Testing and Experimental Facilities network - M12

D3.3

Person responsible / Author:	Wouter Segijn - BPI
Deliverable N.:	D3.3
Work Package N.:	WP3
Date:	29.01.2024
Project N.:	101092069
Classification:	Public
File name:	AI REDGIO_D3.3_Testing and Experimental facilities Network-M12
Number of pages:	45

Funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or Health and Digital Executive Agency (HaDEA). Neither the European Union nor HaDEA can be held responsible for them.

Status of deliverable

Action	By	Date (dd.mm.yyyy)
Submitted (author(s))	Wouter Segijn – BPI	29.01.2024
Responsible (WP Leader)	Isidora Trucco – POLIMI	
Approved by Peer reviewer	Nefeli Bountouni – SUITE5	03.01.2024

Revision History

Date (dd.mm.yyyy)	Revision version	Author	Comments
30.11.2023	V0.1	Wouter Segijn – BPI	Setup initial ToC
14.12.2023	V0.2	Wouter Segijn – BPI	Align ToC with WP leader
18.12.2023	V0.5	Wouter Segijn – BPI	Write chapters 1-3
21.12.2023	V0.7	Wouter Segijn – BPI	Write remaining chapters
22.12.2023	V0.8	Wouter Segijn – BPI	Finalise (summary, conclusion)
03.01.2024	V0.9	Nefeli Bountouni – SUITE5	Peer review
25.01.2024	V0.95	Wouter Segijn – BPI	Processing peer review
26.01.2024	V1.0	Wouter Segijn – BPI	Improving and finalising
29.01.2024	V1.1	Gabriella Monteleone - POLIMI	Quality Check

Author(s) contact information

Name	Organisation	E-mail	Tel
Wouter Segijn	BPI	w.segijn@brainportindustries.nl	
John Blankendaal	BPI	j.blankendaal@brainportindustries.nl	
Nefeli Bountouni	SUITE5	nefeli@suite5.eu	
Gabriella Monteleone	POLIMI	gabriella.monteleone@polimi.it	

Table of Contents

Figures

Tables

Abbreviations and Acronyms:	
AAS	Assets Administration Shell
AGV	Autonomous Guided Vehicles
AI	Artificial Intelligence
AIC	Automotive Intelligence Centre
AR	Augmented Reality
BIC	Brainport Industry Campus
CFD	Computer Fluid Dynamics
CGI	Common Gateway Interface
CI	Collaborative Intelligence
CMM	Capability Maturity Model
CPPS	Computer Program Performance Specification
CPS	Cyber Physical Systems
CRM	Customer Relationship Management
CSA	Coordination and Support Actions
DEP	Digital European Programme
DF	Didactic Factory
DIH	Digital Innovation Hub
DR BEST	Data Remote Business Ecosystem Skills Technology
EC	European Commission
EDIH	European Digital Innovation Hub
EL	Ethics & Legal
ERP	Enterprise Resource Planning
FAIR	Findability, Accessibility, Interoperability and Reusability
FEM	Finite Element Method
FSI	Fluid Structure Interaction
GDPR	General Data Protection Regulation
HEP	Horizon European Programme
HF	Human Factors
HMI	Human Machine Interface
HPC	High Performance Computing
HRC	Human-Robot Collaboration
IDSA	International Data Spaces Association
IOT	Internet of Things
ISO	International Organisation for Standardisation
LEF	Lean Experience Factory
MES	Manufacturing Execution Systems
MVP	Minimum Viable Product
PCB	Printed Circuit Boards
PoC	Proof of Concept
R&D	Research and Development
RFID	Radio-Frequency Identification
PLC	Programmable Logic Controller
SME	Small / Medium Enterprise
TEF	Testing and Experimental Facility
UCP	Use Case Program
VR	Virtual Reality
WP	Work Package

Table 1: Abbreviations and Acronyms

1. Executive Summary

Initially started in the AI REGIO project and successfully continued in this AI REDGIO 5.0 project, the Didactic Factories (DFs) network embodies a thriving ecosystem spanning 22 facilities across Europe, fostering collaboration in knowledge exchange and skill development. Seven new DFs have joined since the start of the AIREDGIO project, of which five were also presented in the last AI REGIO deliverable (AI REGIO, 2023) because both projects had a nine-month overlapping period. Anchored in three pillars—Acquisition, Collaboration, and Inspiration—the network prioritises visibility, skill sharing, and innovative endeavours. The network's sustainability hinges on structured facilitation by Brainport Industries, ensuring consistent engagement and effective organisation. Future expansion targets over 30 DFs by 2026, which has been set in the KPI's of this project and is considered highly feasible. However, it is important for new DFs to align with the joining criteria emphasising activity, European presence, willingness to share knowledge, and sustained involvement.

Additionally, the alignment between Didactic Factories and AI MATTERS' Testing and Experimental Facilities (TEFs) aims to merge theoretical insights with practical applications in AI for manufacturing. This collaboration focuses on joint protocols, stakeholder engagement, and shared objectives, aiming for advancements in AI applications. Moving forward, the network's success relies on meaningful collaboration, synchronised objectives, and active engagement. Guidelines for a strategic partnership, fostering collective growth within Europe's manufacturing landscape, do not only encompass aligning focus areas, but also make clear distinctions between both networks in order to create a valuable synergy in the near future.

2. Introduction

To achieve the European Artificial Intelligence (AI) strategy's aim to optimise the development and the deployment of AI in manufacturing settings, the European Commission have selected multiple initiatives in the field of AI and manufacturing. Next to the AI REDGIO 5.0 project, the EC introduced AI Testing and Experimentation Facilities (TEF) for manufacturing as part of the Digital Europe program. This deliverable identifies, organises and defines Testing and Experimental Facilities, and it shows the network of Didactic Factories that was built, initially during the AI REGIO project, which has been further continued as part of the AI REDGIO 5.0 project.

Deliverable D3.3 serves as a report as part of Task 3.4, and shows the current insights and developments regarding the Didactic Factory and Testing and Experimentation Facility ecosystem. Although some of the aspects already have some proper results and advancements, it is an interim report, addressing new research fields and setting out tasks to be completed within this project under task 3.4. The results will be concluded in the follow-up deliverable D3.8.

2.1. Structure of the Document

After this brief introduction, an overview of the closely related initiatives has been given in paragraph 2.2. In the third chapter the AI REDGIO 5.0 network of Didactic Factories is described, accompanied by the current value proposition. Each Didactic Factory is presented briefly in paragraph 3.3. In the last paragraph of the chapter a future outlook is given on how to proceed and build upon the network that has been established already. In chapter 4, one of the major aspects of the METHODIH methodology, the DR BEST taxonomy has been briefly touched upon. One of the specific aspects targeted towards the DFs, the remotisation services, are elaborated on in paragraph 4.1. After that we will elaborate on the Testing and Experimentation Facilities (TEFs) in chapter 5 before describing the conclusions and future outlook of this report in chapter 6.

2.2. Overview of Relevant Initiatives

There are a lot of initiatives in the field of AI and manufacturing. This paragraph aims to give a non-exhaustive introduction to the most important projects related to the AI REDGIO 5.0 project. Most importantly AI REDGIO 5.0 is **AIREGIO**'s follow-up project 'with the main differentiation lying on the focus on the field of AI at the Edge. To set the scene of the current ecosystem of initiatives that AI REDGIO 5.0 will be building upon, AI REGIO's background is further described.

The AIREGIO project, in close collaboration with **I4MS** and DIHs, was strategically aligned with several key communities and initiatives, focusing on Testing and Experimentation Facilities (TEF), Didactic Factories (DF), and the concept of 'Test Before Invest'. In the I4MS program (https://i4ms.eu/), AI REGIO was positioned as a Phase IV Innovation Action, building upon the foundation laid by the Phase III MIDIH project. Furthermore, in the Support to Hub priority, AI REGIO identified strong collaboration opportunities with DIHs in the manufacturing industry, including those in Smart Anything Everywhere and robotics domains. These efforts were facilitated by relevant CSAs such as S4E and RODIN, and the **DIH4INDUSTRY** (https://dih4industry.eu/) platform that served as the hub for innovation and collaboration in manufacturing. Collaboration opportunities were also explored with DIHNET.eu, encompassing various domains such as energy, agri-food, and healthcare. AI REDGIO 5.0 is a vital project building upon the foundation laid by AI REGIO. In particular for the Task 3.4, reported in this deliverable D3.3, it was possible to start with an existing network of Didactic Factories with an existing infrastructure and value proposition.

AI REDGIO 5.0 will collaborate with various other DIH communities, notably the **Vanguard Initiative** (https://www.s3vanguardinitiative.eu/) and its Efficient and Sustainable Manufacturing pilot (https://www.s3vanguardinitiative.eu/pilots/efficient-and-sustainable-manufacturing-esm), the AI DIH Network project with its mentoring and coaching program. Also, the **DIH4AI platform** (https://www.dih4ai.eu/), which fosters interoperability with **AI4EU** and its services. Additionally, the project explores collaboration opportunities within the European Commission's Multiannual Financial Framework (MFF), specifically in the Digital Europe and Horizon Europe programs. AI REDGIO 5.0's contributions are expected in areas such as EDIH, Data Spaces for Manufacturing (**SM4RTENANCE**), and AI TEF for Manufacturing, **AI MATTERS** (https://ai-matters.eu/) in Digital Europe Programme (DEP). In the AI MATTERS project, which is running for five years in total, 8 nodes and 1 satellite EDIH, have joined forces to build a network of physical and digital facilities across Europe, aiming at increasing the resilience and the flexibility of the European manufacturing sector through the deployments of the latest developments in AI, robotics, smart and autonomous systems. It is clear that the objectives of task 3.4 are closely related to this project and therefore collaboration between AI MATTERS and AI REDGIO 5.0 will be highly valuable.

3. Didactic Factories

To set the stage for collaboration within the AI REDGIO 5.0 consortium, it was initially necessary to find a working definition of a 'Didactic Factory'. This has been done in the AI REGIO project. Looking at other European initiatives there are a lot of concepts being used and mixed together, for example: TEFs, DIHs, EDIHs, Learning Factories, etc. To avoid further confusion on the topic, in AI REGIO's deliverable D7.3 Testing and Experimental Facility V1.0 (AI REGIO, 2022), a working definition of the concept has been conducted through three methods: 'Research', 'Collaboration & Communication', and 'The Golden Circle' method (see Figure 1). This has been done in interactive sessions with all partners involved. In this paragraph, this definition will be presented. A detailed substantiation is presented in the aforementioned deliverable D7.3 (AI REGIO, 2022).

