of innovation are reported in a comprehensive yet concise fashion, together with a description of the laboratories in which they are developed. They are tightly linked to the following disciplinary areas: automotive; manufacturing; materials engineering and science; electron devices, systems, and sensors; telecommunications and control systems; artificial intelligence; big data; cybersecurity; environmental sustainability.

Prof. Massimo Borghi

Our Department

Unimore has a longstanding tradition (it was founded in 1175) and is considered **one of the best universities in Italy** for teaching and research. According to Italy's leading financial daily, it has **ranked first among the engineering programs** since 2015. With over **20,000 students** including **3,500 postgraduates**, it is large enough to offer all the facilities one would expect from a major university (well-stocked libraries, computer rooms, free internet connection, and study support services) but small enough to retain a personal and friendly learning environment. Located in the heart of one of Europe's wealthiest and most dynamic regions (that is world-renowned for the production of mechanical parts, engines, sports cars as well as for its agro-food sector, ceramic tiles, and manufacturing industries), Unimore benefits from a **longstanding relationship with the area's firms and corporations**, which provide private **support for university research** and a unique opportunity for **on-the-job training** before graduation.

The "Enzo Ferrari" Engineering Department in Modena is one of Unimore major departments and manages teaching and research activities in **Civil and Environmental Engineering, Computer Engineering, Electronic and Telecommunication Engineering, Mechanical Engineering, Automotive Engineering, and Industrial Design**.

In this department, new opportunities arise from the synergic mixing of teaching, research, both theoretical

and applied, and technology transfer. Devoted Interdepartmental Centres and Incubators are located in the same Campus. Through its Internship Office, the Department promotes and manages the provision of internships, using a well-established network of relationships with business associations, individual companies, professional firms, government agencies, foundations, and national and international institutions. This context is of particular importance to the implementation of framework agreements with trade associations, as well as agreements with individual companies, aimed at the constant pursuit of learning goals and maintaining an effective relationship between University and companies.

The Department has an important monument, the Observatory, located in the East tower of the Ducal Palace of Modena. Built between 1826 and 1827, it preserves important historical instruments. At first an Astronomical Observatory under the direction of Giuseppe Bianchi from 1826 to 1859, until 1897 it was used for Meteorological purposes, and then it became a Geophysical Observatory. Meteorological observations have been collected continuously since 1860 without interruptions and represent one of the most important meteorological time series of Europe. At present, meteorological and geophysical measurements support many research activities of the University.

Teaching

Bachelor's Degree in Italian

Costruzioni e Gestione del Territorio (Laurea Professionalizzante)

Ingegneria Civile e Ambientale (two curricula: "Ingegneria Ambientale", "Ingegneria Civile")

Ingegneria Elettronica

Ingegneria Informatica (delivered in Modena)

Ingegneria Informatica (delivered in Mantova)

Ingegneria Meccanica (two curricula: "Generale", "Materiali")

Ingegneria del Veicolo

Master's Degree in Italian (some courses are delivered in English)

Ingegneria Civile e Ambientale (four curricula: "Progettazione di Strutture e Infrastrutture", "Gestione delle Risorse Idriche", "Sostenibilità Ambientale", "Sostenibilità Energetica")

Ingegneria Informatica (three curricula: "Cyber Systems", "Data Engineering and Analytics", "Artificial Intelligence Engineering")

Ingegneria dei Materiali

Ingegneria Meccanica (two curricula: "Generale", "Industria 4.0")

Ingegneria del Veicolo (two curricula: "Powertrain", "Sistema Veicolo")

Master's Degree in English

Electronic Engineering (*) (two curricula: "Smart and Connected Systems", "Industrial Automation")

Advanced Automotive Electronic Engineering (with Universities of Bologna, Ferrara, and Parma; administration in Bologna)

Advanced Automotive Engineering (with Universities of Bologna, Ferrara, and Parma; administration in Modena)

Electric Vehicle Engineering (with Universities of Bologna, Ferrara, and Parma; administration in Bologna)

Innovation Design (with University of Ferrara; administration in Ferrara)

(*) it offers a Double Degree with the Federal Technology University of Parana (UTFPR), Brazil.

Postgraduate Master's Courses (1st and 2nd level) and Professional Specialization Courses

Postgraduate Master Courses of 1st and 2nd level in Engineering and Professional Specialization Courses are organized by DIEF. Currently available courses are:

Master in "Cyber Defence Governance" (1st level)

Master in "Digital Forensics and Cyber Technologies" (1st level)

Master in "Ceramic Industry and Technology" (2nd level)

Professional Specialization Course in "Cyber Analyst"

Professional Specialization Course in "Cyber Architect"

Professional Specialization Course in "Pen tester e Specialized Cyber Analyst"

Professional Specialization Course in "Internet-based Services and Systems"

Professional Specialization Course in "Sound Engineering"

Professional Specialization Course in "Plastic Materials Technician"

Professional Specialization Course in "Technologies for safety and forensics"

Some of the Postgraduate Master Courses are inter-departmental or inter-university, others are included in Regional actions for Higher Education, and offer benefits to the students. For a complete and updated list, please refer to: www.international.unimore.it/study.html.

Ph.D. Programs

Ph.D. courses provide high standard educational activities and research training within a program lasting three years. Such a program ends with the defence of the Ph.D. thesis. The Engineering Department “Enzo Ferrari” is the administrative headquarter of the following three doctorate programs:

Ph.D. in Industrial and Environmental Engineering “Enzo Ferrari” (*)

Ph.D. in Industrial Innovation Engineering

Ph.D. in Information and Communication Technologies (ICT) (**)

In addition, the following doctorate program under the administration of University of Bologna is offered in cooperation with Unimore and University of Parma:

Ph.D. in Automotive for Smart Mobility

(*) it offers a Double Degree with the University of Fuzhou (China)

(**) it offers a Double Degree with the Federal Technology University of Parana (UTFPR), Brazil

Didactic Labs

The experimental and practical activities are carried out in the following Didactic Labs:

"Claudio Canali" Lab (12 workstations), is dedicated to fundamental and advanced courses in Electronics, with special concern to prototyping, industrial automation, and telecommunications.

Infomec Lab (34 workstations) and LINFA Lab (53 workstations) are equipped with high performance computers and updated applicative programs. They are dedicated to advanced computing in information technologies and mechanics.

Multimedia Lab (20 workstations), is equipped with PC and printers, and is employed for short courses, videoconferences and seminars. The lab is also equipped with 3 video cameras dedicated to research in the area of artificial vision.

Lab of Chemistry, Applied Chemistry, and Engineering of Materials, is equipped for preparative chemistry and material characterization, and is dedicated to basic teaching in chemistry and training in engineering of materials.

Research Labs shared with Enterprises

The experimental and practical DIEF has always promoted its integration with the enterprise world, by sharing basic and applied research activities. This common activity favours the transfer of knowledge to the students, and eases their integration within the industrial world. There are currently four labs shared with the territory enterprises:

Millechili Lab
Laboratoriorosso
LaPIS
Florimage Lab


d Rock
CAFE
RLIN

Research activity

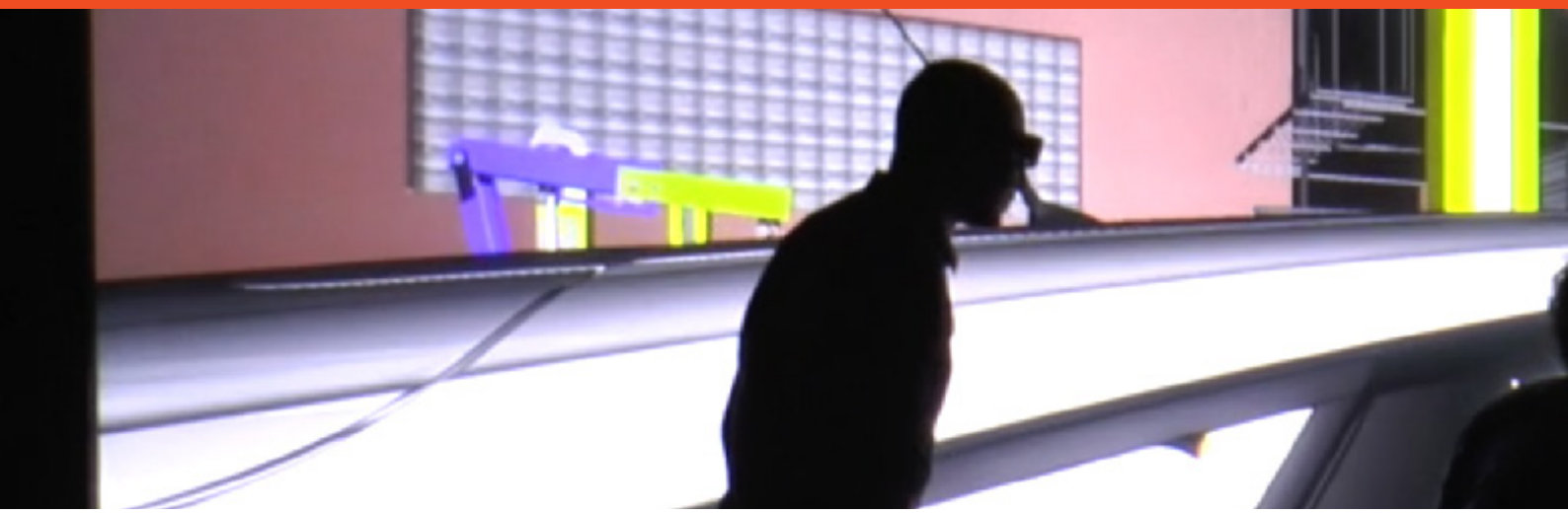
Research activities at the DIEF are divided into **5 main areas** of science and engineering: **Civil and Environmental Engineering, Electronic Engineering, Computer Engineering, Materials Engineering, Mechanical and Vehicle Engineering**. All of them have been steadily growing over the past 30 years in terms of number of research topics, number of researchers and research projects, number of publications, local, national and international impact.

At present, Research at the DIEF involves about **100 permanent staff members and additional 180 non-staff**, early stage contract researchers. About **45 research labs** with highly specialised and state of the art equipment are hosted in the department premises to support the activity, as illustrated in detail in the following.

Every year, the Department elaborates a plan for enhancing specific research activities or transversal actions in support of the research, which receives funding from the University. Remarkable funding opportunities are continuously generated by the staff members, which provide access to regional, national and international support for institutional projects and industry-oriented applied research activities. The competences and skills of the staff members and early stage researchers are instrumental to the success in this field.

Research activity

XiLab



Research activity

The research combines advanced virtual simulation with human factors and ergonomics to design high-quality experiences of use. VR-AR are used to study human-machine interaction before realization, to predict the users' physical stress and mental workload. Main goals: design intuitive, efficient and pleasant products and processes, improving performance and user experience.

Impact on society

From the research, XiLab (X-in-the-Loop simulation Lab) was born (www.xilab.unimore.it). It uses structured methodologies for the analysis of user experience and simulations to predict future problems. It aims at designing intuitive and easy-to-use systems, with huge impact on industry and society, from commercial products, to industrial machines or manufacturing systems.

Context and motivation of the research

Digitization, automation and intelligent technologies are evolving human-machine interaction. Tasks are more complex and attention is frequently shared on multiple topics. The research focuses on using digital simulation to understand the new forms of human-machine interaction and improve system design to optimize the users' physical and mental workload.

National and international academic relationships regarding the activity

UTFPR - Universidade Tecnológica Federal do Paraná (BR), RMIT University (AU), National Tsing Hua University (TW), Jonkoping University (SE), University of Coimbra (PT), Technical University of Delft (NL), BIBA University (DE), PROSTEP AG (DE), CRF - Centro Ricerche Fiat (ITA), Università Politecnica delle Marche (ITA)

Funded projects / grants

COLROBOT - H2020: ICT-24-2015
ADAPTIVE - Italian CFI
ICOSAF - PON 2014-2020
COORSA - POR FESR 2014-2020
CREAM - POR FESR 2014-2020

Engagement of local entities and fallout on the territory

XiLab collaborates with numerous local entities, to share knowledge and build up novel approaches to predict the user experience, from industry (CNH Industrial, Maserati, Lamborghini, SACMI, IMA, SCM, TetraPak, SIR, Fabio Perini, …) to local Labs (LIAM, CRIT) to regional groups of different associations (Italian Society of Human Factors and Ergonomics, Italian Society of Robotics).

Research activity

Materials and Surface Physics Group

Research activity

The Materials and Surface Physics group is active in the study and characterization of surfaces and nanostructured thin films by optical ad electron spectroscopies, also exploiting synchrotron radiation. Techniques include photoemission, x-ray absorption, reflectivity, luminescence. Particular emphasis is given to organic thin films for molecular optoelectronic devices.

Impact on society

The group operates in an international network of collaborators, mainly involved in the improvement of electronic devices in terms of reduced costs and energy consumption, environmental sustainability, enhancement of operation velocity, durability. These are main factors stimulating research towards new materials and architectures tailored at the nanoscale.

Context and motivation of the research

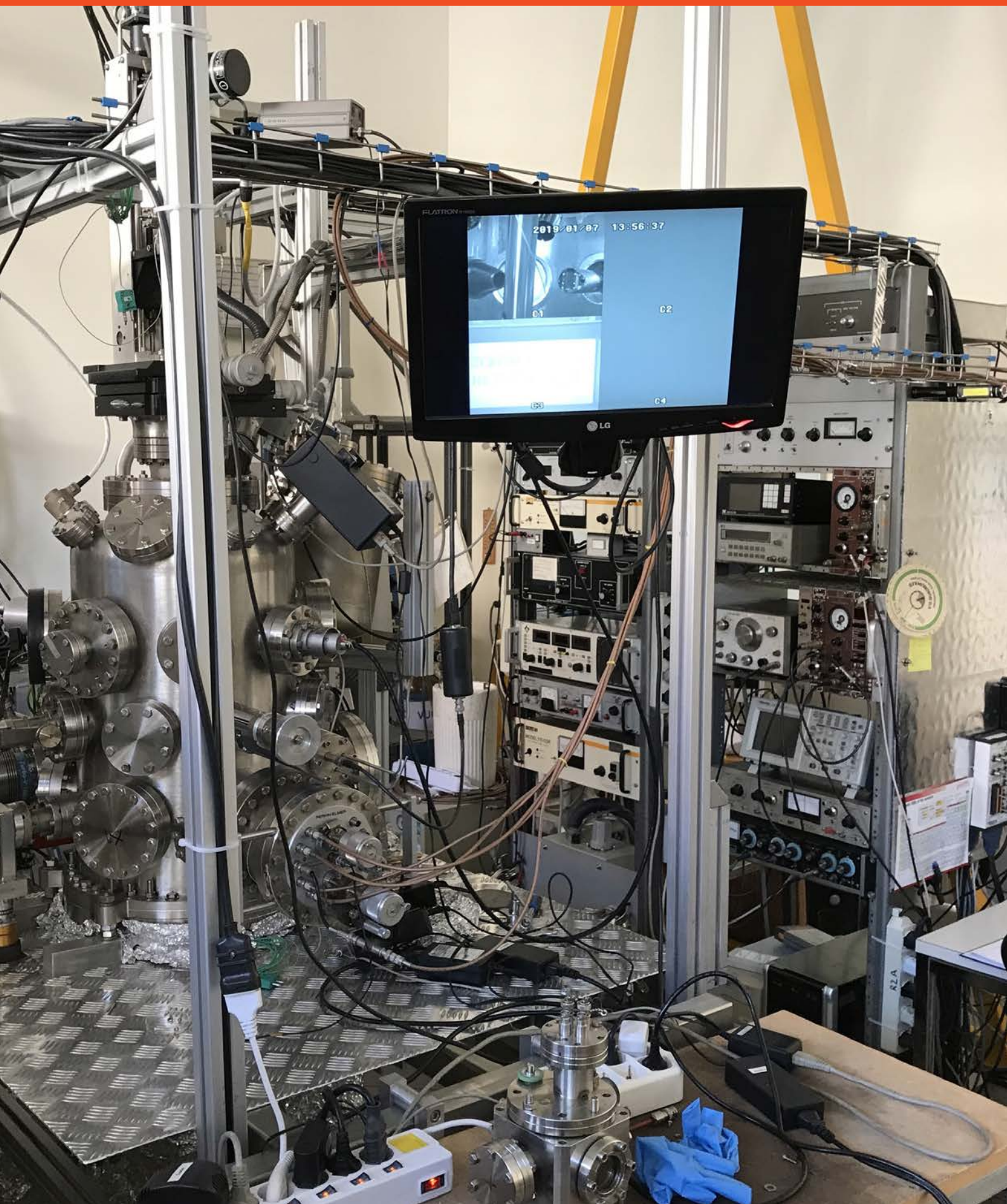
The performance of modern optical and electronic devices is based on their properties at the nanoscale. Therefore, it is essential to control these properties down to the atomic level. This is the research field of the group, aiming at studying experimentally thin films and surfaces that are relevant for applications.

