

**REMARKABLE TECHNOLOGY,
EASY TO USE**



Associação Fraunhofer Portugal Research

Research of Practical Utility lies at the heart of all activities developed by Fraunhofer Portugal

Founded in 2008 by the Fraunhofer-Gesellschaft and the German-Portuguese Chamber of Commerce and Industry (CCILA) – within the framework of a long-term Portuguese-German collaboration to explore mutual interests in science and technology – Associação Fraunhofer Portugal Research (Fraunhofer Portugal) has the mission to undertake applied research of direct utility to private and public enterprises and of wide benefit to society.

Fraunhofer Portugal currently materialises itself through the Fraunhofer Portugal Research Centre for Assistive Information and Communication Solutions (AICOS), located in Porto and born in 2009 following a partnership between the Fraunhofer-Gesellschaft, the Foundation for Science and Technology (FCT) and the University of Porto (UP).

In 2010, Fraunhofer Portugal has been acknowledged by the Portuguese Government as an 'Entity of Public Interest'.

08 **AICOS 10 years Timeline**

26 **Strategic Research Agenda**
Scientific Expertise
Human-Centred Design
Intelligent Systems
Connected Things

80 **Services**
Rapid Prototyping
Innovation Studies
Education & Training

156 **Awards**

10 **Message from the Chairman**

36 **Innovation Themes**
Cognitive Connected Solutions
Digital Farming
Accountable Artificial Intelligence
Decentralised Health Technology
Living and Ageing with Data
Success Story
IoT system-on-a-chip technology

106 **Events**
Highlight Events

160 **Management Report 2019**
Overview
Business Evolution
Economic and Political Background
Business Performance
Employees

14 **Fraunhofer Portugal**
Vision
Mission
Funding Model
Fraunhofer-Gesellschaft
German-Portuguese Chamber for
Industry and Commerce (CCILA)
Business Model

56 **Impact Assessment of Research
Excellence**
Scientific Production
Job Creation and Capacity Building
Public Engagement

128 **Fairs, Conferences & Workshops**
External
Internal

176 **Outlook & Strategic Development**

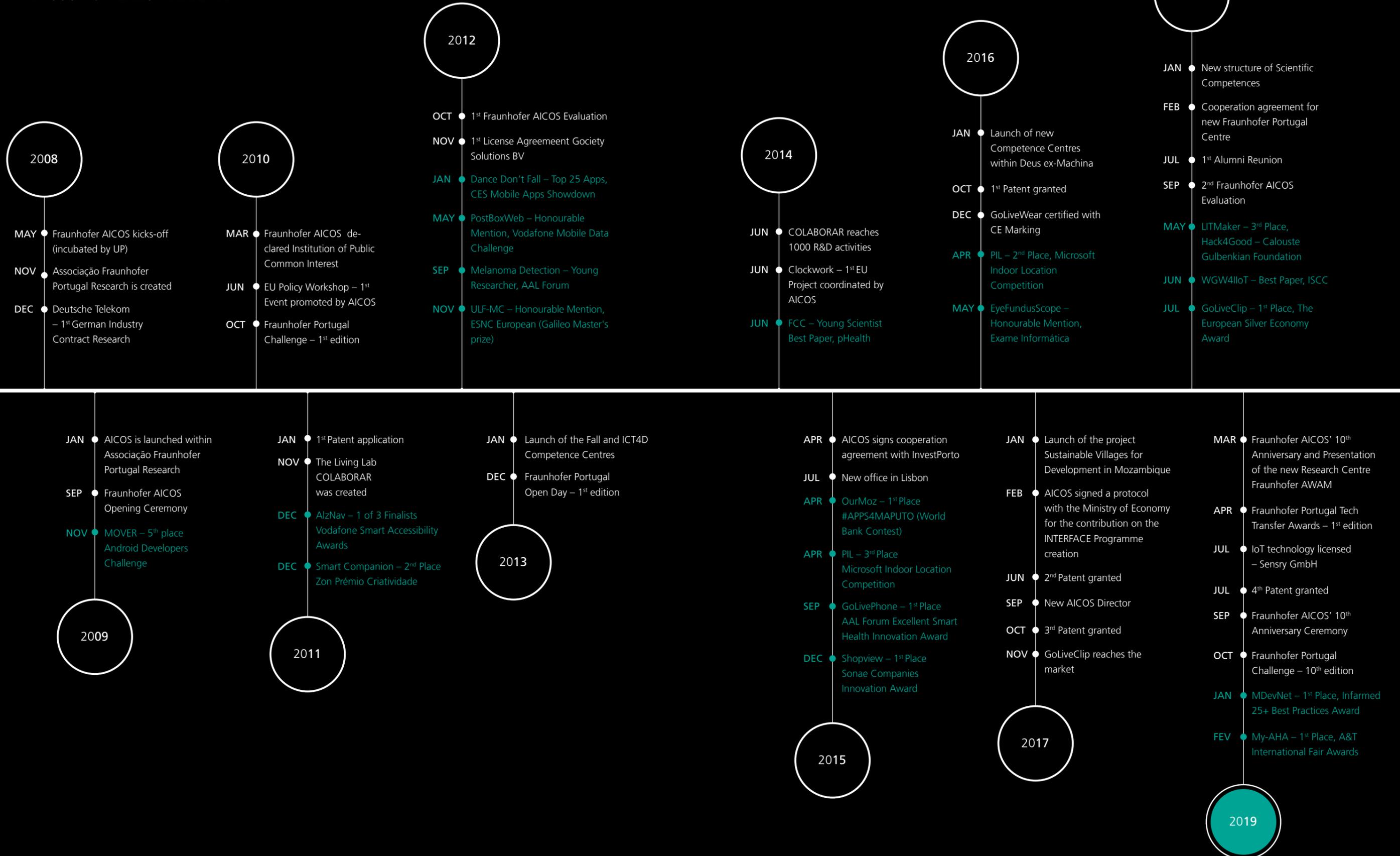
22 **Management & Governance**
Governance Structure
Management
Supervisory Board
Executive Board

66 **Infrastructure**
IT Infrastructure
Digital Fabrication Lab
Living Lab
Motion Lab
Open Lab

150 **Visits**

183 **Acronyms**

AICOS 10 YEARS TIMELINE



MESSAGE FROM THE CHAIRMAN

It is important to celebrate milestones. It is a time to recognise the journey and its actors, but mostly a golden opportunity to set new goals for the future. The 10 years milestone of Fraunhofer Portugal AICOS is a remarkable achievement, an achievement marked by a year of significant growth in our industry revenues, powered by the confidence our customers and partners have in the path of excellence defined by the Fraunhofer Portugal team.

While we celebrate this milestone, we cannot help but ask: what has made this possible? We are part of an outstanding family, the Fraunhofer family. A family with 70 years of future that has guided and supported us intensively over the last 10 years. We are surrounded every day by knowledge and competences, by a combination of innovation and strong foundations resulting from more than 100 years of the distinctive life of the University of Porto. Ensuring that all the actors are involved on everything that we do, working every day to bring results to the hands of whom benefits more from the innovation created at AICOS, is also one of the reasons for this accomplishment. While we focus at application areas as the manufacturing industry, agriculture and health – in bringing health outside of the hospital facilities improving patient experience, reducing the costs of health care

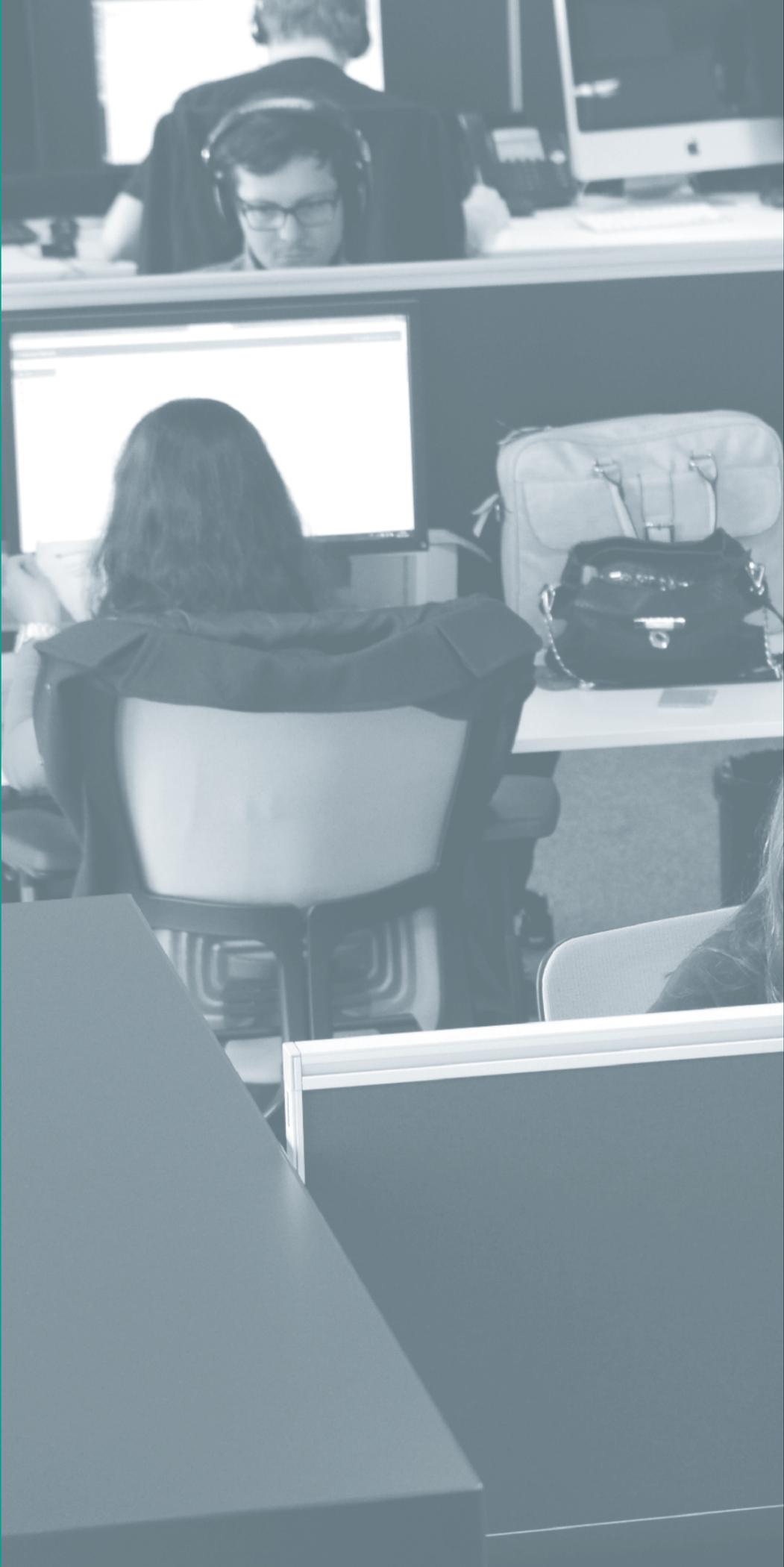
and improving the well-being of populations overall – we understand that we must ask ourselves every day if we should do everything we can do for our future directions: cognitive connected solutions, digital farming, and decentralised health technologies built by accountable models and designed on top of a profound understanding of how society lives and ages with technology. These are our ambitious goals for the next years. Towards these targets, our very own recipe of combining the perspectives of People, Things and Intelligence, while working as one team, gives AICOS the best conditions to continue the success path for many years to come.

Our partners, customers and friends, the funding organisations, the members of Fraunhofer Portugal boards and mostly the team – whose dedication, excellence and enthusiasm created strong bonds and whose efforts over the past 10 years ensure now that the infrastructure is in place to think and act towards these ambitions – are the reasons for this success. The 10th anniversary is indeed a milestone after which we will carry on striving for excellence for many generations to come.

And we are just beginning.

Liliana Ferreira
Director

FRAUNHOFER PORTUGAL



Founded in 2008 by the Fraunhofer-Gesellschaft and the German-Portuguese Chamber of Commerce and Industry (CCILA) – within the framework of a long-term Portuguese-German collaboration to explore mutual interests in science and technology – Associação Fraunhofer Portugal Research (Fraunhofer Portugal) has the mission to undertake applied research of direct utility to private and public enterprises and of wide benefit to society.

Fraunhofer Portugal currently materialises itself through the Fraunhofer Portugal Research Centre for Assistive Information and Communication Solutions (AICOS), located in Porto and born in 2009 following a partnership between the Fraunhofer-Gesellschaft, the Foundation for Science and Technology (FCT) and the University of Porto (UP). A second centre for Smart Agriculture and Water Management (AWAM), is currently being deployed in Trás-os-Montes e Alto Douro and Évora, as reflected in the graph below.



VISION – A DRIVING FORCE IN INNOVATION

Fraunhofer Portugal proposes a radical change regarding technological innovation in collaboration with scientific institutions in Portugal, and aims at creating scientific knowledge capable of generating added value for its clients and partners, exploring technology innovations oriented towards economic growth, social well-being and the improvement of the quality of life of its end-users.

MISSION – RESEARCH OF PRACTICAL UTILITY

Fraunhofer Portugal promotes applied research of direct utility to private and public institutions and of broad benefit to society, by managing and coordinating the cooperation of its research centres with:

- **Other Research Institutions** – such as universities and other relevant Portuguese or non-Portuguese research institutions, as well as Fraunhofer Institutes and other research centres integrated in the Fraunhofer-Gesellschaft knowledge network;
- **Industry Partners** – clearly perceived and understood as our main customer group, we are developing partnerships and cooperation agreements with private and public enterprises, as well as participating in business associations;
- **Supporting Partners** – Government Institutions and other Institutional partners.

FUNDING MODEL

Fraunhofer-Gesellschaft and the Portuguese Foundation for Science and Technology (FCT) agreed on a tripartite funding model similar to the one used by Fraunhofer-Gesellschaft.

At Fraunhofer Portugal, our scientists and engineers work with a budget financed by external revenue (projects and licensing) and institutional funding provided by FCT and Fraunhofer-Gesellschaft.

External revenue should be guaranteed through research projects, development projects, contracts signed with third parties within Fraunhofer Portugal's fields of activity, intellectual property rights and licensing of the commercial optimization of products and services resulting from Fraunhofer Portugal's Research and Development (R&D) results.

FRAUNHOFER-GESELLSCHAFT

Research of practical utility lies at the heart of all activities pursued by the Fraunhofer-Gesellschaft. Founded in 1949, the research organisation undertakes applied research that drives economic development and serves the wider benefit of society. Its services are solicited by customers and contractual partners in industry, the service sector and public administration.

At present, the Fraunhofer-Gesellschaft maintains 72 institutes and research units. The majority of the more than 26,600 staff are qualified scientists and engineers, who work with an annual research budget of 2.6 billion euros. Of this sum, 2.2 billion euros is generated through contract research. Around 70 percent of the Fraunhofer-Gesellschaft's contract research revenue is derived from contracts with industry and from publicly financed research projects. Around 30 percent is contributed by the German federal and state governments in the form of base funding, enabling the institutes to work ahead on solutions to problems that will not become acutely relevant to industry and society until five or ten years from now.

International collaborations with excellent research partners and innovative companies around the world ensure direct access to regions of the greatest importance to present and future scientific progress and economic development.

With its clearly defined mission of application-oriented research and its focus on key technologies of relevance to the future, the Fraunhofer-Gesellschaft plays a prominent role in the German and European innovation process. Applied research has a knock-on effect that extends beyond the direct benefits perceived by the customer: Through their research and development work, the Fraunhofer Institutes help to reinforce the competitive strength of the economy in their local region, and throughout Germany and Europe. They do so by promoting innovation, strengthening the technological base, improving the acceptance of new technologies, and helping to train the urgently needed future generation of scientists and engineers.

As an employer, the Fraunhofer-Gesellschaft offers its staff the opportunity to develop the professional and personal skills that will allow them to take up positions of responsibility within their institute, at universities, in industry and in society. Students who choose to work on projects at the Fraunhofer Institutes have excellent prospects of starting and developing a career in industry by virtue of the practical training and experience they have acquired.

The Fraunhofer-Gesellschaft is a recognized non-profit organisation that takes its name from Joseph von Fraunhofer (1787–1826), the illustrious Munich researcher, inventor and entrepreneur.

GERMAN-PORTUGUESE CHAMBER FOR INDUSTRY AND COMMERCE (CCILA)

With over 1.000 associates in Portugal and Germany, the objective of the Chamber is to enhance and promote the economic relationships between the two countries.

BUSINESS MODEL

Fraunhofer institutes and centres operate independently as 'profit-centres' within the research market under the umbrella of their respective national independent legal entity. Each institute is responsible for its respective budget and correspondingly needs to successfully transfer its competencies to the market. Generally, the financing of Fraunhofer institutes comprises three core elements:

1. Institutional funding from governmental sources (in Portugal provided by FCT and Fraunhofer-Gesellschaft) to conduct pre-competitive research in selected strategic fields;
2. Project funding from public sources linked to specific projects within the context of public programs from the EU or national governments. These grants are acquired in competition with other research facilities and industry;
3. Industrial revenues from contract research commissioned by industry.

The Fraunhofer model is characterised by the high level of independence that its associated institutes enjoy. Institutes put a strong emphasis on research and market-oriented approach. This is combined with networking activities within Fraunhofer, as well as the integration of external national and international actors.

The Fraunhofer model also aims for well-established and distributed shares of funding. Around 70 percent of the Fraunhofer-Gesellschaft's contract research revenue is derived from contracts with industry and publicly financed research projects. Around 30 percent is contributed by the German federal and state governments in the form of base funding, enabling the institutes to work ahead on solutions to problems that will not become acutely relevant to industry and society until five or ten years from now.

International collaborations with excellent research partners and innovative companies around the world ensure direct access to regions of the highest importance to present and future scientific progress and economic development.

Legally independent affiliate Fraunhofer entities operating research centres, besides Portugal, have been founded in the United States, Austria, Italy, Sweden, Chile, United Kingdom, and Singapore to cooperate with leading local academic and research partners. While operating under the same principles as German Fraunhofer Institutes, these centres at the same time adapt to local environments and research markets.

GOVERNANCE & MANAGEMENT



GOVERNANCE STRUCTURE



We seek to follow the best practices in every area of the Association's governance by reflecting such practices in our organisation, principles and transparency.

The Associative Structure of Fraunhofer Portugal clearly distributes functions, duties and responsibilities among its board members.

MANAGEMENT

Fraunhofer Portugal management is a shared responsibility of both the Supervisory Board (with broad assessment powers) and the Executive Board (responsible for daily management and current management actions).

SUPERVISORY BOARD

PRESIDENT
JÖRG LASCHKE
 Director for Finances,
 Controlling and Organisation
 Fraunhofer-Gesellschaft

VICE-PRESIDENT
JOÃO PAULO OLIVEIRA
 Member of the Executive Board
 The Navigator Company

MEMBER
PAULO SIMÕES
 Member of the Executive Board
 Sonae SR, SGPS, SA

MEMBER
ALEXANDER MICHAELIS
 Institute Director
 Fraunhofer IKTS

MEMBER
STEFFEN SCHUDT-PIALAT
 Chief Financial Officer
 Volkswagen Group France

EXECUTIVE BOARD



LILIANA FERREIRA
 PRESIDENT OF THE EXECUTIVE BOARD

With an academic and professional career focused on research in the areas of Health Informatics, Human Language Technologies and Artificial Intelligence, Liliana Ferreira holds a PhD in Informatics Engineering and a MSc in Electronics and Telecommunication Engineering, by the University of Aveiro, complemented with a strong research background developed in several industry and R&D organisations across Europe (Portugal, Germany and the Netherlands).

Functional Assignments
 General Administration, R&D Planning, Business Development, Human Resources, Legal, Facilities.



PEDRO ALMEIDA
 EXECUTIVE BOARD MEMBER

With a professional career that started with R&D activities through to the full innovation cycle with the creation of a spin-off of a prestigious University in Portugal, Pedro Almeida holds a MSc in Electronics and Telecommunications Engineering by the University of Aveiro, and holds a post-graduation in Advanced Management for Executives also from the same university.

Functional Assignments
 Business Development, Planning & Control, Accountancy & Finances.

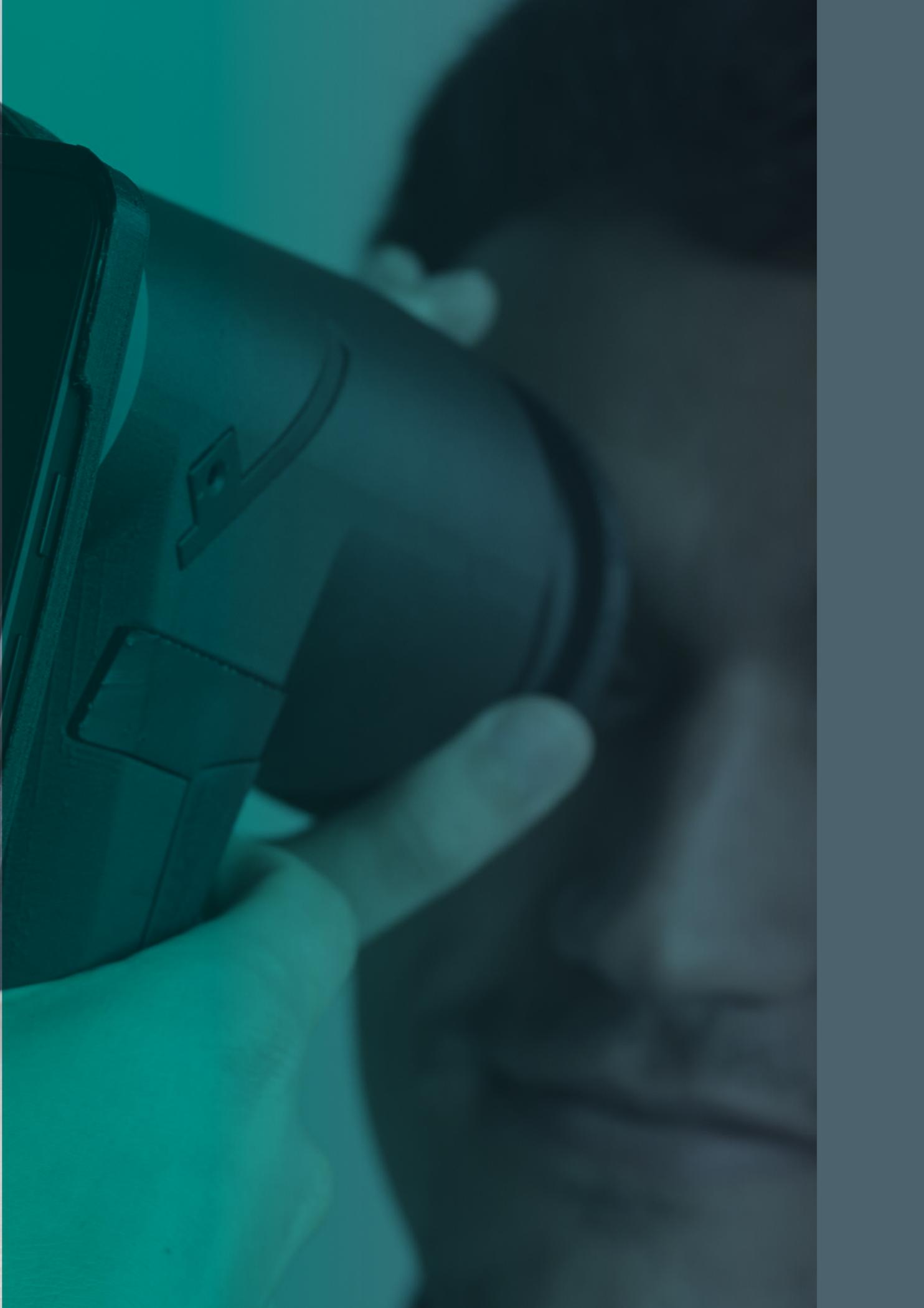


BERTHOLD BUTSCHER
 EXECUTIVE BOARD MEMBER

With a career highly oriented towards R&D, both in industry and in R&D institutions, Berthold Butscher holds a Dipl. Ing. in Electrotechnical and Computer Engineering from the University of Applied Sciences of Konstanz and from the Technical University of Berlin.