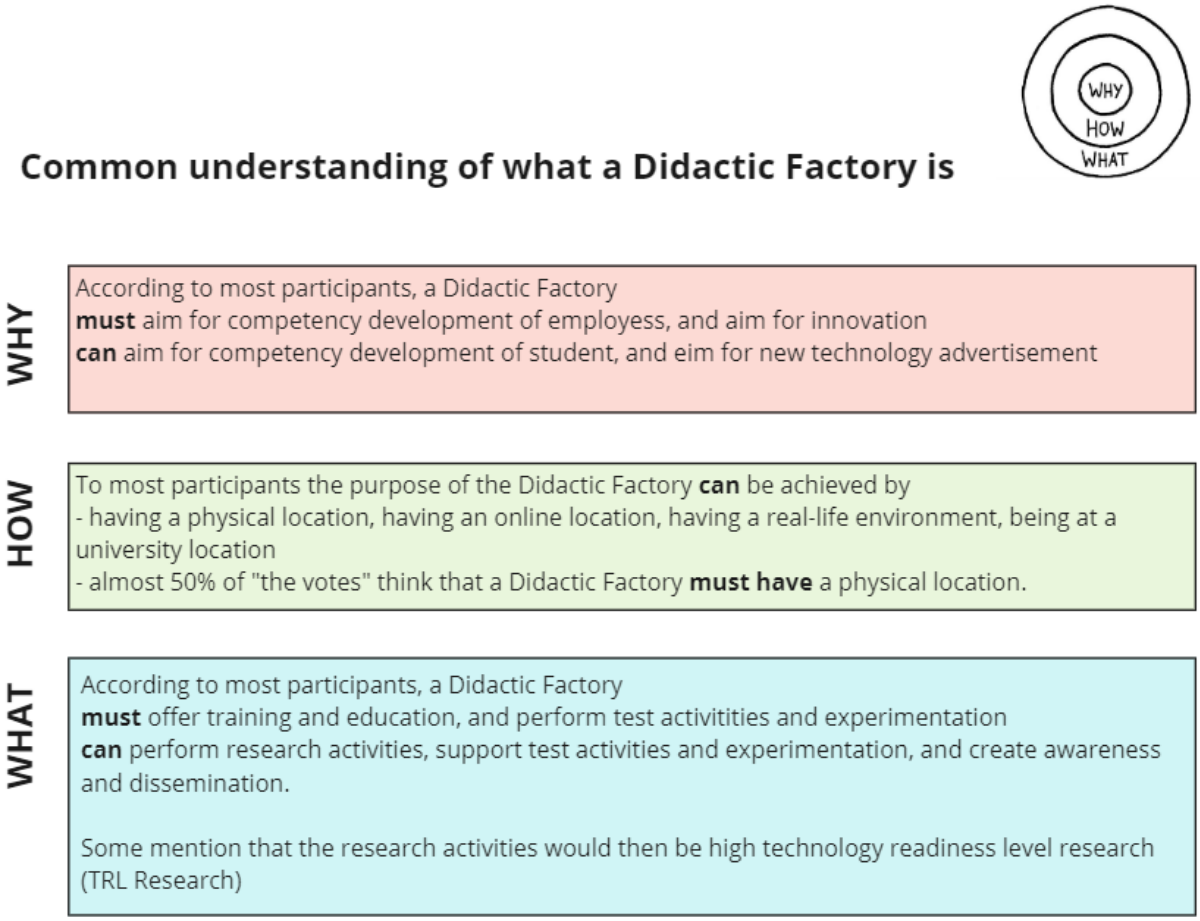

Figure 1: Didactic Factory according to the Golden Circle Method (AI REGIO, 2022)

3.1. Didactic Factory Definition

Based on the conclusions of AI REGIO's deliverable D7.3, a Didactic Factory in this report is defined as follows:

"An open testing and experimentation facility which extends the services of a Learning Factory towards the materialisation of the EDIH "test before invest" pillar. By providing access to technical expertise and experimentation as well as the possibility to "test before invest", a Didactic Factory, like an EDIH, helps companies innovating their business or production."

3.2. Didactic Factory Network Value Proposition

As already described, in the AI REDGIO 5.0 project, we have built upon AI REGIO's Didactic Factory network with the idea to share knowledge and improve collaboration and create international liaisons. In order to have a clear view of the DF-network for all partners involved, the following value proposition has been outlined (see Figure 2). Guided by the AI REDGIO 5.0 vision, an interactive workshop was held to draw up the most important aspects on why Didactic Factories should be part of a pan-European network, resulting in the definition of the AI REDGIO 5.0 DF-network value proposition. This value proposition aims to provide the involved DFs a clear view of the purpose and benefits by a DF-network.

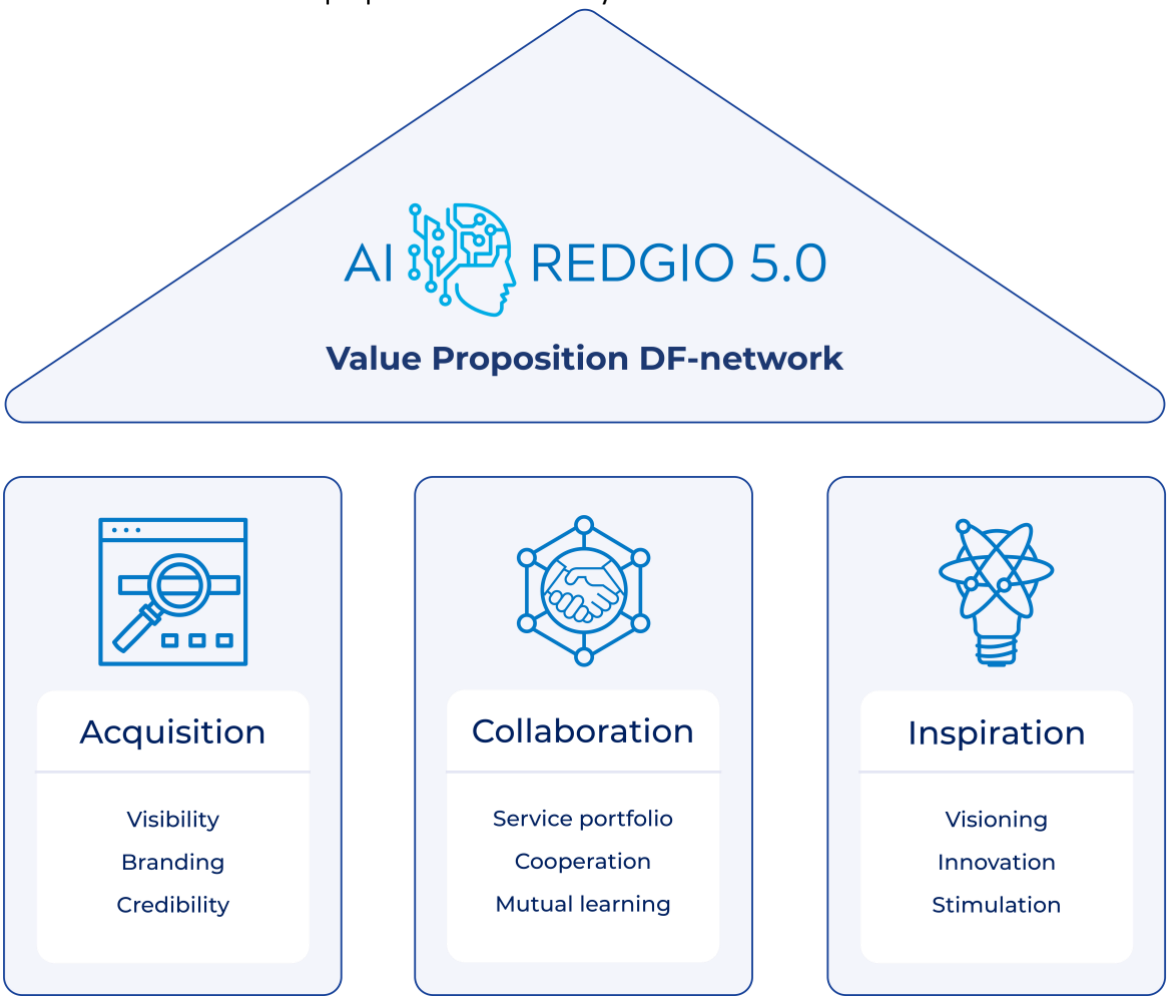

Figure 2: Value proposition DF network

In summary, the value of the Didactic Factory network is based on three pillars:

- **Acquisition**. The acquisition pillar helps DFs to improve their visibility, branding and credibility. By focusing on these aspects, the objective is to acquire more experiments, partners and/or projects. Apart from direct acquisition within their own region, by collaboration at a European level, DFs can share opportunities and refer their SME partners to other relevant DFs enhancing their acquisition process. Even just by being part of the network, the credibility and branding of the DFs are improving.
- **Collaboration**. The collaboration pillar consists of sharing skills and expertise based on their respective service portfolio. Cooperation opportunities can be discussed and searched for also based on the remotization aspect of the DR-BEST methodology (see §4.1). Furthermore, the collaboration pillar is focused on mutual learning by sharing ideas, issues and solutions. Additionally, visits to each other's physical location are part of this pillar.

- **Inspiration**. The inspiration pillar consists of visioning, innovation and stimulation. The network can help disseminate new initiatives and aspects for didactic factories. It helps to share possible upcoming issues and to discuss the ideas and solutions for tomorrow's challenges. Occasionally, an external expert could also share and present the latest relevant research results.

This value proposition is used as a guide for the organised monthly meetings. In each meeting one of the pillars is highlighted and serves as the objective of the respective meeting. Depending on the pillar, a round-table could be organised in which DFs can discuss a certain topic and share their knowledge and expertise. Another possibility is that the facilitator (Brainport Industries) asks a DF representative and/or an external expert to present their view or experiences on a certain topic. It helps structuring the recurring get-togethers and keeps them focussed on certain aspects. The organisation and facilitation were in the hands of the task and work-package leader Brainport Industries.

3.3. Didactic Factories Network

In this paragraph the current Didactic Factories network, that was initially established within the AI REGIO project, is presented. During the AIREDGIO 5.0 project there have been seven new DFs added to the network up to now. Since the AI REGIO project transited into AIREDGIO with an overlap of 9 months, five of these seven DFs were also reported in the last AIREGIO deliverable due in October 2023 (AI REGIO, 2023). For this paragraph, firstly, an overview is provided of the network and its variables. After that, each DF is presented in more detail. In the last paragraph of the chapter, a future outlook of the DF network is discussed.

In the following table, an overview of the current Didactic Factory network is presented. The name and location of the DFs are in the Table 1, together with an indication whether the DF is a partner in the AI REDGIO 5.0 project. In the Table below, we have analysed the network with some interesting figures and maps.

DF Name	Location	Country	AI REDGIO 5.0 partner
Brainport Industries Campus	Eindhoven	The Netherlands	Yes
Radboud Industrial Sustainability	Nijmegen	The Netherlands	No
LIAM Lab	Bologna	Italy	Yes
MUSP Lab	Piacenza	Italy	Yes
Lean Experience Factory	San Vito al Tagliamento	Italy	No
Cognitive Robotics Laboratory	Barcelona	Spain	No
Tampere Robotics Didactic Factory	Tampere	Finland	No
I4.0 LAB	Bilbao	Spain	Yes
SMILE	Bergamo	Italy	Yes
Industry and Innovation Lab	Porto	Portugal	Yes
Smart Lab	Bergamo	Italy	Yes
Swiss Smart Factory	Biel/Bienne	Switzerland	No
MADE Competence Center	Milan	Italy	Yes
SUPSI	Manno	Switzerland	No
POLIMILab	Milan	Italy	Yes
Control2K	Bridgend	United Kingdom	Yes
DMIW	Bridgend	United Kingdom	Yes
MADE	Copenhagen	Denmark	Yes
PBN am-Lab	Szombathely	Hungary	Yes
Fraunhofer IOSB	Ettlingen	Germany	No
Rudolfovo – Science and Techonology Center	Podbreznik	Slovenia	Yes
Smart Factory Research and Demonstration Center	Ljubljana	Slovenia	Yes

Table 1: AIREDGIO 5.0 Didactic Factory network

As can be seen, the network consists of 22 different DFs located in twelve unique countries across Europe (see Figure 3). With seven representatives, Italy is the main supplier of the network country-wise. Apart from that the United Kingdom, the Netherlands, Switzerland, Slovenia and Spain host two DFs each in the current network.

