Position Paper:
Open Innovation in Horizon Europe

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Preamble

In 2019 the European Commission launched a section on new foundations for tomorrow`s industry within the Horizon 2020 work program *Nanotechnologies, Advanced Materials, Biotechnology and Advanced Manufacturing and Processing* (H2020-NMBP-TO-IND-2018-2020). One call topic (ID: DT-NMBP-11-2020) asked for proposals on *Open Innovation Platform for Materials Modelling* as Research and Innovation Actions.

Three projects have been funded under this call: MUSICODE[1], OpenModel[2] and VIPCOAT[3]. All three projects work in close collaboration between research type organizations and industry, however each project has its own focus and its own Open Innovation approach.

MUSICODE project aims to create a multiscale materials-process-device modelling platform (from atoms to devices) for organic and large area electronics (OLAE) industry. Open Innovation in MUSICODE is built around ontology-based semantic interoperability across modelling scales, user-friendly workflow design tools and integrated data management, facilitating the joint development of OLAE devices by multiple industrial and academic innovators.

The overall concept of OpenModel project is to provide a seamless and powerful workflow support underpinned by semantic technologies including ontology-based open simulation platform. The workflow solution consists of a semantic AI-aware multi criteria optimisation - supported workflow designer and builder based on ontology, an integration component for third party tools, and a workflow runner/executor that helps the end users to swiftly choose, build and execute complex optimal validation & verification materials modelling workflows.

The goal of VIPCOAT project is to create a materials modelling platform that should assist engineers in developing active protective coatings and in the construction of accelerated test scenarios to assess their in service durability in aeronautic applications. VIPCOAT project will implement the *quadruple helix open innovation model*, involving industry, academia, government, and society in an innovation process.

This position paper summarizes the ideas of VIPCOAT, MUSICODE and OpenModel on how to extend the concept of Open Innovation under the Horizon Europe framework program into Open Innovation Frameworks (OIF), compliant with the European Open Science Cloud initiatives and the European headline ambitions published by the European Commission.

Open Innovation Frameworks in Horizon Europa

In October 2021 the European Commission published the route to make Europe stronger by executing the delivery on the six headline ambitions[4]:

- The European Green Deal,
- A Europe fit for the digital age,
- An economy that works for people,
- A stronger Europe in the world,
- Promoting our European way of life and
- A new push for European democracy.

[1] https://cordis.europa.eu/project/id/953187, http://musicode.eu/
[2] https://cordis.europa.eu/project/id/953167, https://open-model.eu/
[3] https://cordis.europa.eu/project/id/952903, https://ms.hereon.de/vipcoat/
[4] cwp2022_en.pdf (europa.eu)

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To turn these ambitions into reality, the European vision is to implement a human-centric, digitally-empowered R&I approach in the Horizon Europe framework programme, with a focus on socio-economic impacts towards a greener, fairer, more digital and more resilient Europe. The framework approach thus accelerates the twin green and digital transitions of European industry and society by promoting the involvement and collaboration of citizens and their representatives, Research and Technology Organizations (RTOs), and manufacturing industry in innovation processes. The goal is to enable Europe to take the global and industrial leadership in clean, circular, climate-neutral and sustainable manufacturing at increased autonomy and sovereignty in key strategic value chains.

New materials and materials processing play a crucial role in achieving the technological strategic goals of Horizon Europe. Materials modelling, as a key driver for Innovation and Digitalization of the European Industry, is fostering new materials discovery, establishing descriptor rules like structure-property relationships, optimizing materials processing and upscaling, tailoring novel device properties and functionalities and enhancing product performance and stability. Moreover, Horizon Europe concepts such as sustainability-by-design and circularity-by-design in the area of materials and materials processing strongly rely on materials modelling as backbone technology in order to get implemented.

As a lesson learned from the COVID-19 crisis, it turned out that openness in innovation processes greatly speeds up the development of crucial products, like vaccines. The pressing needs to fight the crisis and in particular the openness of the approach rapidly mobilized RTO`s, companies and governmental institutions all over the world to develop innovative solutions[5] and this process is still on-going. Recent developments in the area of fighting the COVID-19 crisis stress the importance of integrating society in innovation processes using the so-called Quadruple Helix open innovation approach[6]. This integration needs to take into account sociological and cultural differences of societies and has therefore a local character.