National and international academic relationships regarding the activity

The group participates in the coordination of experimental activities at the Elettra Synchrotron national laboratory in Trieste, through the conduction of the BEAR beamline. The group members are also associated to CNR, receiving funding for their activity at Elettra. They are also research fellows of the University of Johannesburg.

Funded projects / grants

The group participates in local, national and international programmes.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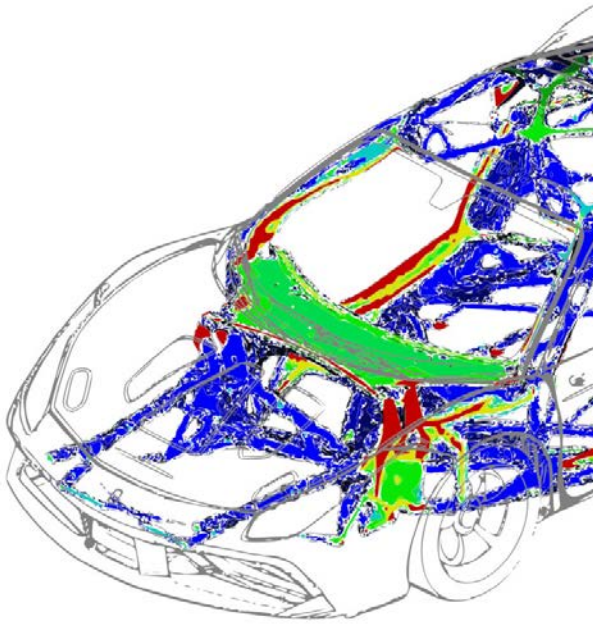
MilleChili

Research activity

MilleChili was founded in 2009 by the Machine Design Group together with Ferrari S.p.A. The Lab has achieved considerable longstanding and recognised expertise in the understanding and modelling of mechanical structures by advanced numerical and experimental techniques. Specific areas of interest are:

- Materials characterization and Finite Element correlation
- Crash event simulation
- Design optimization
- Validation testing and failure analysis

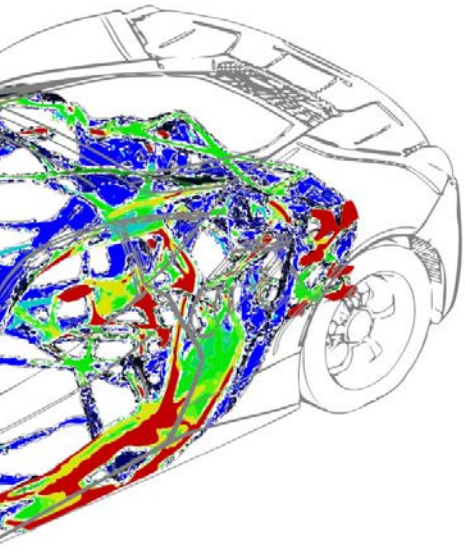


Context and motivation of the research

MilleChili is the academic laboratory working in the field of the automotive chassis design, optimization and innovation. This Lab was founded with the objective of effectively transferring and linking the technology and know-how from the research realm to the industrial environment. The MilleChili belief is that no innovation is possible without research.

Funded projects / grants

During the years, the Lab has participated in several national and international competitive projects. In 2019, the Lab has been involved in the European call MSCA-RISE-2019 - Research and Innovation Staff Exchange called OWHEEL. The project will produce recommendations for improving ride dynamics and passenger comfort through innovative wheel-corner designs for automated vehicles. The project will draw on collaborative research and training between universities and industrial organisations from the EU, Japan and South Africa. Recently, in 2020, the Lab is involved in Regional project entitled Prototype of hydrogen supply and control system set up on fuel cell demonstrator vehicle, as partner for the modelling and structural analyses of the hydrogen storage system and its connections with the vehicle chassis.



Impact on society

During the years, a competent, dynamic, and young working group has developed and has succeeded in gaining the trust of many important companies in the automotive field and in advanced mechanics. To quantify the impact of this lab on the chassis research activity, the total number of master degree students who have attended the laboratory since its foundation are more than 150, 10 per cent of whom having been PhD students. The majority of these students work in the automotive field.

Our heritage

Fino a pochi anni fa si era convinti che l'ingegnere dovesse puntare alla specializzazione estrema, ma le cose sono cambiate: l'ingegnere di domani va formato attraverso un approccio multidisciplinare. Nella terra simbolo del motore termico stiamo affrontando la sfida dell'ibrido, insegnando allo studente come interagire anche con l'informatica, la sensoristica e senza dimenticare l'importanza della fisica. Nella migliore tradizione italiana abbiamo sempre fornito una profonda base culturale, ma nel corso degli anni siamo stati anche capaci di colmare alcune lacune pratiche rispetto agli Atenei esteri.

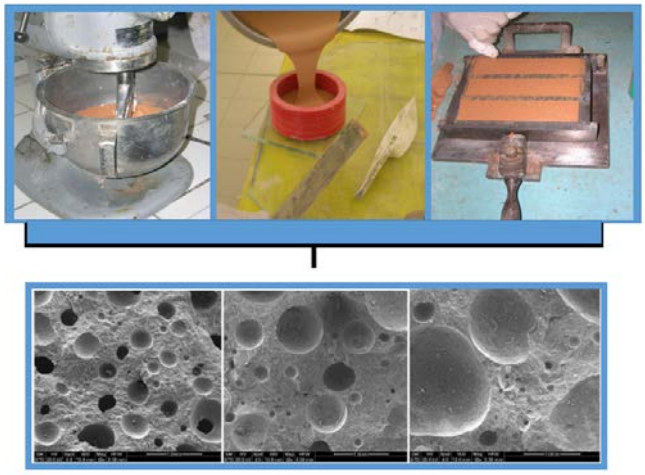
Up until few years ago, we were convinced that engineers should pursue extreme specialization, but the scenario changed: the engineer of tomorrow needs to be raised by means of a multi-disciplinary approach. In the land of combustion engines, we are tackling the hybrid challenge, teaching students how to interact with computers and sensors while avoiding neglecting the relevance of the underlying physics. In line with the long-standing Italian cultural approach, we always delivered a deep and well-structured wide knowledge but, throughout the years, we have been able to fill the "hands-on" gap with foreign universities.

Prof. Giuseppe Cantore, Macchine a Fluido

www.30anniingegneriamodena.unimore.it/site/home/our-heritage.html

Research activity

Geopolymer Group



Research activity

Research Activity of group coordinated by Proff. Cristina Leonelli and Isabella Lancellotti, is focused on formulation and characterization of geopolymers, aluminosilicate materials obtained by alkaline activation of natural or wastes powders. Chemical stability and leaching of metals are investigated in order to understand the consolidation mechanism and raw materials' reactivity.

Impact on society

In 2008 an Italian Working Group on Geopolymers was born within the Italian Ceramic Society. It is coordinated by Prof. Leonelli with the aim of sharing knowledge on these novel materials to address industry towards them. Products of the research are scientific publications congress attendances, projects participation, patents, etc.

Context and motivation of the research

Geopolymeric paste is obtained at room T without or with very low CO2 emissions with respect to cement formulations. Geopolymers have high chemical stability, therefore can be considered a sustainable material useful also for toxic waste encapsulation. Toxic cations can be chemically and physically bound in the 3D aluminosilicatic network.

National and international academic relationships regarding the activity

Numerous national collaboration are active since 2008 as well as international contact and researchers/ students exchange with ZAG (SLO), University of Oulu (F), University of Barcellona (E), Kasetsart University (Thailand), MIPROMALO (Cameroon). Joint international meetings, workshops, seminars and schools are organized worldwide by the group at DIEF.

Funded projects / grants

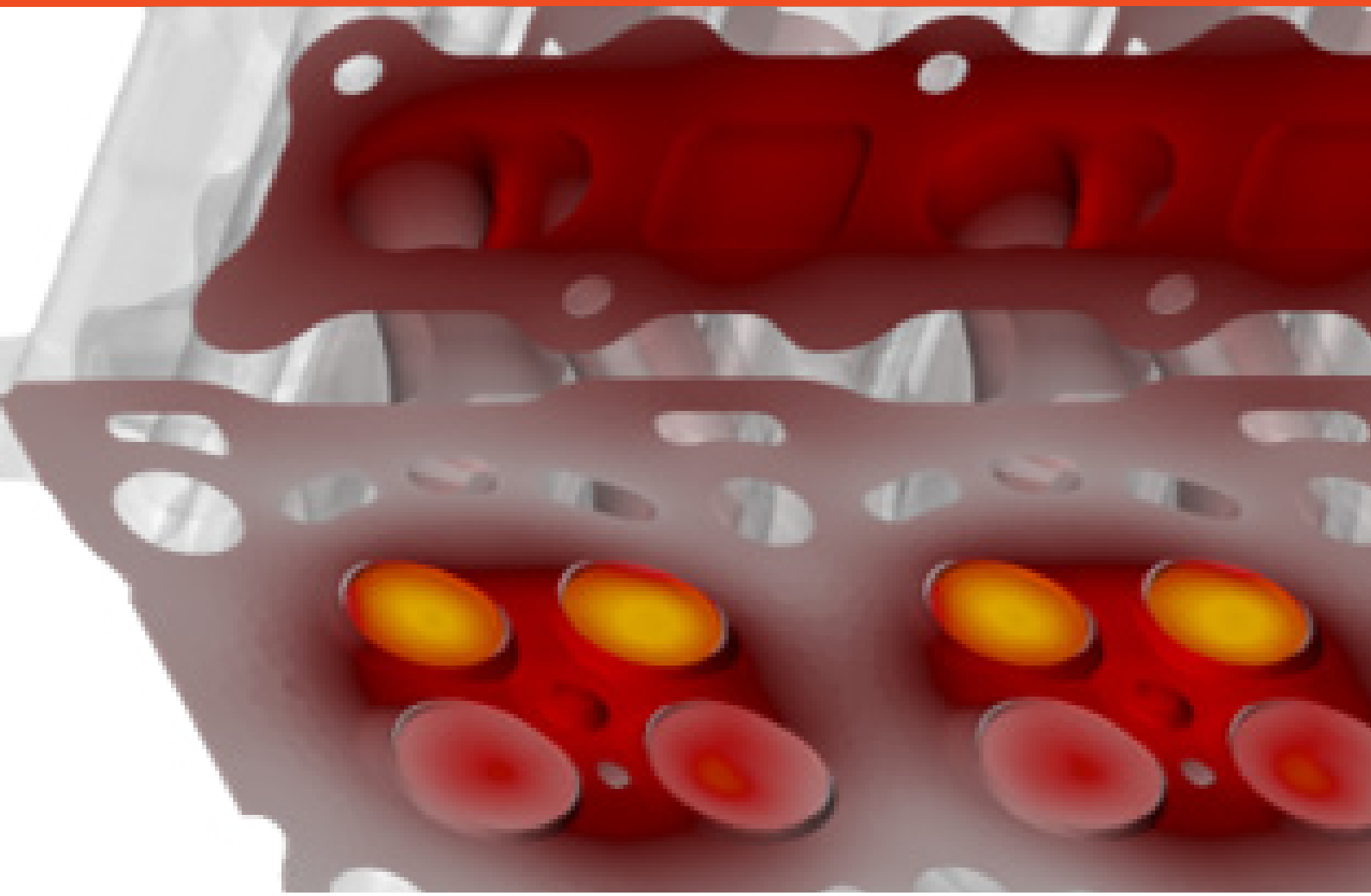
Local, national and international projects have been numerous over the years, just to mention some of them: UNIMORE funds FAR 2016, Emilia Romagna regional call PO FSE 2014/2020 (2018-2019); project “AGM for CuHe” in national call PNR 2015-2020 (2019-2022); project “FLOW” in ERAMIN 2 EU Call (2018-2021), JECS TRUST grants.

Engagement of local entities and fallout on the territory

Engagement of local entities/industries is performed in occasion of the organization of educational events to show the perspective and advantages in using geopolymers. Consultancy activities and applied research promote technology transfer. The first book in Italian language was written to spread the knowledge of these materials.

Research activity

GruMo

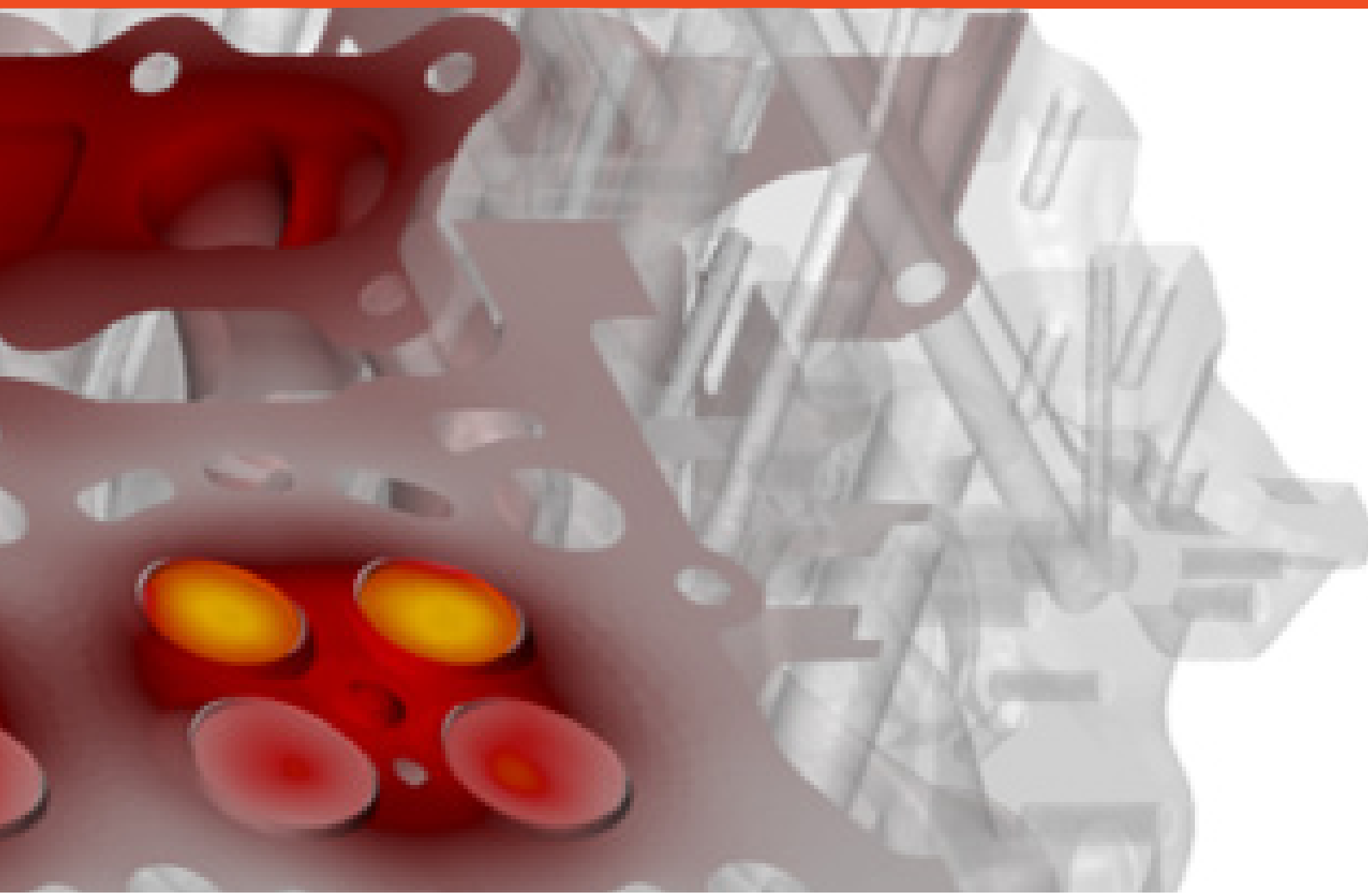


Research activity

The Internal Combustion Engine Research group (Gruppo Motori - GruMo) is specialized in applied fluid-dynamics simulation of internal combustion engines: turbulent flows, fuel sprays, combustion, pollutants formation, heat exchange, fuel cells technology. Advanced 3D-CFD models are developed to address the current and future needs of automotive research and development.