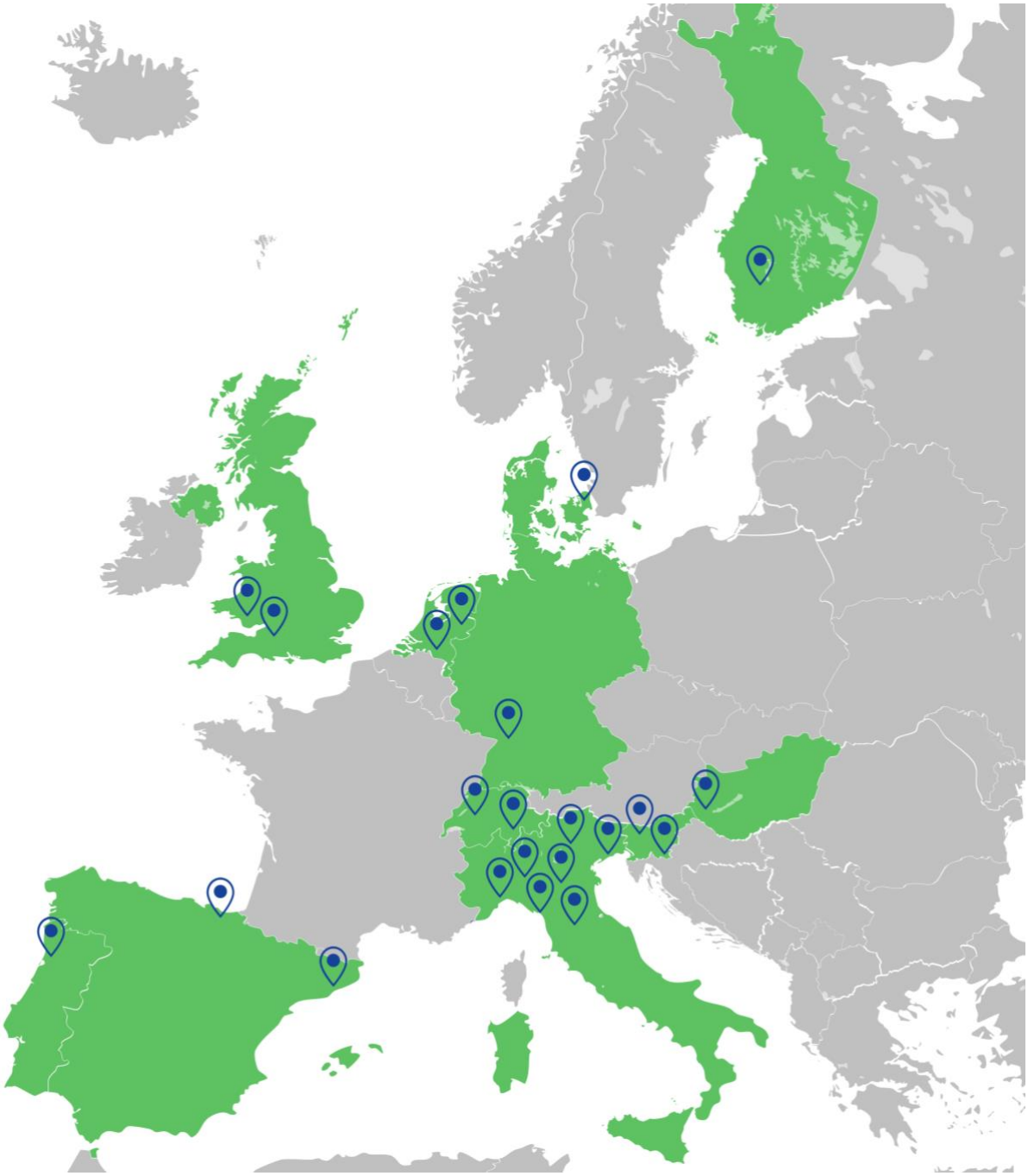

Figure 3: Didactic Factory network countries

As can be seen in Table 1, from the 22 Didactic Factories, fifteen DFs are a direct AI REDGIO 5.0 partner (see Figure 4). That means the seven remaining DFs (indicated with orange pins on the map) have joined the network from outside the project, without direct funding, proving the value of our network.

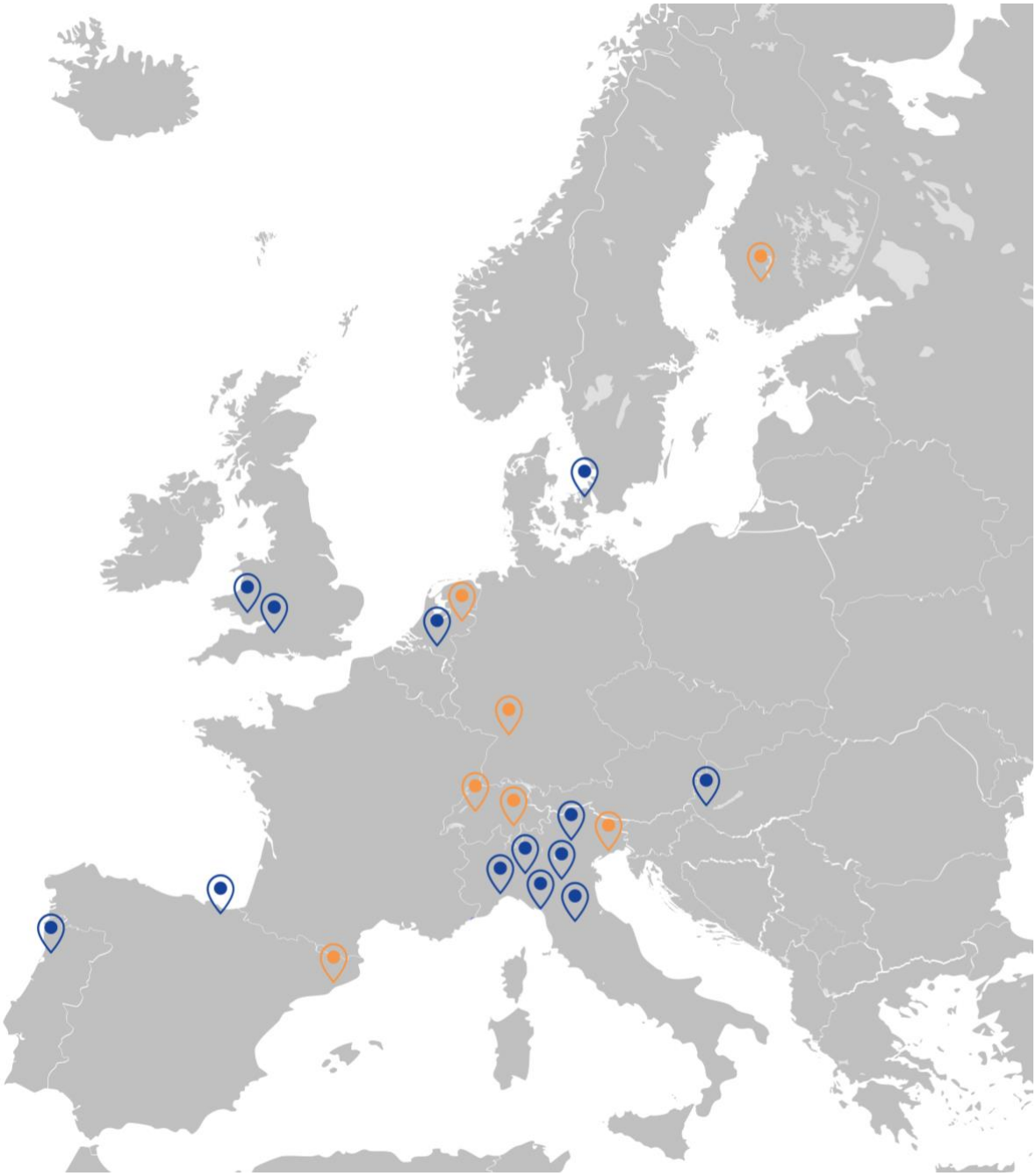

Figure 4: Didactic Factories outside consortium

In the following paragraphs, all Didactic factories are presented in more detail. Apart from organisational and practical information, a short summary is given for each DF. Also, some running experiments and field labs have been described to give an idea of their skills and competences.

3.3.1. Didactic Factory 1: 'Brainport Industries Campus'

Figure 5: Brainport Industries Campus (Eindhoven, The Netherlands)

Organisation: Brainport Industries
Location: BIC 1, 5657 BX Eindhoven, The Netherlands
Website: https://www.brainportindustriescampus.com/en/
Contact Point: John Blankendaal (j.blankendaal@brainportindustries.nl)

Short Summary: From presentation rooms to machine park and anything in between. To facilitate innovation, the campus has everything under a single roof and it offers all the facilities to create a pleasant production and business climate. The Brainport Industries Campus (BIC) has a close connection with the European Digital Innovation Hub SOUTH-NL.

Current Experiments / Field Labs:

- 'Flexible Manufacturing':
  - Flexible production and assembly solutions
  - Focus on robotisation of manufacturing processes
  - Operator support system (TERESA)
- 'Multi Material 3D':
  - Research Pilots with a focus on automation for multi-industry 3D applications
- 'High Tech Software Cluster'
  - Focus on AI, ML, Big Data Analytics, Data Services, Industrial 5G, Industrial IOT, and Wireless Communication
  - Virtual Prototyping and Design
- 'Smart Connected Supplier Network'
  - Platform for information exchange in supply chains
- 'FutureTec':
  - The development of educational content
  - Implementation of innovative technical education in the region

- 'Factory of the Future Game':
  - Serious game to raise awareness about smart manufacturing
- 'Predictive Maintenance TATA/IJSSEL'
  - Based on RAMI 4.0 and AAS models we have designed an experiment with Ijssel and TATA Steel for predictive maintenance.
  - Experiment uses Digital Twin, AAS, Dataspaces, IDS connectors

3.3.2. Didactic Factory 2: 'Radboud Industrial Sustainability'

Figure 6: Didactic Factory Radboud University

Organisation: SKU (Radboud University)
Location: Faculty of Science, Heyendaalseweg 135, 6525 AJ Nijmegen, The Netherlands
Website: https://www.ru.nl/radboudresearchfacilities/english/facilities-0/industrial-sustainability/
Contact Point: Neha Awasthi (neha.awasthi@ru.nl)

Short Summary: The Radboud University Faculty of Science hosts a Didactic Factory for teaching and development of AI for Industry 4.0 and beyond. In public-private projects, they combine methodological development with sustainable industrial innovation, often contributing to novel Industry 4.0 applications. The Didactic Factory is linked to the Digital Innovation Hub in East-Netherlands and is an important platform for collaborations within the manufacturing and process industry.

Current Facilities/Field labs:

- Courses
  - Industrial Chemistry
  - Handheld Spectroscopy in Industry
  - Other courses focused on eAI / spectroscopy
- Master track 'Science, Management and Innovation: Green Information Technology'
- Field lab for (co-)development of AI software for industrial processes
- Research collaboration to develop AI applications with manufacturing-, chemical- and food industry

3.3.3. Didactic Factory 3: 'Liam Lab'

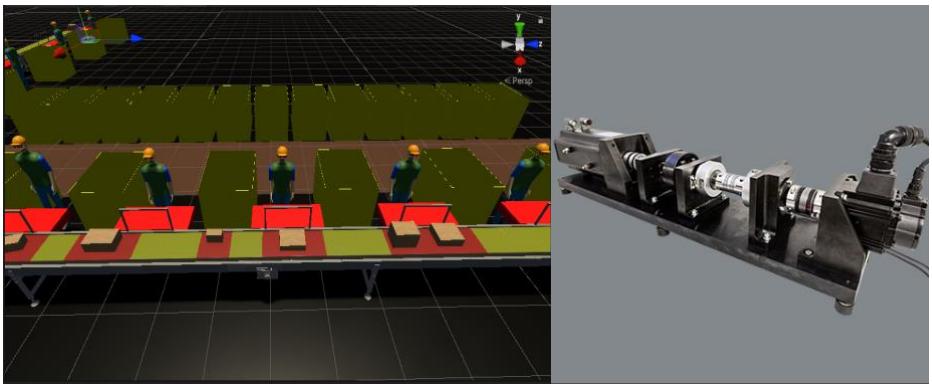

Figure 7: Digital twin application and drive testbed for benchmarking in LIAM Lab

Organisation: LIAM LAB (ART-er)
Location: Via Piero Gobetti 52/3, 40129 Bologna (BO)
Website: https://www.liamlab.it
Contact point: Francesco Mambelli (francesco.mambelli.liamlab.it)

Short Summary: LIAM LAB is an industrial research laboratory created by the main packaging companies of Bologna. LIAM has a strong connection to the academic world. It has easy and quick access to the university of Bologna's research innovation and it can apply them in the industrial automation sector. LIAM Lab works embraces its strong didactic aspects while enhancing the transfer of new technologies to companies.

Current Experiments / Field Labs:

- Predictive maintenance
  - Real time data acquisition
  - Prognosis and Health Management algorithms
  - Data visualisation
- Digital Twin
  - Hard real time hardware in the loop simulation
  - KPI analysis by simulation
- Software libraries for industrial automation system
  - Design pattern for industrial application
  - Develop of industrial control logic based on PLC/PC
  - Develop of software libraries hardware and application independent

3.3.4. Didactic Factory 4: 'MUSP Lab'

Figure 8: Consorzio MUSP (Piacenza, Italy)

Organisation: Consorzio MUSP (ART-er)
Location: Via V.Callegari sn, 29122 Piacenza, Italy
Website: https://www.musp.it/
Contact Point: Benedetta Cesare (benedetta.cesare@musp.net)

Short Summary: MUSP is a research laboratory in the field of engineering that supports entrepreneurs both by carrying out industrial research projects in close collaboration with companies, and by developing custom solutions to respond to direct requests from companies (services), thus increasing the technological level and fostering innovation in the manufacturing field.

MUSP Consortium comprises companies, trade associations and universities with the aim of pooling existing and diversified skills, forming a core of highly skilled specialists open to a multidisciplinary approach.