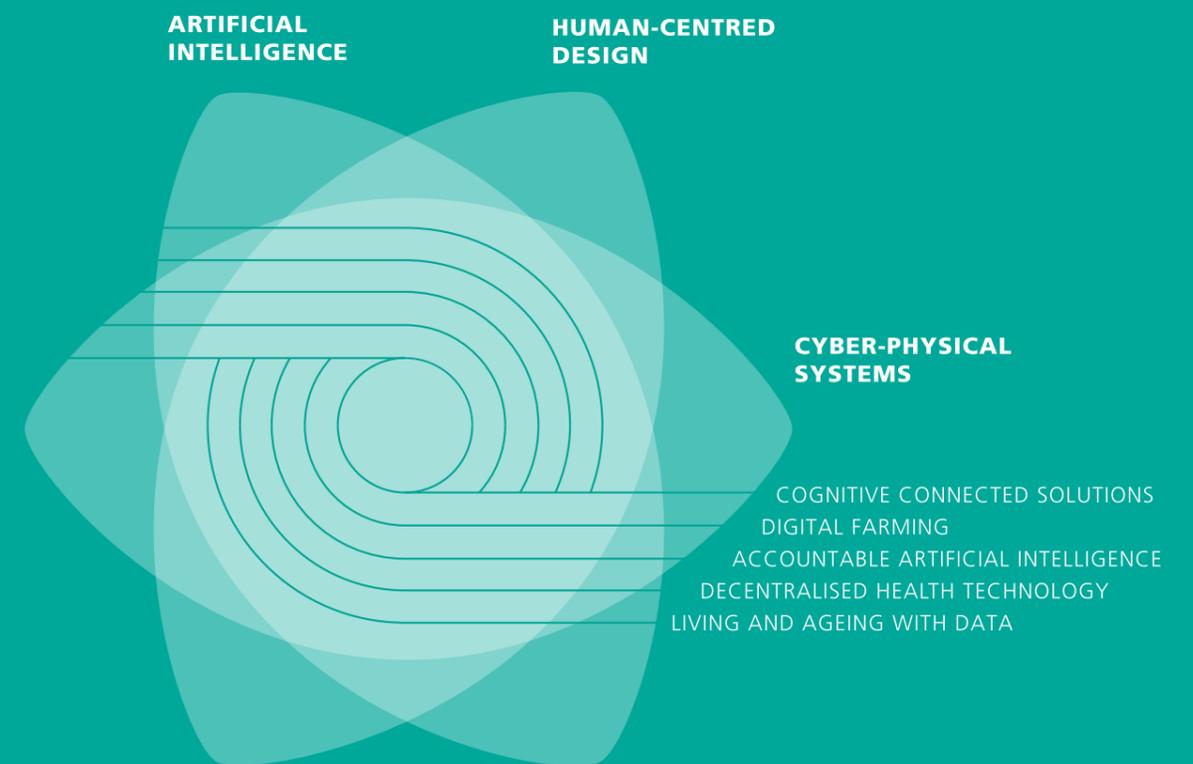
Functional Assignments
 R&D Planning Support.

STRATEGIC RESEARCH AGENDA



The initial set of AICOS' core competencies is a result of the history of Fraunhofer Portugal itself. Back in 2007-2008, the business plan for the installation of Fraunhofer in Portugal and AICOS was created from scratch. This business plan included the vision of setting up a first centre targeting at the extension of the knowledge society using ICT and with a particular focus on Ambient Assisted Living. From this initial business plan, a strategic research agenda was derived focusing AICOS' core competencies on the areas of Autonomic Computing, Information Processing and Human-Computer Interaction. These founding topics of Fraunhofer Portugal AICOS represented a visionary seeding that enabled the creation of expertise and to grow a new researcher profile in Portugal. These topics and the implementation in the last 10 years had a substantial impact on the affirmation of Fraunhofer on the Portuguese Research and Industry environments. This path enabled to adapt and anticipate the technological evolutions, and today we have a base of research contributions and knowledge that is ready to be restructured for the next decade.

In 2018, AICOS' scientific competencies were revisited and restructured considering the characteristics of the team, scientific challenges and industry demand. The three core value areas of personal, intelligent and connected were defined in the tripartite approach: human-centred design (people), artificial intelligence (intelligence) and cyber-physical systems (connected things).

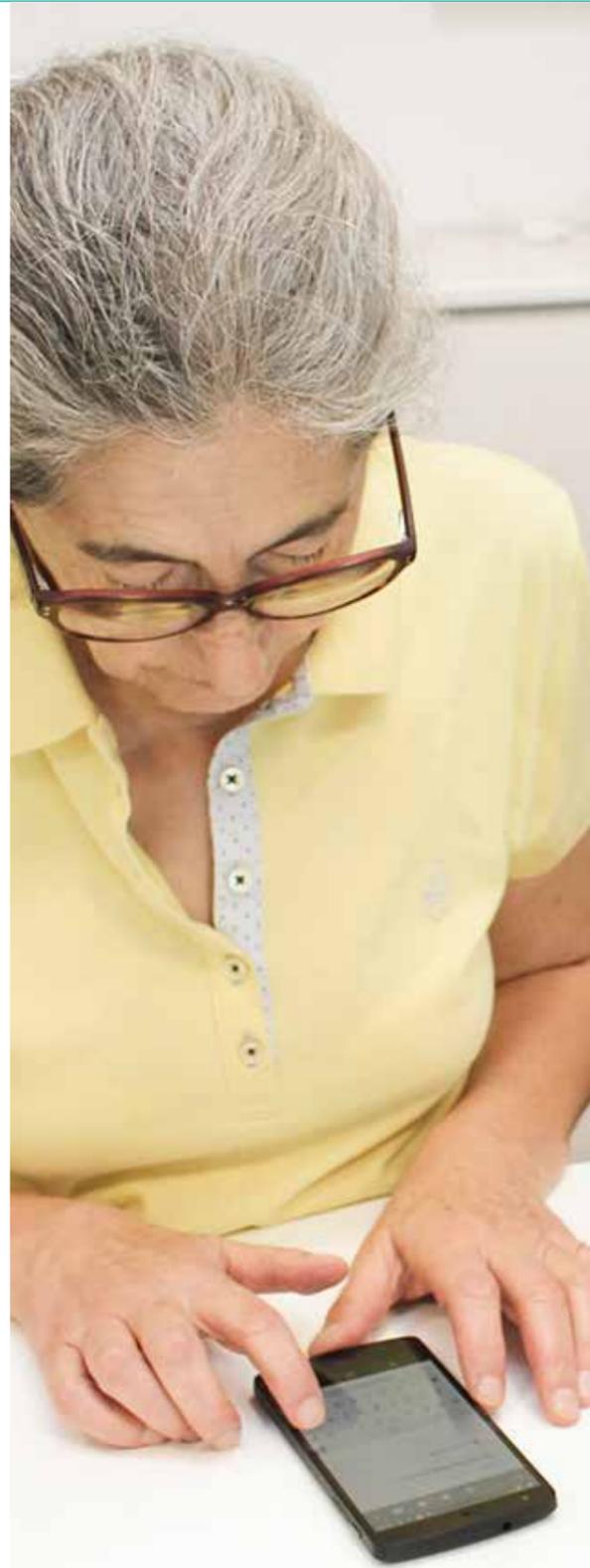


PEOPLE

The scientific competence in **Human-Centred Design** (HCD) constitutes the point of view of **People**. It brings together engineering, design and the social sciences to understand the realms within which technology will operate, to propose new technological scenarios to solve existing problems, and to assess what impact technology has in people's lives. Research in HCD asks the why and the how to inform the what. A key asset of our team is COLABORAR, a network with over 1000 active participants, who regularly take part in our research and development activities. Human-Centred Design has three sub-areas, which coincide with the main phases of a design process.

UNDERSTANDING PEOPLE IN DIVERSE SETTING

Technologists' assumptions about users of technology may be misaligned with reality and thus result in low uptake of technology. To avoid it, we employ proven user research methods, such as naturalistic observation or probes, to understand people, their context and cultural realm, and to inform product development teams. Our team specialises in understanding non-mainstream contexts to validate assumptions and to generate insights for solutions to complex design and interaction problems, using mixed methods of research.



CO-DESIGNING MEANINGFUL TECHNOLOGIES

We perform iterative and inclusive co-design with future users of technology, from neophytes to professionals, striving to create democratic design environments where people can provide their perspective and influence the characteristics of the technology being designed. Using co-design guided by ethical and aesthetic values, we specialise in generating meaningful solutions for self-care, visualisation and serious games, as well as solutions to support the digitalisation process in professional or community contexts.

TECHNOLOGY ASSESSMENT IN REAL LIFE

We design and implement technology assessment studies to investigate its different impacts on prospective users and other stakeholders, specialising in extreme users and new technology. We are experienced in evaluating wireframes, prototypes, and products together with their prospective users, in laboratory or in-situ. Results of technology assessment provide evidence of performance, usability, acceptance, uptake, as well as other impacts of the technology on people's lives or work.



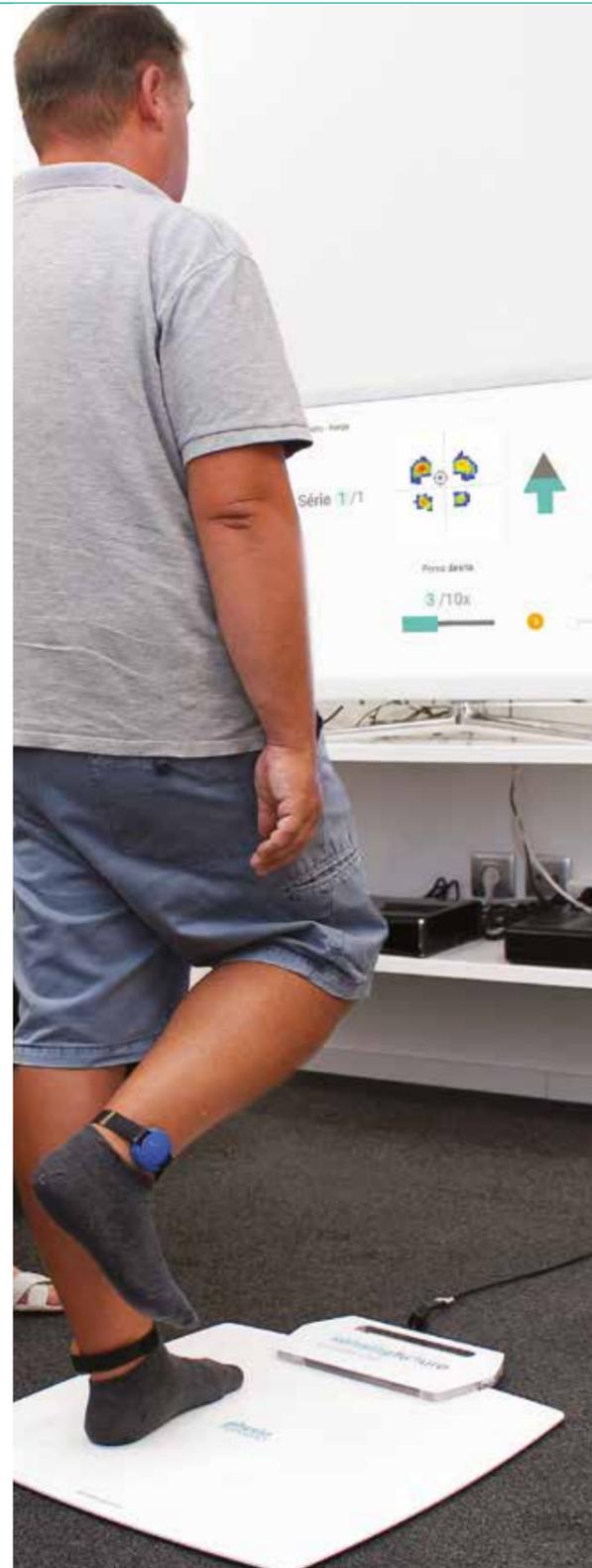
INTELLIGENCE

The point of view of **Intelligence** is represented by the scientific competencies in **Intelligent Systems (IS)**, which investigate ways in which technology can augment human potential in interpreting vast amounts of data, identifying patterns, anticipating events and supporting decisions. Within this wide scientific field, AICOS specialises in machine learning, computer vision, sensor fusion, and intelligence embedded into ever smaller devices with deep knowledge that goes from statistical classification to neural methods using deep learning methodologies and infrastructure. These are fundamental competencies demanded by a fully digitalised world of increasing complexity. The IS group is structurally divided into four main sub-areas, which map our core competencies.

EDGE & CLOUD COMPUTER VISION

We develop edge and cloud computer vision applications not only for image acquisition and processing, but also for identifying the relationship between multiple objects in images or videos. Our team is skilled in the development of portable and affordable image acquisition devices using advanced techniques that culminate in a better understanding of visual contents, which represents a quantum leap in several application areas.

The team is focused on mobile and embedded technology, which facilitate the creation of field-portable, cost-effective imaging and sensing technologies that are approaching laboratory-grade instrument performance. Additionally, we have been developing and optimising advanced algorithms while considering the technological constraints of edge devices, such as small-form IoT, wearables, mobile phones, and embedded processors.



SENSOR FUSION & EMBEDDED INTELLIGENCE

Information-gathering devices and sensors are now ubiquitous due to the explosive growth of smart devices and the emergence of the Internet of Things (IoT). We at Fraunhofer Portugal AICOS use sensor data fusion to integrate multiple data representing the same real world object into a consistent, accurate and useful representation.

Our team came to specialise in higher-levels of data fusion, for instance, through the application of advanced machine learning and statistical processes. By doing this, we maximise the value of data coming from multiple sources, and altogether, we support intelligent system behaviours. By fusing sensors, along with embedded processing and connectivity, we enable context awareness and a plethora of new services for the benefit of society.

COGNITIVE SYSTEMS & DEEP LEARNING

We develop cognitive systems inspired in the way the human brain works as well as its capabilities to learn from past experiences to solve highly complex tasks.

We research different information extraction techniques such as text and natural language processing, computer vision and signal processing, to extract information from unstructured sources of information. We combine and integrate multiple sources of information, so that our cognitive systems can understand the meaning and the relation between relevant concepts in any context.

We are also committed to addressing the legal compliance from the initial stages of development, to ensure that dataset bias and unfairness are minimised, and that the transparency of machine-decisions as well as that our solutions have a positive impact in the world.

PREDICTIVE MODELLING & RECOMMENDATION

Intelligent systems based on predictive modelling use data to assess certain conditions over time and, based on previous events, model their course and predict future states. At AICOS, we build predictive modelling and recommendation based on intelligent systems, that are robust and reliable, but also transparent, self-explanatory and easily interpretable for humans.

We focus on computer-aided detection and decision support systems to assist professionals in their routines, for example, early diagnosis and screening, by integrating their knowledge into computer systems.



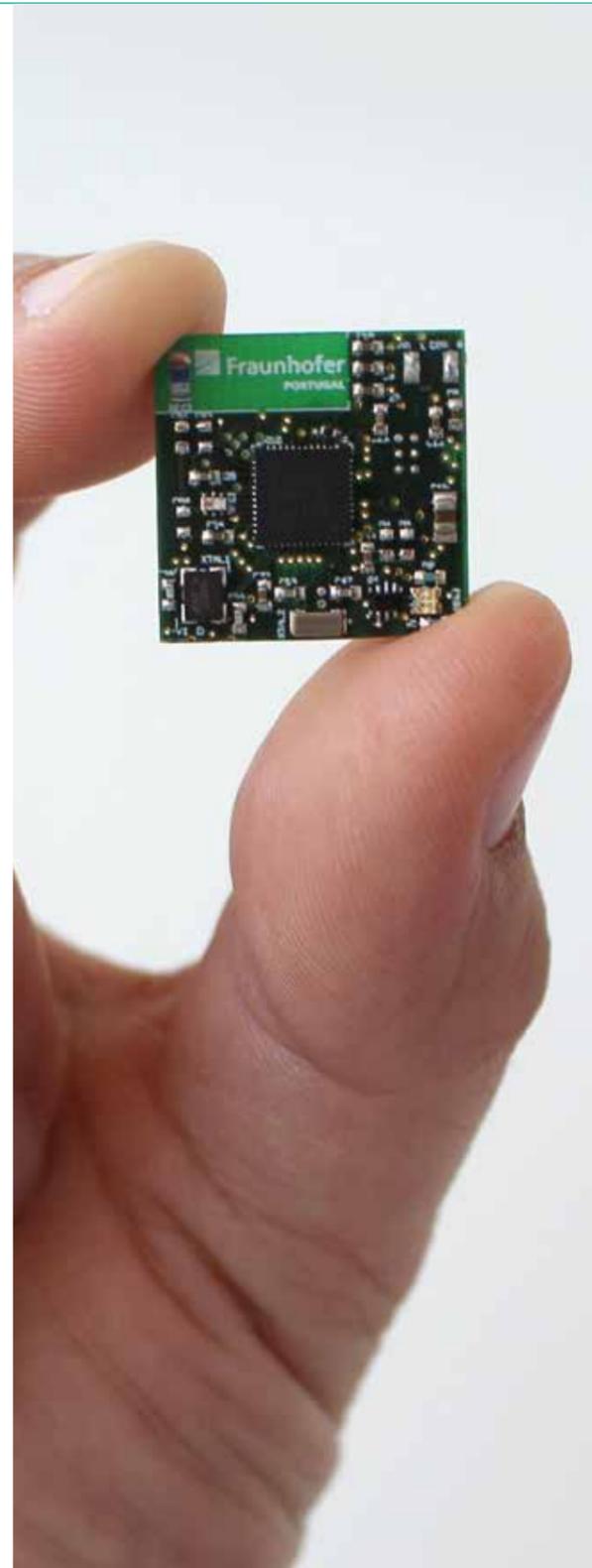
THINGS

Things constitute the mediums through which the power of intelligence is conveyed to people. This point of view is given by **Connected Things** (CT), a scientific area strongly related to cyber-physical systems demanding expertise in embedded electronics, communication and networks, as well as in edge and cloud computing, complemented by quality control and regulatory pre-compliance, which are cornerstones in assisting industry to deliver innovative products to market. CT specialises in four main sub-areas as presented next.

EMBEDDED ELECTRONICS

We create embedded electronics, to sense data from people and the surrounding environment, which can actuate, process data, and relay data to other devices.

When developing electronic devices, we also address privacy and data integrity. We explore scenarios of distributed and opportunistic computing, considering the devices' processing capabilities and taking advantage of the number of devices on the network.



COMMUNICATION & NETWORKS

At AICOS, we create communication networking solutions that exploit the concept of social-aware opportunistic data exchange for cases where the users may be in disconnected areas. Opportunistic communication allows to save networking resources as data exchange happens among socially relevant users, providing a non-real-time, but effective way of transmitting information upon the lack of connectivity.

We also explore the concept of software-defined networks and radios that may serve a wide range of applications from body area network to communications backhaul spanning large areas, with different quality of service requirements (e.g., low latency, improved bandwidth).

EDGE & CLOUD COMPUTING

We are working towards achieving seamless integration of things, edge, and cloud platforms. By exploiting different technologies, such as sensors, communication protocols, and interfaces, available in today's devices, we develop assistive solutions for people with different technology proficiency levels ranging from training purposes to complex task accomplishment.

We seek to create capable and resilient systems in harsh and adverse communication conditions, and balance between edge and cloud computing to find the optimum combination regarding energy, costs, quality, privacy, and user experience.

QUALITY ASSURANCE & REGULATORY PRE-COMPLIANCE

Quality assurance procedures are essential in maintaining a sustainable agile methodology for continuous delivery of results, aligned with customers' expectations. That is why we consider quality metrics that guarantee that the testing results accurately reflect the quality of the deliverables.

We are committed to supporting our partners in smoothing the transition from proof-of-concept prototypes to production-ready products, by providing electronic development services, which follow a pre-compliance approach for the final device.



INNOVATION THEMES



The initial business fields of Fraunhofer Portugal AICOS – Ambient Assisted Living and Information and Communication Technologies for Development – led the team to address challenges faced by older adults and people living in developing regions. In the course of time, due to scientific and technological developments, as well as demand from industry, the research activities evolved to related branches, e.g. healthcare, decentralised and personalised technologies stemming from R&D for old age.

In 2018, the research team was called to identify the areas where we currently apply our scientific competencies and which hold more promising outcomes and impact for industry and society in the foreseeable future. The outcome of this work was the definition of five innovation areas answering current and expected demands from our clients in healthcare, energy, retail, wine and agro-food, electronics and communication, e-government and the automotive industry.

COGNITIVE CONNECTED SOLUTIONS

Cognitive Connected Solutions focuses on AI Solutions with cognitive advantage built in a world of connected objects. We intend to guide our clients and partners into confidently building and using AI-based systems.

Affordable cyber-physical systems can lead the path towards a new digital world. Drawing on cognitive inspired models, we can enable ubiquitous sensing and understanding in complex contexts. Intelligent connected solutions turn data into actionable insights to optimise processes, predict needs, generate relevant recommendations, and support users through natural interactions.