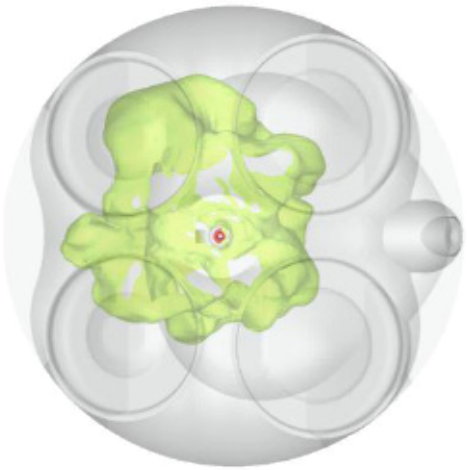
Impact on society

Established and prolonged cooperation with R&Ds of automotive companies are a peculiar trait of the Gruppo Motori – GruMo, with joint projects spanning from student theses to funded PhD and post-doc positions. A consultancy company created from the research group, with cooperation on shared projects between development service and academic research.



Context and motivation of the research

The evolution of internal combustion engines is a mandatory requirement for the development of advanced powertrains. In this context, engine development is more and more carried out on a virtual basis by means of high-end CFD models. The model development carried out at Gruppo Motori – GruMo answers this industrial need.



Research activity

Sustainable Chemical Technologies and Materials Group

Research activity

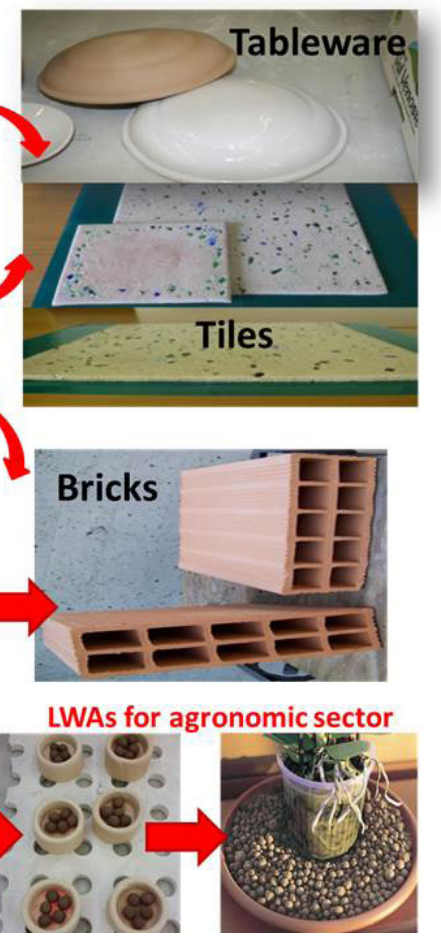
Research Activity of group formed by Proff. Luisa Barbieri, Isabella Lancellotti and Eng. Fernanda Nora Andreola is in the field of sustainable technologies and materials, such as abatement of pollutants from processes, extraction of hazardous or valuable substances from waste, inertization and valorization of waste this last focused on green building.

Context and motivation of the research

Sustainable development, circular economy, green chemistry, air quality and climate change are some of the environmental issues which address research which, in most cases, is performed with private and public external structures, both national and international.

Impact on society

With a methodological-scientific and "super partes" approach, the research group proposes both new technological solutions to industries and understandable dissemination of the results achieved to the community, satisfying present needs, but safeguarding future generations. Products of the research are: PhD, Master and degree theses, scientific publications, congress attendances, projects partecipation, patents, products and prototypes with industrial benefits.



Funded projects / grants

Several international, national and local funded projects (European, bilateral, POR-FESR, CNR, MURST, MIUR, PRRIITT, FAR, Fundations, private structures, Provinces) and grants with a wide feed back on the national and international industry.

Engagement of local entities and fallout on the territory

Engagement of local entities is associated to different private and public comparts: ceramics, steel mills, foundries, agroindustrial, national consortia for the waste management chain, multiutilities, waste treatment plants, etc. with fallout on the territory of new or improved (in particular from the environmental point of view) products and practices.

National and international academic relationships regarding the activity

Several national and international academic relationship: Centre for Waste Valorisation (Portugal), Eduardo Torroja Institute for Construction Sciences of Madrid (Spain), Department of Chemical, Environmental and Material Engineering, High Polytechnic School of Linares (Spain), Department. of Materials Science and Physical-chemistry, University of Barcellona (Spain), Bulgarian Academy of Sciences, Department of Mechanical Engineering, Federal University of Santa Catarina (Brazil), etc.

Nel 2011 feci una previsione agli studenti: dissi loro che saremmo arrivati al pieno utilizzo della tecnologia 5G entro il 2025. Lo strumento è formidabile, il top in termini di prestazioni, ma resto convinto che l'approccio nei suoi confronti vada temperato con valutazioni di carattere ambientale e una particolare attenzione per la salute. Sono convinto di aver dedicato la vita a qualcosa che amo, ed è l'unica strada che conosco per conseguire grandi obiettivi con piena soddisfazione.

Talking to my students in 2011, I forecasted that 5G technology would have been fully developed and deployed by 2025. The technology is magnificent, securing top-notch performance, but I am still convinced that we must approach it by making wise use of careful environmental evaluations, paying specific attention to potential health issues. I am convinced I dedicated my life to something I truly love, and that is the only way I know to satisfyingly pursue relevant goals.

Prof. Gianni Immovilli, Telecomunicazioni

www.30anniingegneriamodena.unimore.it/site/home/our-heritage.html

Research activity

Agent and Pervasive Computing Group

Context and motivation of the research

The research activities range on different topics that are diversely motivated. In particular, the research activities on Smart Cities and on Virtual Factories are recently started since these two topics are considered in all the world very 'hot' topics in the ICT area.

Impact on society

The main results of the research carried out by the Agent and Pervasive Computing Group were the assignment of various "paper awards" and the invitation to write articles on books or special issues of prestigious magazines.

Research activity

The Agent and Pervasive Computing Group (www.agentgroup.unimore.it) is active since 1998 and its participants belong to the Engineering School. Research activities range from theoretical to applied computer science: distributed systems with mobile agents, middleware for mobile and pervasive applications, adaptive and self-organizing systems, systems based on IoT and Data Mining, systems based on bio-inspired approaches, Smart Cities and Virtual Factories.

Laboratory of Geomatics Engineering

Research activity

Researchers at the Laboratory of Geomatics Engineering, coordinated by Prof. Alessandro Capra, focus on geodetic surveying by traditional and novel techniques for environmental/ structural monitoring and risk/hazard assessment. In the field of photogrammetry, researchers develop methodologies devoted to the use of Unmanned Aerial Vehicles for 3D reconstruction of natural and anthropogenic environments and approaches based on geospatial data for managing emergencies.

Impact on society

Hundreds disasters related to natural and technological hazards are reported worldwide every year. Thousands of people are globally killed by disasters and the climate change together with the negligence of human activities strongly contribute to grow the impacts of these events. Preventive approaches and risk mitigation plans are necessary in order to avoid such enormous loss of human lives. The researches of the Geomatics Engineering Lab contribute in designing effective actions to face emergencies, to protect the society and to increase the resilience of the environment.

Context and motivation of the research

The research activities carried out by the Geomatics Engineering Lab aim at testing new approaches and methodologies for the acquisition, processing and analysis of geospatial data in a context of rapid evolution of technological instrumentation, that become increasingly accessible and easy to use. The researches give a tangible solution to the needs of real world applications; among them the construction industry and the whole civil protection ecosystem.

National and international academic relationships regarding the activity

Deformation monitoring and precision surveying are performed on the basis of strong relationships with national and international research institutes such as Polytechnic of Torino, University of Bologna and University of Venice. Within the international scenario, the laboratory is included in the SCAR Giant expert group and cooperates with University of Buenos Aires, University of California Santa Barbara and ETH-Zurich.

Funded projects / grants

- “Monitoring the vertical deformations of the Modena Cathedral” since 2008.
- “Italian Geodetic Observatory in Antarctica” since 2014.
- INSPIRE project funded by Emilia Romagna Region since 2019.
- EuroMarine project on “Developing technology and methods for the precise investigation of marine animal forest 3D-structural complexity” since 2019.
- Archaeological missions in Argentina funded by the Italian Ministry of Foreign Affairs since 2013.

Engagement of local entities and fallout on the territory

The Geomatics Engineering Lab is greatly involved in monitoring deformation activities in cooperation with local Authorities such as the Modena Municipality for the safeguard of the UNESCO site in relation to the effects of subsidence as well as the strong engagement with the Agencies for Civil and Environmental Protection in relation to natural hazards assessment.

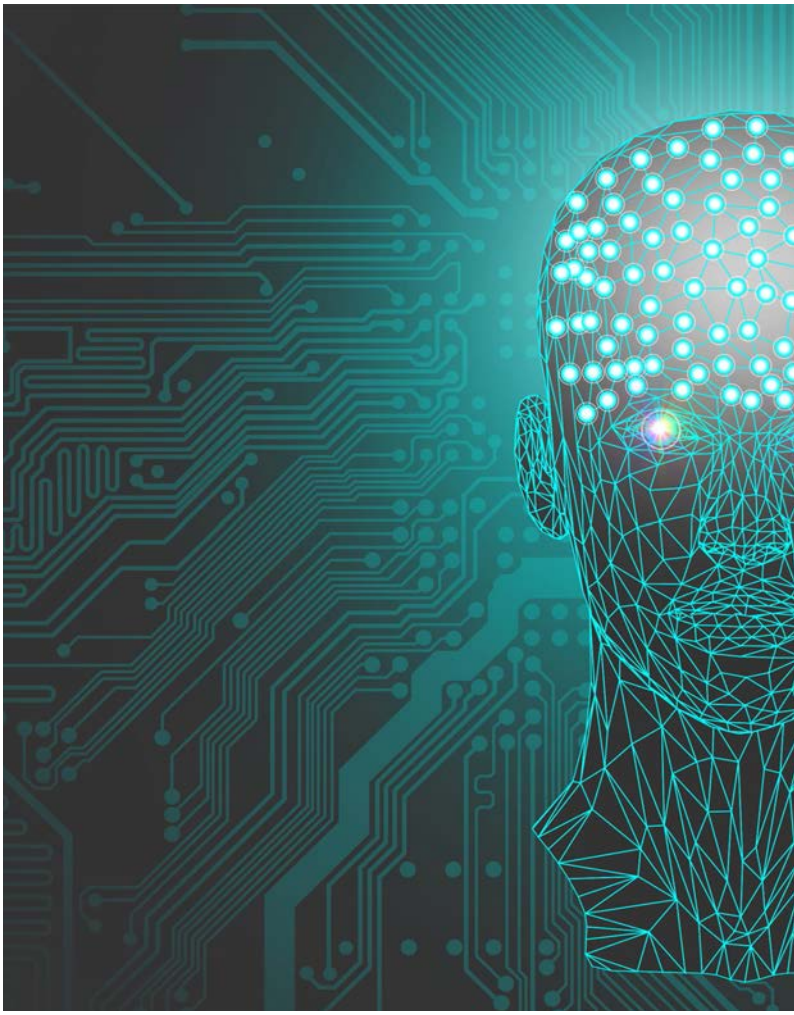
Micro and Nano Electronics Group

Research activity

The micro and nano electronics group is active in the broad area of pervasive electronics for ubiquitous and sustainable energy-efficient applications. Relevant topics are ultra-low power neuromorphic electronics, nano-bio-electronic sensing, more-than-Moore and beyond-Moore components, novel wide bandgap semiconductors for efficient power applications, and RF design for low-power communications, using laboratory experiments and simulations.

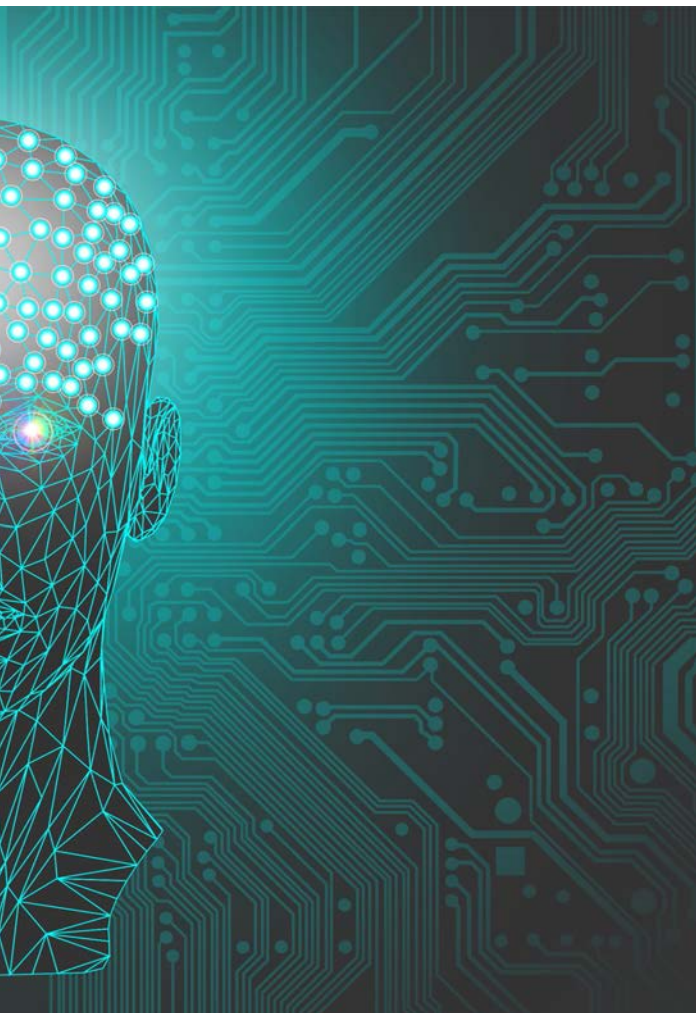
Context and motivation of the research

As the world becomes more interconnected and energy-hungry, key enabling semiconductor micro- and nano-technologies can improve energy efficiency and autonomy of both small portable and large server-farm-like electronic systems, e.g. via smart power management and the deployment of pervasive artificial intelligence solutions from the edge to the cloud.



Impact on society

Our research links to the urgent need of intelligent systems, personalized healthcare, green and sustainable industries. By transferring research to higher education, promoting the creation of successful spin-offs and start-ups, and patenting innovative concepts and results, we ensure long-lasting impact on the scientific and industrial communities and on our society.



Funded projects / grants

The microelectronics group is partnering and/or coordinating numerous national and European projects. Among the on-going ones are: BeFerroSynaptic, on neuromorphic computing with ferroelectric devices, IN-FET, on technology platforms for treating neurological diseases, REACTION and WINSiC4AP on wide bandgap semiconductors, CONVERGENCE on wearable sensors, ADAS+ on advanced autonomous driving.