According to MUSP, INNOVATING means: increasing the competitiveness of stakeholders thanks to a scientific approach resulting from academic research, the development of adaptive edge solutions to deliver products and services with industrial times.

Current Experiments / Field Labs:

- Advanced manufacturing & digital technologies:
  - Robotisation of manufacturing processes
  - Vision and autonomous inspection systems
  - Autonomous manufacturing platform
- Rapid Manufacturing:
  - Large scale additive manufacturing
  - Use of technologies for fast flexible manufacturing
- Advanced Simulation:

- Digital Twin of structures (FE Models), performing thermo-fluid dynamics simulation also with interaction between fluids and structures

- Industrial facility/test area:
  - Development of company R&D projects aimed at realising new product, services, and solutions
  - Engineering and perform of PoC and MVP
  - Design, develop, improve, and realize a prototype at different Technology Readiness Levels
  - Validation of simulations analysis results

3.3.5. Didactic Factory 5: 'LEF

Figure 9: Lean Experience Factory (San Vito al Tagliamento, Pordenone)

Organisation: LEF – Lean Experience Factory Scarl
Location: Viale dei Comunali, 22, 33078 Zona Industriale Ponte Rosso, Italy
Website: https://lef-digital.com/en/
Contact point: Gouya Harirchi (gouya.harirchi@lef-digital.com)

Short Summary: Founded in 2011 as an experiential training centre, over the years LEF has established itself as the world's largest and most integrated digital model company, becoming a leading competence centre for human capital development and a member of several international networks in the fields of Industry 4.0, digital innovation and lean management. The LEF is member of the European Digital Innovation Hub IP4FVG (www.ip4fvg.it), one of its main assets managing the Advanced Manufacturing Solutions node.

Current Experiments / Field Labs:

- "AiPRESTO"
  - Focus and AI, artificial vision and cobot
  - Operator support system (TERESA)

- Use Case Program (UCP)

  Platform that combines:

- Software (ERP, CRM, MES, etc.)
- Hardware (robots, cobots, 3D printers, and tools for a wide range of machining)
- Skills in design thinking, lean manufacturing, Six sigma and digital transformation

- Project PCTO- Pathways for Transversal Skills and Orientation
  - Result of a collaboration with the Autonomous Region of Friuli Venezia Giulia, in providing lean and digital transformation training to high school students at the model company
  - Hands hands-on experience with the most advanced technologies on the market today that can be found in companies
- Deep-tech Center at MIB Trieste School of Management
  - Collaboration with MIB Trieste School of Management and Obloo | Venture Factory
  - Supporting Executive MBA in Business Innovation (EMBAIN) of MIB Trieste School of Management
- LEF Operational talks
  - Quarterly thematic event with strategic vision, technical content and application cases

3.3.6. Didactic Factory 6: 'Cognitive Robotics Laboratory'

Figure 10: Eurecat's Robotic Didactic Factory: 'Cognitive Robotics Laboratory

Organsation:
Location: Av. Universitat Autònoma, 23, 08290 Cerdanyola del Vallès, Barcelona (Spain)
Website: https://eurecat.org/en/field-of-knowledge/robotics-automation/
Contact Point: Mireia Dilmé i Martínez de Huete | mireia.dilme@eurecat.org

Short Summary: The Didactic factory is located in an innovation hub in Barcelona (Spain). It is located in the Parc Tecnològic del Vallès area and is well-connected to the industrial companies around the area.

Current Experiments / Field Labs:

- Technology benchmarking experiments to compare components performances
- Feasibility studies to check/test the technical feasibility of the most critical part of a solution for a company using available components
- Proof of Concept, Test-before-invest type of experiment to conceptualise a full solution and test the estimated performances of a robotic system design at a reduced scale and controlled operational conditions. Possibility to borrow components from providers.

- Piloting solutions, Test-before-invest type of experiment to assess the operations, performance and cost of a solution with real components and in realistic conditions at 1:1 scale. Possibility to borrow equipment and components from providers.

Figure 12: Cognitive Robotics Laboratory Setup

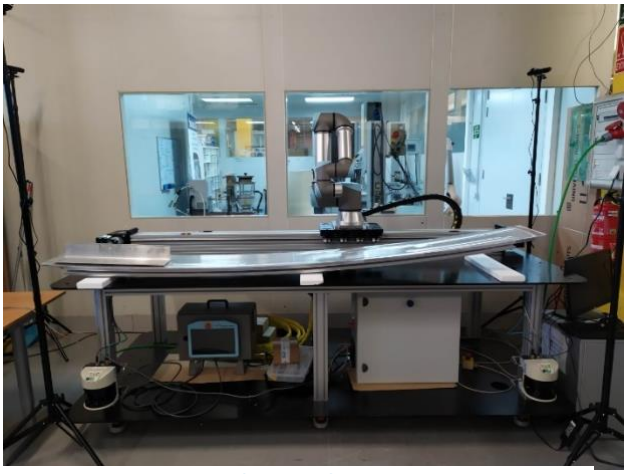

Figure 11: Cognitive Robotics Laboratory

3.3.7. Didactic Factory 7: 'Tampere Robotics Didactic Factory'

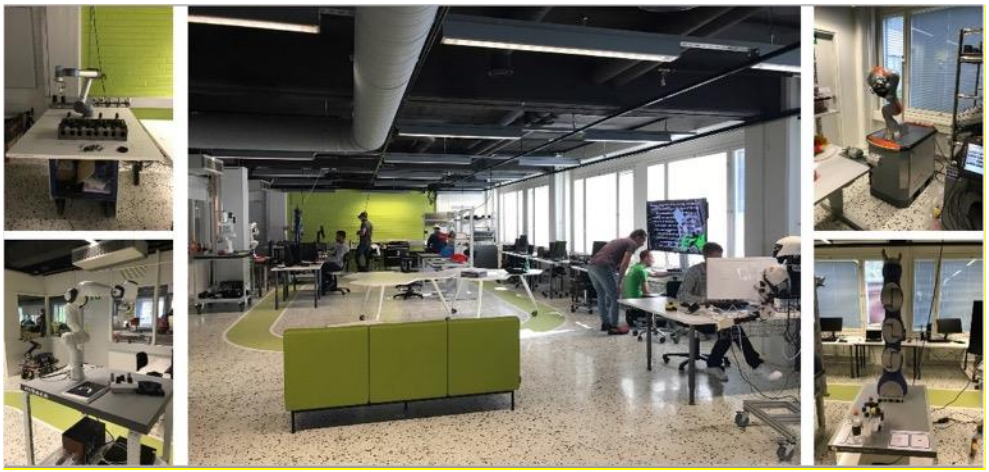

Figure 13: DF Robolab Tampere

Organisation: Tampere University
Location: Tampere, Finland
Website: https://research.tuni.fi/hrc-pilotline/ and https://research.tuni.fi/robolabtampere/
Contact point: Prof. Dr. Minna Lanz (minna.lanz@tuni.fi), Mr. Jyrki Latokartano (Jyrki.latokartano@tuni.fi)

Short Summary: Tampere Robotics Didactic Factory (DF) is utilised for testing and further developing service development and offering formulation for manufacturing SMEs, industry and other interested stakeholders. Firstly, the core services relate to the test-before-invest and to the educational services. These are not offered by the other universities in Finland. Secondly the Human-Robot Collaboration (HRC) Pilot Line and Tampere Robolab (components of the Tampere Robotics Didactic Factory) offer a unique modularised research and education facility. The services related to the educational modules, and the research services are used as a means to transfer modularised research results from scientific projects (e.g. Horizon project results) to demonstrate for relevant SMEs.

The HRC Pilot Line is a reconfigurable advanced robotics R&D&I platform for academics and industry to create and test ideas for future Horizon Europe and national collaboration projects. In addition, this is the place for vocational education for special equipment, robotics programming, virtualisation and AI-based methods. The HRC Pilot environment supports both formal and non-formal education and industry-academy collaboration in research. From the education perspective the robotics learning environment was developed to facilitate the learning process and to allow different robotics projects originating from industry to be carried out. More information about the TAU HRC Pilot Line can be found in the website: https://research.tuni.fi/hrc-pilotline/.

The RoboLab Tampere has been established to facilitate the learning process or both formal and non-formal education, and academia-industry R&D&I collaboration. The RoboLab Tampere operates with similar principles as e.g. Fab Labs. The RoboLab Tampere offers a place for students to work with robotic equipment and experiment without major restrictions. Robots and related technology are for example industrial manipulators (Kuka Iiwa, Flexfellow, Universal robots, Franka Panda, Prob, Epson, Fanuc), mobile robots (turtlebot, MiR100, in-house developed robot), a multitude of sensors (2D/3D ToF cameras, LiDAR, GNSS, IMU, etc.) and different processing platforms (PCs, embedded PCs, Raspberry Pi, Nvidia TX2). The learning environment differs from FabLabs and other learning/teaching factory environments in such way that the lab is available 24/7 to all students interested in robotics. For more information visit: https://research.tuni.fi/robolabtampere/.

3.3.8. Didactic Factory 8: 'I4.0 Lab'

Figure 14: Innovalia Metrology Didactic Factory (I4.0 LAB)

Organisation: CARSA
Location: Parque Empresarial Boroa, P2-A4, 48340 Amorebieta-Etxano, Biscay, Spain
Website: https://www.innovalia-metrology.com/
Contact Point: Alicia González | agonzalez@innovalia.org

Short Summary: The mission of the Didactic Factory by Innovalia consists of ensuring that every partner can fully benefit from digital opportunities (technical support, infrastructure, trainings, market intelligence, etc.) on the following competences: Industrial IoT & CPPS, Metrology 4.0, Zero Defect Manufacturing, Business Digitization, Big Data & 3D Mobile Visualization, Cybersecurity and Digital Trust. As the Didactic factory is immersed in the Automotive Intelligence Centre (https://www.aicenter.eu/), a strong network of international partners in the Automotive Sector has been built and several collaboration activities have taken place: Joint projects and long-term collaborations between the centre partners at regional, national and international level. Experiments carried out in several collaborative H2020 Projects, such as: SERENA; Z-BRE4K; BOOST4.0; BEinCPPS; L4MS; MIDIH; CAXMAN; QU4LITY; etc. ASF, the Automotive Smart Factory, at the Automotive Intelligence Center (AIC), is a joint collaborative laboratory with equipment and services provided by many partners, whose main goal is to cover the whole automotive manufacturing value chain for Demonstration purposes.

Current Experiments / Field Labs:

- An experiment took place between September and December 2021 regarding 5G connection at the Innovalia Metrology Didactic Factory. A series of enhancements have been developed in order to be able to operate a horizontal-arm-type Vulkan CMM equipped with an optical scanner, and a series of tests of wireless remote operation will take place.
- As part of the work at the Didactic Factory, Innovalia is also contributing to the International Data Spaces Association (IDSA) paradigm of trusted and secure data sharing, and is carrying currently experiments with various public and private agents in order to create a market ecosystem of trusted industrial data sharing.
- Experiments on machine state monitoring and predictive maintenance, in order to ever-improve and guarantee the best usage experience to the customers of the CMM machines manufactured by Innovalia Metrology, with the objective of, for instance, predicting when the air bearings of the machines would need a remanufacturing operation or replacement.

3.3.9. Didactic Factory 9: 'SMILE'

Figure 15: SMILE Facility

Organisation: Intellimech
Location: Red Kilometer, Gate 5 - Via Stezzano n. 87, 24126 Bergamo, Italy
Website: https://www.serviziconfindustria.it/it/servizi-confindustria-bergamo-srl/il-laboratorio-smile
Contact Points: info@serviziconfindustria.it

Short Summary: SMILE – ''Smart Manufacturing Innovation Lab for Enterprises" is a project born from the collaboration among Kilometro Rosso, Confindustria Bergamo, Servizi Confindustria Bergamo, ITIS Paleocapa Bergamo, and with the co-financing of Ministry of Research and Education: a synergy between entities engaged in training, innovation and in education on the one hand and the business world on the other, which, starting from the concrete case-study linked to the digital factory, has created an innovative advanced training model.

The aim is to rekindle the interest of young people in the technical-scientific disciplines and steer them into a successful professional future as well as to carry out continuous digital training for those who are already operating in companies. This is the mission of SMILE, a collaboration platform that aims to establish a constructive and coherent dialogue among schools, universities, ITS (it will be the Laboratory of ITS Lombardia Meccatronica), associations, companies, and research and technology transfer centres.