SUBFIELDS

- **Letting everything sense:** measuring different parameters, related to people, work environment and processes, or machines;
- **Prediction and recommendation:** understanding human behaviour, the environment or machine's performance, allowing to predict changes and create recommendations to optimise processes;
- **Natural user experience:** exploiting cognitive elements, such as natural language processing and conversational interfaces.



SUBFIELDS

- **Decision support:** using data from different sources (e.g., sensor, device or user reports) to provide improved, relevant information that aids in the decision-making process;
- **Mobile crowdsensing:** retrieve data (e.g., data reports, photos) produced by those acting directly on the field (e.g., agronomist, farmer, farming engineer) to improve farming operation and management;
- **Efficient and self-managed networks:** providing an efficient, self-managed communication backhaul coupled with low-cost wireless sensor networks to cover large farming cultivated areas.

DIGITAL FARMING

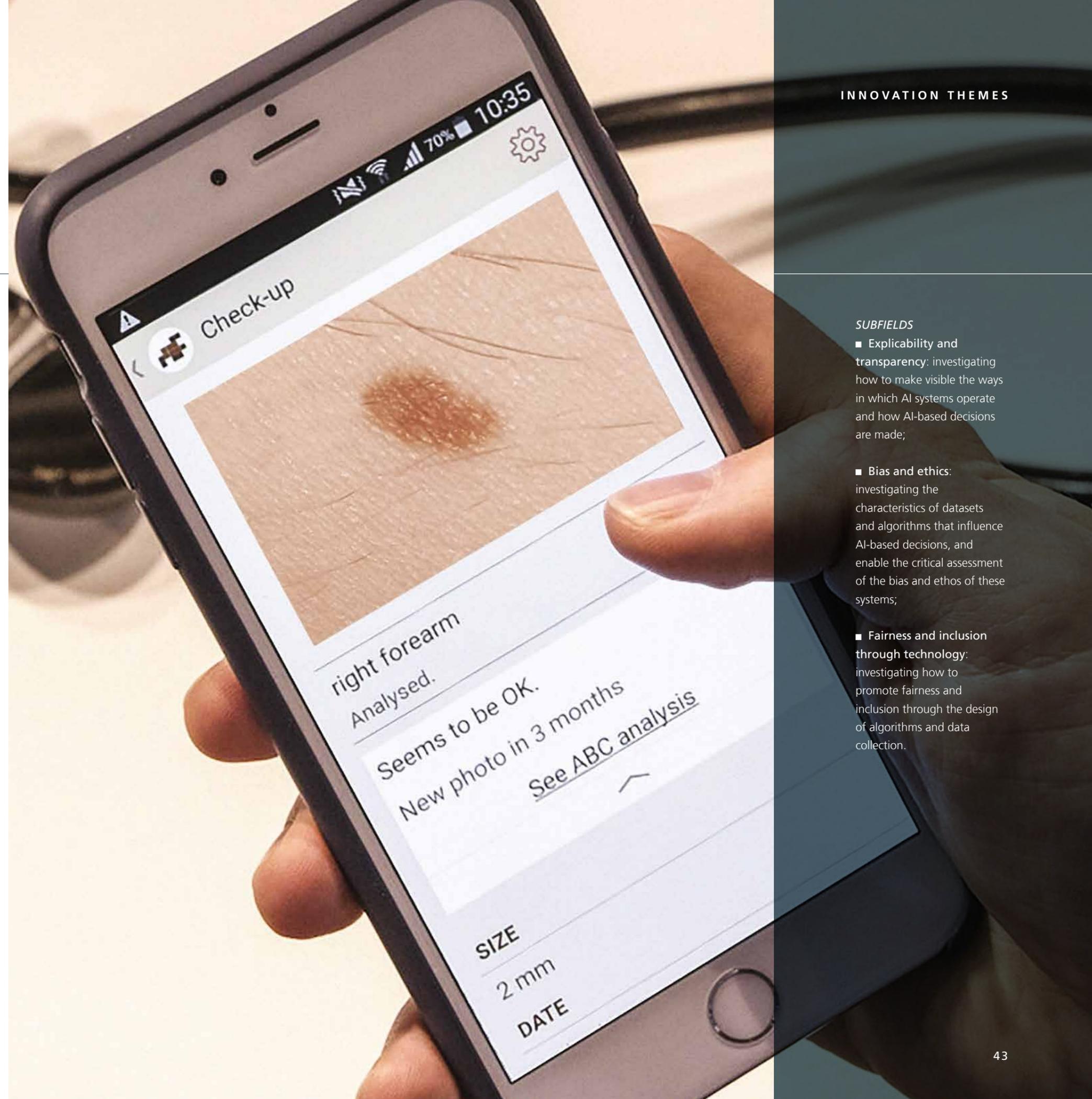
Digital Farming assists traditional farming, winery and agro-food in the digital transformation of their businesses, fuelled by the drive of attaining efficiency gains and waste reduction.

By deploying wireless sensor networks or mobile crowdsensing solutions coupled with computer vision, we can collect relevant measurement data related to plants, soil, water and environmental conditions. Machine and knowledge-based intelligence can then be used to process collected data and produce fused information to support data-driven decisions. To narrow the gap between technology and end-users, it is of paramount importance to involve farmers and stakeholders throughout the development process. This involvement will enable the understanding of farmers' tacit knowledge, design translations of vernacular to digital, and assess usability and technology acceptance. These approaches allow for building farm planning and management systems, meant to increase crop production, while minimising waste and preserving natural resources at ever larger scales.

ACCOUNTABLE ARTIFICIAL INTELLIGENCE

Accountable Artificial Intelligence is an innovation area which seeks to critically analyse and build solutions of AI, so that nefarious outcomes may be prevented and so that people are able to understand and trust AI systems, thus benefiting from their untapped potential.

AI holds the promise of positively impacting society. Through self-driving cars, specialised medical diagnosis or highly automated factories, AI is expected to change whole industries and improve living conditions. However, it can also lead to negative outcomes if AI systems are not appropriately designed. We are thus committed to studying the technical, ethical, and social implications of AI systems. In this innovation area we will help our clients design algorithms that generate self-explanatory AI-based decisions, minimise bias, and act ethically in their context.



SUBFIELDS

- **Explicability and transparency:** investigating how to make visible the ways in which AI systems operate and how AI-based decisions are made;
- **Bias and ethics:** investigating the characteristics of datasets and algorithms that influence AI-based decisions, and enable the critical assessment of the bias and ethos of these systems;
- **Fairness and inclusion through technology:** investigating how to promote fairness and inclusion through the design of algorithms and data collection.

DECENTRALISED HEALTH TECHNOLOGY

Within the area Decentralised Health Technology the focus is on moving existing efforts into the field of medical devices and technology that conveniently addresses ongoing and future changes in the way healthcare is delivered to patients.

We envision healthcare as a continuum process, where predictive, preventive, personalised, and participatory medicine play a key role. By harnessing technology, we contribute to seamlessly effective, efficient and thoughtful points of care from hospital to home and at every point in between. Healthcare is approached as an ecosystem where technology can facilitate human intervention, connection, and collaboration. Our major goals are to improve patient access to early treatment, support clinicians' decisions, enable the participation of patients and informal caregivers in their care, empower non-experts to acquire medical data, and decrease the burden of screening actions on healthcare systems.

SUBFIELDS

- **Early diagnosis:** developing tools to enable the continuous, real-life collection of objective data and the deployment of screening actions closer to target populations, while reducing the burden on clinical staff;
- **Prevention and intervention:** building personalised recommendation systems that encourage healthy behaviours, support interventions in cognitive and physical rehabilitation, and prevent exacerbations in chronic conditions;
- **Portable and affordable, cutting-edge technology:** creating health technology that can be used by non-experts, in clinical or non-clinical settings, to support clinicians' decisions and improve patients' care.





SUBFIELDS

- **Personalised technology:** understanding attitudes, values and routines to inform the design of meaningful adaptation of interaction to user tasks and roles;
- **Socio-technical systems:** understanding technology in context, including the physical and virtual space, as well as the actor network that surrounds systems;
- **Technology design by non-technologists:** understanding appropriation of technology and ways of co-designing it with extreme users.

LIVING AND AGEING WITH DATA

Qualitative and long-term applied research efforts to assist clients in understanding the contexts in which their technology operates and how users, regardless of age or literacy level, relate to this technology and data, so as to achieve the best possible outcomes.

Societies are learning to coexist with digital technology. Relying on thick data, we seek to understand and anticipate how people's existence with tangible or intangible technology unfolds across the lifespan and across contexts. With the democratisation and humanisation of technology, humanities and the social sciences are called upon to help shape how people, regardless of technology proficiency level, relate to data and technology and appropriate it as part of their everyday lives.

SUCCESS STORY

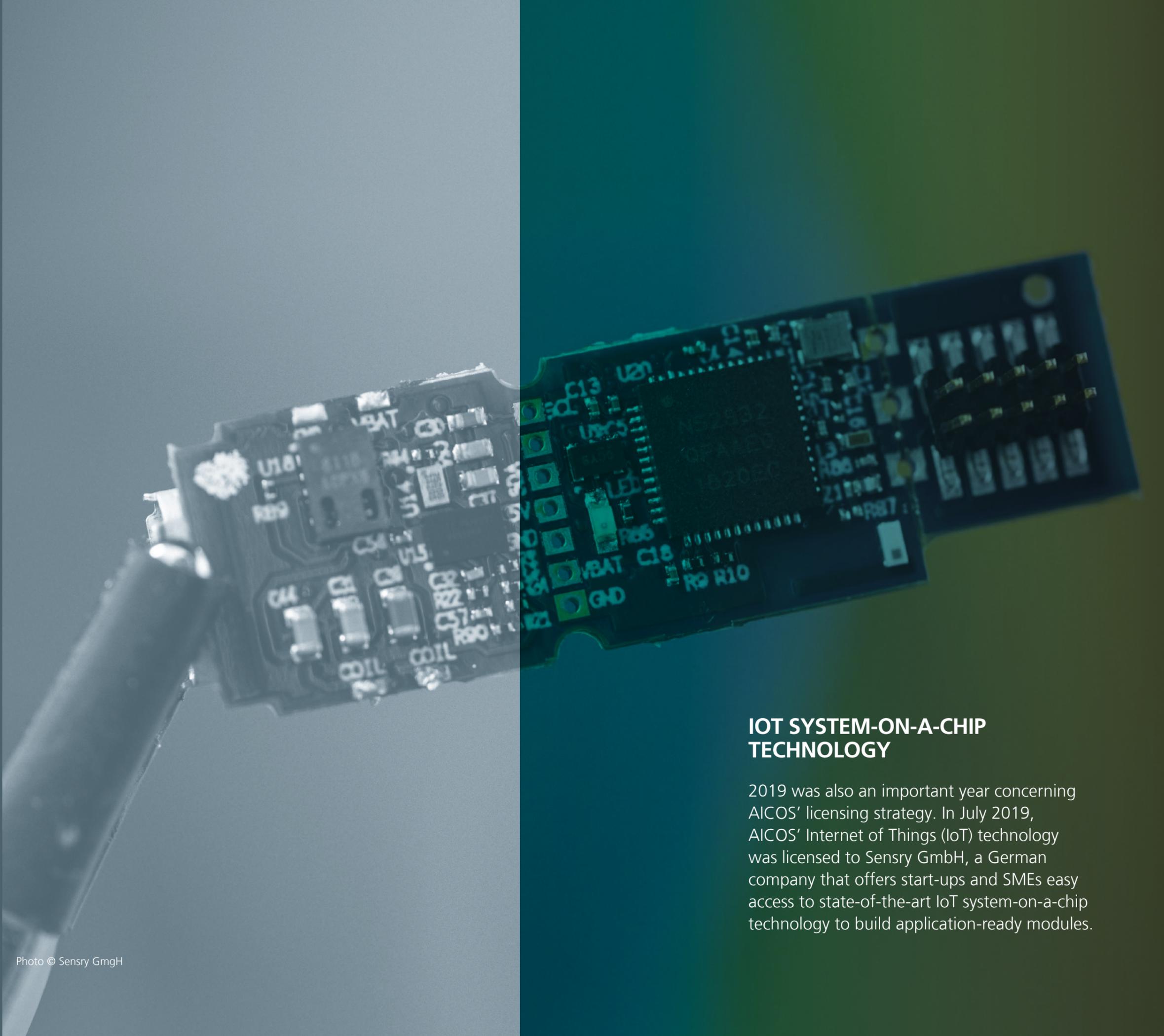


Photo © Sensry GmgH

IOT SYSTEM-ON-A-CHIP TECHNOLOGY

2019 was also an important year concerning AICOS' licensing strategy. In July 2019, AICOS' Internet of Things (IoT) technology was licensed to Sensry GmbH, a German company that offers start-ups and SMEs easy access to state-of-the-art IoT system-on-a-chip technology to build application-ready modules.

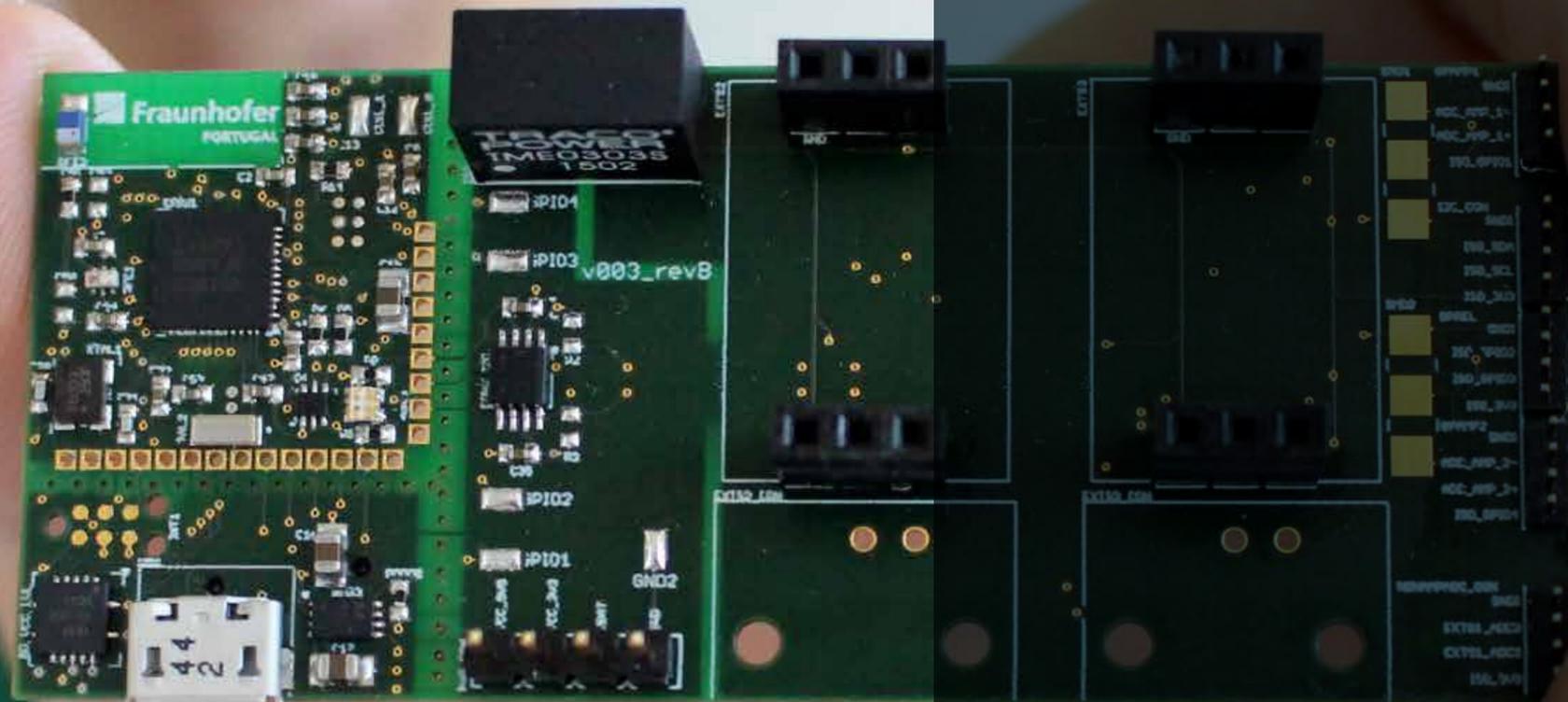


Photo © Amkor Technology

Since 2014, AICOS has been strengthening competencies in electronic design and software development for embedded systems. First as an internal project and then as a research funded one, AICOS' IoT technology became more and more evolved with hardware, firmware and software features being developed to create PANDLETS – a development ecosystem to ease and speed-up the development of new wearable and IoT-based solutions.

For its versatility, PANDLETS set the ground for an industry-led project and, back in 2016, AICOS and Amkor Technology Portugal, S.A. (former NANIMUM, S.A.), started IOTIP, a research and development project focused on the adaptation of the PANDLETS ecosystem to a wafer-level modular architecture for the IoT.

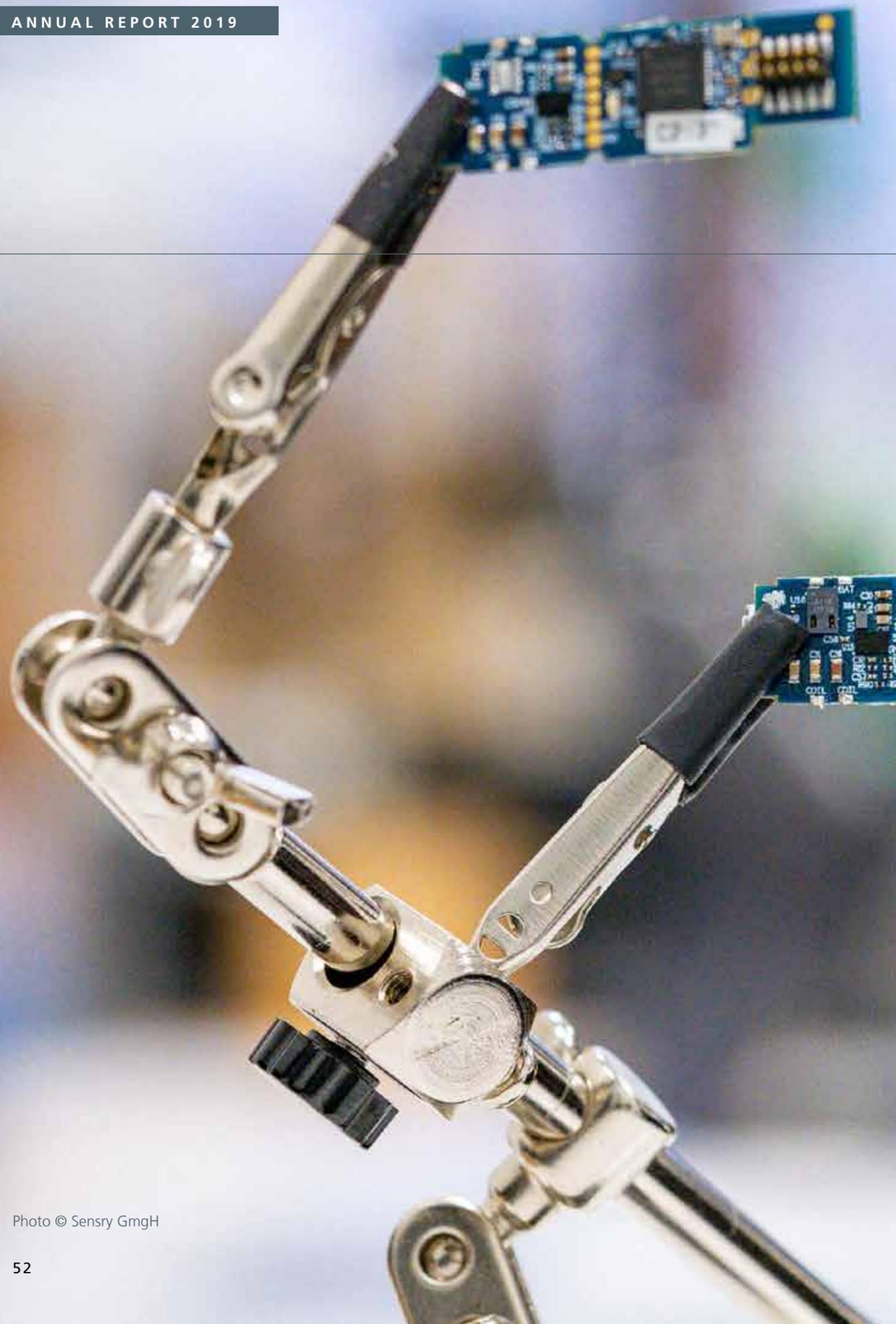


Photo © Sensry GmgH



The success of this endeavour caught the interest of international stakeholders. In 2018 the first discussions with Sensry GmbH, concerning a licensing deal of the PANDLETS ecosystem, begun. After the progresses made under an evaluation license agreement, FhP-AICOS and Sensry GmbH, reached an agreement for the commercial exploitation of the whole PANDLETS ecosystem.

The partnership established with Sensry GmbH allows AICOS to develop new solutions based on a commercially available development platform, branded as Kallisto, as well as enhancing the ecosystem with new features and are also available to third parties, thus creating new business opportunities.

IMPACT ASSESSMENT OF RESEARCH EXCELLENCE



The Scientific team demonstrated a relevant increase in the several indicators for Job creation, public engagement and scientific production. The key indicators defined in the Strategic Research Agenda in 2018 have been followed and monitored proving an important tool for validating the impact of Fraunhofer Portugal AICOS' research.

With a strong signal of scientific maturity, the research team has grown the number of Journal Papers in key journals in more than 50% from last year achievements. The increasing attraction of Msc Students to develop their thesis at AICOS shows improved visibility and reputation, making AICOS a reference for MSc students in Porto and in Lisbon.

SCIENTIFIC PRODUCTION

The defined goals for 2019 for publication numbers have been overcome by the achieved production in this year, with a notable reference for journal papers in key venues such as MDPI Sensors, IEEE ACCESS, IEEE Journal of Biomedical and Health Informatics and IEEE Sensors. Additionally, in 2019, the scientific community has requested the participation of AICOS team members in international committees in relevant scientific venues as BIOSTEC, pHHealth, and CHI. These publications and scientific activities expose the produced research to our potential clients and provide notoriety to AICOS' research.

The areas of the publications cover the three scientific competencies, showing the relevance of each competence and the collaborative and multidisciplinary approach followed at AICOS.