Engagement of local entities and fallout on the territory

Our research addresses core issues for future consumer and industrial “Internet of Everything” applications, smart cities, smart health, 5G and 6G communications. By disseminating anticipated global visions on the upcoming future technologies, we help policy makers take the best decisions to catch future opportunities.

National and international academic relationships regarding the activity

The micro and nano electronics group has a wide network of prestigious academic relations worldwide, e.g., Singapore University of Technology and Design, Soochow University, U. A. Barcelona, T.U. Wien, Purdue University, Université de Grenoble. It is also a very active unit of the IU.NET consortium, grouping the Italian excellence in micro- and nano-electronics research.

Our heritage

Del campus di ingegneria ricordo la prima pietra, le riunioni tecniche a cui noi ingegneri non mancavamo mai per contribuire a mettere a punto tutti i dettagli. E' stato un percorso emozionante e un grande traguardo, che oggi ci consente di essere estremamente competitivi e a progettare nuovi e più ampi spazi per la didattica. Il mio unico piccolo rimpianto è che il mio percorso professionale e didattico si sia concluso in un momento così stimolante, ricco di prospettive e repentini cambiamenti.

I witnessed the laying of the foundation stone of the Engineering campus, the technical meetings we never missed to get all the details straight. It was a thrilling path toward a big goal that allows us today to be extremely competitive and to design new and larger teaching spaces. My only regret is that my professional path got to its conclusion in such a stimulating moment, so embellished with beautiful perspectives and rapid changes of pace.

Prof. Angelo Oreste Andrisano, Disegno e Metodi dell'Ingegneria Industriale

www.30anniingegneriamodena.unimore.it/site/home/our-heritage.html

Numerical Analysis Group

Research activity

The Numerical Analysis Unit performs research on various topics of Numerical Analysis. In particular, research activities are being made on the numerical solution of problems for reaction-diffusion equations, on iterative methods for solving complementarity problems and on topology optimization. In this context, both the theoretical analysis of numerical methods and their software implementation are performed.

Impact on society

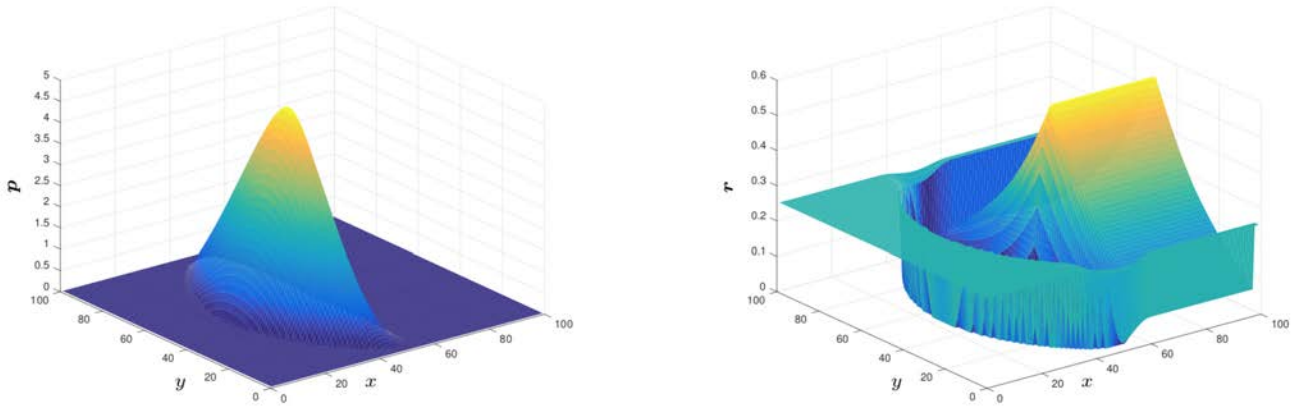
The addressed topics in topology optimization have applications in 3D printing, which is becoming increasingly common not only in the industry, but also for domestic use. Our researches on complementarity problems have, instead, applications in hydrodynamic lubrication, with possible impacts in scientific and industrial contexts. Products of the research include scientific publications, congress attendances and production of numerical software.

Context and motivation of the research

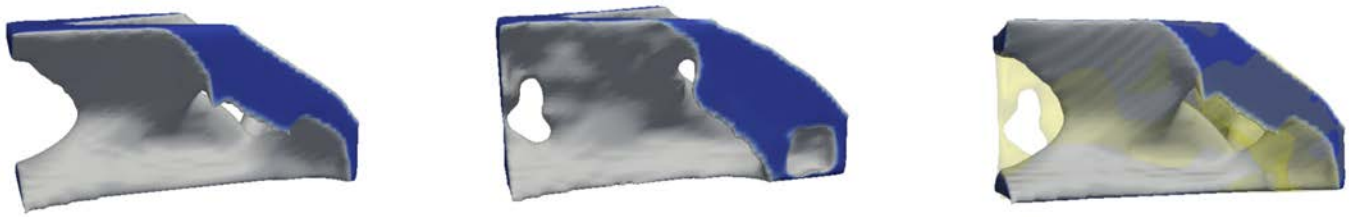
The research is motivated by the need to develop and mathematically analyze new numerical methods in order to efficiently solve a great variety of problems. This is especially relevant in recent years, when computer methods and models have become ever more common in everyday life. In this context, our researches often start from and involve real applications.

National and international academic relationships regarding the activity

Ongoing scientific collaboration: research on topology optimization with prof. Xiaoping Qian at the Department of Mechanical Engineering, University of Wisconsin-Madison.



Profiles of pressure (left) and of a variable related to density (right) that solve a complementarity problem in hydrodynamic lubrication.



Suppression of oscillating boundaries (visible in the design on the left) by objective penalization.

Structural Design for Seismeic protection Lab

Research activity

We investigate the strength of fibre reinforced composite materials (FRCM) for building strengthening and retrofitting, with special emphasis on recycled and secondary raw materials. We optimize fibre adhesion of the inorganic matrix, crack pattern and failure modes. Applications to Fibre Reinforced Concrete (FRC) is also considered.

Context and motivation of the research

The need for materials which offer high-performance alongside compatibility with the building tradition, fire resistance, durability and safety is much felt in the ever growing field of building restoration and rehabilitation. Research activity aims at merging skills in the field of innovative building materials and new technologies.

Engagement of local entities and fallout on the territory

The research activity involves several companies, ranging from plastics manufacturers to cement producers, from high-performance dry fabric rolls sellers to nation-wide recycling consortia. Moreover, development of new technologies, equipment and patents by industries and laboratories working in the field of building materials is pursued.

Impact on society

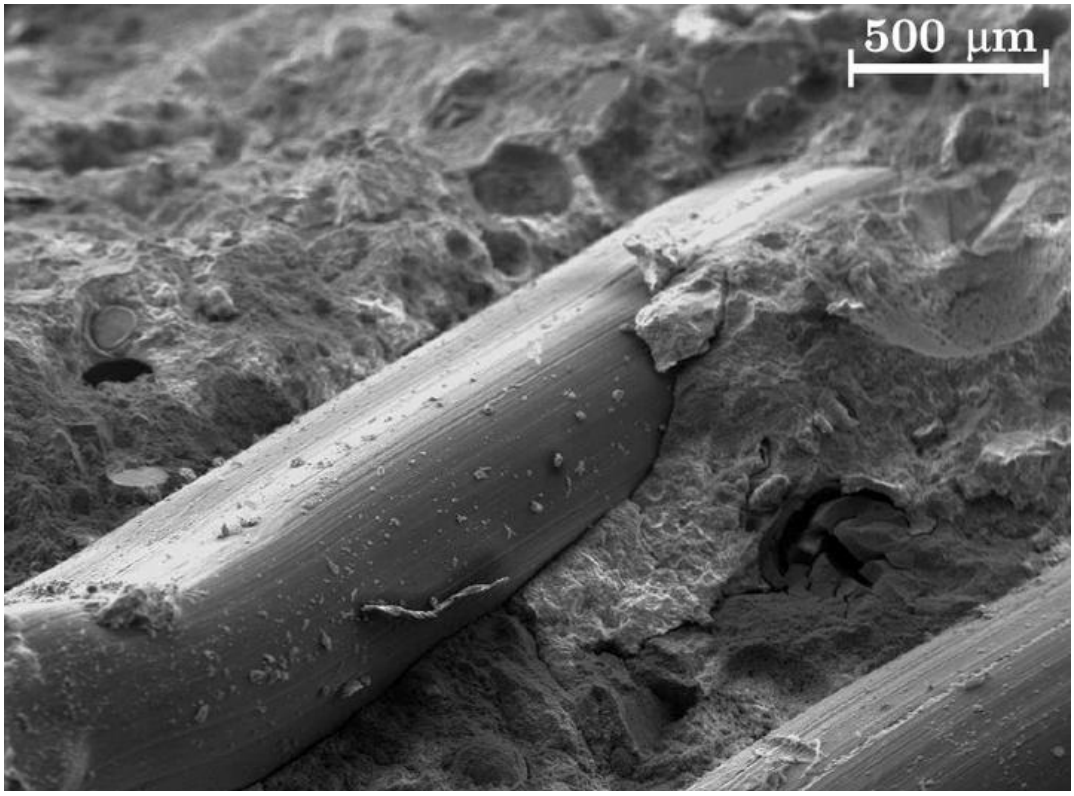
We aim to develop new industry grade processes and materials that fill in the gap of existing retrofitting systems. The group is already patent owner of high-perf FRC systems. Development of new design tools to address durability issues (safe lifetime) of both new and existing buildings materials is carried out.

National and international academic relationships regarding the activity

The activity takes place in partnership with international academias such as Keele, Sheffield (UK) and Minho (PT). A significant interaction with international research units from China (Fuzhou University) and Switzerland (HEIG-VD), USA (Cornell University, Ithaca NY) is taking place.

Funded projects / grants

Bando di Ricerca Applicata 2013/2014 – Sviluppo, modellazione e applicazione di sistemi di rinforzo strutturale in materiale composito di fibra di carbonio e resina IPN per l'adeguamento sismico, il ripristino ed il consolidamento di edifici civili e industriali: metodologie, prestazioni e failure analysis (140 K€)
POR FESR 2014-2020 ASSE 1 AZIONE 1.2.2 CUP E81F18000310009 Impiego di Materiali Plastici da Riciclo per malte e calcestruzzi Strutturali Alleggeriti (700 K€)
Financial support from (MIUR) in the framework of the Project PRIN-2017HFPKZY (680 K€).


500 µm

Research activity

Measurements, Instrumentation, and Sensors Group

Research activity

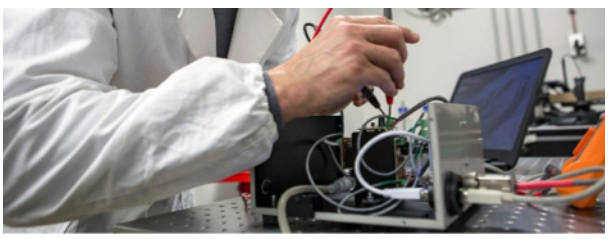
The Measurements, Instrumentation, and Sensors Group is devoted to the design, development, and characterization of sensors and instrumentation for biomedical, automotive, agricultural and, industrial applications.
Headed by Professor Luigi Rovati, the group operates in four laboratories namely OptoLab, BrightLab, MS2 and ASELab (for more information please visit www.misure.unimore.it)

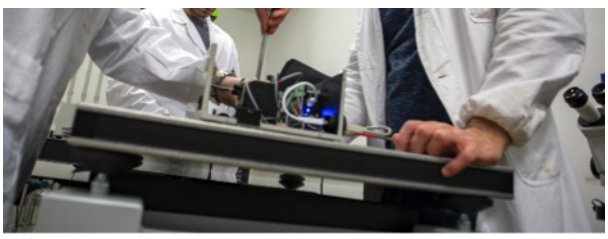
Context and motivation of the research

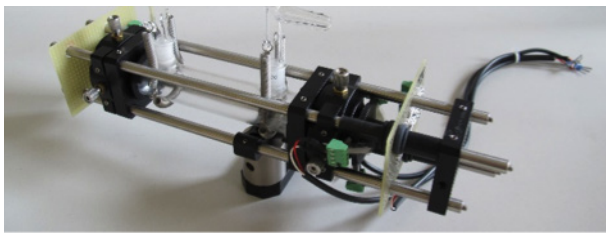
The group deals with applied research in the field of measurements to support biomedical, automotive, and industrial applications in general. In particular, the research interests have been and continue to be dominated by the challenge to develop innovative measurement methods, calibration procedures, measuring systems and sensors.

Engagement of local entities and fallout on the territory

Starting from the first laboratory “Optolab”, the close collaboration with the regional manufacturing base has prompted the Group to set up laboratories specifically dedicated to supporting the main production sectors: MS2 (biomedical applications), AseLab (automotive applications) and, BrightLab (characterization of optical sources and detectors).







Impact on society

The group has consolidated research collaborations with various research centers and companies both regional and international. Over the years, these collaborations have led and are leading to the filing of various patents and the development of devices currently used in industrial applications.

National and international academic relationships regarding the activity

The group has consolidated collaborations both nationally and internationally: Università di Bologna, Università di Brescia, Università di Trento, Nasa Gleen Research Center (Cleveland, USA), Bascom Palmer Eye Institute (Miami, USA), Florida International University (Miami, USA), University of Applied Sciences Western Switzerland (Sion, Switzerland), Mid Sweden University (Sundsvall, Sweden)

Funded projects / grants

1. Development of a new non-contact screening method and instrument for the detection of narrow ocular anterior chamber angle, Partner: Policlinico S. Matteo di Pavia, Fondazione Bietti, 2020-2023
2. Sostenibilità e innovazione per il miglioramento e la valorizzazione delle risorse biologiche agroalimentari (sostinnovi), Partner: CRPV, Università di Bologna, Università di Parma, 2016-2018

Our heritage

Al DIEF abbiamo sempre pensato che fare università significasse innanzitutto fare ricerca e innovazione. Inoltre dobbiamo preparare gli ingegneri informatici a risolvere i mille problemi dei diversi settori, mantenendo un approccio curioso. Paradossalmente, il problema principale di un territorio a forte vocazione industriale come il nostro è che le aziende hanno bisogno di ingegneri e cercano di acquisirli subito, ma è meglio che rimangano ancora due o tre anni dopo la laurea ad approfondire temi d'avanguardia nei nostri laboratori.

At DIEF, we have always thought that University firstly meant research and innovation. Moreover, we have to teach computer engineers to solve the typical problems of many different sectors, while keeping a curiosity-driven approach. Ironically, the main problem of a strongly industry-driven territory like the one in which we are is that companies need engineers and they try to hire them quickly, although it would be better for them to remain in the University for a couple of years after graduation to take a deeper look at cutting-edge research topics.

Prof. Paolo Tiberio, Sistemi di Elaborazione delle Informazioni

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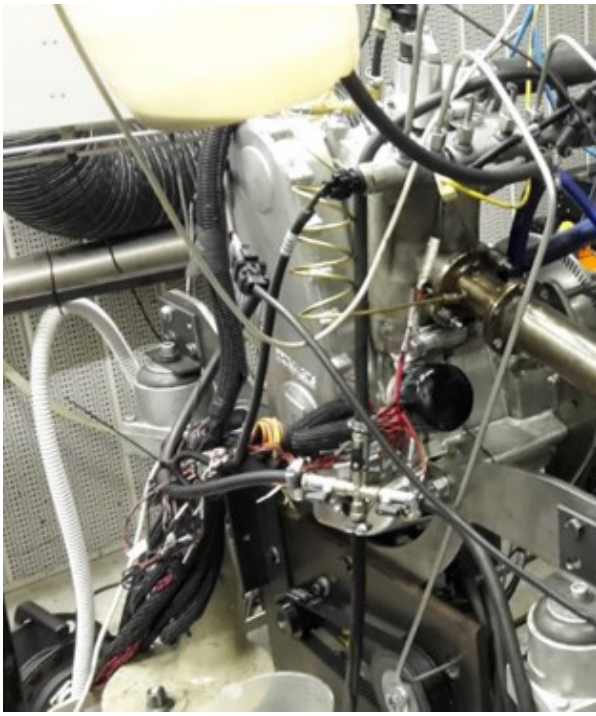
Advanced 2-Stroke Engines

Research activity

The goal of the research group, lead by Prof. Enrico Mattarelli and Prof. Carlo Alberto Rinaldini, is to explore and further develop the potential of the 2-stroke cycle, applied to all types of internal combustion engines



Context and motivation of the research

The most efficient and sustainable piston engines in the world are the two-stroke big power units used on ships: however, some issues are still to be addressed, in order to extend the application of this concept to other fields. Today, the technology progress provides the tools to achieve this purpose.