Supported by Confindustria Bergamo and Confindustria Bergamo Servizi, which is coordinating the space management, it operates, with the collaboration of some technological partners, in different areas: PLC programming, Virtual Commissioning, HMI, Industrial Automation, Robotics, Vision Systems, Analysis of production flows, Big data, 3D printing.

Current Experiments / Field Labs:

- Orientation to technical-scientific disciplines and contrasting early school leaving for secondary school students, thanks to NAUTILUS @ SMILE - the network of laboratories centred on the campus of the ITIS Paleocapa and ISIS Natta technical schools
- Advanced training of teachers in advanced laboratory teaching of ITS and universities
- Continuous training for workers' Upskilling and Reskilling, through skills development activities on the Smart Factory

3.3.10. Didactic Factory 10: 'iiLab: Industry and Innovation Lab'

Figure 16: Robot Arm (iilab, Inesctec)

Organisation: INESC TEC
Location: Campus da Faculdade de Engenharia da Universidade do Porto Rua Dr. Roberto Frias 4200-465 Porto Portugal
Website: https://www.inesctec.pt/en/laboratories/iilab-industry-and-innovation-lab#technologies
Contact Points:

- Rafael Lírio Arrais | rafael.l.arrais@inesctec.pt
- Ana Cristina Barros | ana.c.barros@inesctec.pt

Short Summary: To disclose the state-of-the-art in advanced production technologies through the demonstration of research, experimentation and advanced training results. iiLab supports technology-based innovation in public and private organisations, thus contributing to the development of their skills in the development, adoption and implementation of advanced production technologies, leading to a sustainable competitiveness in the circular economy context.

Current Experiments / Field Labs: Multiple technonology demonstrators for European and National R&D initiatives in the domains of:

- Cyber Physical Systems (CPS) & Internet of Things (IoT)
- Advanced Automation & Industrial Robotics
- Mobile Robotics & Internal Logistics
- Industrial Vision Systems for Inspection and Quality Control
- Business Intelligence & Decision Support Systems

3.3.11. Didactic Factory 11: 'Smart Lab'

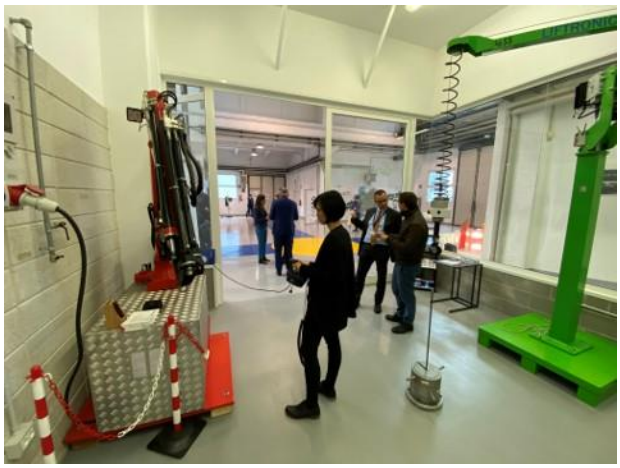

Figure 17: Intellimech Smart Lab

Organisation: Intellimech
Location: Kilometro Rosso innovation district Via Stezzano, 87 – 24126 Bergamo
Website: https://www.intellimech.it/en/ricerca/
Contact Point: Alissa Zaccaria | alissa.zaccaria@intellimech.it

Short Summary: The Smart Lab is a showroom established by Intellimech at the Point, the technological innovation hub for the province of Bergamo, headquartered in Dalmine. This laboratory is intended to exploit prototypes and demonstrators, resulting from joint research conducted by Intellimech and its partners.

Current Experiments / Field Labs:

- 'Touchplant' Project (smart monitoring of industrial machines and plants)
- Projects of the National Technology Cluster Intelligent Factory:
  - Adaptive project demonstrators
  - Demonstrators of the Smart Manufacturing project
- Web monitoring of industrial plants
- Predictive maintenance of low voltage circuit breakers
- Control and supervision of autonomous guided vehicles (AGVs)

3.3.12. Didactic Factory 12: 'Swiss Smart Factory'

Figure 18: DF Swiss Smart Factory

Organisation: SIPBB
Location: Aarbergstrasse 46, 2503 Biel/Bienne, Switzerland
Website: https://www.sipbb.ch/en/forschung/swiss-smart-factory/
Contact point: Dominic Gorecky (dominic.gorecky@sipbb.ch)

Short Summary: The Swiss Smart Factory serves as a didactic factory to showcase cutting-edge advancements in advanced production technologies. Through research, experimentation, and advanced training, it supports technology-based innovation in both public and private organisations. This initiative aims to enhance skills in the development, adoption, and implementation of advanced production technologies, fostering sustainable competitiveness within the context of the circular economy.

Current Experiment / Field Labs:

- Live demonstrations of ERP+ proALPHA with the Swiss Smart Factory, showcasing a product configurator for drones and innovative industrial processes.
- Rollomatic's innovation cell at SIPBB collaborates with academic and industry-oriented research labs, offering Bachelor and Master projects to students in various fields.
- Integration of research centres like Swiss Smart Factory enables Rollomatic to undertake concrete industrial projects.
- Rollomatic's SIPBB office, located 15 kilometres from their headquarters, offers a unique opportunity to engage with both French and German-speaking students in the region.

3.3.13. Didactic Factory 13: 'MADE cc'

Figure 19: DF MADE competence centre

Organisation: Politecnico di Milano
Location: Piazza Leonardo Da Vinci, 32 – 20133 Milan, Italy
Website: https://www.made-cc.eu/en
Contact point: Maria Rossetti (maria.rossetti@made-cc.eu)

Short Summary: MADE Competence Center for Industry 4.0 is a digital and sustainable factory that offers comprehensive support for manufacturing companies, with a primary focus on small and medium enterprises. Their mission involves implementing orientation, training, and technology transfer projects, facilitating the transition to smart, connected, and sustainable factories. As a technical interlocutor, MADE cc engages with companies to increase awareness of Industry 4.0 and develop dedicated training paths. The ultimate goal is to enhance the competitiveness and sustainability of manufacturing companies, covering aspects from design and production to logistics and end-of-life management, and leveraging a broad spectrum of digital knowledge, methods, and tools. MADE cc is established by the Italian Ministry of Economic Development (MISE) to ensure that businesses have the necessary resources and expertise to excel in the era of digital transformation and Industry 4.0.

Current Experiment / Field Labs:

- Virtual Design and New Product Development
- Digital Twin and Virtual Commissioning, Lean Manufacturing 4.0, Logistics 4.0
- Collaborative robotics and intelligent worker assistance systems
- Quality 4.0, Product traceability and additive manufacturing
- Smart monitoring and control of industrial processes, Smart energy monitoring and control, Smart maintenance
- Industrial Cyber Security and Big Data Analytics

3.3.14. Didactic Factory 14: 'SUPSI mini factory'

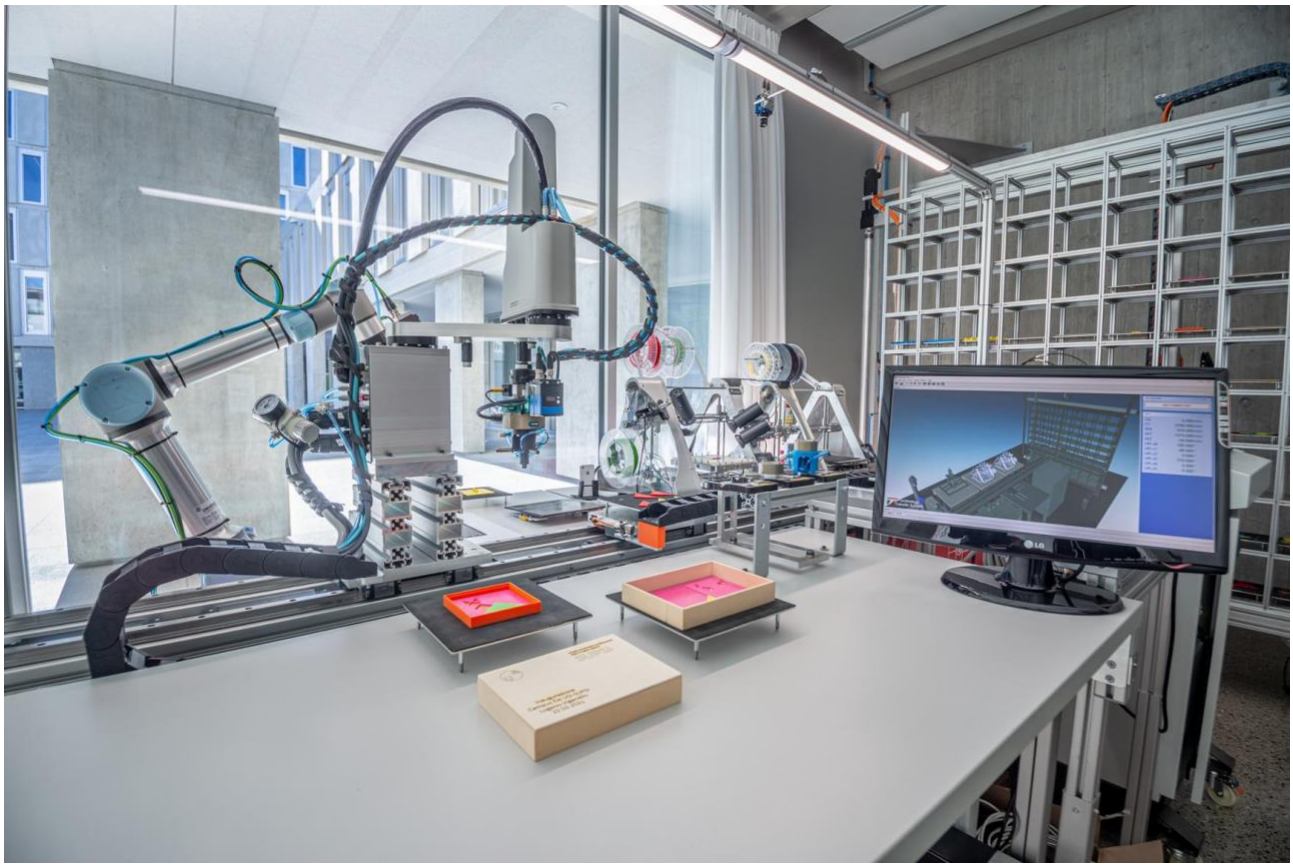

Figure 20: DF Supsi mini factory

Organisation: SUPSI
Location: Lugano, Switzerland
Website: https://www.supsi.ch/en/mini-factory-4.0
Contact point: Paolo Pedrazzoli (paolo.pedrazzoli@supsi.ch), Elias Montini (elias.montini@supsi.ch)

Short Summary: The SUPSI Mini-Factory is a dynamic learning environment that embodies the principles of Industry 4.0, emphasising hands-on training and technological experimentation. It operates as an automated production and assembly system, where students apply the fundamentals of Industry 4.0 through practical experience. The SUPSI Mini-Factory is a real-world learning environment that combines practical experience, technology innovation, and interdisciplinary collaboration, making it a valuable asset for both educational and research purposes.

Current Experiment / Field Labs:

- **Customizable Production**: The Mini-Factory offers a customisable production process, enabling personalised orders and demonstrating remarkable adaptability and resilience.
- **Hardware and Software Integration**: The facility is equipped with a range of hardware and software components, including robots, RFID systems, and machine vision, to create an integrated and highly automated production environment.
- **Hands-On Learning**: The Mini-Factory serves as a hands-on learning environment, providing students with practical training and interdisciplinary activities to develop competencies in real-world manufacturing.

- **Applied Research**: Beyond education, the Mini-Factory supports applied research by offering an environment to study, test, and deploy fully automated and modular solutions, fostering innovation in modern industries.
- **Industry 4.0 Principles**: The Mini-Factory embraces Industry 4.0 principles, emphasising modularity, flexible automation, and integration of diverse technology vendors to meet the challenges of modern manufacturing.