In this Position Paper, the lessons learned are adapted with the aim to accelerate innovation realizations in **Open Innovation Frameworks (OIF) based on Materials Modelling.** Open Innovation Frameworks foster broad consensus on the European way to implement its headline ambitions through engagement of all possible sociological actors in open innovation processes, including a fair and transparent share of the knowledge/IP and economic value generated. Open Innovation Frameworks, empowered by materials modelling and simulation-driven design of new functional materials, have a huge potential to support Europe in the implementation of its ambitions, especially to accelerate the twin green and digital transitions corresponding to the Digital Compass, and build a fairer, more resilient and more cohesive society. OIFs integrate user-friendly (data, knowledge and physics based) interoperable tools, implementing the recommendations from the EOSC Interoperability Framework[7] to ensure safe and secure digital services and support a common digital identity in Europe. Open Innovation Frameworks incorporate trustworthy Artificial Intelligence (AI/ML) and physics-based materials modelling and optimization services in order to facilitate and accelerate technological innovations towards the six European headline ambitions.

Open Innovation Frameworks are therefore well aligned to the EIT's (European Institute of Innovation and Technology) new ambitious strategy for 2021 to 2027[8], focusing on four main elements that reflect the needs of European innovation:

[5] https://doi.org/10.1016/j.indmarman.2020.04.010
[6] https://doi.org/10.3390/joitmc6040132
[7] https://op.europa.eu/en/publication-detail/-/publication/d787ea54-6a87-11eb-aeb5-01aa75ed71a1
[8] https://eur-lex.europa.eu/eli/dec/2021/820/oj

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- Strengthening the impact of Knowledge and Innovation Communities (KICs)
- Boosting the innovation capacity of higher education
- Increasing the regional impact of Knowledge and Innovation Communities
- Launching new EIT KICs

The specific **strategic targets** in the Open Innovation Framework (OIF) serving as hubs for RTOs, companies, governmental institutions and society (i.e. NGOs) to rapidly co-create innovations include:

- Reduce source material waste during production
- Improve process efficiency with regard to
  - Energy consumption, Carbon footprint and environmental impact
  - Critical raw material consumption and waste streams
- Avoid duplication of work in scientific and industrial innovation
- Increase reliability and quality assurance in industrial manufacturing
- Digitalize manufacturing processes with a focus on improved process control as well as processing and integration of sensory data
- Support the development of enhanced product durability and in-service lifetime
- Discover renewable and/or bio-based (critical) raw materials
- Discover new innovative routes to products based on European natural resources.
- Improve green energy (solar, wind, hydro) production, storage capacity and transport.
- Promote Life Cycle Assessment (LCA) as a guiding principle in R&I to enhance circularity, following the DIN EN ISO standards.

Open Innovation Frameworks by themselves are interoperable, equipped with a business plan (including a resource acquisition plan) and integrate concepts for knowledge sharing, co-innovation and fair share of the economic, ecologic and societal value and knowledge/IP generated by an innovation.

An interconnected and interoperable multi-platform environment is strategically preferred over the single-platform-for-all solution. OIFs may benefit from EOSC as an overarching framework for data integration and reusability by hosting the EC`s software marketplaces and hubs. To ensure wide adoption by industry and society in Europe, **the proposed Open Innovation Modelling Frameworks should:**

- Offer open access and training to all actors including European society
- Offer seamless integration of third-party tools and solvers
- Integrate Artificial Intelligence (AI) / Machine Learning (ML) capabilities for predictive modelling, optimization and life cycle assessment
- Improve value chain integration (product life-cycle management PLM)
- Offer seamless interoperability with other open platforms and hubs developed under H2020 and to be developed further under Horizon Europe
- Host data and data management, including distributed Knowledge Graph technologies
- Allow systematic data-driven, bottom-up construction of surrogate models (emulators)
- Focus on Verification, Validation, Uncertainty Quantification of modelling solutions in the light of target innovations

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Support value driven business decisions by establishing transparency in the impact of production chains on Key Performance Indicators as defined by European strategic targets.Frameworks should be developed steered by technology demonstration in relevant environments (industrially relevant environment) or system prototype demonstrations in operational environments (TRL 6-7).

Specific **strategic use cases** that are most pressing for the OIF implementation are

- Molecular design: back-engineering desired properties to nanomaterials and processes
- Product durability: inhibiting degradation under in-service conditions
- Process efficiency: predictive modelling for materials and performance, and error estimation across industrial production
- Green energy: materials, processes and architectures for sustainable production, storage and distribution
- Circular-by-design, save resources, facilitate circularity, improve environmental footprint and reduce development time and operational costs
- Accelerate the twin green and digital transition of manufacturing
- Sustainable-by-design: local, green materials supply chains, including bio-based materials
- Increase productivity, innovation capacity, resilience, sustainability and global competitiveness
- Environmental impact: Life Cycle Management (digital twins) for mission critical elements, reduction of environment issues to protect human health and nature.

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