Engagement of local entities and fallout on the territory

The research team cooperates on this specific subject with international companies located in Emilia Romagna and in the Italian territory. Among the first ones: EMAK, Malossi, Kohler Engines, Oral Engineering, 4-E Consulting, Hypertec Solutions; out of the region, research projects have been carried out with General Motors, CMD, MTM.

Impact on society

Several projects have been completed, and others are currently in progress. In particular, the research activity brought to the construction and experimental calibration of two innovative prototypes of 2-stroke engines, both Compression and Spark Ignition. Moreover, a patent regarding the design of opposed piston engines has been submitted.

National and international academic relationships regarding the activity

The research group is an active member of the international scientific community focused on 2-stroke engines, including, as an example: Università di Firenze, IFP Energies Nouvelles, University of Stuttgart, Graz University of Technology, University of Bath, Universitat Politècnica de València, and many others.

Funded projects / grants

1) Thermo-fluid-dynamic optimization of CI 2-Stroke aircraft engines (CMD); 2) Modeling of 2-Stroke high speed diesel engine for passenger car application (General Motors); 3) Analysis of Loop Scavenged and Opposed Piston 2-Stroke Diesel Engines (GM); 4) Low Heat Rejection 2-Stroke Engine Study (GM); 5) CFD analysis for the development of a 2-stroke GDI engine (MTM)

DBGroup

Research activity

The DBGroup research addresses issues related to the storage, management, querying, and analysis of data. Big Data Integration techniques and entity recognition -the process for identifying the same real world entity in different data sources- are the main current research interests. Other topics include Semantic Web, Data Mining, NLP and Databases.

Context and motivation of the research

Managing large amounts of data, extracting information and knowledge from them has always been a great research interest, and undoubtedly offers competitive advantages when applied to real business problems. The recent big data explosion and the need of big data required by artificial intelligence applications make the DBGroup research topics particularly challenging and timely.

Engagement of local entities and fallout on the territory

DBGroup members collaborate with public and private organizations in data management and analysis projects. An agreement with CINECA allows DBGroup members to exploit the capabilities of one of the most powerful European super computers. Other projects concern Big Data Integration in the health sector by providing cutting-edge solutions for the Internet of Medical Things.

Funded projects / grants

The DBGroup participated in European and Local projects. Recently, Trafair, a CEF Telecom project to study the impact of the traffic on air pollution, Re-search Alps, a CEF Telecom project to integrate open databases describing research laboratories, Keystone, a cost Action involving 200+ researchers working in the keyword search area, SBDIOI40, a regional project developing a data analytic platform.

Impact on society

The DBGroup developed a number of theoretic data integration techniques published in prestigious international venues, and implemented prototype applications to support the research. MOMIS, a data integration system developed by DBGroup, has been reengineered and is now marketed by DATA RIVER a startup founded by group members.

National and international academic relationships regarding the activity

DBGroup members have carried out and are carrying out research projects with important national and international institutions. The group has consolidated relationships with international Universities, such as the University of Zaragoza and Santiago (ES), Potsdam (DE), Paris Decartes and Aix-Marseille (FR), Rijeka (HR) and with companies such as Microsoft, and Huawei.

Research activity

ISE

Research activity

The research activities of Industrial and Systems Engineers (ISE) group of DIEF are related to the achievement of a waste and accident free smart factory, enhanced by a digitally enabled lean. In this regard, ISE group will focus on Cyber-Physical Systems (CPS) and will leverage on the Industry 4.0 technologies.

Impact on society

The impact of the group's research activities is linked to the various technology transfer projects that are being carried out. The group has contributed significantly to the creation of a European Digital Innovation Hub.

Engagement of local entities and fallout on the territory

Collaborations with local / regional an national Confindustria (the main association representing manufacturing and service companies in Italy) with local and regional/national companies. Participation in the activities of the Global RF Lab Alliance (GRFLA). Participation at italian Industrial System Engineering Association

Context and motivation of the research

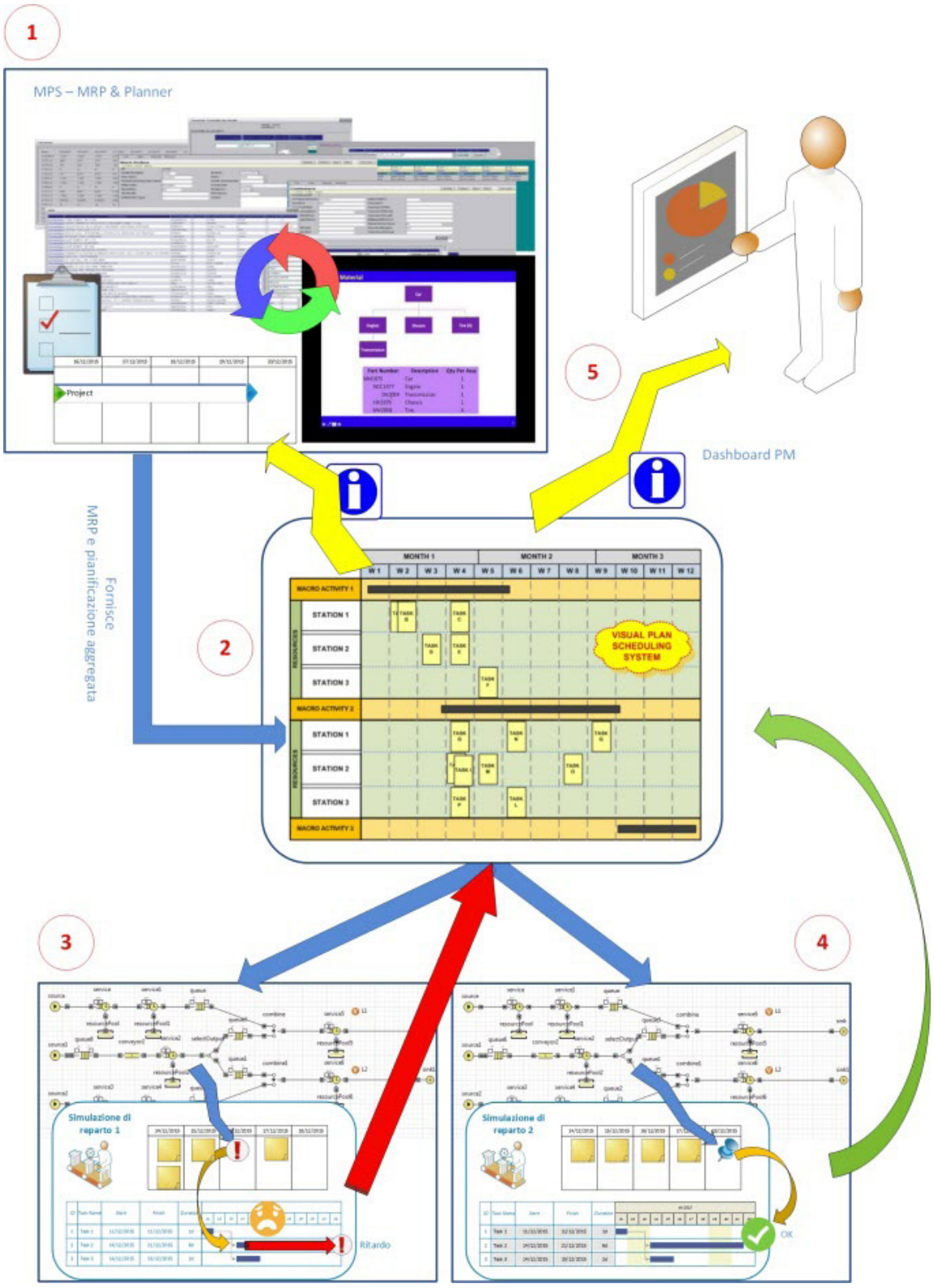
The I4.0 revolution will enable lean/operational excellence fully adoption, but to reach the goal the holistic lean toolkits will have to be modified. Technologies alone are particularly effective in the short-medium term. To get a long term competitive edge it is necessary to combine technologies with adequate business models.

National and international academic relationships regarding the activity

- Hochschule für Technik Stuttgart
- BIBA – Bremen Institute for Production and Logistics GmbH
- Institut für Wissensmedien Koblenz-Landau
- RWTH Aachen University
- Universitat Oberta de Catalunya
- The National Institute for Insurance against Accidents at Work (INAIL)

Funded projects / grants

- Smart de-energization of machine sets with wearable RFID system
- Reorganisation of the company's first aid service
- Open Digital lab for you
- An operative framework for the risk management in repetitive complex projects
- Development of an integrated hardware and software system for cold chain management


1
MPS – MRP & Planner
Project
5
Dashboard PM
Fornisce
MRP e pianificazione aggregata
2
MONTH 1
MONTH 2
MONTH 3
W 1
W 2
W 3
W 4
W 5
W 6
W 7
W 8
W 9
W 10
W 11
W 12
MACRO ACTIVITY 1
STATION 1
STATION 2
STATION 3
MACRO ACTIVITY 2
STATION 1
STATION 2
STATION 3
MACRO ACTIVITY 3
RESOURCES
VISUAL PLAN SCHEDULING SYSTEM
3
4
Simulazione di reparto 1
Ritardo
Simulazione di reparto 2
OK

Our heritage

L'ingegnere meccanico non può limitarsi ad acquisire competenze, deve avere passione, e questo è un territorio speciale per chi è appassionato di meccanica. Noi stessi docenti abbiamo tratto grande giovamento dal contatto con le aziende, sviluppando un approccio più pratico e diventando col tempo buoni ingegneri. Gli strumenti di cui oggi è dotato il dipartimento sono formidabili, ma è importante che l'ingegnere di oggi non abbandoni completamente la modellazione analitica per diventare capace di ideare soluzioni più ampie.

Mechanical engineers shall not just learn new competencies but must show passion, and this is a special territory for mechanic's enthusiasts. We, as professors, have benefited significantly from the relationships with enterprises and companies, developing a more down to earth and practical approach, refining and perfecting our engineering skills over time. The tools that DIEF boasts today are formidable, but it is fundamentally important for todays' engineers not to abandon completely the analytical modelling, in order to develop wide-impact solutions.

Prof. Antonio Strozzi, Progettazione Meccanica E Costruzione Di Macchine

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Research activity

Vibration and Powertrain Group

Research activity

The group consists of Prof. Francesco Pellicano, Prof. Silvio Sorrentino, Prof. Marco Barbieri, Dr. Antonio Zippo and the main research topics (theory, modeling, testing) are:

- Innovative materials for NVH applications
- Gears and powertrain
- Mechanical Vibration
- Dynamics and stability of structures, mechanical systems and vehicles
- Fluid structure interaction.

Impact on society

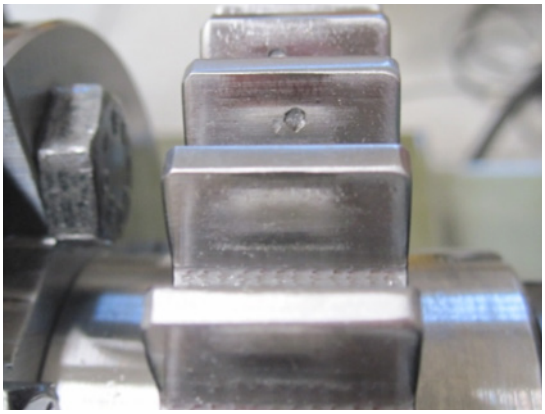
The scientific research is the main activity of the group, the results are published on the main international journals, contributing in spreading the knowledge. The intense cooperation with industries of the region allow a direct technology transfer to the society. The research group founded the startup Pulsar Dynamics in 2014.

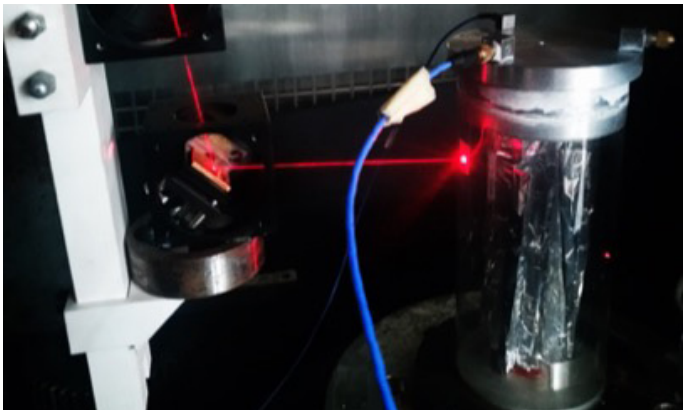
Context and motivation of the research

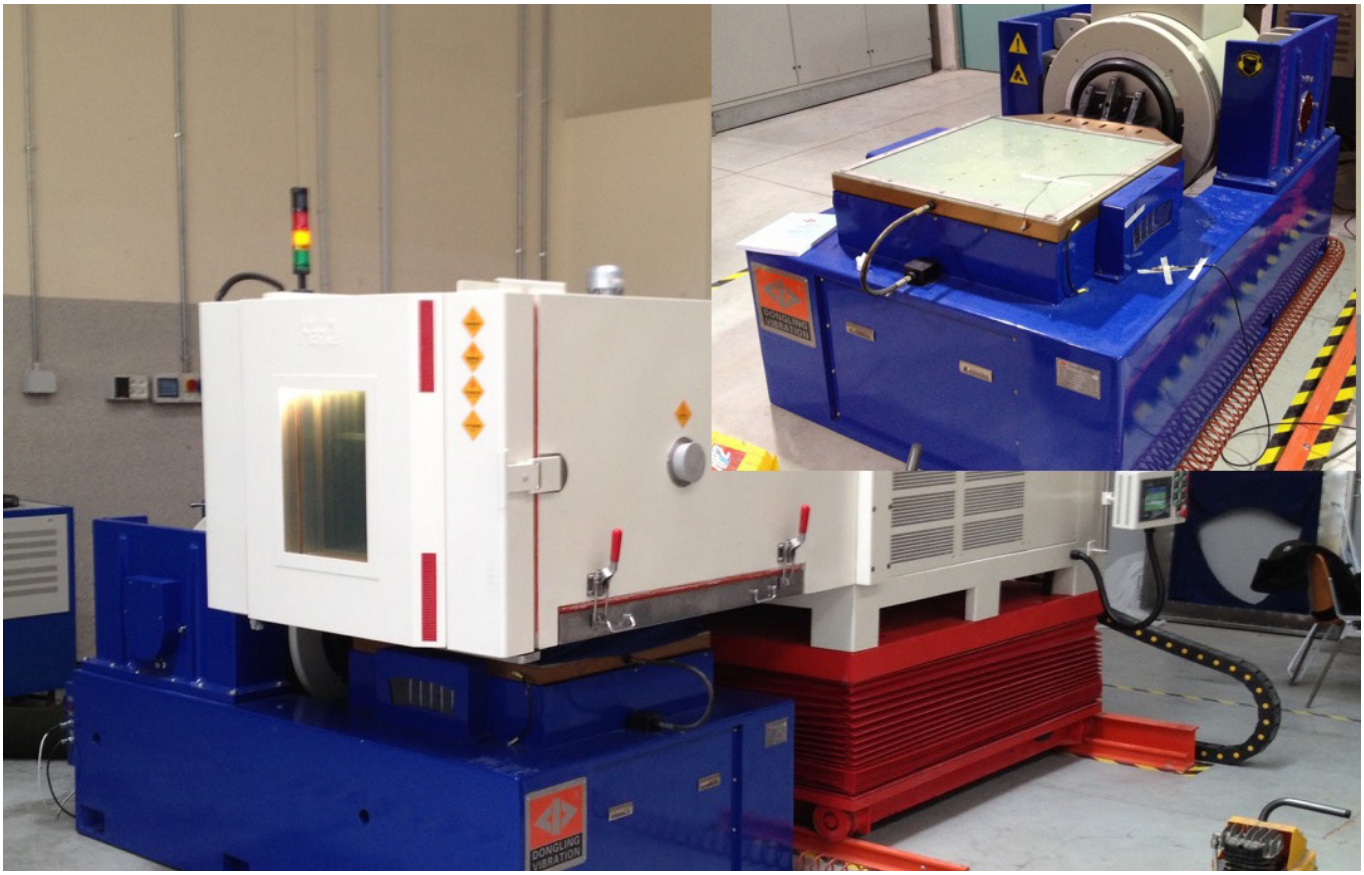
The need of competitiveness for the European Union with respect to its competitors is leading to find new solutions, materials and technologies as for the application of lightweight structures and innovative materials in different fields as Civil, Nuclear, Aerospace, Automotive, and is a key point the study of dynamic properties

National and international academic relationships regarding the activity

- Prof. Len Gelman, The University of Huddersfield.
- Prof. Sinniah Ilanko, Waikato University, Hamilton, New Zealand.
- Prof. Marco Amabili, Università di Parma, Mc Gill University.