3.3.15. Didactic Factory 15: 'POLIMI Lab'

Figure 21: Industry 4.0 Laboratory at the Politecnico di Milano

Organisation: Politecnico di Milano
Location: Via Raffaele Lambruschini, 4B, 20156 Milan, Italy
Website: https://www.industry40lab.org/
Contact point: Walter Quadrini (walter.quadrini@polimi.it)

Short Summary: The I4.0 Lab at POLIMIlab is a cutting-edge facility equipped with industrial assets that replicate a real environment, enabling the testing of research results and the development of customised solutions using state-of-the-art equipment and technological solutions. This facility serves as a dynamic hub for research and development, fostering collaborations with industrial partners and research centres to experiment with and implement the latest solutions in both industry and research. It functions as a centre of excellence and education for both university and corporate partners.

Current Experiment / Field Labs:

- **Production Line:** The lab features a physical production line equipped with industrial programmable logic controllers (PLC), sensors, actuators, and interfaces that mimic an industrial assembly environment, providing a practical setting for research and development.
- **Collaborative Robot:** A collaborative robot is employed to perform assembly and disassembly operations in a mixed environment where human operators work alongside industrial equipment. This approach highlights the seamless integration of humans and automation in an Industry 4.0 context.
- **Automated Guided Vehicles (AGV):** AGVs, or Automated Guided Vehicles, are autonomous vehicles designed for material transport within the shop floor. These vehicles operate without the need for human intervention, efficiently transporting materials between workstations and enhancing overall automation and efficiency.

3.3.16. Didactic Factory 16: 'Control2K'

Figure 22: DF Control2K

Organisation: Control 2K Ltd
Location: Waterton Technology Centre, Bridgend Wales UK CF31 3WT
Website: www.industreweb.co.uk
Contact points: Gash Bhullar (gbhullar@control2k.co.uk) , Rachel Davies (rdavies@control2k.co.uk) and Simon Osborne (sosborne@control2k.co.uk)

Short Summary: Industrial Training Centre and Systems Integration services based in the heart of South Wales, UK. Control 2K offers specialist Control Systems training and consultancy as well as a range of industrial software products. Control 2K is an established Research & Development partner and has participated in Horizon2020, Horizon Europe and UKRI programmes since 2003. Control 2K has strong links with UK industry partners in the manufacturing sector and focuses on technologies for SME exploitation.

Control 2K is also the architect behind the Industreweb™ Data Integration Platform used to connect and collect data from multi-vendor systems in industrial research and commercial applications.

Current Experiments / Field Labs:

- COREF (Connected Reconfigurable Factory) Connected Cell
  - POC Demonstration cell focussing on smart workspaces in high-precision, low-volume manufacturing environments
  - Showcase of Industreweb™ data layer and protocol translation tools
  - AI Vision System integration
  - AR / VR Dashboard prototype
- Production Monitoring Pilot
  - Full production monitoring environment modelling
  - KPI and Data Aggregation demonstration
  - OEE and performance monitoring
- Intelligent Workflow Engine
  - Dynamic work instructions based on production tasks and workflow
  - Track and Trace using UWB and BLE

3.3.17. Didactic Factory 17: 'DMIW'

Figure 23: DF DMIW

Organisation: Digital Manufacturing Innovation Wales (DMIW) Ltd
Location: Waterton Technology Centre, Bridgend Wales UK CF31 3WT
Website: www.dmiw.co.uk
Contact points: Gash Bhullar (gbhullar@dmiw.co.uk) and Rachel Davies (rae@dmiw.co.uk)

Short Summary: DMIW is a non-profit DIH focussed on the adoption and exploitation of innovative manufacturing and process technologies (including CPS, AI, Digital Twins, Virtual Factory, Control Systems), within the SME community. We do this through direct support and advice; referrals from Business Support organisations and through participation in R&D programmes, Open Calls and Industry 4.0 experimentation. Our Machine Tool Facility (MTF) is a purpose-built machine area and Industry 4.0 Demonstrator. Housing a range of technologies from robotics and IoT, to digital twins and AI; the MTF is supported by numerous technology partners throughout the manufacturing industry.

Current Experiments / Field Labs:

- Mini-Factory
  - Festo Didactic Factory presenting an assembly process
  - Demonstrates Industreweb™ Data Integration Platform to connect multiple PLCs and systems including I/O devices and IIoT
  - AI Vision System integration
- Industreweb Operator Knowledgebase (IWOK) demonstration
  - Integration of analogue and digital data points with production process
  - POC for self-healing manufacturing process based on AI-driven quality Control
  - Human-Machine collaboration

3.3.18. Didactic Factory 18: 'MADE'

Figure 24: Unimec A/S, one of MADE's SME members

Location: Vesterbrogade 1^{E}, 1620 Copenhagen V, Denmark
Website: https://www.made.dk/en/about/
Contact point: Merete Norby (mnorby@made.dk)

Short Summary: MADE, the Danish Cluster for Advanced Manufacturing, is a certified Gold Cluster and holds the official designation of the Danish Cluster for Advanced Manufacturing by the Danish Ministry of Higher Education and Science, as well as the Danish Board of Business Development. MADE serves as a crucial hub for advancing the manufacturing industry in Denmark through a holistic approach encompassing research, innovation, and education. MADE specialises in advanced manufacturing, fostering collaborations among manufacturing companies, research and technology organisations (RTOs), and higher-education institutions. These partnerships, projects, and activities involve stakeholders from diverse industries and sizes, promoting the sharing of expertise to enhance Denmark's global competitiveness.

Current Experiment / Field Labs:

- **Applied Research**: MADE engages in industrial research and development, testing new solutions and technologies in close collaboration with industry. The research platform, MADE FAST, focuses on thematic domains aligned with the evolving needs of Danish manufacturing companies.
- **Innovation**: Knowledge sharing with companies is a central aspect. MADE disseminates knowledge through various channels, such as events, articles, videos, podcasts, and networking groups. New knowledge is actively applied in innovation projects, ensuring that science and technology reach a broad spectrum of manufacturing companies.
- **Education**: MADE plays a pivotal role in preparing the current and future workforce of Manufacturing Denmark for the factory of the future. It offers digital learning resources and assistive materials to equip employees with the skills and knowledge required to work with state-of-the-art manufacturing concepts and technologies.

3.3.19. Didactic Factory 19: 'am-Lab'

Figure 25: DF am-LAB

Organisation: Pannon Business Network (PBN)
Location: Hungary, HU-9700 Szombathely, Zanati út (street) 32-36
Website: https://www.am-lab.hu/main.php?Lang=EN
Contact point:

- Balázs Barta (Managing Director) balazs.barta@pbn.hu +36 30 915 0340
- Attila Joós (Didactic Factory Division Leader) attila.joos@pbn.hu +36 30 330 2112

Short Summary:
am-LAB is a research, development, and training laboratory for digitalisation. It provides a development environment to meet unique business needs with state-of-the-art technology tools related to manufacturing and product development. With a wide range of equipment and an expert engineering team, am-LAB provides a competitive research and development environment, primarily for manufacturing companies. Founded in 2017, am-LAB won the title of Best Digital Innovation Center in Europe in 2020.

Current Experiments / Field Labs:

- Complex manufacturing simulation and training Hub with special teaching and learning factory unit
    - The Teaching and Learning Factory "TLF" (aka: cyberphysical factory) is a manufacturing unit with online, remote access to broaden services directly related to digitisation competencies of the partners. The TLF shall integrate different Industry 4.0 solutions in one manufacturing demonstration line, and it has to be able to demonstrate on site the automated production.
    - Complex and accredited education activities and services focusing on Industry 4.0 and IoT technologies
- Industrial and marketing solutions with different AR (Augmented Reality) and MR (Mixed Reality) technologies
    - AR Mobile applications
        - Development of extended reality applications for iOS and Android devices in the following areas
        - Real-time display of manufacturing data series on the shopfloor
        - AR gamification application development
        - AR applications supporting machine maintenance and component visualisation
        - Product marketing with AR applications
        - Mobile applications for general public
    - WEB based AR applications
        - WEB AR content applications for printed materials
        - WEB AR applications supporting machine maintenance and component visualization
        - Product marketing with WEB AR applications
    - Head mounted devices (Hololens 2, Oculus Quest Pro) applications
        - Real-time display of manufacturing data series on the shopfloor
        - AR applications supporting machine maintenance and component visualization
        - Product marketing with WEB AR applications
        - Digital twin simulation with MR (Mixed Reality) Technology
- Big Data and Analytics
    - Increasing the profitability and efficiency of businesses by analysing previously untapped but valuable data. Our service enables smaller businesses to profit from data analytical services.
- Collaborative robotic solutions
    - Focusing on high added value automated processes with unique developments
- High added value product development and prototyping services
    - Designing custom products and tools from idea to prototype production
    - Model and tool preparation and mass production optimization
    - Prototype production using 3D printing (with FDM and SLA technologies)
- Reverse engineering and 3D scanning
    - Digitising from unique parts to complete objects
    - CAD modelling

3.3.20. Didactic Factory 20: 'Fraunhofer IOSB'

Figure 26: Fraunhofer IFF Swap-IT architecture for aircraft construction

Organisation: Fraunhofer
Location: Fraunhoferstraße 1, 76131 Karlsruhe, Duitsland
Website: https://www.iosb.fraunhofer.de/en.html
Contact point: Ljiljana Stojanovic (ljiljana.stojanovic@iosb.fraunhofer.de)

Short Summary: Fraunhofer IOSB specialises in the development of innovative visual systems, optimising sensor utilisation, data processing, and evaluation. Our primary focus is to harness this data to effectively enhance human decision-making, streamline processes, and intelligently control autonomous systems. Our expertise encompasses three core competences: Optronics, System Technologies, and Image Exploitation. Fraunhofer IOSB is rooted in application-oriented research, actively contributing to the betterment of society and a stronger economy. The institute excels in scientific and technological excellence and prioritises customer-focused solutions, with a strong commitment to issues such as open standards, interoperability, IT security, and data protection/privacy.

Current Experiment / Field Labs:

- **Autonomous systems / robotics**: The institute conducts extensive research and development in autonomous mobile robot systems, equipping them to function effectively across a diverse range of environments. This research encompasses the creation of autonomous construction machinery for unstructured surroundings, the development of underwater robots, and the operation of automated vehicles that promote cooperative driving on roadways.
- **AI-Based Assistance Systems**: Creation of AI-supported assistance systems that leverage knowledge-based and machine learning procedures to guide people in task processing efficiently. These systems can analyse large datasets, such as videos, texts, and data series, and offer insights and automation.

3.3.21. Didactic Factory 21: 'Rudolfovo – Science and Technology Centre'

Figure 27: LabTOP (Laboratory for Factories of the Future)

Organisation: Rudolfovo – Science and Technology Centre Novo mesto
Location: Podbreznik 15, 8000 Novo mesto, Slovenia
Website: https://www.rudolfovo.eu/
Contact point: dr. Krištof Debeljak (kristof.debeljak@rudolfovo.eu)

Short Summary: Rudolfovo represents a science and technology hub in southeastern Slovenia. The institute fosters innovation potential, enabling the development and testing of new tools and methods, thereby promoting comprehensive and sustainable regional development. The research and development activities of Rudolfovo are based on four pillars: factories of the future, digital transformation, circular economy, and technology transfer and intellectual property.

Current Experiments / Field Labs:

- **LabTOP (Laboratory for Factories of the Future)**
  Robots with various addons, lasers, computer vision, AR, VR, and autonomous vehicles are integrated into an intelligent production line controlled by an ERP system, enabling customized production. A demonstration centre with Factory of the Future enables: (A) students to get hands-on experience with the latest technology; (B) companies to test their solutions at our smart factory (connecting to ERP systems etc.) or to test before they decide to invest; (C) industry to cooperate with us by implementing their equipment.
- **LabE (Laboratory for electrical Energy management)**
  The project integrates all possible resources to help users (factories) optimize their electric energy-related expenses into an advanced vertically integrated Energy Management System (EMS):
  - Multiple sources: (grid with dynamic or static tariff system, local renewable sources, local clean sources (hydrogen), and local traditional sources (diesel generators)
  - Demand side modelling through consumer management
  - Energy storage (batteries)
- **LabX (Laboratory for eXtended reality)**

Laboratory with state-of-the-art equipment and technology for AR (Augmented Reality) and VR (Virtual Reality). We are developing solutions for different industries (pharmacy, civil engineering, manufacturing, etc.).