The number of theses that occurred in collaboration with Fraunhofer AICOS increased to 27. All the theses have been defined under the scientific competencies, with relevant outputs for AICOS' scientific agenda. This collaboration process is key to the attraction of the best talent to AICOS and to provide a learning environment with interaction with industry partners and industry-oriented context. The students that conduct their research under AICOS' supervision establish a young generation that will have Fraunhofer as a reference in Portugal for mature applied research.

This year AICOS was awarded in five occasions, in international and national venues with a notable reference for the recognition of mDevNet project as a best practice example by Infarmed, the Portuguese Authority for drugs and medical products. Fraunhofer Portugal AICOS received the first prize in the Research & University category of the 2019 Innovation Award at the 13th edition of the A&T International Fair in Turin, Italy. This award was given in the context of My-AHA project, a European project focused on active and healthy ageing.

45

Papers

27

M.Sc. Theses

1

Ph.D. Theses

1

Posters

3

Book Chapters



Tips for conducting Usability Tests
Some rules of thumb

- Explain to participants that they are not being tested
- Think about the most important issues/features – so
- Pilot test everything – to see e.g. if duration and tasks are
- Shut up – Let participants talk as you cannot learn otherwise
- Stay alert to confirmation bias – it is easy to
- Don't teach participants how to do tasks – your goal is to
- Consider using a validated scale (e.g. SUS) – to compare

JOB CREATION AND CAPACITY BUILDING

AICOS has grown the number of PhD holders from 8 at the end of 2018 to 16 in 2019, providing the needed senior researchers to continue the support for applied research in the projects under execution, to increase the capacity of attraction of new projects, and to be able to answer to the increased number of industry projects, and the generation of an increased number of industry projects. The continuous collaboration with the Academia enable us to attract an increased number of Master students, and a Professor from University of Porto (UP), Prof. Carlos Soares, from the Informatics department of the University of Porto started a closer collaboration with Fraunhofer as Innovation Lead. This collaboration is aligned with the identified strategy of stronger connection with our academic partners, namely the University of Porto.

The support of capacity building in the Portuguese industry was strengthened with an increased offer of Industry-oriented courses on the areas of AI for Industry, AI for Business and Deep Learning promoted by the Intelligent Systems group. The Human-Centred Design group has created an offer of professional training sessions User Research and Usability, and the Connected Things group offers courses on Embedded System Development and Mobile Development. This initiative started to generate revenue and to show to relevant national partners our capabilities as experts in the areas with the needed knowledge to support them in developing their research strategies.



PUBLIC ENGAGEMENT

To reach the potential partners and clients, Fraunhofer Portugal AICOS has promoted 16 events along 2019 with a wide audience from academia to industry. The most impactful moment was centred in the celebration of the 10th anniversary of Fraunhofer Portugal AICOS that occurred at the Terminal de Cruzeiros of Porto de Leixões where many of our current industry clients and academia partners joined to witness the achievements of a decade devoted to establishing Fraunhofer's Mission in Portugal. In this event Fraunhofer's international clients gave testimony of the collaboration and mature relation they were able to establish with Fraunhofer with a particular emphasis of the CEO of Sensry, Konrad Herre, describing the process of introducing a new product in the market of IoT under a Licensing agreement with FhP-AICOS.



INFRASTRUCTURE



The activity of Fraunhofer Portugal AICOS started in Campo Alegre, Porto, in an office located in the premises of the Faculty of Sciences. Given the objective of expanding FhP-AICOS' activities, namely the need of physical infrastructure with the necessary offices and labs to perform the agreed R&D activity, the University of Porto, authorized by UPTEC, ceded to Fraunhofer Portugal an office area of circa 1800m² in the Science and Technology Park of the University of Porto, UPTEC's Asprela.

In 2011, and after an initial investment of more than 1.4M€ in the preparation of these offices to perform R&D activity, Fraunhofer AICOS' team moves to the Asprela UPTEC's park. The following investment of 1.7M€ in equipment, including IT infrastructure and office equipment, created the space currently occupied by Fraunhofer Portugal AICOS in this location. This location and investments offer access to a state-of-the-art IT infrastructure and well-equipped laboratories to AICOS' collaborators, clients and partners.

IT INFRASTRUCTURE

Since 2011, when Fraunhofer Portugal AICOS moved to its current premises, IT infrastructure has increased significantly to offer the necessary resources to Fraunhofer AICOS' ever growing team and keep up with the innovations in this domain. Besides the most common IT resources, FhP-AICOS has recently invested in equipment and software (SW) that allowed for the setup of new R&D Services, namely a:

Development Network

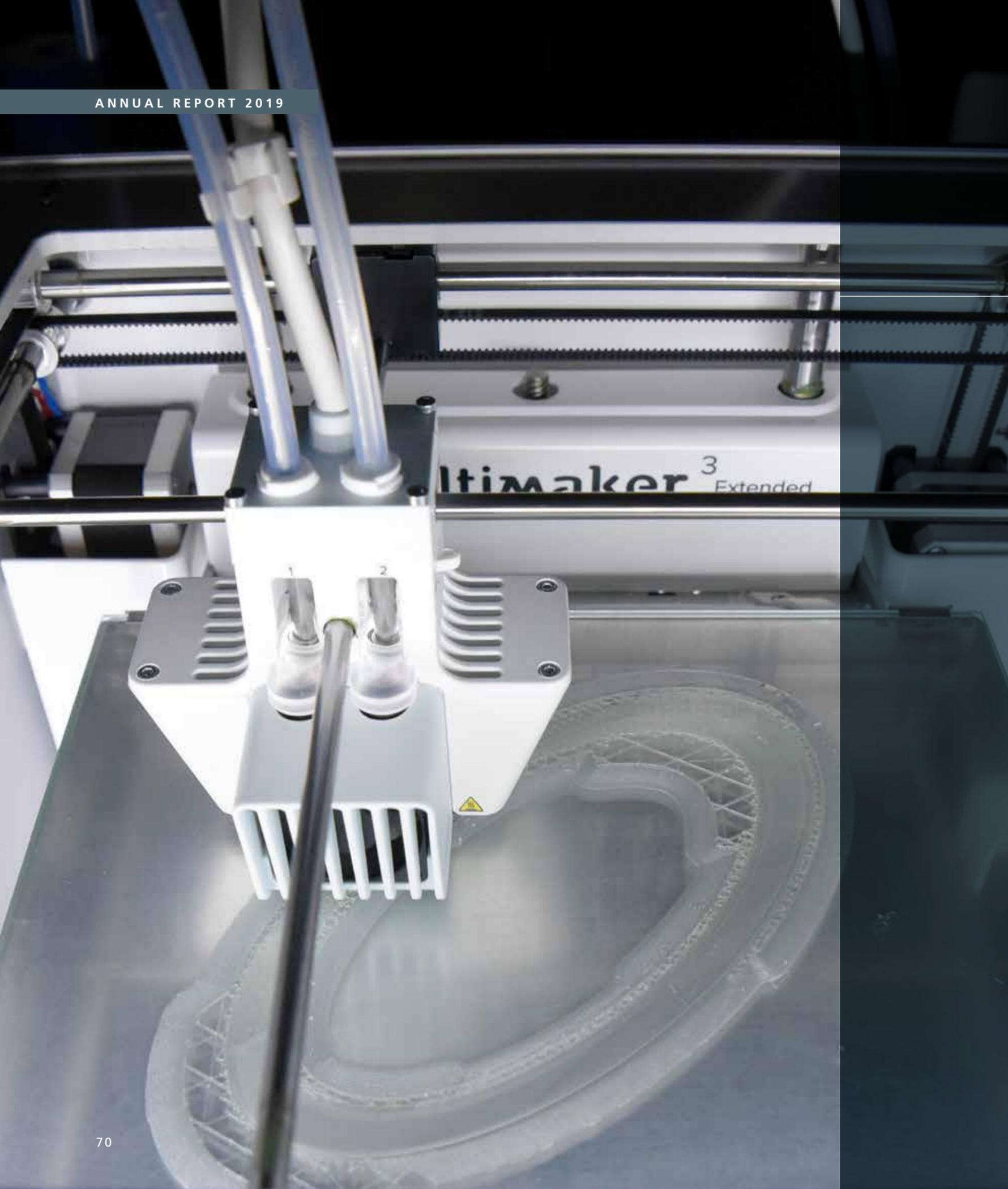
Fraunhofer Portugal Development Network provides connectivity to registered devices, with relaxed policies and limited internal networks access;

Deep Learning Platform

Fraunhofer Portugal Deep Learning machines are full-fledged physical and virtual machines that feature dedicated Graphical Processing Units (GPUs) to train machine learning models applied to several domains, namely computer vision and signal processing;

Internal Cloud Platform

Fraunhofer Portugal Cloud is built on top of OpenNebula cloud computing platform and offers unmanaged sandboxes to AICOS' scientists, to install, test, and deploy whatever technologies are required, while still benefiting from centralised backup and network security.



DIGITAL FABRICATION LAB

To support the activities in the field of Human-Centred Design and to bridge the gap between ideation and prototyping, Fraunhofer Portugal AICOS has recently set up a Digital Fabrication Lab. AICOS' Digital Fabrication Lab features state-of-the-art 3D printing machines, namely a 3D Systems Multijet 2500 printer, and Computer-Aided Design (CAD) software, that can guarantee the fabrication of detailed parts to test pre-production, as well as more traditional fused deposition models that create polymer parts to rapidly test and iterate evolving ideas. The following printing technologies and manufacturing techniques are made available to AICOS' scientists, clients and partners:

Lab Equipment

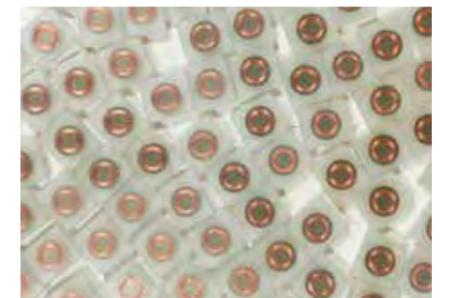
- ProJet 2500 Plus Form 2;
- Ultimaker 3 Extended;
- Formech 450 DT;
- Vacuum chamber for silicone moulding;
- Benchtop injection moulding machine.

3D Printing Technologies

- Fused Deposition Modelling (FDM);
- Multijet (MJP);
- Stereolithography (SLA).

Moulding Techniques

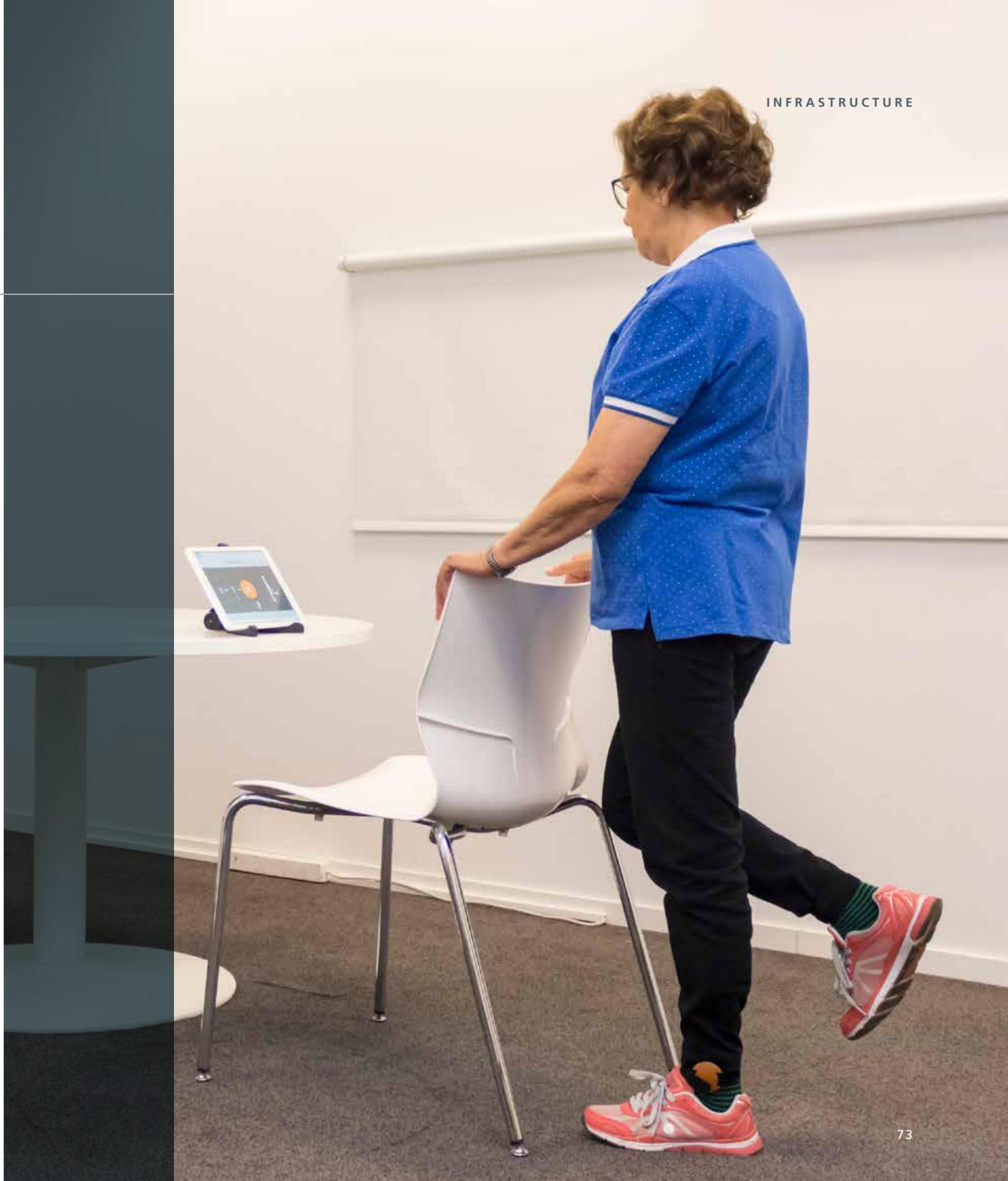
- Injection;
- Vacuum forming.



LIVING LAB

Fraunhofer Portugal AICOS began with a physical space inside its facilities which simulates an apartment and where research participants take part in technology assessment activities. In time, FhP-AICOS succeeded in creating a Living Lab defined not by physical boundaries, but by a network of volunteers (most of whom older adults) who allow validation of assumptions, testing technology in the field and, with it, an increased likelihood of technology uptake in the market, which, in turn, renders our applied research more attractive to businesses. This Living Lab, COLABORAR, was built through protocols with associations, care organisations and other types of entities, currently reaching over 1200 end-users in 77 partner institutions. So far, it has supported 76 R&D projects and has allowed over 3000 research activities involving research participants.

In order to manage, maintain and grow the Living Lab, FhP-AICOS has invested in creating its own Customer Relationship manager (CRM) support application for the Living Lab. Through the application, the Living Lab manager is able, amongst others, to control recruitment processes, extract indicators about the network or analyse questionnaires involving the participants.



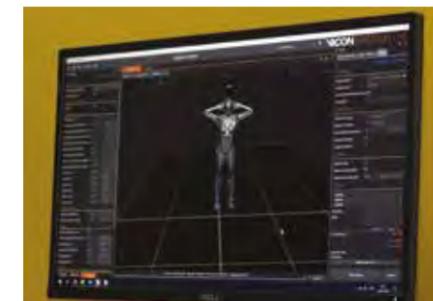


MOTION LAB

Following its research activities related to human motion analysis, Fraunhofer Portugal AICOS has recently established the new Motion Lab. The Motion Lab features a VICON motion capture system that comprises eight infrared cameras, calibration kits, body markers, and motion analysis software. The Motion Lab offers additional equipment, namely:

- Depth sensors and cameras;
- Electromyography sensors;
- Force platforms;
- In-shoe plantar pressure systems;
- Inertial Measurement Units (IMUs) and data loggers;
- Leap motion system.

The Motion Lab offers FhP-AICOS' scientists tools and resources to support the development and validation of algorithms for gait analysis, movement monitoring, and a range of motion estimation, based on inertial sensors' data, against to the gold standard defined by the motion capture system.



OPEN LAB

Following its internal research activities and market demand, Fraunhofer Portugal AICOS has been constantly improving its embedded development, electronics' design and assembly capabilities. When first established in the new premises, FhP-AICOS equipped two different spaces: one for hardware related tasks and a second one for multipurpose software development. In order to bring together these close activities, FhP-AICOS has recently merged these two labs into a new 85 square meter space called Open Lab.

This new space offers the necessary resources and tools to create state-of-the-art cyberphysical solutions, offering development, assembly, debug, and test equipment:

- Electronics assembly equipment;
- Electronics development tools;
- Telecommunications test equipment;
- Testbeds.

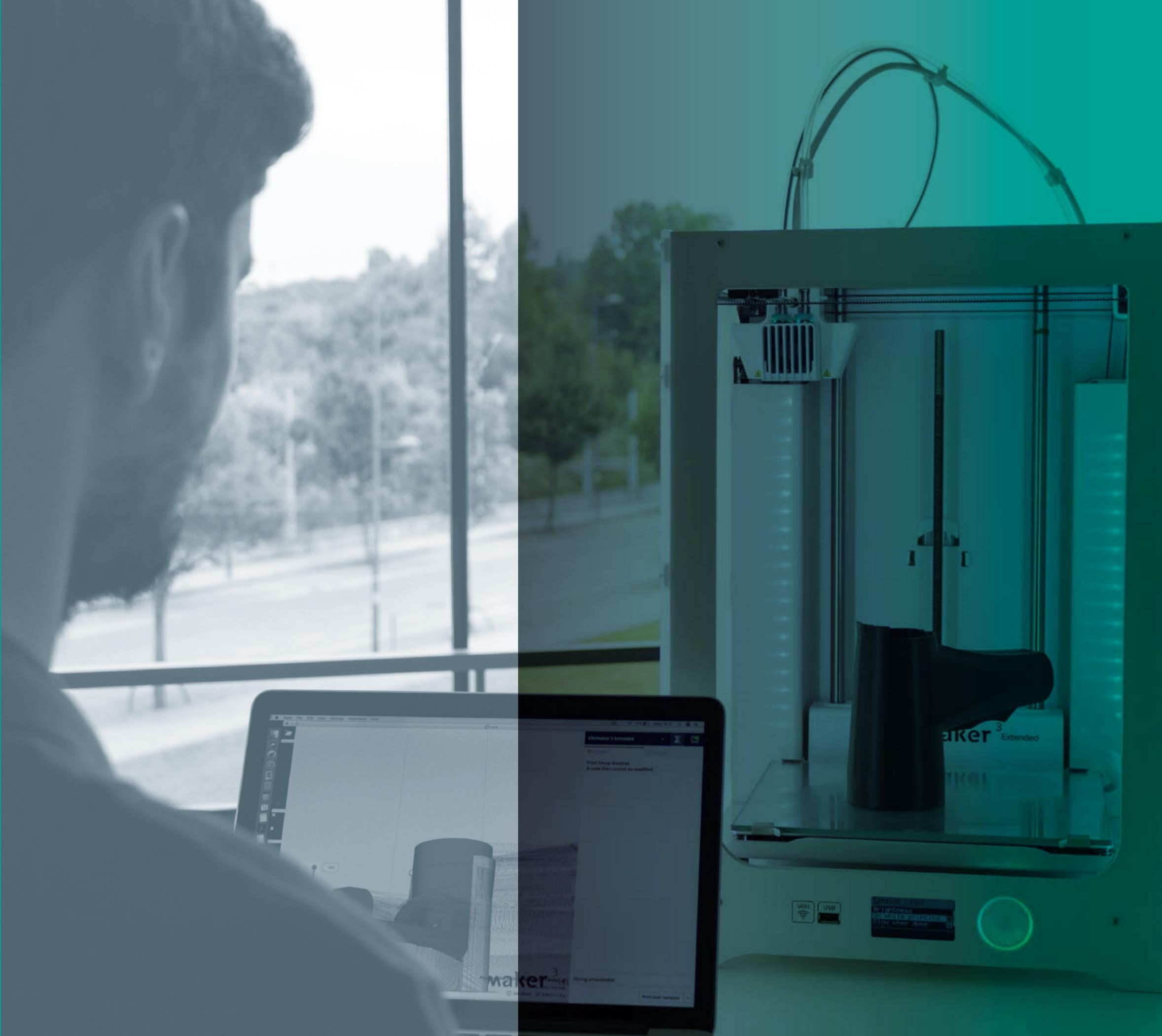
Fraunhofer Portugal AICOS' emerging competencies in optical image acquisition and processing demand for specialised tools and equipment. Thus, the Open Lab also includes an area reserved for optics related developments, featuring:

- Accessories for lens positioning and mounting;
- Digital image sensors and acquisition systems;
- Optical breadboards;
- Standards of high-resolution, colour and focus test targets.

These tools and equipment are being used for development, calibration, validation and test of image acquisition prototypes that require dedicated optical materials and experimental setups.



SERVICES



Fraunhofer Portugal's Research Services, rendered through the research institution it operates (AICOS), has been at the service of its clients and partners by offering R&D Consulting with new solutions and ideas for evolving products and services, Proofs of Concept for the initial implementation for proving that new ideas really work; and Prototype Implementation services.

We support our partners in the early phases of innovation and technology strategy identification, and in the design and development of innovative solutions. We offer technical knowledge at the highest levels of science and technology and wide-ranging expertise in the areas of Intelligence, Connectivity and Human-Centred Design.



Rapid Prototyping

We help our partners create early prototypes of technology to enable technical verification and quick decision making. Rapid prototyping services at AICOS include software and hardware: 3D printing, application design and development, electronics, machine learning and networks.