Engagement of local entities and fallout on the territory

The research group has a close collaborative relationship with companies in the automotive field: Ferrari, Maserati, Dallara, Lamborghini and Ducati for on-road vehicles, supercars and motorbikes, and also for off-road vehicles and tractors with CNH

Funded projects / grants

- TASC “Trattrici Agricole Smart & Clean”
- DiaPro4.0: Sistema ‘cost-effective’ multisensore di Diagnostica-Prognostica integrato in azionamenti meccanici dell’Industria 4.0
- MetAGEAR - Piattaforma integrata per la progettazione e la produzione avanzata di riduttori industriali
- Project FP7 FORTISSIMO
- INDGEAR - On-line early damage diagnosis, prognosis and root cause analysis for Industrial multi-stage gearboxes

Research activity

SIGCOMM Lab

Research activity

Prof. Giorgio Matteo Vitetta (The SIGCOMM Lab – Laboratory for Signal Processing and Data Communications, www.sigcomm.unimore.it) - Automotive Imaging Radar for ADAS and Precision Agriculture Applications.

Context and motivation of the research

This research activity aims at exploring the use of modern integrated radar devices, operating at millimeter waves and equipped with antenna arrays (MIMO radars), in modern cars and in industrial agricultural vehicles.

Impact on society

This research activity is leading to the development of new radar imaging algorithms that allow to improve the efficiency, precision and safety of industrial agricultural vehicles.

National and international academic relationships regarding the activity

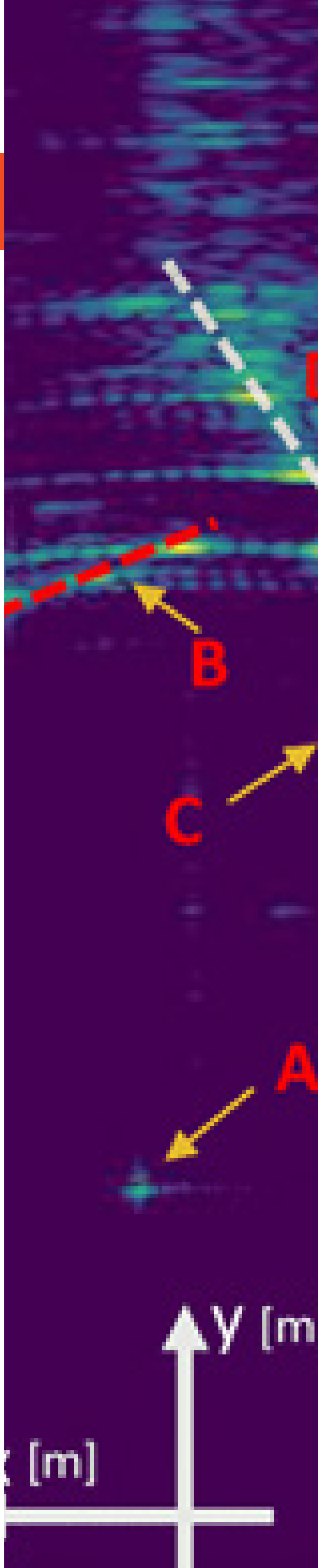
The prestigious KU LEUVEN university (Leuven, Belgium) is involved in this research activity.

Engagement of local entities and fallout on the territory

Most of the tasks being carried out within this research activity are currently funded by the CNH company through its Italian headquarters (Modena) and its Belgian headquarters (Zedelgem).

Funded projects / grants

CNH is currently funding this research through two collaboration contracts.



EELab - BEELab - LIFT

Research activity

During the years, the heat transfer researches lead to consequential impacts into various topics: Renewable energy solutions for a low carbon society; Super-reflective materials mitigating the overheating of large urban areas; Electric propulsion and hydrogen propulsion for more sustainable mobility; Fire protection engineering applied to the industrial and historical heritage. Group: Fisica Tecnica.

Context and motivation of the research

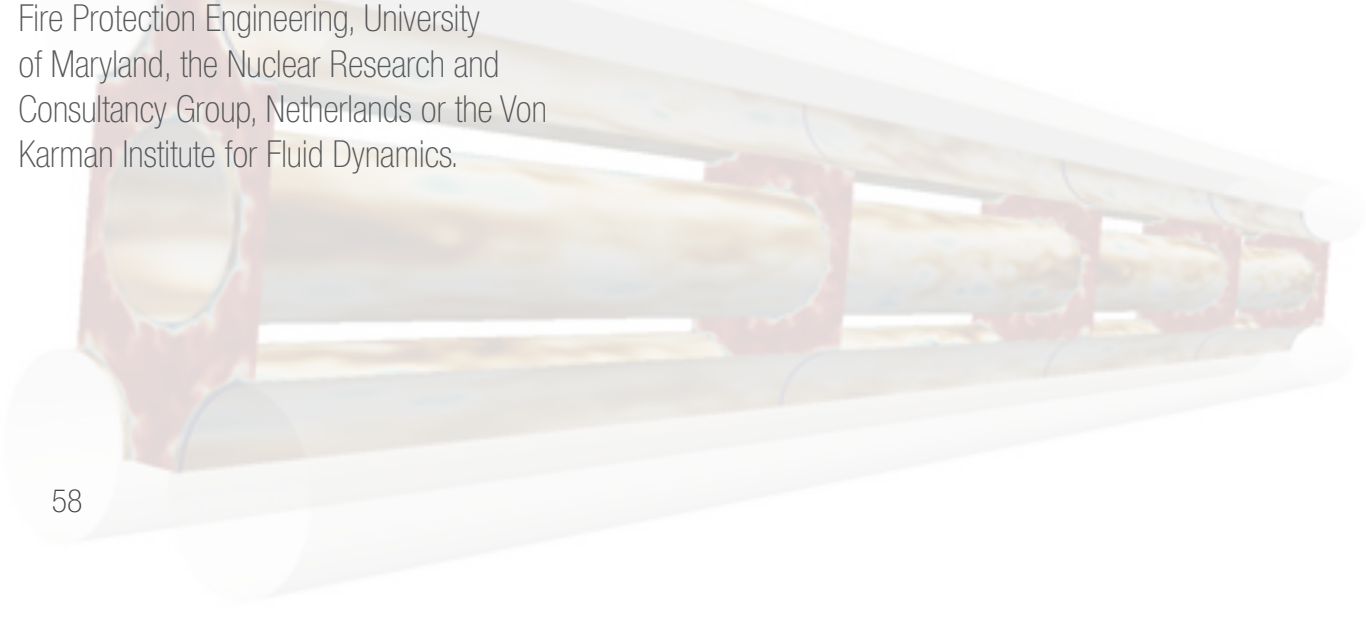
Sophisticated modeling and experimental investigation tools were used, in all the different aspects of heat exchange: from the optimization of cooling micro-channels of electric motors, the control of biomass energy conversion, the overall analysis of the thermal behavior of electromechanical systems, up to the buildings-environment thermal interaction.

Impact on society

Results obtained allowed to recognize the research group as key actor in several fields: the Energy efficiency Laboratory is globally recognized as one of the few certified labs for solar reflecting materials evaluations; International companies such as ALL Power Labs sponsored research positions in the department to assure a collaboration among bio-energy topics. Over the years, several collaborations were established, i.e. the Department of Fire Protection Engineering, University of Maryland, the Nuclear Research and Consultancy Group, Netherlands or the Von Karman Institute for Fluid Dynamics.

Funded projects / grants

Projects: MAIN - Materiaux Intelligents, MED EU, SESAME - “Thermal hydraulics Simulations and Experiments for the Safety Assessment of MEtal cooled reactors”, H2020-Euratom, Project MAMA-MEA (p.i. Prof. Romagnoli) - “Mass Manufacture Membrane Electrode Assembly”, EU Horizon 2020 FCH-02-8-2017 Project P-TURB - “Prandtl number effect on TUrbulent Rayleigh-Bénard convection”, - Partnership for Advanced Computing in Europe, Project Rebaf (recupero energetico biomasse alvei fluviali), PRO FERS.



Our heritage

La progettazione in tre dimensioni e la simulazione avanzata hanno trasformato il nostro mondo: si è passati dalla lavorazione in più fasi alla possibilità di integrare ogni parte del processo. Il lavoro del progettista non è solo quello di rappresentare un oggetto, l'obiettivo finale è la lavorazione: deve essere perfetta e anche comprensibile, che è la cosa più difficile. Se Enzo Ferrari ci vedesse oggi ci farebbe i complimenti, credo, perché queste cose i nostri laureati le sanno fare.

Three-dimensional advanced simulations changed our world: we moved from multi-step production to the possibility of integrating each part of the process. The designer's task is not just limited to represent an object, but it extends to its machining as well: the latter process must end up being perfect, and intelligible as well, which is the hardest part. If Enzo Ferrari were to look at us today, I believe he would congratulate to us, as our graduate students actually master these relevant aspects.

Prof. Giovanni Sebastiano Barozzi, Fisica Tecnica Industriale

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Tribology and Surface Engineering

Research activity

The research group on tribology and surface engineering deals with inorganic coatings by thermal spraying and physical/chemical vapour deposition (PVD/CVD), and with the wear and friction performance of materials. The group is equipped with various tribometers, including some operating at high temperatures, and a HVOF thermal spray system.

Context and motivation of the research

Friction and wear are significant sources of energy loss and prime causes of failure of many engineering components. Unfortunately, due to their complexity, these system-related phenomena are still not completely understood; hence, research on the topic is of particular relevance. Coatings are among the most effective means to control them.

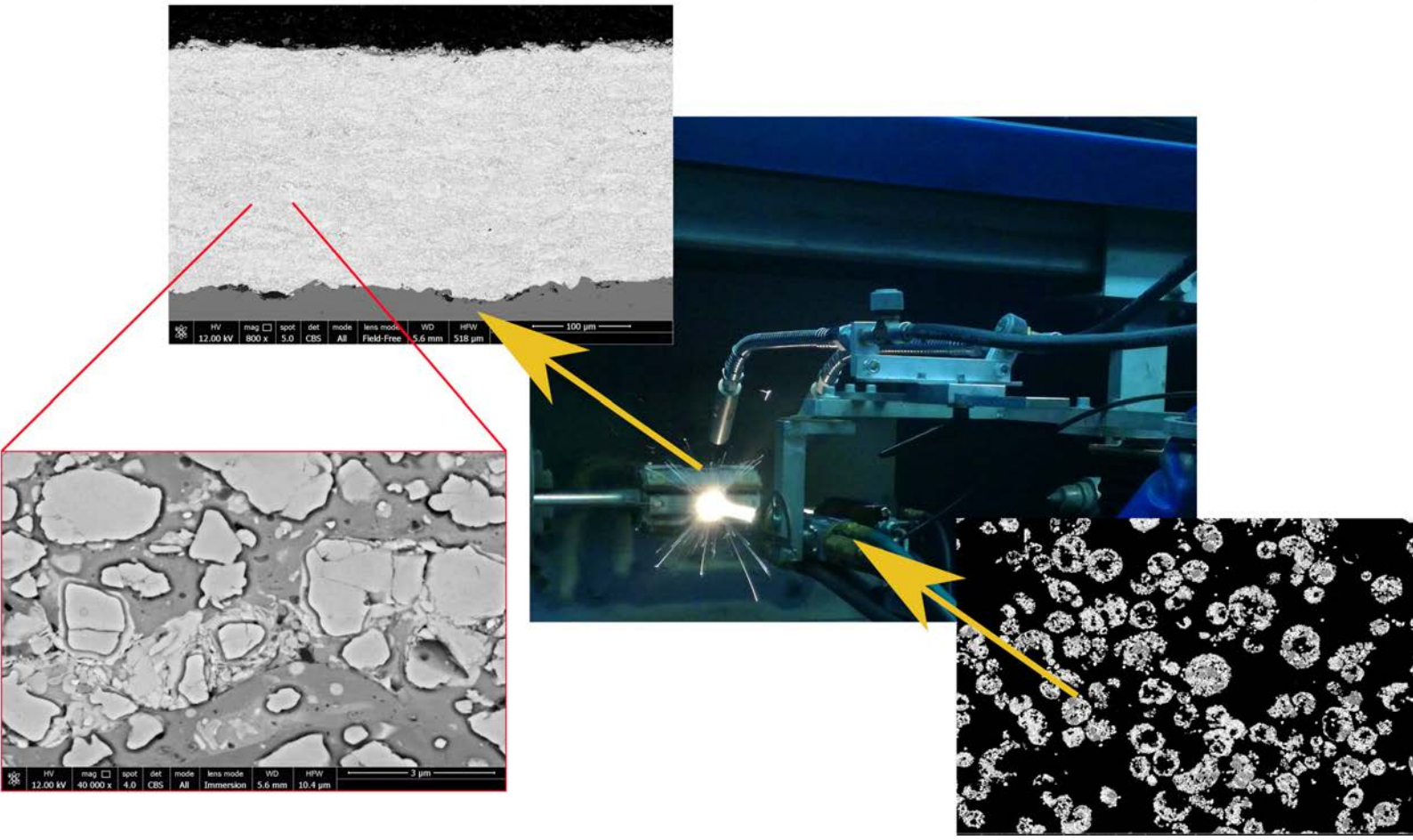
Impact on society

The group has contributed to the development/optimization of a wide range of materials and coatings which are currently in industrial use for wear and friction control. The pilot plant for HVOF thermal spraying allows the production of prototypes under industrial conditions, which facilitates technological transfer.

National and international academic relationships regarding the activity

Many research activities have been carried out in cooperation with a wide range of academic and/or industrial partners, including some important EU research centres such as the University of Stuttgart (Germany), the University of Tampere (Finland), the Fraunhofer IWS Institute (Dresden, Germany), the University West (Trollhättan, Sweden), etc.

HVOF deposition of a WC-based hardmetal coating



Engagement of local entities and fallout on the territory

The group has been involved in multiple applied research activities with some key industrial partners in the region, including but not limited to companies operating in the packaging and food-&-beverage, automotive, petrochemical, and energy production fields. It has also taken part to various regional projects.

Funded projects / grants

- EU project FP7-NMP-2012-SMALL-6: HydroBond (01/01/2013 - 31/12/2016)
- POR-FESR EMILIA ROMAGNA 2014-2020: RIMMEL (15/07/2019 - 14/07/2021)
- FAR 2017 - Fondo di Ateneo per la ricerca: Microstructural and Mechanical investigation of Nickel-Titanium Endodontic instruments – MMiNTEndo (30/01/2018-31/03/2020)

Research activity

DIMANT

Research activity

The DIMANT (Design of Innovative MAterials for New Technologies) research group was founded in 2013 with the aim of creating a synergy between research and teaching, pursuing excellence in the first and effectiveness in the second, and offering support to regional companies operating in the production and transformation of materials.