3.3.22. Didactic Factory 22: 'Smart Factory Research and Demonstration Center'

Figure 28: Smart Factory Research and Demonstration Center (LASIM)

Organisation: University of Ljubljana, Faculty of Mechanical Engineering, Laboratory LASIM
Location: Faculty of Mechanical Engineering, Laboratory LASIM, Askerceva 6, 1000 Ljubljana, Slovenia
Website: https://web.fs.uni-lj.si/lasim/index.php?page=home
Contact point: Prof. dr. Niko Herakovic (niko.herakovic@fs.uni-lj.si)

Short Summary: The demo centre (Smart Manufacturing and Innovation Center) is developed and built according to the principles of Industry 4.0 (I4.0) and provides the possibilities for basic and applied research of all I4.0 key technologies and logistics. 5G wireless technology (stand-alone and non-stand-alone) is used to research wireless communication and data transfer in the production line. The equipment includes a modern self-configurable production line, two industrial robots, one collaborative robot, automated smart rack warehouse, machine vision technology on different locations, RFID technology and traceability, cloud technologies and edge computing, BIG Data technology (data capturing, processing and transferring and real-time data processing), digital twin's technology of processes and digital agents, based on AI at different levels (global, local, etc.), distributed production systems technology based on Holon's theory, virtual and augmented reality technologies, smart and self-adaptive and self-configurable manual assembly cell with self-developed LPM (Lean Production Management) system, supported by visualisation, etc. The whole production process is totally autonomous and self-controlled by digital twins and AI.

Current Experiments / Field Labs:

- Development of innovative architecture models for Smart factories (LASFA model), which is used for digitalization and SMEs transformation strategies.
- Robotic assembly
    - Robotic self-programmed path optimization with simulation support (optimal path, time evaluation, comparison between real and simulated cycles)
    - Robotic safety, machine vison, safety areas and strategies

  - Assembly operation optimisation according to the production plan, product structure and assembly process (sequence, tool changing strategy)
- RFID pallet and material (products) tracking
- Testing and analysis of communication protocols for different production processes (OPC UA, etc.)
- Optimisation of manual assembly processes (advanced manual assembly work station, innovative I4.0-reated approaches, LPM product management system integration, workstation reconfiguration according to the worker's needs and product complexity, pick-by-light, AR and VR supported assembly)
- Digital twin development by using Siemens Tecnomatix Plant simulation (production processes, logistics, real-time data gathering, data analyses, production planning, real-time process optimisation)
- Simulation of production processes (Process Simulate)
- AI-based Edge Computing with 5G technology for distributed systems control (production processes and systems, logistic systems)
- 5G industrial architecture analyses (stand-alone, non-stand-alone, communication analyses, data transfer analyses, stability and robustness)
- Collaborative robotics in assembly processes

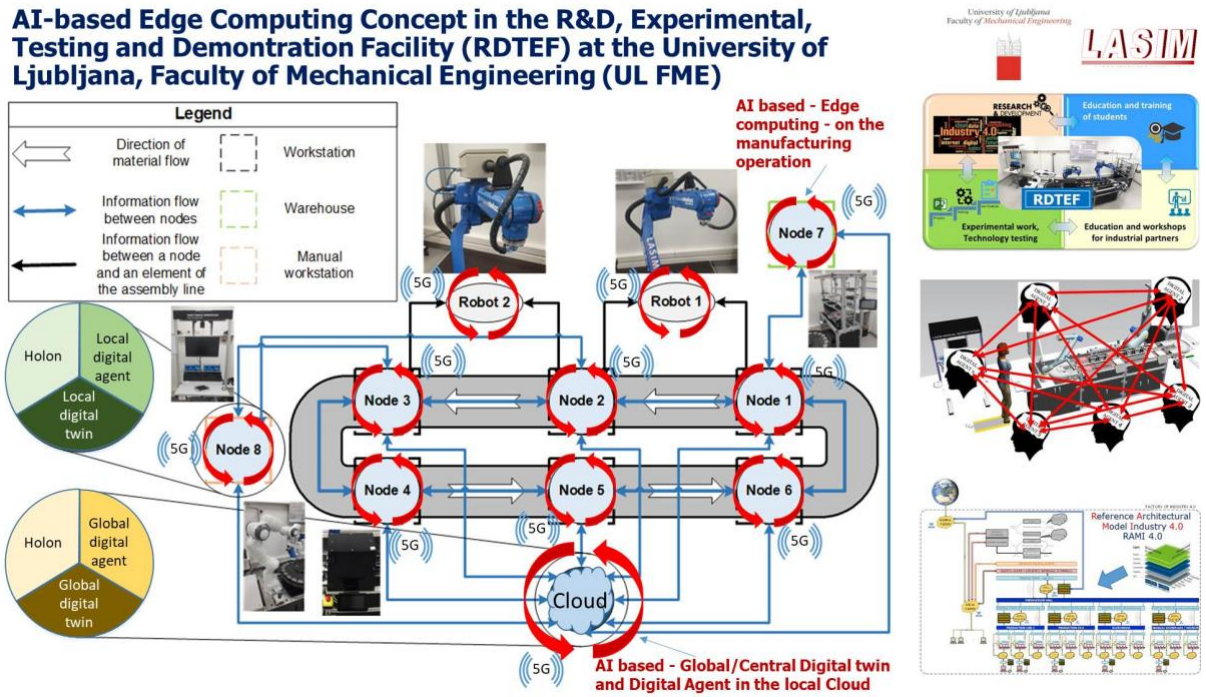

Figure 29: AI-based Edge Computing concept (LASIM)

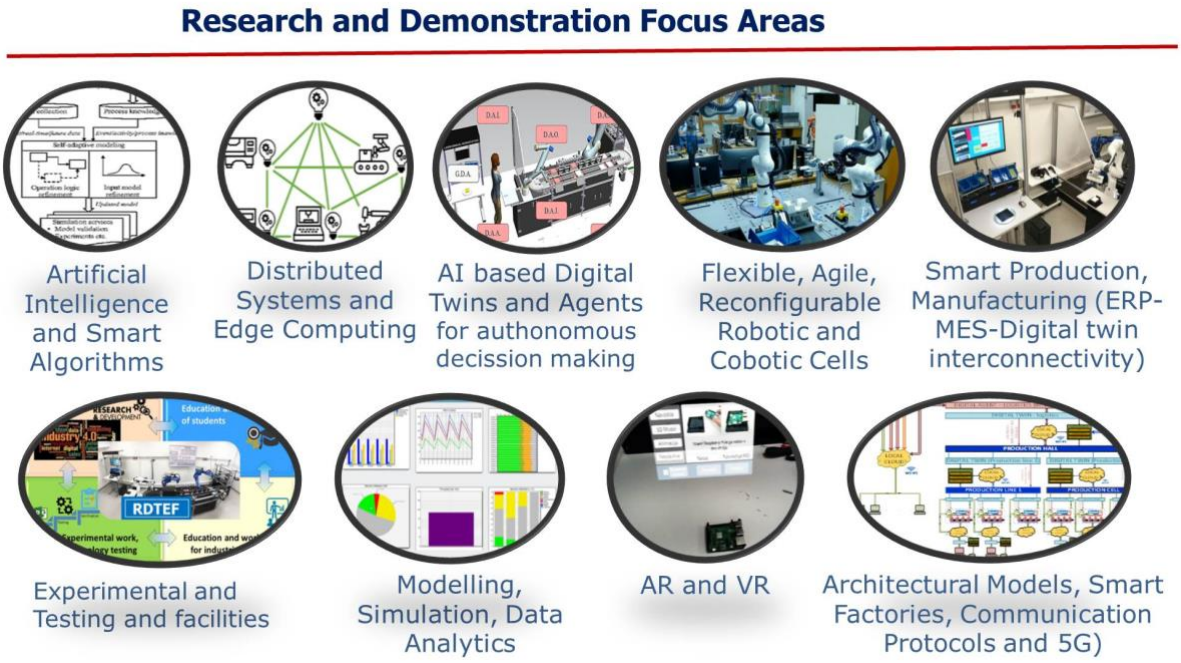

Figure 30: Research and Demonstration Focus Areas (LASIM)

3.4. Future Outlook of Didactic Factories Network

The Didactic Factories network is a clear and tangible result of the AI REGIO project, which has been continued in the AI REDGIO 5.0 project. It is important to search for ways to keep the network alive and active in the future, so that 22 DFs can continue collaborating. In the lifetime of this project, the objective is to expand the network even more to over 30 DFs. We will try to incorporate as many different European countries as possible, resulting in a strong Pan-European network. Since already 7 out of 22 DF's are from outside the consortium, it has been proven that the network yields value for the individual DFs. The organisation and facilitation of the network has been, and will be, the responsibility of Brainport Industries. In this paragraph, the outlook and structure for the future will be discussed in terms of organisation, facilitation and funding.

But first, why is it important to continue the network? The best answer to this question is that the DFs think it is a valuable way to stay connected with like-minded people and organisations, that encounter the same challenges and opportunities. Besides that, all procedures and infrastructures are already in place, so it requires less organisation and facilitation than setting up the network.

3.4.1. Organisation and Facilitation of the DF Network

From a practical point of view Brainport Industries is responsible for managing the DF network within task 3.4 in the AIREDGIO 5.0 project. Some of the DFs are also part of this project, while others are not. The described value proposition will be applied, although some adjustments might be needed in the near future to properly meet the DFs expectations. One of the wishes of the DFs is to search for possibilities to visit each other physical locations, and it is expected that this will be implemented on a regular basis within the AIREDGIO 5.0 project.

Furthermore, we have organised meetings for the network each month. In the future the frequency will be adjusted to once every two-months, in order to keep the content of the meeting of high-level. A risk with organising shorter meetings or meetings with less interesting subjects, is that DF managers start to skip the

meetings. It is of vital importance that the attendance of these meetings is above 90 percent, otherwise the value of the network decreases very fast.
Another idea for the future is to create a website dedicated to the DF network. This way, we can attract new DFs, but also create a platform for the current DFs to share interesting events. Furthermore, it could also function as a knowledge sharing platform for the network itself.

It is also important to keep a strong liaison with the large AI MATTERS project focused on the Testing and Experimental facilities. In the upcoming two years of this project, we need to search for ways to integrate both ecosystems in a feasibly sustainable way.

3.4.2. DF extended network

This deliverable D3.3 only marks a point in time, and the Didactic Factory network is expanding and strengthening even more in the upcoming two years. It is expected that the network will organically grow over the coming years into more than 30 DFs in 2026, as set in the KPIs. Also, the liaison and/or integration with AI MATTERS should be an important strategy. Although the ambition is to grow the network even more, there are some criteria for joining the DF network:

- **Active Didactic Factory**. It is important that the DF that wants to join the network, is an active – up and running – didactic factory. It should have a physical location and it must meet the working definition presented in §3.1.
- **Located in Europe**. The network was founded with European funding, and therefore, it is critical that the DF is located in Europe. As mentioned in AI REGIO's deliverable D7.3 (AI REGIO, 2022), it is preferred to have even more European countries covered than we already do.
- **Willing to share knowledge and experience**. The value proposition, as described in §3.2, is completely depending on the active involvement of all the DFs involved. Therefore, it is of utmost importance that new DFs are willing to share their knowledge and experience.
- **Open to participate actively**. In line with the former bullet point, the network thrives with active partners. It is required for DFs to keep participating in the meetings. Without their individual involvement, the network is useless.

4. DR-BEST

To support Didactic Factories (DFs) in their path, a common approach of representing services which they can offer would be beneficial to enable standardisation of services to be offered to their stakeholders. In this section, first a brief introduction of the DR-BEST taxonomy and the importance of its Remotization dimension is provided.

4.1. The DR-BEST Taxonomy

The proposed structured method known as DR-BEST analysis serves as the foundation for the Service Portfolio study carried out by the DFs. It is part of the METHODIH methodology developed within the AI REGIO project (AI REGIO, 2023). The framework (see Figure 31) was developed considering the needs of the DFs, helping them to outline their current service portfolio and highlight any gaps in what they offer. A three-level taxonomy is used to classify services, which has two benefits: first, it provides a comprehensive overview of all the services that a DF could offer; second, it ensures that services are presented in a consistent and understandable manner. The macro-classification (level 1 of the taxonomy) divides services into six classes (Data, Remote, Business, Ecosystem, Skills, Technology), from which the acronym DR-BEST is derived; for each class, level 2 and level 3 are defined to further clarify and categorise the type of activity.