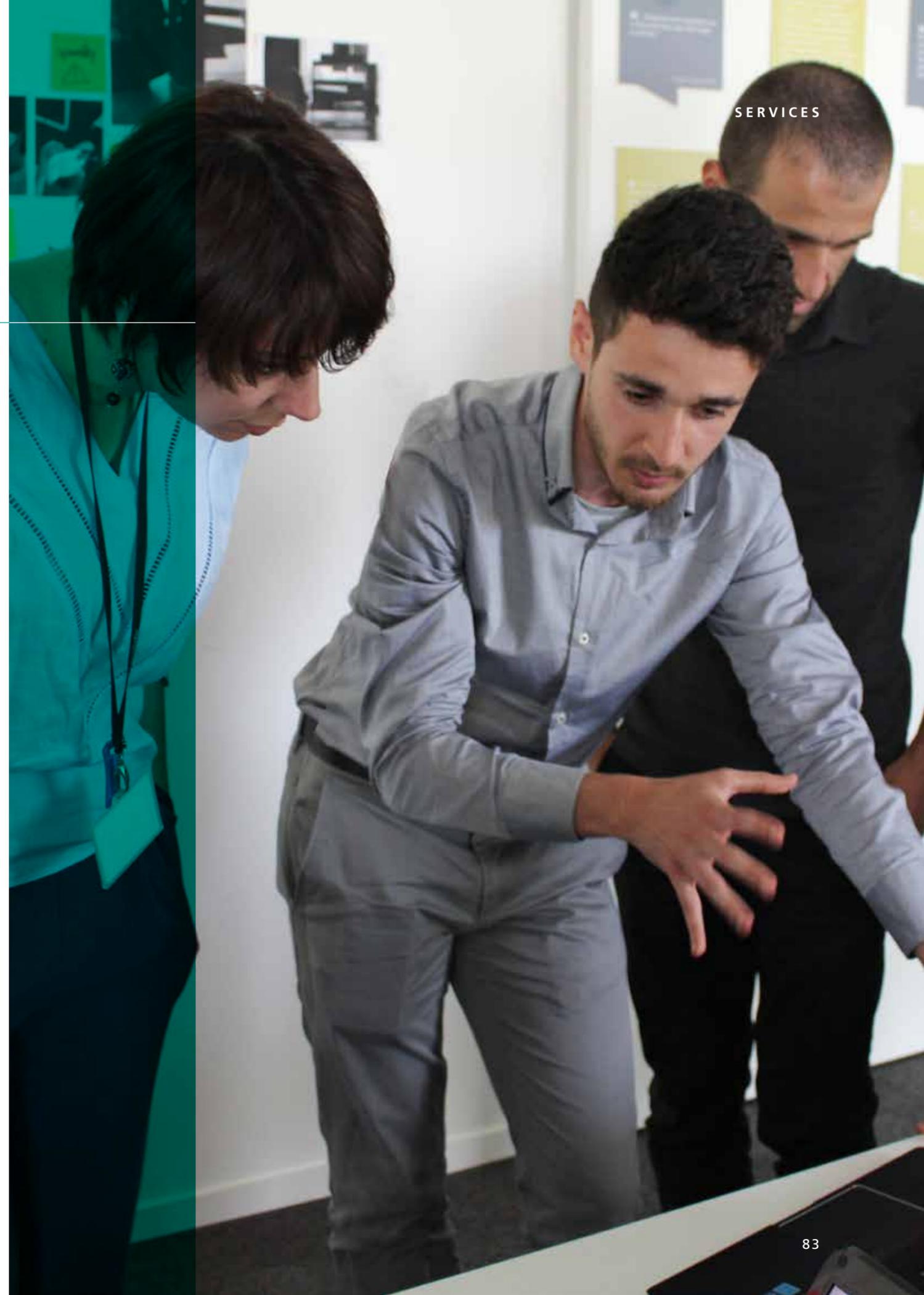
Innovation Studies

These services are mostly related to assumption validation and evidence gathering. We are able to offer custom-designed studies, analyses of the state-of-the-art, and technology assessment through technical tests, heuristic evaluation or tests involving users. In order to tailor technology to users' needs and demands, we also offer user research services, whereby we gather insights on end-user groups which help our partners gain in-depth knowledge of their target groups.



Education & Training

Throughout the years, researchers at AICOS have been organising internal workshops for the R&D team and for partners in R&D projects. As part of our catalogue of services, we are able to offer technical and scientific workshops, as well as professional training, in order to support capacity building within our partners' and clients' teams.





RAPID PROTOTYPING

We help our partners create early prototypes of technology to enable technical verification and quick decision making. Rapid prototyping services at AICOS include software and hardware, as shown below:

3D Printing

AICOS' Digital Fabrication Lab is the bridge that allows filling the gap between ideation and production of small series. Relying on state of the art machinery and on a skilful and competent workforce with competence in Human-Centred Design, we can offer a complete service to enhance ideas and make them tangible. Ready for use at our Digital Fabrication Lab are state of the art 3D printing machines offering several different techniques that can guarantee both the manufacture of detailed parts to test pre-production, with layer thickness starting at 32 micrometres, as well as the more traditional fused deposition models that create plastic parts to rapidly test and iterate evolving ideas. Our Digital Fabrication Lab also features other machines to enhance or build prototypes using silicone moulds, polymer injected parts for small series and thermoforming vacuum machines to offer a wider range of possibilities.

Applications

Application prototyping enables concept or assumption validation without spending valuable development time in a actual product. At AICOS we have the capability of working in prototypes focusing on Design and/or Functionality: Design prototypes help to understand user interactions and how information is displayed within an application; Functional prototypes aim to perform early validation of technical requirements to prevent additional issues in later stages of development. We have the know-how to work in several different technical fields enabling us to provide full-stack support, ranging from Mobile and Web Applications to Back-end solutions.



Electronics

Making use of a proprietary hardware development ecosystem, AICOS' rapid prototyping service eases the creation of sensing electronics to measure different phenomena. By doing so, we can easily understand if movement, environment, or spectral data is meaningful in order to realize a certain event. Additionally, our competence in electronics design and embedded development, together with state-of-the-art lab infrastructures, allows us to create, assemble, and test electronic devices designed to meet specific purposes.

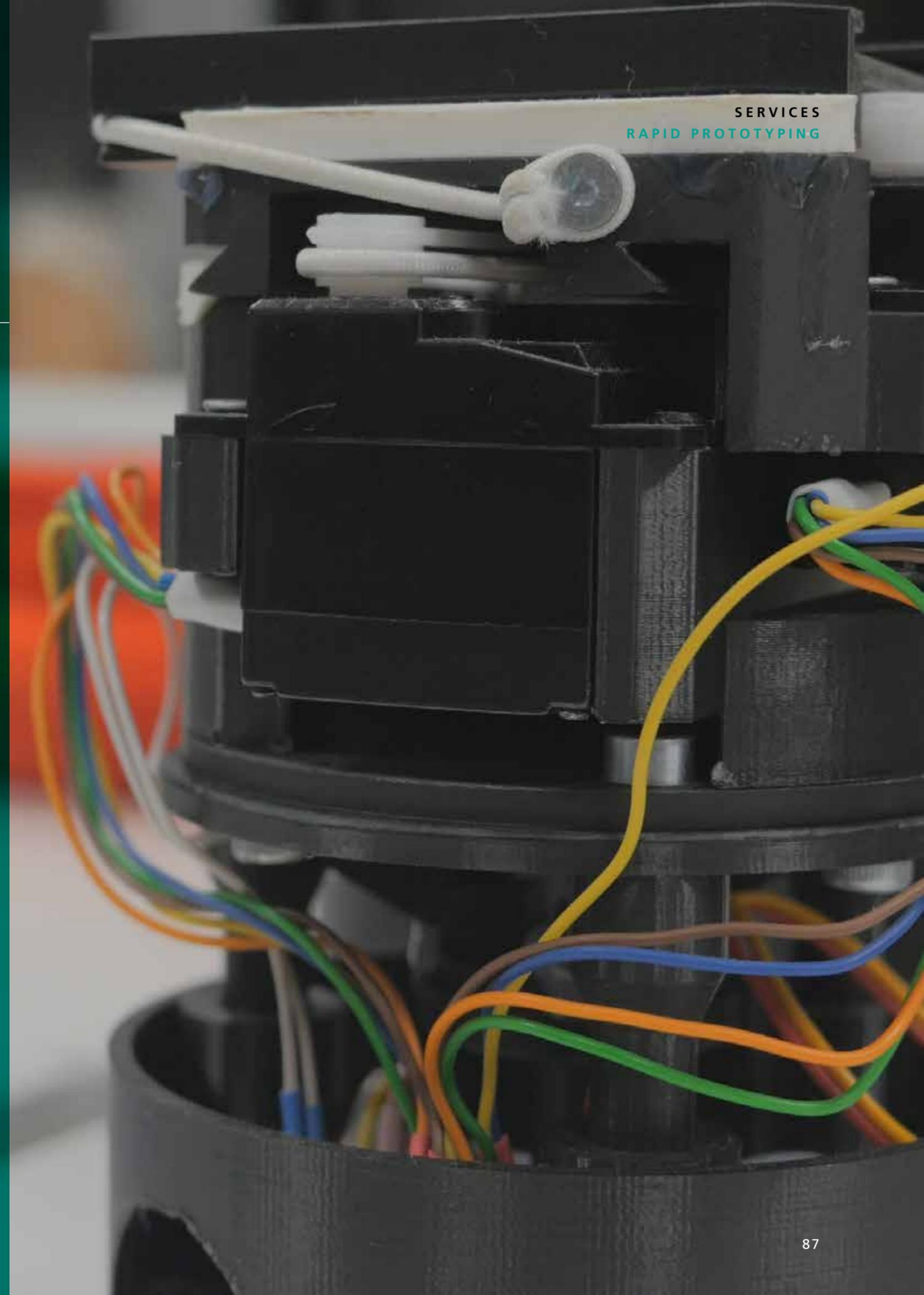
Therefore, we can assist our partners realizing new ideas or creating small series for proofs of concept, which can be later used for usability tests, assumption validation or to further explore business models. Furthermore, AICOS' know-how in certification, pre-compliance, and supply chain enables us to help our partners establish scalable production runs, smoothing the transition between prototyping and production phases.

Machine Learning

AICOS is continuously working on software components for data acquisition, feature extraction and machine-learning classification. These modules can easily be connected and represent the building blocks of our machine learning pipelines. By being highly flexible and customizable, they allow rapid testing of different machine learning strategies, in order to build classification models tailored to meet our clients' needs.

Networks

AICOS' networking rapid prototyping service is based on the WiBACK technology. It is built with low-cost, off-the-shelf hardware, integrating WiFi, Bluetooth Low Energy, and GPS interfaces. Added to that, the latest WiBACK node can be powered directly from the power grid or through solar energy. These features, added to WiBACK's self-configuring and self-managing features, allow for fast deployment in a wide range of scenarios (i.e., rural and urban) aiming at different applications (e.g., digital farming, industry 4.0, ICT for development). Given its flexibility, AICOS is able to further extend the WiBACK solution, providing fast prototyping services upon our customer's specific needs and requirements for networks and communication.



INNOVATION STUDIES

We support our clients with assumption validation and evidence gathering. We are able to offer custom-designed studies, analyses of the state of the art, and technology assessment through technical tests, heuristic evaluation or tests involving users.

In order to tailor technology to users' needs and demands, we also offer user research services, whereby we gather insights on end-user groups which help our partners to gain in-depth knowledge of their target groups.

Custom-designed studies

From understanding user needs to assessing feasibility or impact of any given technology, we can help you design your study in order to gather the evidence you require to make better informed decisions or to validate assumptions about your technology.

State of Art

Within our scientific competences, we are able to help you through analyses of state of the art, including not only scientific literature review, but also on competitive analyses of existing technology.

Technology Assessment

We can perform technology assessment through different techniques, depending on your requirements and your purposes, which can be discussed with our researchers. Technology assessment may be made with experts in the subject domain, with end-users of the technology or even without resorting to human beings, in cases where only technical performance is to be evaluated. Assessment protocols with users may be made in situ or within a controlled environment. AICOS will help you design the study.

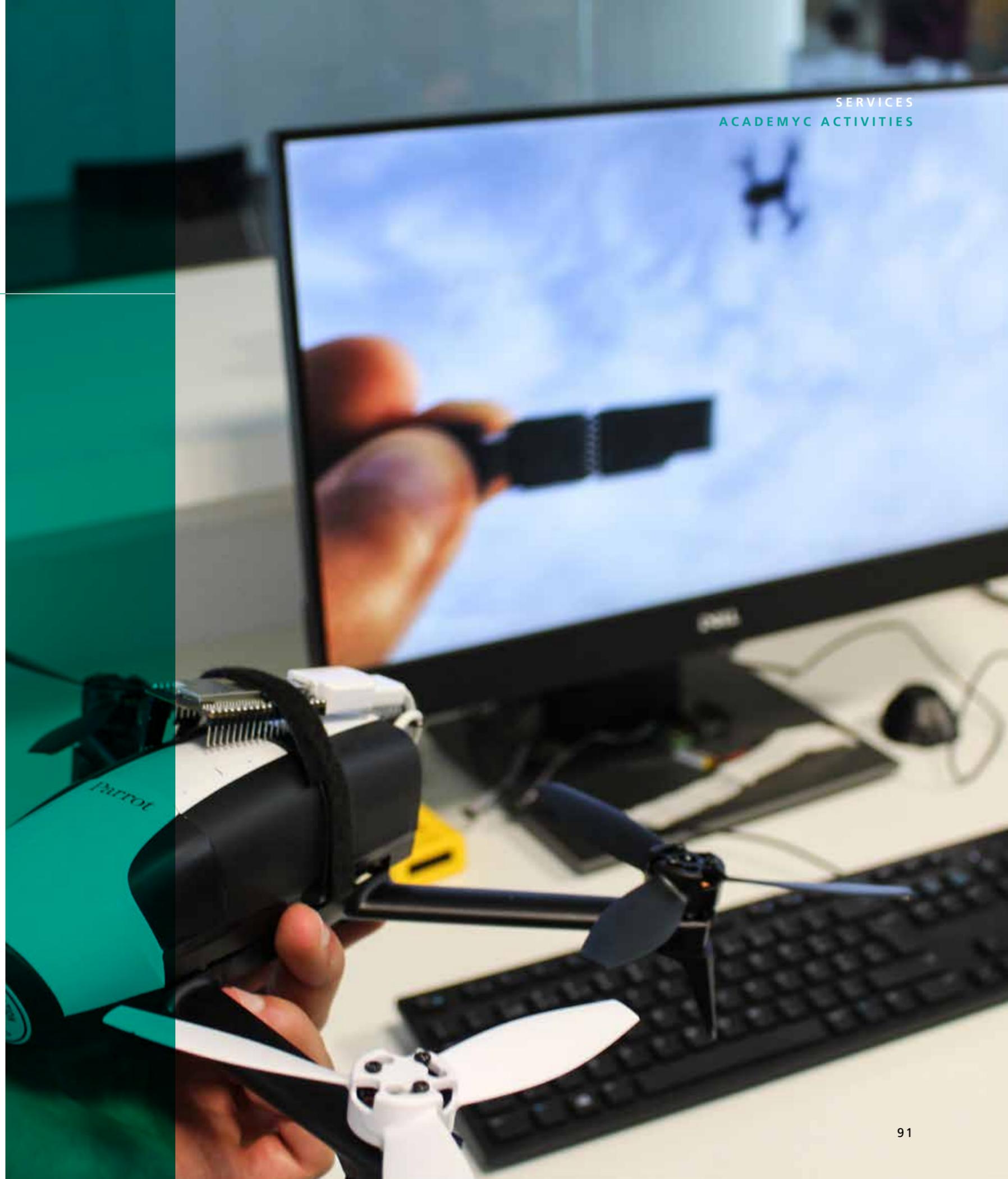
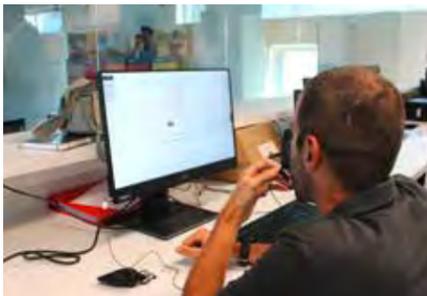
User Research

User research studies may inform different stages of technology development. AICOS may support you in eliciting requirements by conducting initial studies with future end-users of the technology, and we may conduct user research in the scope of technology assessment by validating prototypes at different readiness levels.

M.Sc. THESES

In order to provide students the opportunity to experiment a professional atmosphere, each year has Fraunhofer Portugal AICOS been integrating Master students, facilitating the adjustment from the academic into the industry reality. Accompanied by researchers and specialized professionals from FhP-AICOS throughout the development of their theses, students have had the opportunity to absorb the experience of a reference institution such as FhP-AICOS, specialized in creating cutting-edge technology and following the trends of the technological world.

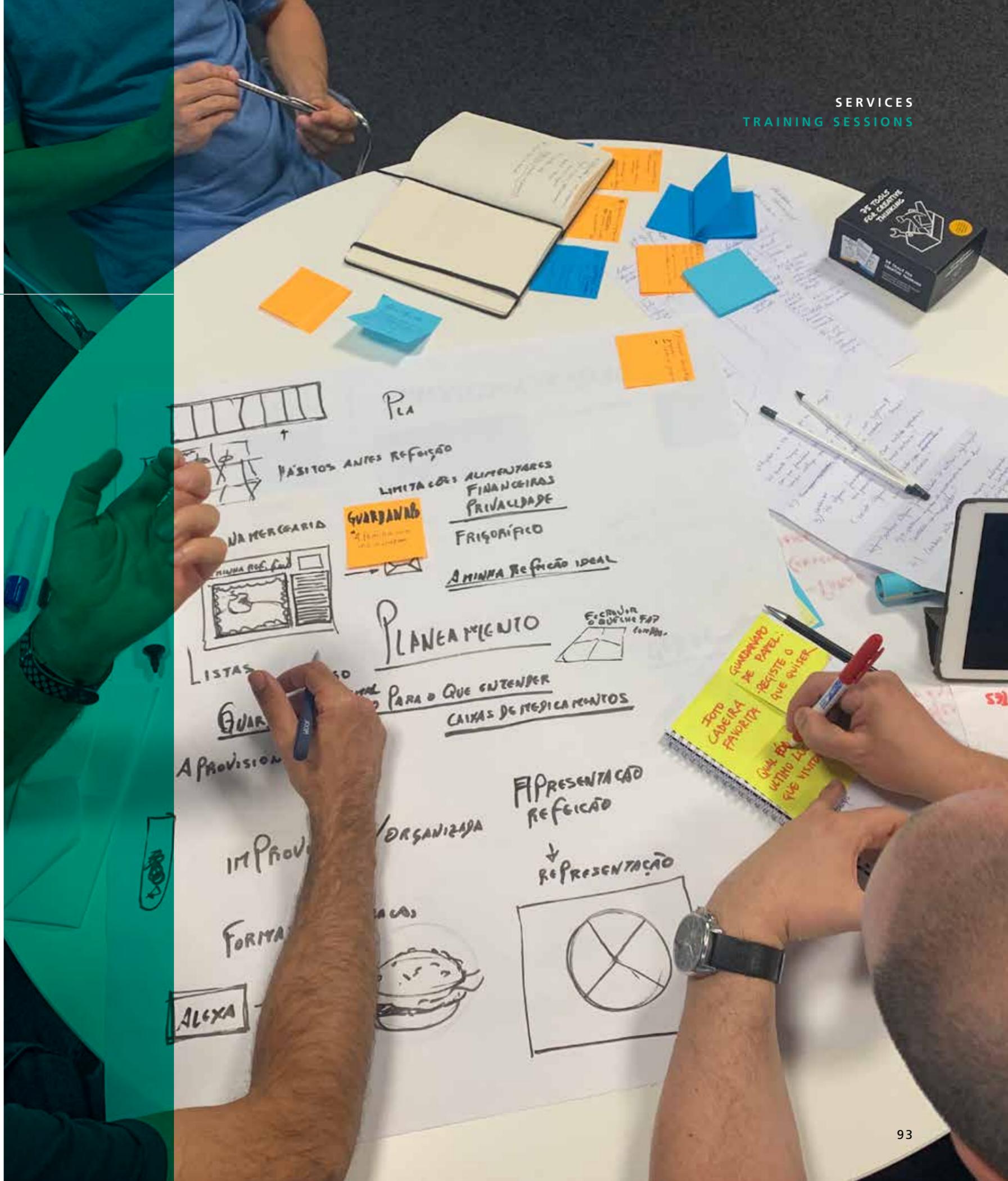
This cooperation results in a win-win relationship, since it also allows FhP-AICOS to benefit from these students will for knowledge.



TRAINING SESSIONS HCD, IS AND CT

At AICOS we also offer specialized training on our competence areas: Human-Centred Design (HCD), Intelligent Systems (IS) and Connected Things (CT).

During 2019, we organized training courses, in each of the above-mentioned areas. By focusing on topics of general interest and adapting the program to the technical or scientific level of the attendees, our training courses have been designed for both students and professionals.





USER RESEARCH AND USABILITY TRAINING

Developing successful technologies that fit customers' lives and work requires a deep understanding of said customers and their context. To do otherwise is to risk project failure, low product adoption, and high costs correcting design problems after product or service launch.

Fraunhofer Portugal AICOS offers a custom-built training series on User Research and Usability to help clients learn about their own clients or users. The program focuses on methods for collection, analysis and evaluation of qualitative data, as well as methods for technology assessment in the lab or in the wild. Through the analysis of practical examples from our years of experience in designing technology-mediated solutions for several user groups, including non-mainstream audiences, we are able to provide best-practices from real-world scenarios. For quicker consulting with our experts in human-centred and interaction design, our partners are also invited to bring their own products in order to receive personalised feedback on usability, interaction or inclusive design, coupled with recommendations for product improvement.

KEY BENEFITS

- Bespoke training sessions according to your specific needs and challenges, coupled with exercises designed for your specific challenge, and practical examples from Fraunhofer AICOS' work;
- Capacity building in your team, so that human-centred design processes can be implemented more easily in your innovative product development;
- Access to team of researchers who are up-to-date with latest technologies, methods and scientific advancements in user research and usability.

CONTENTS

Introduction to User Research

Basic concepts of user experience research methods such as ethnographic field studies, focus groups, participatory design, diary studies or interviews, among others.

Analysis of Qualitative Data

Methods and best practices for the analysis of qualitative data, including Thematic Analysis or Grounded Theory.

Evaluation Methods

Introduction to methods, techniques and tools for technology assessment of products and prototypes throughout the different phases of development.

Design requirements

Hands-on sessions on ideation, elicitation, and co-design of requirements informed by user-research, i.e. actionable insights.

"Bring your own app"

Personalised feedback, based on heuristic analyses, regarding usability and interaction design of the client's products.





MACHINE LEARNING TRAINING

A new digital transformation is currently taking place, boosted by the exponential availability of accessible data and of the required computing power to process it. This is leading to the widespread use of intelligent systems based on Machine Learning with potential to disrupt almost every industry field, transforming the ways of production, management and governance.

Fraunhofer Portugal AICOS is offering a custom-built training series on Machine Learning (ML), composed of theoretical and hands-on sessions. The training is based on practical examples, exploring the multiple methods and uses of Machine Learning, with the aim of promoting a deeper understanding of real problems and delivering tangible outcomes that have an impact in the short term. Our partners are challenged to bring their own data in order to create a truly tailored learning experience.

KEY BENEFITS

- Selected training sessions, focused on your company's specific business environment;
- Open source tools developed at FhP-AICOS are available to speed up the learning and implementation process (TSFEL);
- Increase Machine Learning competences applied on your real problems.