Context and motivation of the research

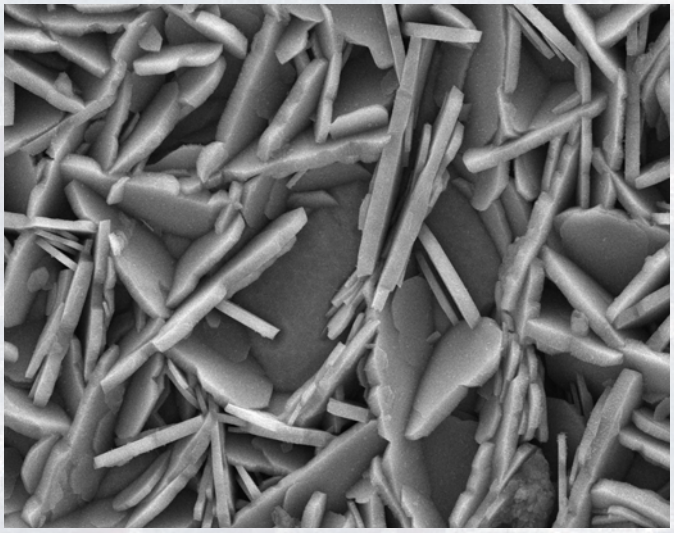
DIMANT brings together experts and skills on the science and engineering of several materials and coatings: plastics, ceramics, metals, biomaterials and geopolymers. DIMANT also deals with sustainable technologies for synthesis and transformation of materials as well as the surface interactions between materials and the environment, including tribological and corrosion phenomena.

Impact on society

DIMANT has successfully contributed to the development of different new materials, processes and products, including, for example, magnetocaloric alloys for magnetic refrigeration, fuel cells and hydrogen production systems, processes for the valorisation of industrial wastes to produce ceramic materials. More information on the page: www.dimant.unimore.it.

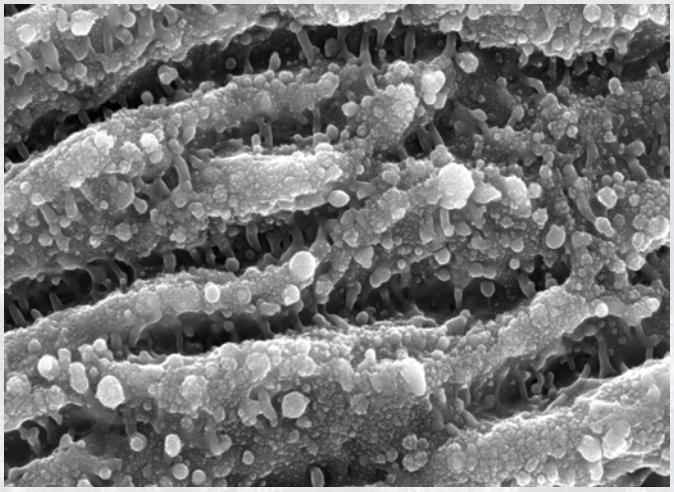
National and international academic relationships regarding the activity

DIMANT is well integrated in several national and international academic relationship with associated projects and cultural exchanges. DIMANT members are members of technical committees or associations in the field of traditional and advanced ceramics and glasses, powder metallurgy, coatings, polymers, electro-heat processing, safety and recycling.



Engagement of local entities and fallout on the territory

DIMANT collaborates with producers of traditional ceramic materials including pigments and glazes. There is a continuous collaboration with manufacturing, heat-treatment and coating companies of metallic materials and of polymeric and composite materials for different uses. Representatives of such companies are part of the steering committee of the Materials Engineering course.



Funded projects / grants

Several international, national and local funded projects (in particular, to promote sustainable development (LIFE+)) and grants with a wide feedback on the national and international industry. Advanced characterization laboratories have been set up in collaboration with leading companies (thermal analysis laboratory, microwave processing of materials, surface engineering laboratories).

Research activity

WEBLab

Research activity

The WEBLab, led by Prof. Michele Colajanni, focuses on Cyber Security research topics:

- Novel methodologies and techniques for cyber defenses
- Cyber security of cloud services, Industry 4.0 and IoT
- Modern cryptographic protocols and blockchain applications
- Cyber defenses for vehicles, smart mobility and smart cities
- Machine and deep learning algorithms for cyber defense.

Context and motivation of the research

The ubiquitous and smart world including the cloud, Internet of Things, Industry 4.0 and autonomous vehicles is widening the cyber vulnerability surface, and extends the consequences of cyber attacks to the physical world. Innovative cyber security technologies and methodologies are required to improve the security and safety of modern societies.

Impact on society

The research group publishes scientific papers in top journals and conferences, but has strong contacts with industries, public administrations, Ministry of Defense for the common goal of improving security and anticipate threat through cyber intelligence. They founded the Interdepartmental center for security and safety (CRIS).

National and international academic relationships regarding the activity

The research group manage the Modena research unit of the CINI National Cybersecurity Lab, has permanent relationships with research groups of other Italian and foreign Universities and the CNR. We founded the CyberLab that is the first of the joint laboratory on cybersecurity between Italy and Israel (Tel Aviv University).

Engagement of local entities and fallout on the territory

The research group has worked with more than fifty local enterprises of all sizes and sectors as well as with the Modena Municipality. Cyber security courses at all levels (from technical to management, from undergraduate to post-graduate) train more than 200 students per year, and contribute to fill the cyber security competence gap of the society.

Funded projects / grants

Our research attracted funds from 15 European projects as well as many other national and regional projects including the Ministry of Defense, the Ministry of Economic Development, the Ministry of Interior and we are leading two projects of the Emilia Romagna region on cyber security and blockchain for industrial supply chains.

Our heritage

Il Dipartimento di Ingegneria “Enzo Ferrari” e il suo campus sono stati resi possibili dalla collaborazione di tutta la città di Modena: ritengo sia stato l’ultimo progetto che ha unito senza eccezioni parti sociali, tessuto economico, politica e naturalmente l’ambiente accademico. Puntavamo a far crescere l’Ateneo attraverso le eccellenze ed è stata una scommessa vinta: oggi, oltre alla meccanica che è motivo d’orgoglio internazionale, siamo un’Università avanzata anche nello sviluppo dell’intelligenza artificiale e nella ricerca medica, avendo accolto il centro di ricerca sulle cellule staminali. In un distretto che, nel raggio di pochi chilometri, raggruppa tutti e tre i centri di competenza scientifica: le scienze, la sanità e l’ingegneria.

DIEF and its campus were made possible by means of the collaboration of the whole city of Modena: I think it has been the latest project that managed to join together with no exclusions all social parts, the economic fabric, politics, and of course the academic environment. We were aiming at the growth of the University by pursuing excellence and that bet was won: today, let alone mechanical engineering that remains the pride and joy of the department, we are a truly advanced reality also in the development of artificial intelligence and in medical research, as we welcomed the research centre on staminal cells in a district in which, within a few kilometres, groups together the three most relevant scientific poles: science, health care, engineering.

Prof. Gian Carlo Pellacani, Scienze e Tecnologie dei Materiali

www.30anniingegneriamodena.unimore.it/site/home/our-heritage.html

Research activity

LARMA

Research activity

The LARMA group leads research aimed to investigate the main drivers of atmospheric pollution by modelling and monitoring tools, to assess population exposure to risk factors, to perform environmental monitoring by remote sensing and meteorological in-situ observations. Finally LARMA coordinates the environmental sustainability actions within UniMORE.

Impact on society

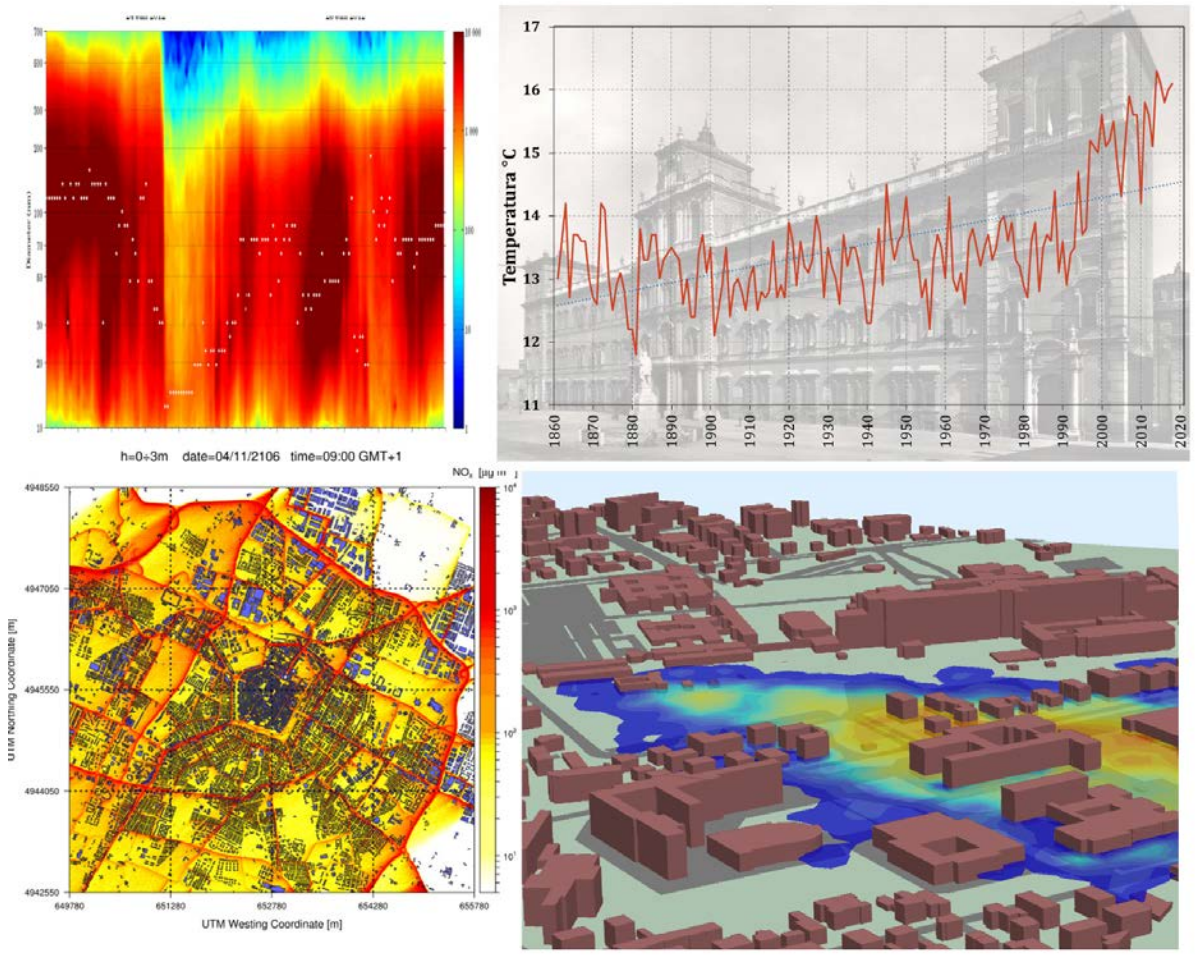
The LARMA delivers high impact research: this granted a collaboration with the University of Helsinki and ISAC-CNR (outstanding centres for atmospheric research), for hosting in the LARMA premises a monitoring activity on airborne atmospheric nanoparticles in the Po valley during the lockdown for the SARS-CoV-2 pandemic.

Context and motivation of the research

The LARMA research approach is transdisciplinary: it aims to bring together different forms of knowledge to understand the most urgent environmental problems under a broader perspective and it has among its goals the identification of the appropriate solutions through a sustainable approach.

National and international academic relationships regarding the activity

Among the various active research collaborations,the main on-going ones are with ISAC-CNR, INGV, INAIL at a national level, and with University of KU-Leuven (Belgium), INAR - University of Helsinki, EMPA (Zurich) at an International level.



Engagement of local entities and fallout on the territory

The expertise of LARMA supports the institutional activities of the local Environmental Agency and of the local Municipality. LARMA is also providing services to the local industry for environmental sustainability studies and has activated various active collaborations on issues such as air quality, remote sensing and GIS processing.

Funded projects / grants

Recent projects are: the European project TRAFAIR (trafair.eu) regarding air quality and smart cities, in synergy with the DB-Group of DIEF, the university project BlackAir (tiny.cc/blackair) regarding Environment and Health, the national project ASBESTOP (tiny.cc/asbestop) on the identification of asbestos roofing.

Research activity

NetLab and MultimediaComLab

Research activity

The NetLab and MultimediaComLab groups operate in the Telecommunications field. The research topics include vehicular communications; multi-radio access technologies; multimedia protocol analysis and monitoring in LTE-A and 5G networks; technologies for creating vehicle-to-vehicle and vehicle-to-infrastructure networks; Software-Defined Networking; Wi-Fi systems.

Context and motivation of the research

5G and new wireless technologies shape the way we communicate, collect data and learn from them. Novel radio solutions will play a pivotal role in the development of new Intelligent Transport System (ITS) services for interconnected vehicles, offering unprecedented levels of road safety.

Impact on society

The groups provide concrete outputs to the industry and scientific communities through the design and modeling of wireless systems, research solutions at the bleeding edge of the radio networking field, prototypes, software included in the Linux kernel mainline.

National and international academic relationships regarding the activity

We have active collaborations with:

- Karlstad University, Sweden, for real-test research on Wi-Fi protocols;
- Universidad Miguel Hernández de Elche, Spain, for vehicular communications;
- St. Louis University, St. Louis, Missouri, USA, for federated learning.

Funded projects / grants

The most recent projects are:
"Dynamic, Energy-AwaRe PaTh Selection in Hybrid Wireless SeTtings (DART-HIT)", funded on the Fifth Call for Experiments by the EU H2020 WiSHFUL project, years 2017-2018.
"eXploiting mulTi-Radio Access technologies for Communications in vehicuIAR environmentS (XTRA-CARS)" funded on the third Open Call for Scientific Excellence Experiments by the EU H2020 ORCA project, years 2019-2020.

Engagement of local entities and fallout on the territory

The groups actively collaborate with local companies on topics ranging from 5G monitoring to vehicular communications. Alstom, Empirix and Redox are among their main partners.

Research activity

LIV Lab

Research activity

The LIV Lab (Idraulica del Veicolo Lab - Fluid Power lab) is dedicated to research on industrial and mobile fluid power applications, with special focus on energy efficiency, integration with electrical systems and controls, evaluation of hybrid power distribution systems.

Context and motivation of the research

The FPRLab supports the strong fluid power industry in Emilia Romagna region and north Italy in general, by promoting research activities focused on new fluid power solutions, where the traditional fluid power systems are coupled with electric actuators as in the hybrid systems, or with smart electronic control. Moreover, any idea exploring the improvement of efficiency is analysed, both regarding the single components (especially pumps and motors) and the systems architecture.

Impact on society

The aim of the FPRLab is to lead the transformation of the traditional fluid power systems in more efficient, clean and smart systems, by promoting:

- research activities with focus on improving efficiency, explore new solutions and applications;
- spreading the use of simulation in industry during the design and prototyping phase, to save time, cost and energy constantly needed for experimental testing; by creating virtual tools customized for the industrial usage (smart.fluidpower.it).

Funded projects / grants

TASC - www.tascproject.eu
This project was born as part of the research on the energy efficiency of power distribution architectures in agricultural machines to reduce the consumption of fossil fuels and polluting emissions outside of urban areas too.
In the last two years: 3 industrial projects (imprese.regione.emilia-romagna.it/Finanziamenti/ricerca-e-innovazione/promozione-di-progetti-di-investimenti) on the development of mechatronic valves, equipped with custom made sensors and opportune control strategies and on the application of pressure amplifier on hydraulic cylinders for mobile and industrial applications.

National and international academic relationships regarding the activity

Active cooperation with: University of Parma, Padova, Ferrara, Politecnico of Bari, IMAMOTER CNR (PRIN2007, TASC).