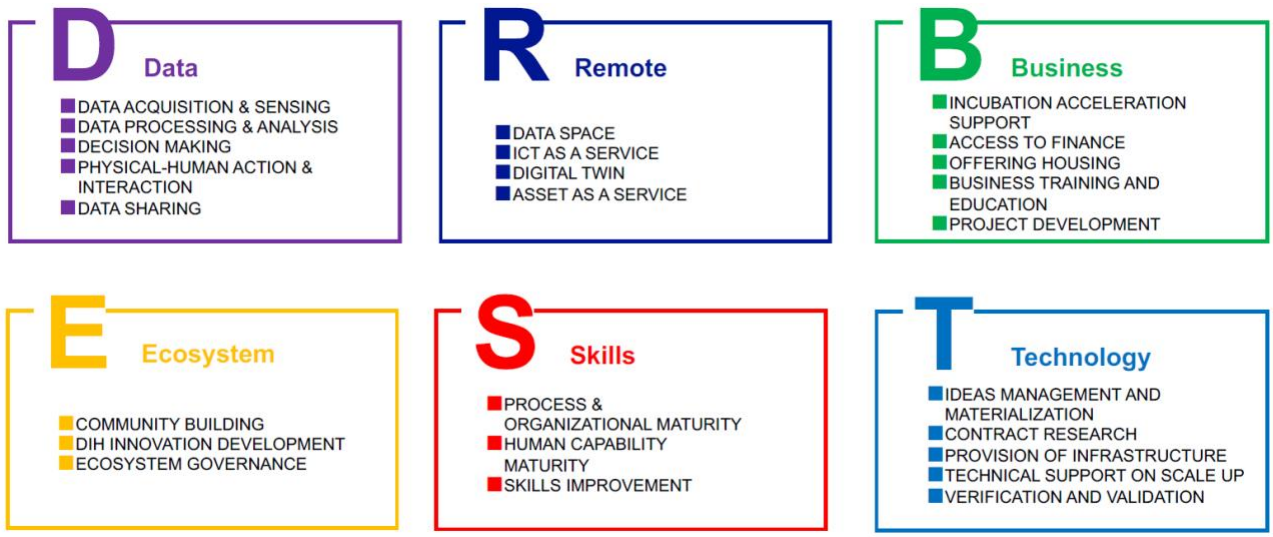

Figure 31: DR-BEST taxonomy - level 1 and 2 (Razzetti, Gusmeroli, Terzi, & Sassanelli, 2022)

4.2. Remotization Dimension

Within the context of AI REGIO project (AI REGIO, 2023), the Remotization macro-class has been added to the D-BEST (Razzetti, Gusmeroli, Terzi, & Sassanelli, 2022)taxonomy to focus on the DFs that operate in AI domain. This class contains all the services that a DF may provide from remote to enable experimentation and that do not require the physical interaction with the customer. The sub-classes identified cover different degrees of DF-customer interaction, including four type of assets that can be put at disposal: data space (Real Time Industrial Data Platform, Assets Administration Shell, Assets Data Marketplace), ICT as a Service (Software as a Service, Platform as a Service, Infrastructure as a Service), Digital Twin (FEM/CFD/FSI simulation, Discrete event simulation, Ambient virtualisation), Assets as a Service (Teleoperation, Monitoring platform, Avatar).

5. Testing and Experimental Facilities

Testing and Experimentation Facilities, commonly referred to as TEFs, are instrumental components of the European Artificial Intelligence strategy (EU, 2024), particularly within the Digital Europe program. These facilities serve a pivotal role in advancing the development and deployment of artificial intelligence across various sectors. TEFs encompass a multifaceted approach, combining physical and virtual resources that are made available to technology providers seeking technical support for rigorous testing and experimentation of their latest AI-based software and hardware solutions. Their primary function is to provide a real-world testing environment where AI-powered technologies, including AI-driven robotics, can be tested, integrated, and validated. These TEFs are designed to focus on mature AI-based technologies and solutions that have successfully undergone laboratory testing, with the aim of addressing real-world challenges and enhancing solutions within specific application sectors, including validation and demonstration. Moreover, TEFs emphasize active engagement with end-users, allowing them to actively participate in defining testing scenarios, protocols, and performance metrics most relevant and impactful to their respective industries.

As an integral component of the Digital Europe Program and the broader European AI Strategy, AI Testing and Experimentation Facilities (TEFs) play a pivotal role in driving innovation within the manufacturing sector. These TEFs are specialised environments, providing essential resources and support for technology providers to thoroughly test and validate their cutting-edge AI-based software and hardware technologies within real-world settings. For the manufacturing sector **AI MATTERS** (https://ai-matters.eu/) is the selected TEF launched by the Digital Europe programme. All consortium members bring their expertise in manufacturing for different sectors such as automotive, space and mobility, textile, recycling, etc.

5.1. Testing and Experimentation Facility Definition

Within the context of the European Digital Europe program, Testing and Experimentation Facilities (TEFs) tailored for the manufacturing sector are specialised environments designed to support the rigorous testing and experimentation of advanced artificial intelligence (AI) technologies in real-world manufacturing settings. These manufacturing-focused TEFs provide a unique combination of physical and virtual resources to assist technology providers in validating and fine-tuning their latest AI-based software and hardware solutions. Notably, TEFs for Manufacturing are dedicated to mature AI technologies and solutions that have already demonstrated their capabilities in controlled laboratory environments and are now in need of validation and optimisation within actual manufacturing processes. These facilities actively engage end-users from the manufacturing sector, allowing them to collaborate in defining testing scenarios, protocols, and performance metrics, ensuring that the AI technologies are aligned with the sector's specific needs and challenges. By focusing on manufacturing, TEFs aim to contribute to the development of trustworthy and innovative AI solutions, bolstering the European manufacturing ecosystem.

5.2. Collaboration between DFs and TEFs

In paragraph 1.1.3.4 of the AI REDGIO 5.0 Grant Agreement has been stated that '*AI REDGIO 5.0 will exploit the AI REGIO network of Didactic Factories and integrate it with the Nodes and Satellites funded under the AI TEF for Manufacturing DEP call. But specifically, AI REDGIO 5.0 will address those AI TEFs which could not be part of funded Nodes and Satellites inside DEP.*' In the past year, a strong liaison has been created between the parties involved in AI TEF for Manufacturing (AI MATTERS) and AI REDGIO 5.0's task leader Brainport Industries. In the upcoming years of the project a clear collaboration strategy should be drawn up. Some of the topics that need to be addressed are:

- **Knowledge Exchange and Integration**: We need to establish a seamless flow of knowledge exchange between Didactic Factories and TEFs. One of the obvious things that we could use is the METHODIH-methodology of which the DR-BEST taxonomy (see chapter 4) is part of. This might involve exchange programs, joint workshops, and collaborative research initiatives aimed at integrating the expertise

and insights garnered from both entities. Shared learning experiences will enrich the understanding of AI applications in manufacturing, bridging theoretical knowledge with real-world testing scenarios.

- **Aligned Objectives and Focus Areas**: The collaboration strategy needs to be designed to align the objectives of Didactic Factories and TEFs within AI REDGIO 5.0 and AI MATTERS, respectively. Identifying overlapping areas of interest, such as AI-driven robotics or edge computing for manufacturing, ensures synchronised efforts toward common goals. This alignment optimises resources and expertise for maximum impact.

- **Distinct Objectives and Focused Areas**: While it is important to identify the overlap between both projects and align the objectives and focus areas, it is also very important to describe the differences. 'Who serves which target groups and supports what types of experiments?' is a vital question in this regard.

- **Protocol Development for Joint Experimentation**: The strategy needs to emphasise the development of protocols and frameworks for (joint) experimentation. Didactic Factories and TEFs should collaborate to define testing scenarios, protocols, and performance metrics relevant to manufacturing sectors like automotive, space and mobility, textile, and recycling. This ensures that the experimentation environment reflects real-world challenges and requirements.

- **Stakeholder Engagement and End-User Involvement**: Active engagement with end-users and stakeholders from diverse manufacturing sectors forms a cornerstone of the collaboration strategy. Both Didactic Factories and TEFs will involve these stakeholders in defining testing scenarios, gathering feedback, and validating solutions. This participatory approach ensures that the developed technologies address industry-specific needs and challenges.

- **Monitoring Progress and Iterative Improvement**: Continuous monitoring and evaluation mechanisms need to be implemented to track the progress of collaborative initiatives. Regular assessments of joint experiments, knowledge exchange programs, and workshops will facilitate iterative improvements in the collaboration strategy itself, ensuring adaptability and responsiveness to evolving industry needs.

This strategy, built upon mutual collaboration and knowledge sharing between Didactic Factories in AI REDGIO 5.0 and TEFs in AI MATTERS, aims to catalyse technological advancements within European manufacturing. By leveraging expertise, aligning objectives, and actively engaging stakeholders, the collaboration is poised to drive transformative innovations, enhancing the resilience and competitiveness of the manufacturing sector.

6. Conclusions and Future Outlook

The vision of the AI REDGIO 5.0 project encapsulates EU's pivotal stride forward in AI and the manufacturing domain. The continuation of the Didactic Factories (DFs) network has unveiled profound insights and set the stage for strategic growth. These DFs fuel innovation by fostering experimentation and serving as catalysts for business advancements. The DF network's vitality is rooted in its value proposition, structured around three core pillars: Acquisition, Collaboration, and Inspiration. These pillars underpin growth, knowledge sharing, and visionary initiatives among participants. In the upcoming period, this value proposition might be reviewed and adjusted according the active demands of the DFs involved. Spanning already 22 facilities across twelve European countries, the current DF network demonstrates diversity and collaborative strength. Future aspirations focus on organic growth, aiming to exceed 30 DFs by 2026, as has been set in the initial AI REDGIO 5.0 KPIs, which is progressing very nicely. This expansion prioritises active participation, European outreach, and a culture of knowledge exchange for incoming DFs. Possible improvements to the current network encompass initiatives like a dedicated website, aiming to amplify visibility and bolster knowledge exchange among DFs. In the upcoming months, T3.4 will continue and intensify its activities, focusing on a thriving and extending pan-European DF network.

Furthermore, collaboration between Didactic Factories and AI TEFs for Manufacturing (AI MATTERS) is poised to propel synergistic advancements. This strategic collaboration enhances knowledge exchange, aligns objectives, and optimises resources toward common industry goals. Continuous assessments, joint experimentation protocols, and progress monitoring establish the groundwork for an adaptive collaboration strategy. This iterative approach ensures dynamic responses to industry shifts and evolving needs. Optimising resources through aligned objectives and targeted initiatives between DFs and TEFs promises heightened impact, synchronised efforts, and amplified innovation within Europe's manufacturing landscape. The most important objective of AI REDGIO 5.0 Task 3.4, besides continuing the DF network, is designing a collaboration strategy together with the involved nodes and satellites in AI MATTERS.

As we stride forward in the AI REDGIO 5.0 project, the envisaged success of this alliance hinges not merely on expansion but on the depth of collaboration, meticulous alignment of objectives, and proactive engagement. The nurturing of our DF network, sustained through streamlined facilitation, stringent criteria, and strategic liaisons, embodies the ethos of collective growth, innovation, and resilience within Europe's manufacturing landscape. The results of the upcoming period in this project will be reported in the final deliverable D3.8 Testing and Experimental Facilities Network due in M36 of the project (December 2025).

7. References

AI REGIO. (2022). *D7.3 Testing and Experimental Facilities Network.* Eindhoven: Brainport Industries (https://airegio.ems-carsa.com/nfs/programme_5/call_4/call_preparation/A20TGE~R.PDF).

AI REGIO. (2023). *D7.4 Testing and Experimentation Facilities V2.0.* Eindhoven: Brainport Industries.

AI REGIO. (2023, 12 15). *AI REGIO Portal*. Retrieved from AI REGIO METHODIH: https://airegio-portal.eu/service-marketplace

Razzetti, S., Gusmeroli, S., Terzi, S., & Sassanelli, C. (2022). *METHOdology for DIH: Adding the Remote Macro-Class to the D-BEST Reference Model.* Milan: https://ceur-ws.org/Vol-3214/WS8Paper2.pdf.

EU. (2024, 1 25). *Sectorial AI Testing and Experimentation Facilities under the Digital Europe Programme*. Retrieved from Digital-Strategy.ec.europa.eu: https://digital-strategy.ec.europa.eu/en/activities/testing-and-experimentation-facilities