FORGING

INDUSTRY-ACADEMIA FORUM
TO UNCOVER THE POTENTIAL OF
EMERGING ENABLING TECHNOLOGIES

CO-CREATION WORKSHOP PRELIMINARY RESULTS

Novel Enabling Technologies For A Sustainable Future: Bio-inspired Technologies & Smart Materials

Braga, Portugal | November 14th-15th, 2024

Funded by the European Union

Group 1: Amir S. Samani, Carme Gual Via, Dmitri Petrovykh, Josué G. Camejo, Laura Margheri

Use-case: Precision Forged from Chaos & Uncertainty

Facilitators: Brigita Jurisic (INL), Matteo Anzalone (APRE)

The group focused on the agri-food sector. After exploring a series of problems of the sector – such as desertification, food losses due to pests and climate adversities, and soil fertility issues – the group identified the root causes of those problems. Not all of them are addressable with technological solutions, as some are a source of economic forces leading to overexploitation of local resources, decoupling of production and consumption. The group also touched upon the cultural aspects of food consumption and the effects of education as well as "excessive" globalisation of food value chains and diffusion of pollution. Water scarcity and saline intrusion were also root causes discussed. The effects of the problems manifest in environmental factors, such as diversity loss and ecosystem degradation, and in socio-economic factors, such as food pricing at farmer level and the length and "globalisation" of value chains. The proposed solution focuses on localisation of production (0 km paradigm) and on the use of technologies enabling precision agriculture to ensure sustainable and responsible use of resources. This solution leads to less food waste, more efficient crop productivity, and fairer prices for the farmers.

The group developed a thesis that the sector operates in a chaotic environment influenced by climate and (subsequently) the weather, resulting in uncertainty for the farmers, the key stakeholder in the agri-food sector that the group zoomed in on. Food production consumes significant resources, whether we are talking about water, land area, agricultural equipment and other resources needed to increase the productivity. The current use of resources, based on an overexploitation of resources, is quite inefficient and creates a set of issues. The group proposes precision agriculture as a solution that is fuelled by a series of technologies such as bio-inspired sensing technologies, robotics and artificial intelligence (for scenario creation improving crop yield) enabling a more sustainable use of resources, lowering the negative impacts on the environment (specifically on water and soil), and ultimately ensuring a healthier and safer food availability for the growing population. The support of AI and biosensors enables precise data gathering, thus providing the necessary tools for a better resource management. Key enabling resource for the proposed solution is technology co-creation with the farmers and exposing the hidden costs of the proposed digital solution. Key limitations preventing the solution from being implemented are beyond the technology development and have to do with a systemic change encompassing a renovated education system to better connect natural environments and technology and an increase in the social acceptance of technology itself.

The group agreed that precision, localised farming practices would create socio-economic benefits for farmers and environmental benefits through more efficient and effective use of resources enabling long-term sustainability and healthy society.

Group 2: Ajay Kottapalli, Alexandra E. Persicanu, Ana Ribeiro, Andreas Falk, Bertram Müller, Catarina Gonçalves, Tijana Kostovska, Paulina N. Bernal

Use-case: METRIKOT – Make Up Your Life Quality & MEDRIKOT – The Medical Supporter to Stay Healthy

Facilitators: Francesca Foliti (APRE), Marta Martorell Camps (i2CAT)

This working group's discussion was centered around the healthcare sector. As a first step towards the co-creation of their use-case, participants identified several problems producing negative effects in the focus sector, such as higher chances of disease spread, reduced fertility, reduced life expectancy and quality of life. Some of the most discussed issues were the lack of awareness in the general public, misinformation and poor transparency resulting from business interest of specific categories operating in the market, scarce prevention, the gap between tech development processes and market uptake, the overload of medical personnel, the little societal acceptance of in-vitro models, the low transition of drugs into the market, and the cross-contamination in healthcare facilities due to pollutants and human-induced materials. Several solutions were presented to address the identified problems: an increase in incentives for health insurance and in public funding to promote prevention, communication and education campaigns to raise awareness, the design of user-friendly and accessible devices (e.g., wearable devices), the introduction of cheap solutions for early detection, the delivery of in-vitro methods to the market, and the development of sensors to detect contamination.

The group decided to focus on prevention with the aim of supporting a healthy lifestyle for all individuals. The final use-case is a solution enabling convenient, user-friendly, and early detection for the prevention of triggers. It consists of two types of multi-sensing wearable devices that monitor oxidative stress, a key indicator of physiological issues: (i) tattoo-like sensors and smart garments for continuous measuring (*MeTrikot*), and (ii) micro-needling for invasive (or minimally invasive) sensing for targeted monitoring (*MeDrikot*). Such solutions can be enabled by an organ-on-chip during the validation phase through in-vitro models. Key resources for their development would be biocompatible and recyclable materials, funding, and external data centers (also meaning synergies with external providers). They are beneficial both to society and the environment. In fact, by promoting preventive medicine, they empower individuals to self-monitor their health status, to become more conscious about their own health, and to early detect diseases. As a result, the use-cases this group co-created have the potential to lower individual health care costs, to enhance individuals' quality of life, to reduce hospitalization rates, and to lighten the workload of medical personnel in healthcare facilities. Their environmental impact is also positive, as they do not rely on biohazards in laboratories and would generate less biohazardous waste. However, these use-cases may pose some concerns in terms of data privacy, societal acceptance, accessibility, long critical trials, invasiveness (at least during the first stages), and poor adaptability to market needs (especially to the interests of major players).

Group 3: Amaya Igartua, Joana Antunes, Jordi G. Garcia, Magda Barros, Tommaso Magrini, Ugur Kaya, Xinyi Tu

Use-case: VitriTex

Facilitators: Marina Dias (INL), Viviana Perez Clausen (i2CAT)

The focus sector of this group was manufacturing, and specifically the textile industry. After identifying a list of challenges that this industry faces – including air, water and soil pollution, the lack of natural resources, and overconsumption – participants agreed that the main problem they wanted to address was the recyclability of textiles and how to increase their self-healing properties, in order to make the manufacturing processes more "bio-inspired", environmentally friendly, and socially responsible. In fact, among the negative effects caused by the identified problems, participants indicated the lack of circular strategies, poor working conditions, and the high financial and environmental costs of raw materials extraction.

The group built a solution entailing bio-based, reusable, recyclable, scalable and circular self-healing materials with a potential of application and adoption in other sectors too, such as energy, mobility, construction, and healthcare. The envisaged solution was named "VitriTex" - a combination of "vitrimers" and "textile" - and it consists of bio-based vitrimers for protective clothing. Bio-engineered bacteria play a pivotal role in the development of this solution: they are employed to create textiles that can break down harmful pollutants in the environment, thus significantly reducing the ecological footprint of textile production. Bacteria are engineered to produce bioactive compounds that can be incorporated into textiles and thereby accelerating healing processes, offering both safety and durability for first responders, sports and workers that work in harsh environments.

Key resources to develop VitriTex are: biocompatible materials to ensure that the textiles are safe for the environment, materials that are compatible with the bio-engineered bacteria, advanced research facilities, significant investment from both public and private sector, partnerships with universities and research institutions, and an enhanced regulatory framework ensuring that all safety and efficacy standards are met before the products reach the market. To foster acceptance and proper use of these innovative textiles, awareness initiatives will also be necessary to inform the consumer base about the benefits and maintenance of such textiles.

As for potential limits to the feasibility of VitriTex, participants mentioned the lack of funding in the broader Research & Development ecosystem, the increasingly high cost of raw materials, and the fact that this solution may be challenging in terms of scalability and complex chemistry.