Engagement of local entities and fallout on the territory

The FPRLab lab has created a strong network of research laboratories and industries via two main actions:

- promoting the connection between research labs from the university and CNR and industry through the FP value chain (mech.clust-er.it/value-chain/), which has led to numerous cooperation and projects developed together with industry and academy (TASC - www.tascproject.eu, Smartcylinder, Independent Metering, Intelligent Mechatronic Valves, Microfluidic devices for biomedical applications).
- education of young mechanical and automotive engineers in the field of fluid power systems for mobile and industrial applications and exchange of students with the industry and foreign universities for internship.

Our heritage

Gli ingegneri ambientali di domani saranno molto più tecnologici. Già noi abbiamo fatto un passo avanti usando tanto i dati da satellite e riuscendo, ad esempio, a sfruttare il lockdown per isolare l'inquinamento prodotto dalle automobili da quello proveniente da altre fonti: un dato raro e potenzialmente decisivo. Ci rendiamo conto che il nostro è un compito importante: dobbiamo creare figure in grado di ridurre l'impatto ambientale delle attività umane intervenendo prima, durante o dopo la loro attuazione.

The environmental engineers of tomorrow will be much more "technological". We already stepped forward by starting using satellites data and by managing, for instance, to exploit the lockdown to discern the pollution generated by cars from the one caused by other sources: a rare and potentially decisive piece of information. We are aware that our role is of fundamental importance: we must help in shaping professionals who are able to reduce the environmental impact of human activities by acting before, during, and after their actuation.

Prof. Rodolfo Cecchi, Ingegneria Sanitaria - Ambientale

www.30anniingegneriamodena.unimore.it/site/home/our-heritage.html

Research activity

Technology and Manufacturing Systems

Research activity

The research group in Technology and Manufacturing Systems is active in several areas of innovative manufacturing solutions, with a special focus on Additive Manufacturing of metals. The study of fatigue performance, the process optimization for lattice structures and the development of innovative alloys are examples of the latest topics.

Impact on society

The research turned into more than 25 papers only on the described topic, published in highly rated scientific journals in the last 5 years.

Context and motivation of the research

Additive Manufacturing of metals is regarded as one of the pillars of innovation in many fields, as it enables great geometric freedom and lightweighting, high flexibility and short lead times. Despite its quick rise, the process needs better robustness and reliability to be achieved through a thorough study of the process phenomena.

Engagement of local entities and fallout on the territory

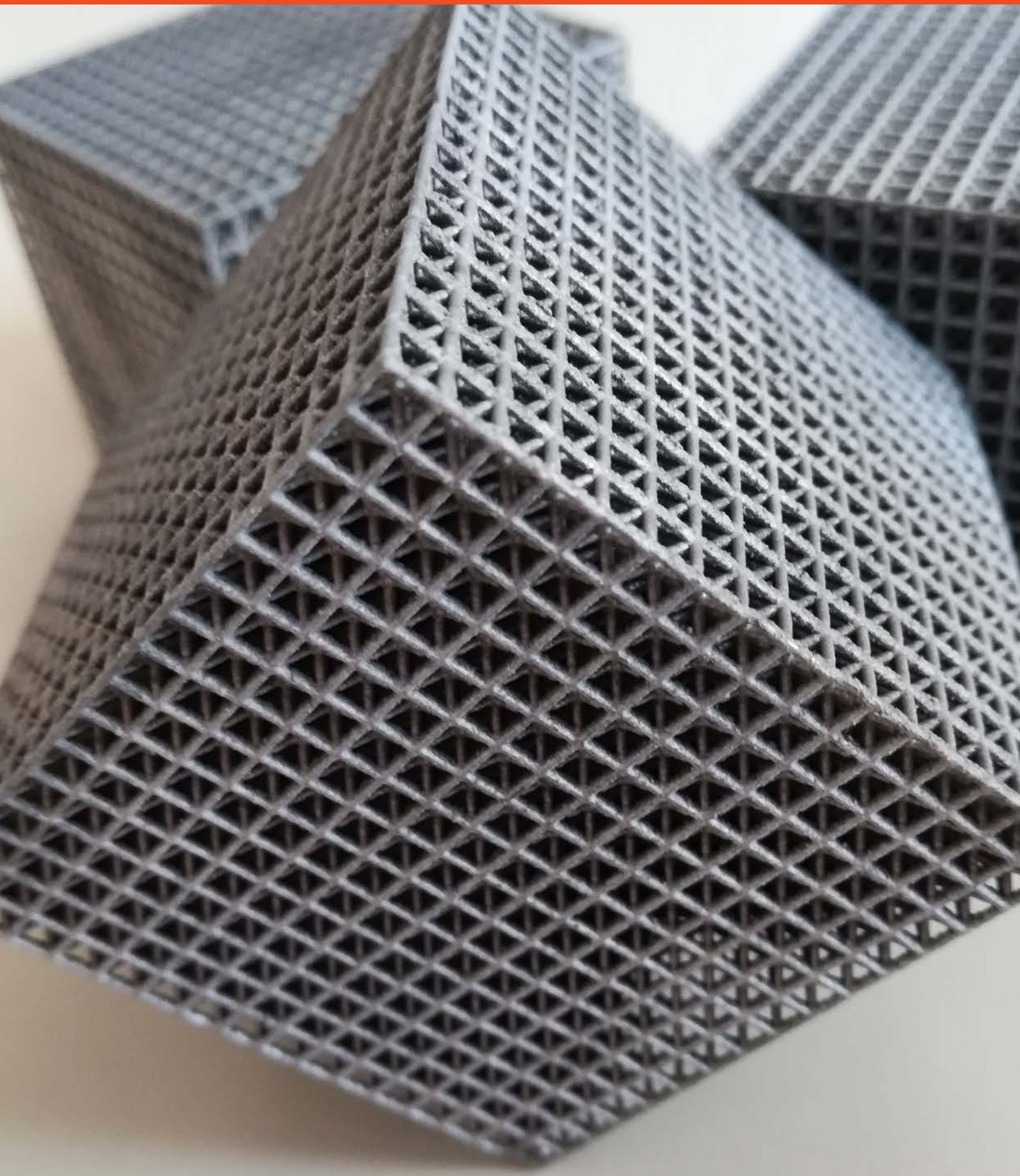
The group is engaged in several industrial contracts related to Additive Manufacturing of metals and dedicated to the characterization of parts, to the development of the process as well as of the machine, to the identification of new standards for raw material.

Funded projects / grants

The expertise in Additive Manufacturing led to the important result of the approval of the project Driving up Reliability and Efficiency of Additive Manufacturing (DREAM), Horizon 2020- FOF13 2016, which sees the group coordinator of the entire project.

National and international academic relationships regarding the activity

The group established many academic relationships on the topic of Additive Manufacturing, with Politecnico di Torino, University of Parma, Polytechnic University of Marche, Ilmenau University (Germany), Federal Technological University (Brazil).



IDEA

Research activity

IDEA - Integrated Design and Engineering Applications LAB researchers study and develop Computer Aided methods and tools for the integrated design of products and production processes. Design by Simulation, Robotic Manufacturing and Assembly, GD&T Model Based Design, Design for Additive Manufacturing, 3D capturing techniques for reverse modelling and inspection are scientific and technical skills mainly applied to industrial applications, in particular in the automotive and healthcare fields.
Lab Coordinator: Prof. Francesco Leali

Context and motivation of the research

The main task of engineers is to apply their scientific knowledge to the solution of technical problems, and then to optimize those solutions within the requirements and constraints set by material, technological, economic, legal, environmental and human-related considerations (G. Pahl, W. Beitz).

Impact on society

IDEA LAB researchers authored scientific papers awarded in international conferences or published in international journals. They are inventors of industrial patents for automotive and healthcare. Scientific results are offered to engineering students in university classes and in life-long learning services. The university spin-off IDEATIVA srl, founded in 2017, commercially exploits the most effective research results.

Funded projects / grants

COMET - Plug-and-produce COmponents and METhods for adaptive control of industrial robots enabling cost effective, high precision manufacturing in factories of the future (EU project);
SYMPLEXITY - Symbiotic Human-Robot Solutions for Complex Surface Finishing Operations (EU project);
AUTOMOTIVE ACADEMY UNIMORE - International Automotive Academy UNIMORE for Advanced Technologies in High-performance Vehicles and Engines (funded by MIUR).

National and international academic relationships regarding the activity

IDEA LAB national and international academic network includes R&D engineers, researchers, professors, Ph.D. and master degree students from prestigious universities and research departments, e.g. Fraunhofer Institute (Germany), NTNU (Norway), Chalmers (Sweden), University of Pretoria (South Africa), Cal Poly (USA), University of Toledo (USA), Stanford University (USA), ICAM School of Engineering (France), University of Central Florida (USA).

Engagement of local entities and fallout on the territory

IDEA LAB is an active research partner of the Emilia-Romagna Region high technology network, involved in the Intermech Centre (Modena) and in the Science and Technological Park for Medicine (Mirandola). IDEA LAB researchers are part of MUNER - Motorvehicle University of Emilia-Romagna, Automotive Academy UNIMORE and Modena Automotive Smart Area.

Research activity

AImageLab

Research activity

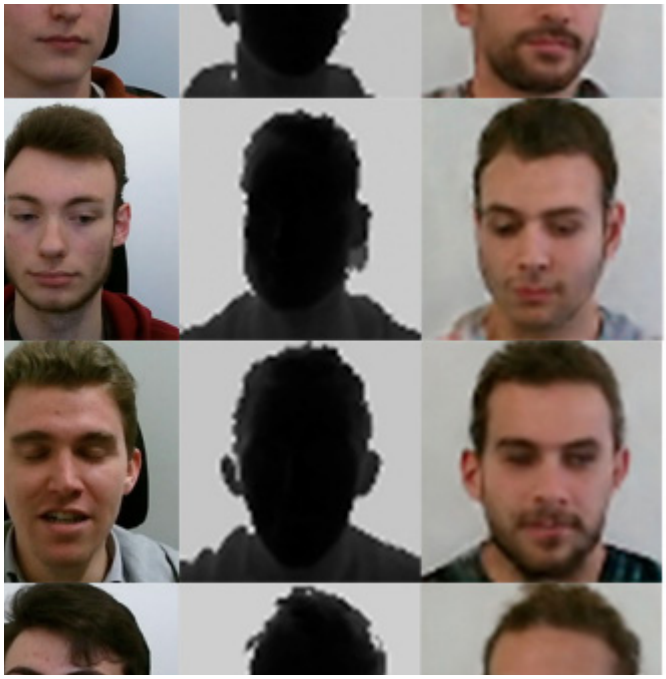
AImageLab is the Research Laboratory devoted to research on AI technologies and in particular on Computer Vision, Pattern Recognition, Machine Learning on Multimedia Data. It is directed by Prof. Rita Cucchiara since 1998: the staff comprises 4 Full and Associate Professors, 2 Assistant Professors and 23 Ph.D. students and Research Fellows working on foundational and applied research.

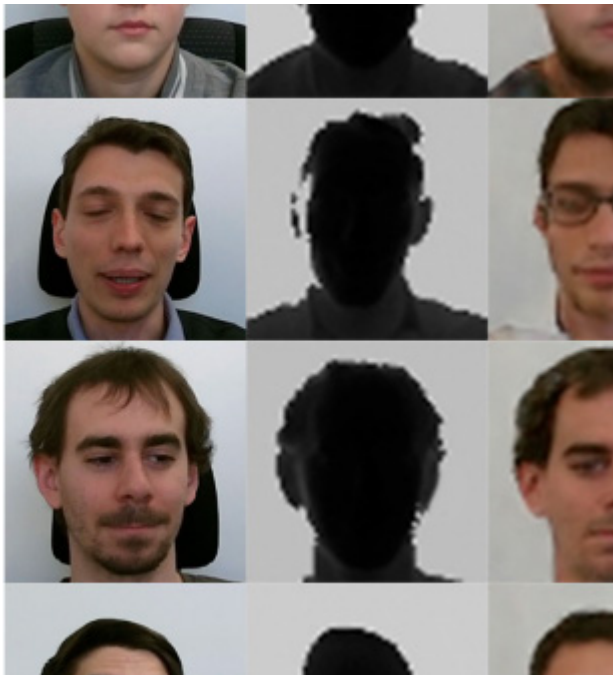
Impact on society

The consolidation of the work and the study conducted in the laboratory by the research group will pave the way to launch innovative start-ups, to collaborate with local industry through joint lab, to contribute to the professional updating by transferring knowledge and skills in the AI area.

Context and motivation of the research

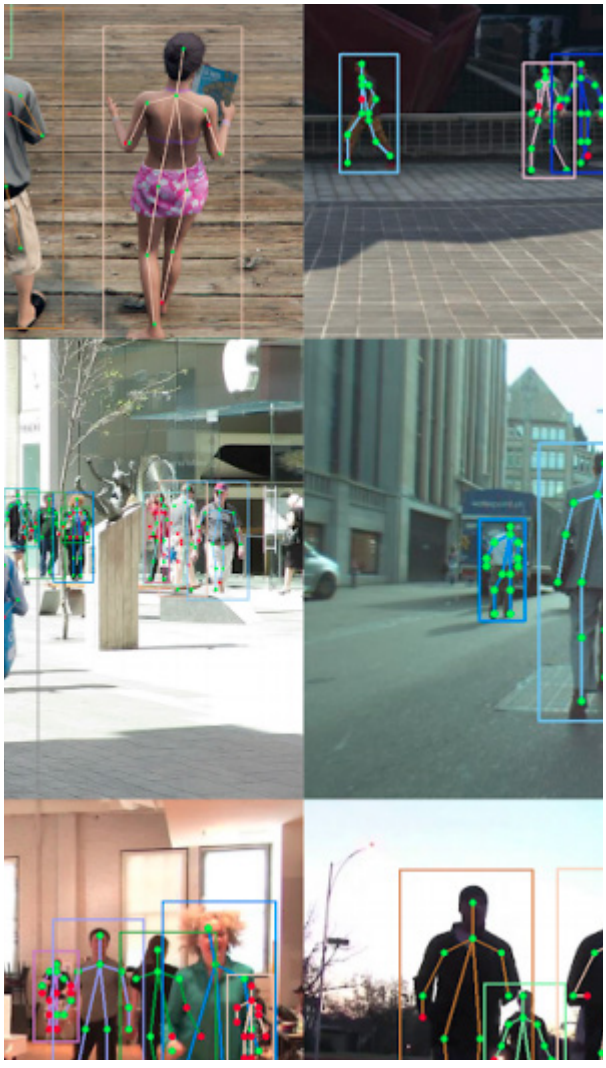
Artificial Intelligence is one of the kernel of Computer Engineering, worldwide. At AImagelab we worked and want to work towards to the future AI, mainly focused on human-AI Interaction, autonomous or semi-autonomous intelligent systems and its related applications. The research with industry and society is a priority: foundational research in computer Vision. and Machine learning on Multimedia data should be joined “by-design” with industrial and societal-driven applications.





Funded projects / grants

Examples of funded projects in the last 3 years are EU projects (DeepHealth, HumanE-AI-Net, InSectt, ArrowHead Tools.), International projects (NVidia NVAITC, Facebook FAIR, Panasonic Beta Lab), National PRIN (Cosmos, PREVUE) and PON (IDHEA, CULTMEDIA) and many regional ones. The list of projects is available at aimagelab.unimore.it.



Engagement of local entities and fallout on the territory

AImagelab with AIRI and AI Academy is engaged in several initiatives worked with Regione Emilia-Romagna Association (working in different clustER and Association Big Data), with local Municipalities of Modena and Reggio Emilia, National Museums and Hospitals for co-research and prototyping. A long term research has been carried out with Modena's Policlinico.

National and international academic relationships regarding the activity

AImageLab has many international contacts, thanks to EU projects in the fields of medical imaging, human behavior understanding and smart cities, as well as in the ELLIS and CLAIRE European Networks. The Laboratory has currently projects with ESA for analysis of satellite images and has opened recently a joint lab with NVIDIA (NVAITC-Nvidia AI Technology Center) in Modena.

ingmo.unimore.it