CONTENTS

An Introduction to Machine Learning

Basic concepts of ML, presenting base datasets structures, understanding the principles of supervised and unsupervised learning, neural networks and validation techniques.

Machine Learning at Fraunhofer Portugal AICOS

Examples of application scenarios both in time series and image contexts within our innovation portfolio: Motion, Nutrition, Derma, Ophtha, Micron, Audit.

Partner Machine Learning Challenges

Share the contexts where the introduction of ML in the partner workflow would boost productivity.

Hands-On (Using public datasets)

Every participant will work on public datasets and use Python tools to extract information, implement and train a classifier.

Hands-On (Using your own data)

Using partners own data to demonstrate the potential of Machine Learning to solve their own real challenges.





DEEP LEARNING TRAINING

Last years have witnessed the onset of a paradigm change on how businesses work. Data is becoming more accessible, and there is much value to extract from it in virtually every industry field. Along with improvements in computing power, industry players need to keep up with the ever-changing technology, constantly evolving their use of intelligent systems to boost performance and efficiency.

Fraunhofer Portugal AICOS is offering a custom-built training series on Deep Learning (DL), consisting of theoretical and hands-on sessions. These are built upon practical examples, exploring multiple methods and uses of Deep Neural Networks, considered the cutting-edge of Machine Learning techniques, to achieve a deeper understanding of real-world problems and deliver tangible solutions with a short-term impact. Our partners are challenged to bring their own data resulting in a truly tailored learning experience.

KEY BENEFITS

- Selected training sessions, focused on your company's specific business environment;
- Tools used in practical sessions are open source (either publicly available or developed at FhP-AICOS), so your company can apply the solutions right away;
- Increase Deep Learning competences applied on your real problems.

CONTENTS

An Introduction to Deep Learning

Basic concepts of DL: the Artificial Neuron and its role as a basic unit of Deep Neural Networks; training through backpropagation; different network architectures and their most appropriate applications.

Best Practices in Deep Learning

Tricks of the trade, from data preprocessing and augmentation to model evaluation and optimization. Examples of applications within our innovation portfolio.

Partner Challenges

Partners are challenged to share some pain points where DL could have the most impact, even if traditional Machine Learning is already employed. A round-table discussion is promoted to pinpoint possible solutions and next steps with FhP-AICOS experts.

Hands-On

Participants work on public datasets and use DL frameworks to implement and train a classifier. Optionally, the partners' own data can be used to reveal the potential of DL to solve their real challenges.





MOBILE DEVELOPMENT TRAINING

The creation of long living, reliable and stable software solutions is directly tied to the developer itself. His ability to produce and document good straightforward modular code will dictate how reusable and reliable the solution will be.

Fraunhofer Portugal AICOS offers class-leading training series on Mobile software development (mainly Android/iOS) to help clients learn about the process and implementation. The program can be custom built based on the client's needs, level of expertise and short term objectives. Thanks to several years of experience and market-ready solutions, we can provide training on various topics of mobile computing. The training may range from basic solutions development and debugging to more advanced scenarios such as continuous integration, modular design, test-driven-development, sensorial data and dependency injection. Based on the client's end goal and objectives, we can also consult on best implementation choices and technologies.

KEY BENEFITS

- Custom training sessions based on the client's profile and objectives;
- Hands-on training with the support of experienced developers;
- Extensive selection of available technologies;
- Introduction of sustainable software techniques.

CONTENTS

Introduction to Android/iOS Development

Basic concepts of version controlling your code, IDE tools (Android Studio), UI Design and demo application deployment.

Test your Application

Methods and best practices to introduce unit and instrumental testing to your applications, supported by a continuous integration system.

Make your application Ambient Aware

Overview and examples on the usage of sensors like IMU, proximity, and GPS.

Advanced Application

Overview of architecture patterns (MVVM/MVC) and persistence methods.

Take your app to the store

Code obfuscation, localisation, crash reporting platforms, versioning, product flavours and remote monitoring.





EMBEDDED SYSTEM DEVELOPMENT TRAINING

Following the IoT paradigm and its increasing number of sensors monitoring various aspects of our daily living: from our homes, workout routines, work posture and environment, to the industry, agriculture and logistic companies that produce and transport the goods we consume; embedded system development is a fundamental competence for the development of the sensors and the gateways that monitor, aggregate and transport such data to the inter(or intra)net.

Thanks to several years of experience and market-ready solutions, Fraunhofer Portugal AICOS is able to provide class-leading training on various topics of embedded system development, to help clients learn about the process and implementation. The program can be custom built based on the client's needs, level of expertise and short term objectives.

KEY BENEFITS

- Custom training sessions based on the client's profile and objectives;
- Hands-on training with the support of experienced developers;
- Extensive selection of available technologies to develop and monitor embedded systems;
- Learning about the creation of embedded Linux OS and embedded software;
- Consultancy on best implementation choices and technologies based on the client's end goal and objectives.

CONTENTS

Introduction to Linux based Operating Systems

- Linux basics;
- Bash scripting and development tools.

Developing modular solutions with C/C++

- Inter process communication;
- Threads, shared libraries and memory management;
- Communicating with peripherals;
- Integration with cloud services;
- Debugging using Open Source tools - Valgrind and gdb.

Yocto

- Overview about the Yocto project and its terminology;
- Building a full Linux based image with Yocto;
- Personalising and building a custom Linux based image;
- How to add support to new hardware (CPU, peripherals) to the Yocto build environment.

Maintenance and monitoring tools

- Process supervision using Monit and M/Monit;
- OS update using Mender.

Hardware for embedded systems

- How to choose the right platform and its expansion modules;
- Hardware designing guidelines for mass production.



EVENTS



AICOS 10 YEARS CEREMONY

The Fraunhofer Portugal AICOS Research Center celebrated its 10th anniversary in 2019. In an event which took place in September 27, at the Porto Cruise Terminal building, several special guests, who somehow contributed and were part of these 10 years of history, joined us to celebrate this special date.

Among the invited speakers were João Sobrinho Teixeira, Secretary of State of Science, Technology and Higher Education; Helena Pereira, President of FCT; João Falcão e Cunha, Dean of the Faculty of Engineering of the University of Porto; Konrad Herre, CEO of Sensry GmbH; Frank Treppe, Director, Political and International Affairs of the Fraunhofer-Gesellschaft and Dirk Elias, SVP and Division Manager at Robert Bosch Corporate Research and former Director of Fraunhofer Portugal AICOS (2009 – 2017).



The celebration of AICOS' 10th anniversary took place at the Porto Cruise Terminal building, in Matosinhos.



Liliana Ferreira, Director of Fraunhofer Portugal AICOS, hosted the event that brought together important personalities in the context of science and technology, both national and internationally.



AICOS' researchers who have been distinguished over the years with the ELEA – AICOS 'Entry Level Excellence Award'.



Fraunhofer

AWAM

THE NEW FRAUNHOFER CENTRE IN PORTUGAL, FOR SMART AGRICULTURE AND WATER MANAGEMENT

2019 was also the year when Fraunhofer Portugal AWAM was founded. The public presentation of the new Fraunhofer Centre in Portugal, dedicated to "Smart Agriculture and Water Management", took place in March, as part of the inaugural event of Fraunhofer Portugal AICOS' 10th Anniversary celebrations, which included the presence of the Portuguese Minister of Science, Technology and Higher Education, Manuel Heitor.

The event, held at the Rectory of UTAD (Universidade Trás-os-Montes e Alto Douro), counted with the presence of: Liliana Ferreira (Fraunhofer Portugal AICOS, Universidade do Porto); Pedro Almeida (Fraunhofer Portugal AICOS); Filipe Sousa (Fraunhofer Portugal AICOS); Jörg Laschke and Alexander Michaelis (Fraunhofer-Gesellschaft and Fraunhofer IKTS); Thomas Härtling (Fraunhofer IKTS); Gottlieb Basch (Fraunhofer Portugal AWAM); António Augusto Fontaínhas Fernandes (Rector of UTAD); Tim Hogg (UTAD); Teresa Pinto Correia (Universidade de Évora); and João Paulo Oliveira (The Navigator Company).



Fraunhofer Portugal AWAM results of a partnership between the Fraunhofer Society (Fraunhofer-Gesellschaft), Fraunhofer Portugal, the Foundation

for Science and Technology (FCT), the Universidade de Évora (UEvora) and the Universidade de Trás-os-Montes e Alto Douro (UTAD).

CHALLENGE 10TH EDITION

With the 10th anniversary of Fraunhofer Portugal AICOS, we also celebrated the 10th anniversary of the Fraunhofer Challenge, the idea contest which annually awards the best ideas based on MSc and PhD theses, aiming to promote "Research of Practical Utility" among Portuguese universities' students and researchers. At the closing event, in October, we had the special participation of one of the winners of the first edition of the contest, Ana Ferreira.



Each year, the Fraunhofer Portugal Challenge awards the best ideas in two categories, MSc and PhD.



TECH TRANSFER AWARD

Intended to distinguish R&D projects, developed by R&D institutions, in cooperation with companies, which contribute to a positive impact in the quality of life of citizens and companies' competitiveness, Fraunhofer Portugal has promoted the "Fraunhofer Portugal Tech Transfer Awards". Being based on research of practical utility and apply or promote best practices of knowledge transfer in the area of ICT was one of the requirements.

"Fraunhofer Portugal Tech Transfer Awards" was an initiative promoted under the scope of project "CTFhP – Collective Transfer Fraunhofer Portugal", co-funded by "NORTE 2020 – Programa Operacional Regional do Norte", "Portugal 2020" and the European Union through the "FEDER – Fundo Europeu de Desenvolvimento Regional".



The public presentation of the finalists and award ceremony was held at Fraunhofer Portugal AICOS' headquarters, in Porto, on April 12th.

CCILA BREAKFAST

Building on the successful cooperation with CCILA, Fraunhofer Portugal AICOS has hosted the “CCILA Industry Breakfasts: Workshop Fraunhofer AICOS”, an event gathering 10 companies, interested in learning in detail AICOS’ R&D activities and projects’ results.

This initiative, which took place on the premises of FhP-AICOS, allowed the research center to present some of the work developed, arousing the interest and curiosity of the participants.

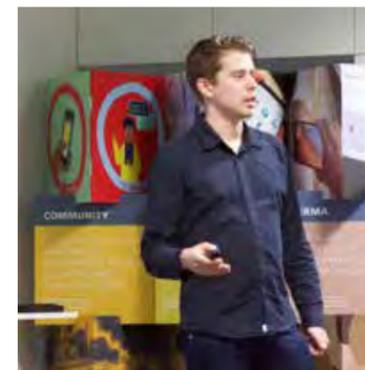
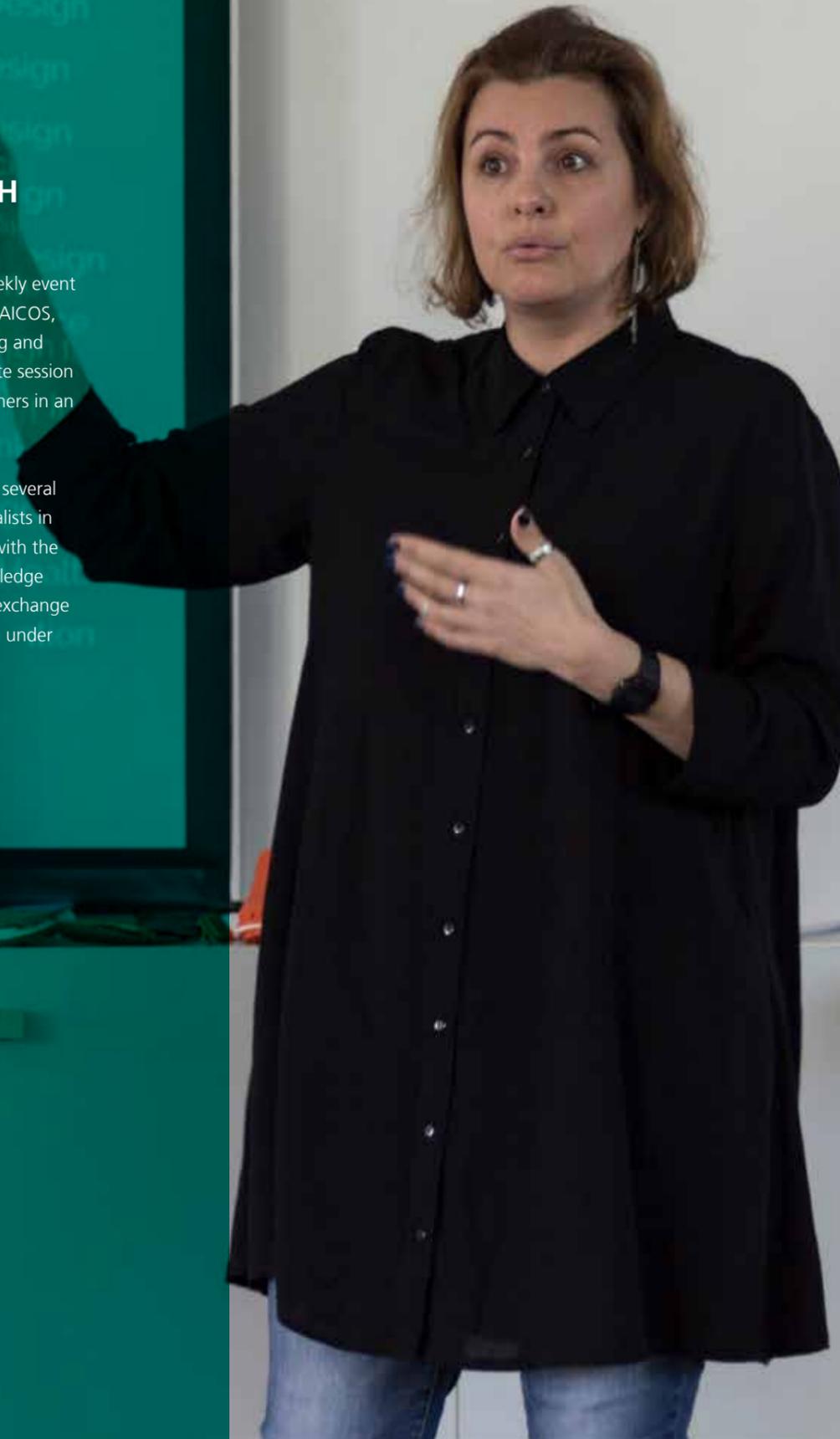


This breakfast was an excellent opportunity to network and exchange ideas about projects and opportunities.

THURSDAYS WITH SCIENCE

Thursdays with Science is a weekly event hosted by Fraunhofer Portugal AICOS, dedicated to knowledge sharing and science debating, in a 30-minute session gathering all of AICOS' researchers in an open discussion forum.

Throughout 2019, we received several guests. Professionals and specialists in the most diverse areas shared with the AICOS' team their paths, knowledge and experiences, allowing the exchange of ideas and enriching debates, under different perspectives.



Within *Thursdays with Science* we have welcomed national and international guests with different professional backgrounds and experiences.

PHILOSOPHY SESSIONS

For two months, Fraunhofer Portugal AICOS held three Philosophy Sessions, where researchers were challenged to debate relevant topics with invited philosophy researchers. Mário Correia, Alberto Romele, and João Rebalde brought some interesting subjects to debate such as the dispute between person and machine decision, systems monitoring people, and cyber-physical systems and its influence on social interaction of workers.



Philosophy Sessions intended to bring relevant topics to debate among AICOS' researchers.

COLABORAR 8TH ANNIVERSARY

In November, COLABORAR celebrated its 8th anniversary. Although recruiting older adults has been a challenge, this network for gathering researchers and users managed to integrate geographically distant institutions, as well as achieving a bank of 1100 participants.

COLABORAR continues to seek to understand people in order to create technology.



We were proud to celebrate the 8th anniversary of COLABORAR with some of its participants.

**FRAUNHOFER
GESELLSCHAFT
70TH YEARS**

FRAUNHOFER –
EIN BLICK IN
DIE ZUKUNFT
PROF. DR.-ING.
REIMUND NEUGEBAUER
Präsident der Fraunhofer-Gesellschaft

70 JAHRE
FRAUNHOFER
70 JAHRE
ZUKUNFT
#WHATSNEXT



**FRAUNHOFER
GESELLSCHAFT
ANNUAL MEETING**



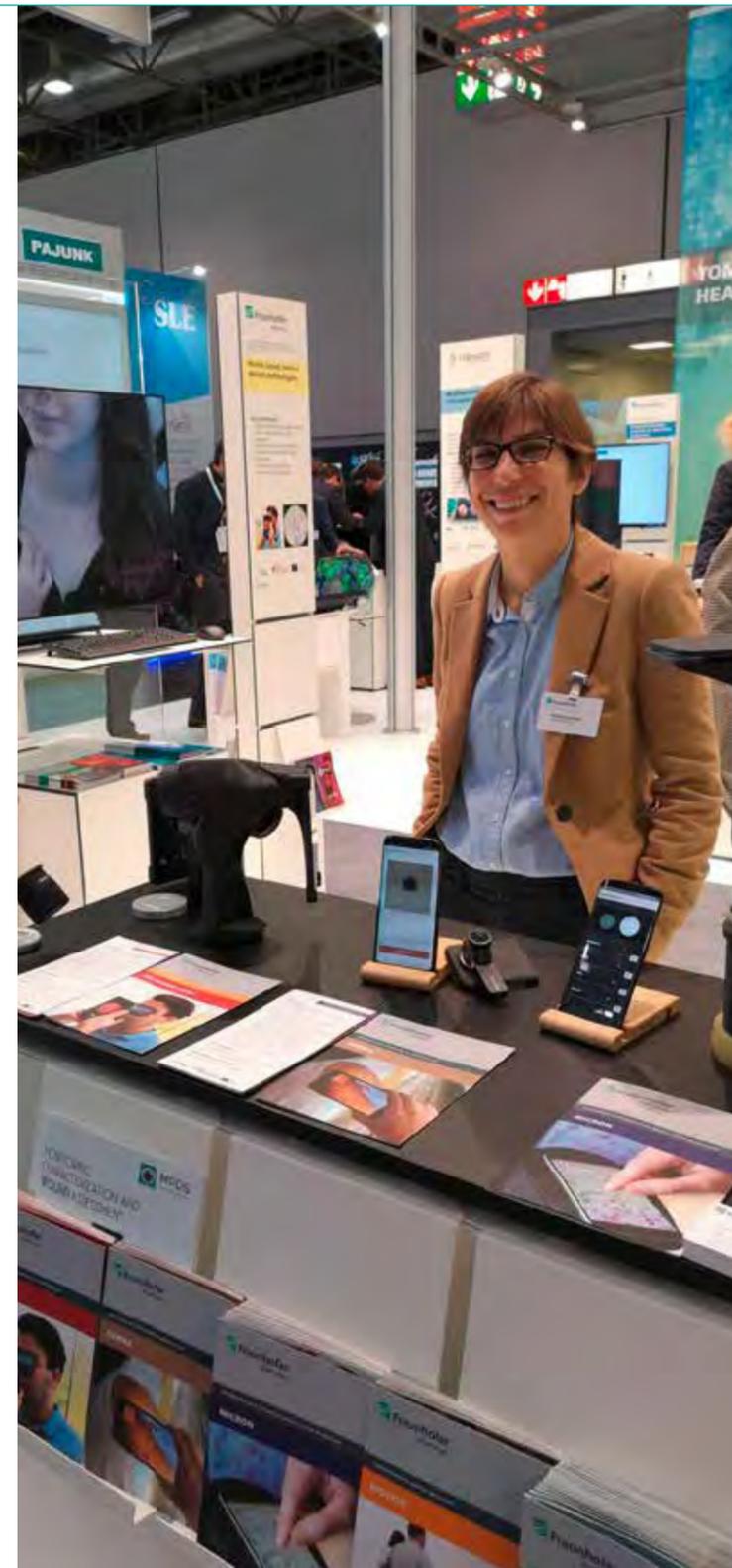
FAIRS, CONFERENCES & WORKSHOPS





AAL FORUM

Fraunhofer Portugal participated in the AAL Forum 2019 – one of the biggest conferences on active ageing and technology in Europe. AICOS' researchers Jorge Ribeiro and Alberto Carvalho showcased some of our projects, namely VITAAL and LIFANA.



MEDICA

During Fraunhofer Portugal active presence at MEDICA 2019, from November 18th to the 21st, the team – Maria Vasconcelos, Filipe Soares, and Hugo Grácio – had the opportunity to showcase our portfolio and competences. Derma, Ophta, and EyeFundusScope were some of the projects highlighted.

MEDICA is the largest international event for the medical industry.





HANNOVER MESSE

AICOS' IoT technology, developed in partnership with TekOn Electronics, was on display at the Hannover Messe, a fair with 6,632 exhibitors, which hosted more than 220,000 visitors, and is considered to be the world's leading fair for promoting industrial technologies worldwide.

The presence at Hannover Messe of a product developed by AICOS in partnership with the TekOn Electronics, effectively demonstrates the centre's capacity to develop R&D knowledge and advanced technologies, capable of generating added value to our partners or clients.



FUTURAS IN RES

André Carreiro, Inês Sousa and Duarte Folgado attended "FUTURAS IN RES", a conference, this year, related to the theme of Artificial Intelligence ("What's the IQ of AI?"), hosted by Fraunhofer-Gesellschaft and held in November.





5TH ITU/WHO WORKSHOP AND FOCUS GROUP ON AI FOR HEALTH

The Fifth ITU/WHO Workshop on Artificial Intelligence for Health took place at 2019 AI for Good Summit – Breakthrough Session, under the theme "Good Health and Well Being". AICOS' researchers, Inês Sousa and Maria Vasconcelos, participated in the event which took place in Geneva, Switzerland, in May.



MIUA 2019 UNIVERSITY OF LIVERPOOL

The 23rd Conference on Medical Image Understanding and Analysis (MIUA) took place at Liverpool, from the 24th to the 26th July. At the event, a team of researchers from AICOS presented the paper "Automated Mobile Image Acquisition of Skin Wounds using Real-Time Deep Neural Networks", within the MpDS project.

MIUA is an international conference for the communication of image processing and analysis research and its application to medical imaging and biomedicine.





PORTUGAL DIGITAL SUMMIT '19

ACEPI

To accelerate the next wave of digital transformation in Portugal, ACEPI promoted the international conference Portugal Digital Summit '19, with Germany as a guest country, considered the most innovative economy in the world, and which is at the forefront of digital.

The event had about 40 sessions and more than 150 speakers. The panel of speakers, which included Liliana Ferreira, director of Fraunhofer Portugal, also involved representatives from leading companies at international level.



MEDICON 2019

The 15th Mediterranean Conference on Medical and Biological Engineering and Computing (MEDICON) was in 2019, and for the first time, organized in Portugal and hosted by the UNESCO World Heritage University, the University of Coimbra.

Fraunhofer Portugal has always been supportive of fostering motivation and awarding scientific excellence and has, therefore, joined this event by granting two awards: Fraunhofer Best Portuguese PhD/MSc Thesis in Biomedical Engineering Competition, intended to distinguish PhD and MSc thesis sponsored by the Portuguese Society of Biomedical Engineering.





FUTURE OF COMPUTING

AICOS' Director, Liliana Ferreira, and the Head of HCD, Ana Correia de Barros, integrated the Steering Committee of the second edition of UPTEC School on the Future of Computing, an initiative intended for people who are interested in learning the fundamentals of current and emerging computer technologies, specially non-conventional ones.



OECD DEBATE

"Digital": Portugal and the OECD was the theme of the event that promoted the debate around the national artificial intelligence strategy, at UPTEC, in February. The event, attended by the Minister of Science, Technology and Higher Education, Manuel Heitor, the Mayor of Porto, Rui Moreira, the director of Fraunhofer Portugal, Liliana Ferreira, members of the University of Porto, the Government, companies and institutions related to the theme, is part of INCoDe.2030 – National Digital Skills Initiative.





EIT HEALTH SCALE UP WORKSHOP
MORNING HEALTH TALKS

Within the EIT Health Scale Up Workshop, an event promoted by the EIT Health InnoStars, Liliana Ferreira was a guest speaker on the "Morning Health Talks".

The EIT Health Portugal Community (start-ups, Alumni and Partners) joined Porto Innovation Hub (Scale Up Porto) to talk about personal growth and scaling up companies.



EIT PITCHES

Fraunhofer Portugal participated in the EIT Pitches, organized by ISCTE, with some projects that served as use cases. Based on some AICOS' projects, the participating students had the opportunity to develop business plans based on real scenarios and use cases. In this context, the students also had the opportunity to visit the Fraunhofer facilities in Lisbon.





BOSCH CONNECT FEST

Under the motto "Technology for all!", the first edition of the Connect Fest kicked-off in 2019 and our Head of Human-Centred Design, Ana Correia de Barros, was present with the talk: "Back to the Future – Through the Inclusive Design".

The lecture focused on age and methods of use to understand the perspectives of users of different ages, using Inclusive Design to idealize and create solutions to cover as many users as possible, regardless of ability, education, fitness, age or other characteristics.



DIGITAL HEALTH VENTURE FORUM

The Digital Health Venture Forum took place on the 23rd and 24th of May at Porto Business School. Within this initiative, organized by Tech Tour and the University of Porto (through U.Porto Innovation), AICOS participated in the workshop "Porto4Ageing Ecosystem and Porto Living Lab" organized by the Porto4Ageing Consortium, of which U.Porto is a partner. During this event, pertinent topics such as artificial intelligence applied to health and social care; sharing and reuse of research data; and the ecosystem of Porto4Ageing and Porto Living Lab, were discussed.



MDEVNET WORKSHOP

Within the scope of the MDevNet project, Fraunhofer Portugal held, in February, the workshop "Prospection and Identification of Technologies with High Potential of Transfer to the Market". This session intended to support the participants promoting research results of entities of the national scientific system to analyze and work on their respective technologies regarding information and plans that will condition their transfer to the market.



LAURA BOFFI WORKSHOP

Interaction and service designer Laura Boffi was one of the special guests we had the pleasure of hosting during 2019. She guided the workshop "Unlocking Autonomous Car Sensitivity" and addressed an audience of researchers and automotive industry entrepreneurs.

The participants were encouraged to think in a creative way, through hands-on activities around the technologies that exist in autonomous cars and all the potential that remains unexpressed and unexploited.



BOSCH WORKSHOP

Two specific workshops were design for Bosh. A two-day workshop, for the Bosch Car Multimedia department, which was based mainly on Deep Learning content; and another one, of 3 days, for the Chassis Control department (Bosch CC) focused on Machine Learning and Deep Learning.



HACK FRIDAY

2019 was also a year of novelties, since AICOS had the inaugural edition of the Hack Friday, on March 1st. Gathering researchers from all the teams, we played and explored the creative possibilities for real life use of professional shoes.



eHEALTH TALKS

Fraunhofer Portugal AICOS hosted Licínio Kustra Mano, Project Manager at the European Commission for the area of "Connecting Europe Facility eHealth Digital Service Infrastructure". Under the theme of "Interoperability and Best Practices for its implementation", our guest speaker addressed some highly important topics related to eHealth, namely opportunities created by European policies; interoperability as an instrument of leverage; disruptive perspectives on how to promote innovation; and focus on what citizens/patients will require/pay for and H2020 funding opportunities.



COLLABORATIVE SESSION WITH LABX AND COTEC

In order to promote the discussion on how to overcome barriers to the integration of digital technologies in public administration institutions, AICOS held a collaborative session with LabX and COTEC, which gathered entrepreneurs, researchers and public leaders.



VISITS



SENSRY
 In 2019, we received a visit from Konrad Herre, CEO of Sensry, one of our partners.



LABX
 A LabX team visited Fraunhofer Portugal AICOS and had the opportunity to learn more about our work and projects in a visit led by Ana Correia de Barros, Head of the Human-Centred Design.

NAVIGATOR
 Fraunhofer Portugal AICOS hosted a group of executives from the Navigator Company at our headquarters, in Porto, where we showcased our expertise and led a workshop to identify areas of common interest, building bridges for future joint projects.



PORTO DESIGN FACTORY
 As part of a European project in which they are involved, Porto Design Factory visited Fraunhofer Portugal AICOS, along with some of their international partners. The group attended a talk on Human-Centred Design (HCD), by Ana Correia de Barros, Head of HCD.



HOSPITAL ISRAELITA ALBERT EINSTEIN
 Camila Hernandes (Innovation Projects Consultant) and Julio Frias Dias (Intellectual Property and Innovation Analyst), from Hospital Albert Einstein, visited AICOS.



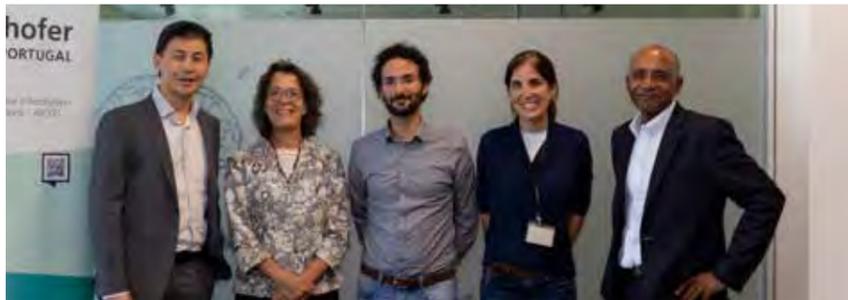
UT AUSTIN
 Fraunhofer Portugal AICOS has hosted some students from the University of Texas at Austin (UT Austin). Inês Sousa, Head of Intelligent Systems, had the opportunity to present and talk about AICOS, our work.

EIT HEALTH
 We hosted the best-in-class health members of the EIT Health. They had the opportunity of getting to know Fraunhofer Portugal AICOS and the work under development.



PRESIDENT OF THE FRAUNHOFER-GESELLSCHAFT
 We had the privilege of receiving the visit of Fraunhofer-Gesellschaft's president, Professor Reimund Neugebauer. We had the chance to demo some of our technology, display our new business strategy and our ever-growing connection with our Fraunhofer brother institutes.

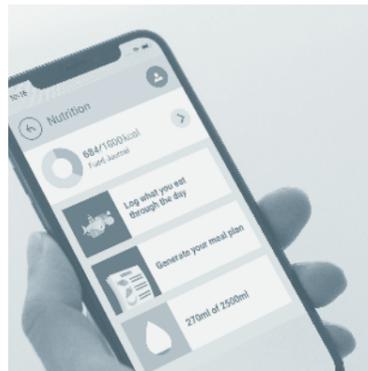
TELEMEDC
 In the scope of the EyeScan project, we welcomed Para Segaram, CEO, Founder and Chair of Board of the partner company TeleMedC.



GERMAN AMBASSADOR
 The German ambassador to Portugal, Dr. Martin Ney, was another honorable visit at Fraunhofer Portugal AICOS. During this visit we had the opportunity to show our facilities and to demo some of our work and associated technologies.

AWARDS





**1st Place – My-AHA
A&T International Fair
Awards**

The My-AHA project won the “Research & University” category of the “2019 Innovation Award 4.0” in the context of the 13th edition of the A&T International Fair, held at Turin, Italy. This prize awards the best innovative 4.0 solutions in the industrial field.



**1st Place – MDevNet
25+ Best Practices Awards**

The MDevNet project, coordinated by Fraunhofer Portugal AICOS, was awarded the “Best Practices Awards Infarmed 25+” by Infarmed, which honours projects and institutions that promote best practices in the pharmaceutical and health products sectors.



**Finalist – Malaria Scope i3S
– Hovione Capital Innovation
Prize**

Fraunhofer Portugal AICOS’ project ‘MalariaScope – Automatic Detection of Malaria in Blood Smears Using Smartphones’ was one of the eight finalists at the i3S-Hovione Capital Innovation Prize, an international award aimed at distinguishing innovative ideas in the health sector.



**Patent Granted – PIL
Position Tracking for a Bearer
of Mobile Device**

In 2019 another significant milestone was achieved with the attribution of the US patent: “Position Tracking for a Bearer of Mobile Device”, granted to FhP-AICOS’ solution for indoor location. This important scientific landmark reinforced our efficiency in research and practical development.

MANAGEMENT REPORT 2019



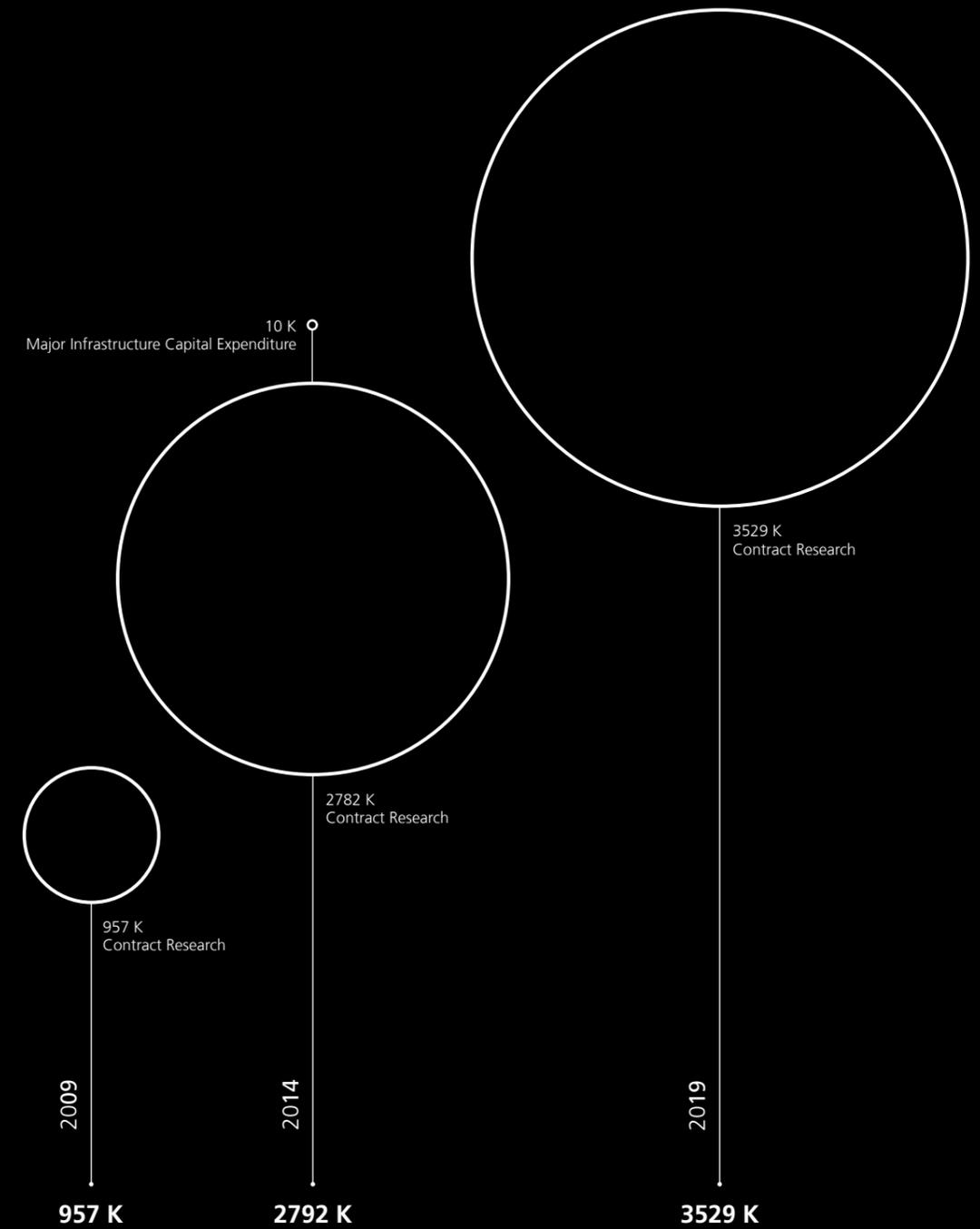
KEY FIGURES
2009 – 2019

2009	2014	2019	
11	45	89	Industry Partners
189	1626	1921	Contract Research [K€] (915% Growth)
3	36	191	Publications
1	10	31	Achievements (Awards & Honourable Mentions)
7	117	233	Research Projects
8	85	190	Theses

TOTAL BUSINESS VOLUME

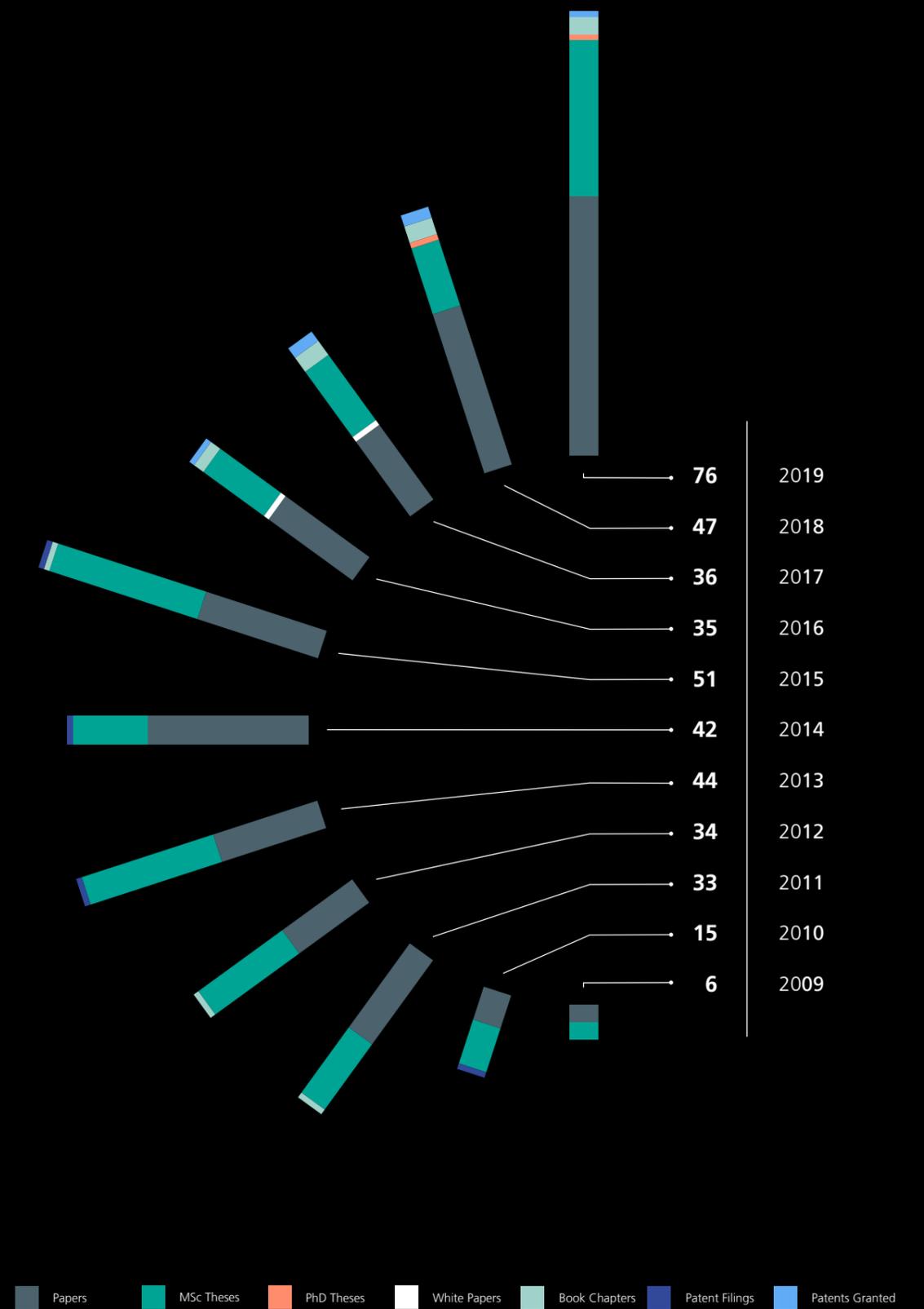
[K€]

After two years of significant growth in Project Revenue, Fraunhofer Portugal AICOS was able to consolidate its position.



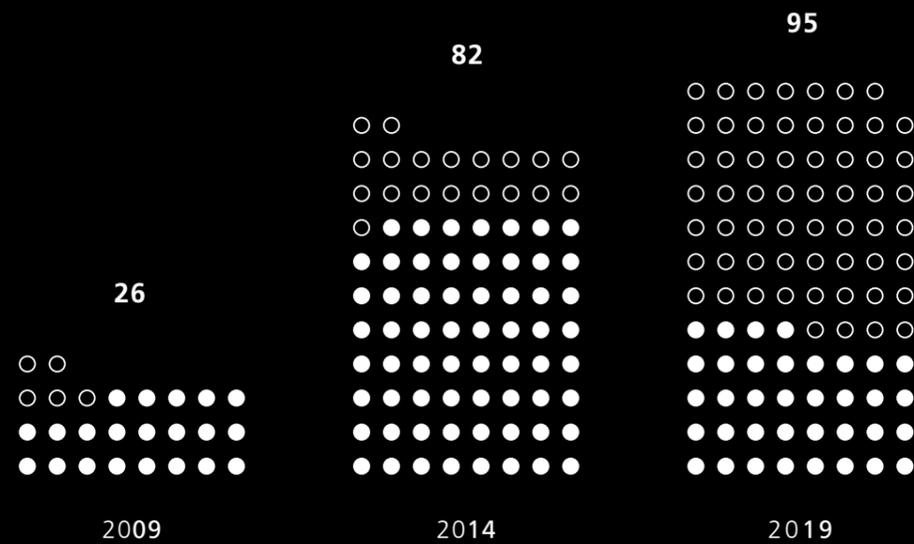
SCIENTIFIC ACTIVITIES

The areas of the publications cover the three scientific competences, showing the relevance of each competence and the collaborative and multidisciplinary approach followed at AICOS.

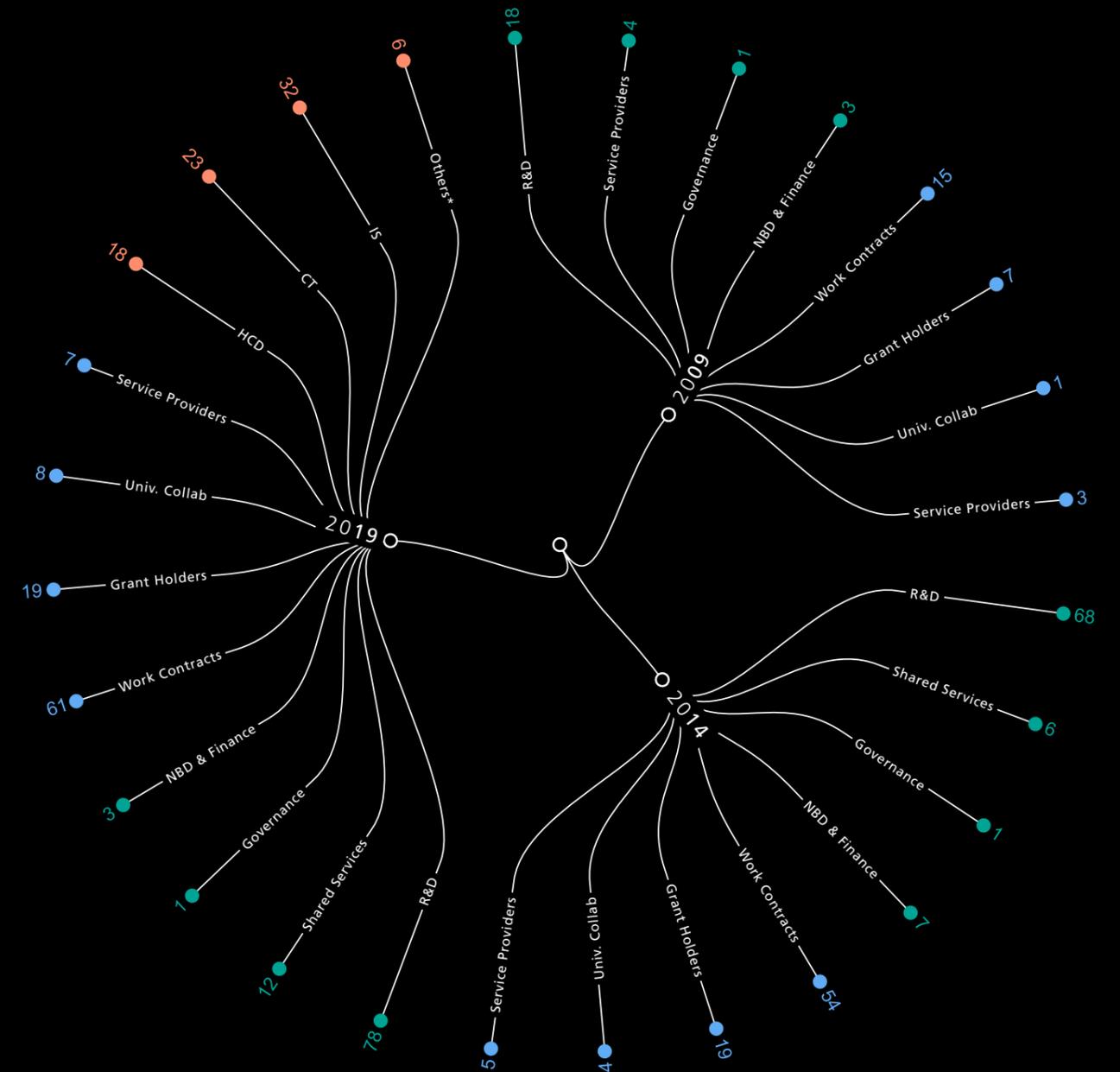


HEADCOUNT

During 2019, we were able to increase our regular staff FTE in 2%, proving that Fraunhofer Portugal is able to retain talents.



● Male ○ Female



● by Scientific Competence (N) ● by Type of Collaboration (N) ● by Department (N)
*R&D Support & Direction



BUSINESS EVOLUTION

Business Development

After two years of significant growth in Project Revenue, Fraunhofer Portugal AICOS (FhP-AICOS) was able to consolidate its position and increase its Project Revenue to 1,92M€. This result shows that, on the one hand, the scientific activities fostered by FhP-AICOS are valued by our peers and that, on the other hand, industry clients see value in the result of the scientific and technological developments achieved by FhP-AICOS.

Actually, looking at the Industry revenue of FhP-AICOS in 2019, it is evident that this was the type of revenue that most increased. Compared with last year, Industry revenue registered a growth of 21% to 893K€, having FhP-AICOS achieved once again a new record in the volume of Industry revenue. This result can be explained by the high commitment of all team members to direct their efforts to the development of projects with Industry partners, being the current results an evidence that this strategy works and it's being successful!

Regarding National projects, in 2019 two important projects that started in 2016 came to an end. The first one, DeM – Deus ex Machina, was an important R&D initiative that during four years allowed our scientific team to further develop their scientific and technical skills and to increase their competences in leading knowledge areas. The overall implementation of the project was successful and several projects with industry clients benefited from results that were achieved in the DEM project, namely most of the projects with industry clients that were referred above. The second national project that ended in 2019 was CTFhP - Collective Transfer FhP. This last initiative concerned with knowledge and technology transfer and, based on the results achieved on this project,

it was possible to implement three pilot communication networks based on the WiBACK technology that is being co-developed with Fraunhofer FIT. The first pilot was implemented in Mozambique and the second and third pilot installations were implemented in Cape Verde, namely in the islands of Santiago and Maio. Based on these results, it is expected to install a fourth network in the island of Maio, being this last case an example of a subsequent project to be fully funded by the local administration authorities.

Besides the existing national initiatives, in December 2019 FhP-AICOS was awarded with a new project funded by CCDR-N that aims to support the employment of high qualified human resources. This project is named HighSkillHR and it was granted with ~557K€ that will be used to fund at 100% six new collaborators of FhP-AICOS that have different roles and contributions for the organisation. One of the persons hired has a PhD and will be supporting the scientific teams in the preparation and submission of National and EU proposals. Another person to be hired will be contributing for the improvement of the communication of FhP-AICOS activities and another one will be supporting the New Business Development department, being always the goal to increase the engagement with more industry clients. These three people will work mainly in support activities and other three people will be more directly involved in the scientific work developed by FhP-AICOS' research groups.

In terms of EU projects, there was a significant effort in the preparation of EU proposals with several European consortia, but the final evaluations that we've received did not allow to add more contracts to FhP-AICOS backlog. In some cases, the evaluation of the project proposals was very good but, as the calls become more and more competitive, only a reduced number of project proposals are being funded.

As it was mentioned before in the case of National revenue, this reduction was also compensated by an increase in the Industry revenue, which once again means that in what concerns with FhP-AICOS' goals and strategy it is a positive outcome.

Finally, still in the Business Evolution section, some words must be mentioned about the Collaborative Laboratories – CoLAB initiatives where Fraunhofer Portugal is involved. At the moment, Fraunhofer Portugal participates in two CoLABs that have close business relation with FhP-AICOS. One of these CoLABs is the VOH CoLAB – Value for Health CoLAB that was founded by Universidade Nova de Lisboa, Vodafone, CUF Saúde and Fraunhofer Portugal. This CoLAB aims to validate innovative methodologies to measure outcomes and costs that influence the health value of every person. It is expected that these methodologies provide trustful scientific evidence under the scope of Value-based Healthcare principles. The funding for this CoLAB has been granted in 2019 and at the moment they are recruiting the scientists that will be directly involved in R&D projects.

The other CoLAB is ALMASCIENCE, which is an applied research organisation focused on innovation, development and deployment of cellulose based smart and sustainable applications. This CoLAB was founded by Imprensa Nacional Casa da Moeda – INCM, The Navigator Company, Clara Saúde, NOVA id.FCT, RAIZ – Forest and Paper Research Institute, Universidade Nova de Lisboa and Fraunhofer Portugal. The funding for this CoLAB was also granted in 2019 and the initial period of operation was mainly focused on the establishment of the organisation and the recruitment of the researchers that will be involved in R&D projects associated to the ALMASCIENCE CoLAB.

Overall, looking at all the initiatives developed by FhP-AICOS in 2019 and the fact that Project Revenue registered a slight increase to 1,92K€, it can be stated that 2019 was a positive year where the research centre was able to consolidate its operation by increasing Industry revenue which compensated for a lower revenue volume in National and EU projects, which, having in consideration Fraunhofer Funding Model, was an important step on the right direction, i.e., bring value for Industry and contribute to a more vibrant and innovative European economy.

ECONOMIC AND POLITICAL BACKGROUND

The Portuguese economy continued to develop positively in 2019 although the external environment has become less favourable, with the growth pace of world GDP and trade projected to recover modestly over the remainder of the projection horizon of 2019-2022.

However, the recovery projected for Portuguese economy in the future years is still uncertain due to external factors that can have a direct impact on the projected growth, in particular due to world trade reduction. During the last two years, 2018 and 2019, world trade decelerated due to a set of interconnected causes, such as the adoption of protectionist measures by the government of the USA, the prevalence of high levels of political uncertainty, e.g. Brexit, and the combination of a mature global business cycle. At the moment this economic background is not affecting the operation of Fraunhofer Portugal AICOS, but looking at the future, and the potential impact of these threats in investment and industrial activity, there's a possibility to have a more competitive R&D market due to these external constraints.

Actually, the current projections for the Portuguese economy in following years point to a deceleration in economic activity, from a rate of change of 2.4% in 2018 to 1.6% in 2022. These projections are part of the Eurosystem's projection exercise, and as such are conditional on a series of external assumptions common to all Euro area countries.

During 2019 Portugal has also experienced a slowdown in exports and manufacturing, but in contrast, the services sector has remained resilient, allowing the labour market situation to remain stable and with possibilities to grow even further. The employment rate is growing at a slower pace and this reflects in a context where the availability of high specialised human resources begins to be scarce. In terms of the GDP growth in Portugal, it is projected to maintain a positive differential vis-à-vis the Euro area in 2019-22, evidencing a gradual decline over the projection horizon.

Inflation in Portugal remained moderate in 2019, having different factors contributed to the reduction of inflation to a particularly low figure, 0.3%. In terms of projections, it is expected that the inflation levels remain relatively low given the current economic background, reaching 1.4% at the end of the projection horizon. This behaviour fits also in the inflation projection for the Euro area.

At the political level, 2019 was marked as a year of legislative elections. The economic and political developments of the last four years allowed to envisage that there wouldn't be significant changes in the composition of the Portuguese government, and that was precisely the outcome of the elections. The political party that governed Portugal, the Socialist party, had the highest percentage of votes and was able to form a government that was approved by the Presidency and the Parliament.

The composition of the actual government is very similar to the previous one, meaning that in what concerns with the

activity of Fraunhofer Portugal, there were no changes in the Ministries that have a closer relation with our operation. Prof. Dr. Manuel Heitor was once again appointed as the Minister of Science and Higher Education and therefore he continues to perform this important position.

Nevertheless, before the elections a new regulation was published to change the Statutes of Grant Students. These changes forced the organisation to modify its current methodology to attract young talents, as it was usual to offer grants to students that were finalising their Master thesis to be part of Fraunhofer Portugal's scientific team in an initial adaptation period.

BUSINESS PERFORMANCE

During 2019 FhP-AICOS business performance continued to grow having registered new records in terms of Projects Revenue, above 1,92M€, and Business Volume, above 3,52M€, combined with a global performance in line with the best achievements of the last years, 60%.

By the end of the year, the total Business Volume was circa 3,52M€, representing an increase of 1% compared with the previous year.

The total Projects Revenue surpassed 1,92M€, representing an increase of 1% when compared with the previous year.

As a result of the combination of the above results, FhP-AICOS' global performance KPI, which measures the volume of revenues over the total operational costs, is in line with the previous year. The total operational costs increased 1% to 3,2M€, which in combination with the increase of external revenues of 1% (~12K€) to 1,92M€, resulted in a global performance KPI (total external revenues / total operational costs) of 60%.



EMPLOYEES

Fraunhofer Portugal's success and Human Resources policy is based on the respect for human values, merit, pro-activity, observance of the law, and on knowing how to reach the goals we propose, in order to build a motivated team united towards innovation.

During 2019, we were able to increase our regular staff FTE in 2%, proving that Fraunhofer Portugal is able to retain talents. As in previous years, Fraunhofer Portugal had a peak of collaborators during the months in which the M.Sc. thesis students were welcomed, reflected between February and July 2019 with a headcount of 116 people.

During 2019, Fraunhofer Portugal was able to maintain the team on the average of 105 (Increase of 13%) collaborators and closed the year with a total headcount of 95 collaborators (66% regular staff, 21% grant holders, 13% external collaborators). We run a highly qualified team, as 98% of our staff members have a university degree, 53% are M.Sc. and 18% have a Ph.D. degree. 2019 was the year we had the highest number ever of scientists with Ph.D. degree, we closed the year with 17.

Also, during 2019, 57 collaborators joined Fraunhofer Portugal, 12 under work contract, 20 grant holders, 22 Students under University Collaboration, 1 Ph.D. professor under University Collaboration and 2 service providers. From the 12 celebrated employment contracts 4 are the result of grants that we have attributed.

Regarding Human Resources activity, and following our vision to motivate the team and promote merit and pro-activity of all collaborators, in the second semester of 2019 we proudly announced the winner of the 2019 Early Level Excellence Award, awarded to young researchers that achieved outstanding results in the previous years: Marília Barandas and Paulo Torres.

OUTLOOK & STRATEGIC DEVELOPMENT

Liliana Ferreira



The Portuguese economy is projected to continue expanding at a stable pace. Strong exports across a variety of manufacturing sectors are sustaining economic activity, which is underpinned by rapid growth in the tourism sector.

Portugal is showing good results in several innovation indicators. These results are particularly relevant when considering that, in many of them, we have been typically placed below the average of the European Union. Numbers from 2018 show that Portugal has still a shortage of qualified human resources in advanced technological areas, mostly in terms of higher education (67% of the EU average in 2018) but also in new PhDs (86%). Employment in knowledge intensive activities is low (58% of EU). Portuguese research has a high level of international collaboration (116% of the EU average in 2018), and the attraction of foreign PhD students has raised from 98.3% in 2017 to 123.1% in 2018.

The slice of employment of fast-growing companies in the most innovative sectors has been improving (94.3% of the EU average in 2018). The R&D expenditure of the business sector has increased since 2015 and represents about 48% of the gross expenditure on R&D. SMEs are doing quite well and steadily growing in innovations in the product or processes (175%) and in marketing/organisation levels (147%). Besides SMEs with product or process innovations, Portugal scores particularly well on broadband penetration (177%). Knowledge-intensive services exports is one of the lowest indicators score (41%).

Portugal has seen in the latest years several reforms in the science and technology sector. The program to stimulate scientific employment in Portugal, which started in 2017 with the final goal of promoting 5000 new doctorate contracts in academic, research and business organisations until the end of 2019, is an example of such effort. Several collaborative laboratories, which aim at promoting the participation of the scientific and academic system in the resolution of complex and large-scale problems and the implementation of effective solutions with socio-economic impact, have been created. The business model behind these entities is also inspired by the Fraunhofer model of public and private financing sharing, respectively: 1/3 public, 1/3 public competitive (national and European) and 1/3 private. Additionally, the "Global S&T Partnerships Portugal – GoPortugal" initiative was launched in 2018 and joins international partnerships in research and academia, involving universities and polytechnics, and promotes science-based entrepreneurship to foster the creation and development of new technology businesses. The next phase of a strengthened cooperation with Fraunhofer Portugal, through the creation of a new research centre in Agriculture and Water Management, is included in this initiative.

In the day-to-day of R&D management, we understand that the inexistence of a consistent calendar of calls for projects and the frequent delays are some of the most substantial obstacles to innovation that are still present in the Portuguese R&D ecosystem.

How do we build universally trusted technology with real impact in the lives of people?

Worldwide, we have seen an increasing evolution of data-driven innovation and the consequent understanding of the enormous benefits it can bring for citizens. This evolution also brings an intensified awareness that AI systems, particularly, should empower human beings, allowing them to make informed decisions and fostering their fundamental rights. Consequently, the risks of opaque decision making and the value of trust are topics more relevant today than ever before. The debate around the impact of AI technologies is growing. The European Commission has recently identified the principles of trustworthy use of AI and the requirements to guide the development of AI-based applications. Ethics and law, autonomy and control, fairness, transparency, reliability, security, and data protection are some of the identified guidelines.

Fraunhofer Portugal AICOS' innovation area of Accountable AI, focused in a safe, beneficial and trusted use of AI, is, therefore, one of the pillars of the future development of our AI competencies. In 2019, we initiated several internal initiatives related to the analysis and discussion of the human and ethical implications of AI. To reflect on the impact and the questions that need to be posed when creating technology, three debate sessions between FhP-AICOS' researchers and philosophy researchers were promoted. The impact of the computer-automated decision algorithms, the uncertainty and explainability of AI models and what happens when technology augments human workers were some of the topics in discussion in this initiative, which will be continued in 2020. The general understanding that we are not just creating technology as tools which users are responsible for using, but also that we, as creators of this technology, bring our values to it and may frame ways for users to observe reality, were some of the primary outcomes of this initiative.

In the coming years, Fraunhofer Portugal AICOS' R&D team will continue to take advantage of the opportunities AI already offers while looking at the future. Decentralised health solutions, focused on personalised and preventive approaches, and based on large sources of multimodal data, such as text, image and audio, have the

potential to better respond to the patients' needs by enabling physicians to make better data-enabled decisions. Accountable AI solutions can benefit physicians by comparing the course of a disease in a large number of patients and offering suggestions for the best possible personalised treatment while ensuring trust and safety.

However, current AI systems are developed for a specific purpose, and it is not possible to automatically apply these systems to other purposes. If asked to do so, the results derived are not meaningful and should not be used. Therefore, the investment in the traceability of AI algorithms, considering each phase of algorithm development, the data it derives from, and the purpose of the algorithm is also one of Fraunhofer Portugal AICOS' AI-related future developments.

We envision Industry 4.0 as a holistic workplace, which considers the workers' point of view, gathering and crossing quantitative and qualitative data, building a richer picture of the workers' well-being and enabling better predictive models. The industry and service sector in Portugal employs around 94% of active workers being, therefore, a highly relevant sector for the National Economy. However, to guarantee competitiveness, modernisation and internationalisation strategies are needed, especially concerning digital transformation in manufacturing. Systems developed for this purpose need to be flexible to assist the shift from mass production to mass customisation, while always keeping workers, their productivity, job satisfaction and health in the centre so that digital transformation enables sustainable operations. The development of tools for data analysis in the workplace, by collecting and visualising data on physical environment, technology components able to monitor human movements and ubiquitous exposure, with subsequent detailed movement analysis and continuous monitoring of ideal work methods, are some of the envisioned applications of AICOS' strong know-how in human-centred design and human motion technology. Additionally, these systems have a high potential of contributing to increased mental well-being through self-reporting and individual visualisations for worker awareness, education and self-management. Digital twins and the capacity to create a virtual replica of a physical product, process or system is one of the key potentials of the current digital transformation process. The replica can, for example, predict when a machine will fail, based on data analysis, which allows increasing productivity through predictive maintenance. However, today, 80% of data processing and analysis that takes place in the cloud occurs in data centres and centralised computing facilities, and 20% in smart connected objects, such as cars, home appliances or manufacturing robots, and computing facilities close to the user

(,edge computing'). By 2025 these proportions are set to change markedly. Embedding intelligence in tiny devices that allow connecting objects at a lower cost and efficiently process data, together with stronger investment in AI for edge-computing is, therefore, another critical strategic direction of Fraunhofer Portugal AICOS, which benefits from the strong current and past know-how on the area.

Finally, a strong effort was initiated in 2019 to maximise the impact of our innovation being it through a sharper focus in direct industry projects, increased outreach of our competencies or by the creation of more synergies and participation in networks. In 2019, AICOS' R&D team organised 15 visits to German Fraunhofer institutes resulting in one new European project proposal, currently under evaluation, and others being prepared together with a better knowledge of complementary competencies and research interests. These efforts to create more synergies and strengthen the relationship with our German colleagues are set to continue in the coming years.

Additionally, the implementation of tools to promote the uptake existing ideas and help them grow in a new environment through specific funding support and entrepreneurship initiatives is also one of the key envisioned paths for the future of Fraunhofer Portugal AICOS' innovation.

People. Things. Intelligence.
Proposing Futures. Impacting Lives.

Liliana Ferreira

Director

ACRONYMS



A

AAL – Ambient Assisted Living
ADAS 2+ – Advanced Driver Assistance Systems
AHA – Active and Healthy Ageing
AI – Artificial Intelligence
AICOS – Fraunhofer Centre for Assistive Information and Communication Solutions
AM – Activity Monitoring
AMA – Agency for the Modernisation of Public Administration
API – Application Programming Interface
AWAM – Fraunhofer Centre for Smart Agriculture and Water Management

B

BE – Building Envelopes
BP – Blood pressure
BPM – Business Process Management

C

C3 – Companion Competence Centre
CAD – Computer Assisted Design
CCILA – German-Portuguese Chamber of Commerce and Industry
CIDESD – Centro de Investigação em Desporto, Saúde e Desenvolvimento Humano
CINTESIS – Centro de Investigação em Tecnologias e Serviços de Saúde
CITAB – Centro de Investigação e Tecnologias Agroambientais e Biológicas
CITEVE – Centro Tecnológico das Indústrias Têxteis e do Vestuário de Portugal

CIUEM – Centro de Informática da Universidade Eduardo Mondlane
CoLAB – Collaborative Laboratorie
CPUP – Centro de Psicologia da Universidade do Porto
CRM – Customer Relationship Management
CT – Connected Things

D

DeM – Deus ex Machina
DSS – Decision Support System
DTN – Delay Tolerant Network

E

ECD – Early Childhood Development
ECG – Electrocardiogram
EITCC – Eyes of the Internet of Things Competence Centre
EMG – Electromiography
ETH Zürich – Eidgenössische Technische Hochschule Zürich | Departement Gesundheitswissenschaften und Technologie
EU – European Union

F

FCT – Foundation for Science and Technology
FCT NOVA – Faculdade de Ciências e Tecnologia da Universidade Nova de Lisboa
FET – Future And Emerging Technologies
FEUP – Faculdade de Engenharia da

Universidade do Porto
FhG – Fraunhofer-Gesellschaft
FhP – Fraunhofer Portugal
FMUP – Faculdade de Medicina da Universidade do Porto
FTE – Full Time Equivalent
FW – Firmware

G

GESMED – Gestió Socio Sanitaria al Mediterrani SL
GhLA – Ghana Library Authority
GLA – GoLiveAssist
GLC – GoLiveClip
GLP – GoLivePhone
GPS – Global Positioning System

H

HCD – Human-Centred Design
HDD – Hospital Dermatology Departments
HF – Heart Failure
HIL – Hardware-in-Loop
HR – Human Resources
HRQoL – Health-related Quality of Life

I

IBV – Instituto de Biomecánica de Valencia
ICET – Information, Communication and Electronics Technologies
ICT – Information and Communication Technologies
ICT4D – Information and Communication Technologies for Development

IDE – Integrated Development Environment
INESC TEC – Instituto de Engenharia de Sistemas e Computadores, Tecnologia e Ciência

InovaRia – Associação de Empresas para uma Rede de Inovação

INSA – Instituto Nacional de Saúde Dr. Ricardo Jorge

IoT – Internet of Things

IoTIP – Internet of things in Package

IS – Intelligent Systems

ISEP – Instituto Superior de Engenharia do Porto

ISMB – Istituto Superiore Mario Boella sulle Tecnologie dell'Informazione e delle Telecomunicazioni

K

KTH – KTH Royal Institute of Technology

L

LBC – Liquid-based Cytology

LHC – Local Health Centres

LIH – Luxembourg Institute of Health

LIPOR – Serviço Intermunicipalizado de Gestão de Resíduos do Grande Porto

LIST – Luxembourg Institute of Science and Technology

M

ML – Machine Learning

MSc – Master of Science

N

NGO – Non-Governmental Organisation

NMMU – Nelson Mandela Metropolitan University

O

OML – Online Machine Learning

P

PCB – Printed Circuit Board

PCM – Phase Change Materials

PD – Parkinson's Disease

PhD – Doctor of Philosophy

R

R&D – Research and Development

RGPD – Regulamento Geral sobre a Proteção de Dados

RPA – Robotic Process Automation

RTO – Research & Technology Organization

S

SANJOTEC – Associação Científica e Tecnológica

SCML – Santa Casa da Misericórdia de Lisboa

SCMP – Santa Casa da Misericórdia do Porto

SDN – Software-Defined Network

SME – Small and medium-sized enterprises

Sonae MC – Sonae Modelo Continente

SWISS-TPH – Swiss Tropical and Public Health Institute

T

TAU – Treatment As Usual

TTS – Text To Speech

TU/e – Technische Universiteit Eindhoven

TUHN – Toronto University Health Network

U

Unie KBO – Unie van Katholieke Bonden van Ouderen

UNINOVA – Instituto de Desenvolvimento de Novas Tecnologias

UNITO – Università degli Studi di Torino

UP – Universidade do Porto

UTAD – Universidade de Trás-os-Montes e Alto Douro

UX – User Experience

V

VF – Verbal Fluency

VR – Virtual Reality

W

WLC – Waiting List Control Group

X

XAI – Explainable Artificial Intelligence

#

2C2T – Centro de Ciência e Tecnologia Têxtil

3D – Three-dimensional

5G – Fifth generation wireless technology for digital cellular networks

