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Authors: Papacharalampopoulos A. and Dhondt, S.

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WP leader: Alexios Papacharalampopoulos (LMS)

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Author/s:	Alexios Papacharalampopoulos
	Steven Dhondt
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This document summarizes the recommendations to the stakeholders that have been concluded from the activities related to the integration of Industry 5.0 components to the Teaching & Learning Factory intervention in companies.

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BRIDGES 5.0 partners*

Panepistimio Patron (Patras University - LMS), TNO

*all participating in this Deliverable

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Summary and Key Points.

Teaching Factory 5.0: Scaling an Innovative Learning Model for Europe.

BRIDGES 5.0 has pioneered Teaching Factory 5.0 (TF5.0) — a new, experience-driven training model that connects industry and education in real time. Pilots have proven its value in accelerating skills acquisition and fostering innovation transfer. The concept has proven scalable at the organisation level. Now it needs further testing for large-scale deployment. This Policy Brief places the results of research among a set of Teaching Factories 5.0 in the picture (Papacharalampopoulos et al., 2025).

The recommendations are focused on the scale up of such an intervention in the workplace. Three priorities stand out:

- Remove bottlenecks – Address the shortage of qualified trainers through train-the-trainer schemes and regional capacity building; develop standardised templates for implementation, delivery, and evaluation.
- Boost visibility and uptake – Engage companies, social partners, and policymakers in structured partnerships for joint curriculum development; establish ROI measurement frameworks linking TF5.0 outcomes to economic and innovation impact.
- Secure policy and financial support – Create an EU TF5.0 Transformation Fund, leveraging Erasmus+, Horizon Europe, ESF+, and EIB resources to drive adoption.

The TF5.0 provides companies with an organisational innovation that helps improve company practices in many ways. Companies become ‘greener’, less dependent on international developments, and more focused on the quality of its workforce. Future development should integrate gamification, simulation, and personalised learning pathways. In the longer term, EU-wide accreditation could guarantee quality and consistency, linked to modular micro-credentials and interoperable certifications in line with European qualification frameworks.

TF5.0 is a ready-to-grow instrument for helping companies navigate the digital transition. With targeted investment and policy backing, it can become a cornerstone of Europe’s skills and innovation strategy.

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Strategic Investment in Skills for Industry 5.0.

As Europe charts its course through the twin transitions of digitalisation and sustainability, the need to reshape industrial training formats has become increasingly urgent. The European Union's future competitiveness will depend not only on technological readiness but also on how well it empowers its workforce to thrive in more human-centric, sustainable, and resilient environments. The evolution from Industry 4.0 to Industry 5.0 is not simply a matter of smarter machines—it is a call to place people and the planet at the centre of technological change. It is also a call for new ways of skilling of the workforce. The BRIDGES 5.0 project has tested new ways to make the workforce fit for this Industry 5.0 context.

The landscape of industrial training formats.

Companies use a great number of training methods to keep their workforce up-to-date. The most commonly used approach is on-the-job training. Training is provided for individual retraining or for promotion to other tasks or position. It can bring specific or general knowledge. In the last years, companies are increasingly looking to collective training formats, such as workshops, sector-wide academies and public–private partnerships to apprenticeship schemes, joint online learning platforms, and simulated environments for skill development. These initiatives often pool resources across companies or institutions, enabling shared curricula, equipment, and expertise, and sometimes involve "rotational" models where participants gain exposure to multiple firms. Collective forms improve engagement, mainly because of the social component of the training. They may still lack the real-world complexity and continuous feedback loops. These collective forms tend to be constrained in three ways: (1) limited real-time interaction with authentic, live industrial problems—training is often based on case studies or past scenarios rather than active production challenges; (2) separation between learning and the actual production environment, which can slow skill transfer; and (3) relatively weak integration between academic knowledge generation and industrial innovation cycles. Teaching Factories, on the other hand, integrate students and practitioners into a simulated or real production environment, allowing for hands-on experience with authentic industrial challenges and fostering a two-way knowledge exchange between academia and industry — industry receives fresh perspectives and potential solutions, while learners develop skills in the authentic context where they will be applied (Pittich et al., 2020). Certainly in a world of more digitalisation, more attention is needed to let workers learn and develop in such Teaching Factories.

TF as models for industry training formats.

Within the context of Industry 5.0, the BRIDGES 5.0 project has redeveloped and evaluated Teaching Factories into the Teaching Factories 5.0 model. This new intervention has been piloted across several diverse European industrial contexts. The project experience offers practical evidence of how we can build a more inclusive, adaptive, and innovation-ready workforce. Box 1 presents the concepts of Teaching and Learning Factories.

bridges 5.0

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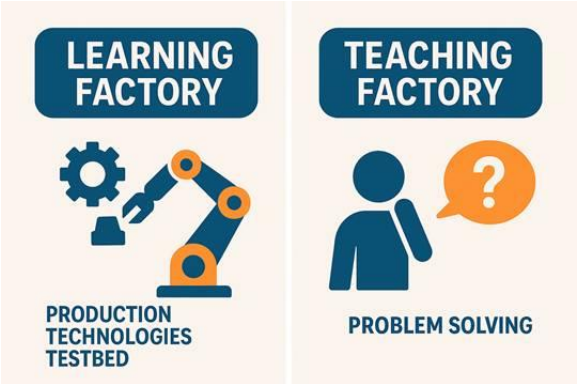
Box 1: The concepts of Teaching and Learning Factories



Teaching Factories (TFs) are defined as collaborative learning environments where practitioners from industry share their expertise with students, while students and academic staff bring theoretical knowledge into the workplace setting. This reciprocal exchange is structured as a continuous learning process, characterised by regular interaction and mutual problem-solving. The central pedagogical emphasis of TFs is on problem-solving, critical thinking, and innovation in real-time industrial contexts (Mavrikios et al., 2019).

The Bridges 5.0 project also looks at another training concept called 'learning factories'.

Learning Factories (LFs), by contrast, are controlled learning environments that simulate industrial settings. These spaces use actual tools, machinery, and workflows that mirror real factories, enabling participants to engage in hands-on learning of industrial techniques and concepts (Abele et al., 2017). The core focus of LFs lies in innovation management and the acquisition of technical competencies through immersive, practice-based learning. For more: see Ziarsolo et al., 2025.

Why Teaching Factory 5.0 Matters Now.

The original concept of TFs brought industry and education together in collaborative, hands-on environments. Workers engaged with students and researchers, bridging the gap between theoretical knowledge and real-world problems. In the new TF 5.0 format, these spaces have been reimagined to align with the values of Industry 5.0. The TF allows to bring the values of Industry 5.0, human-centricity, sustainability and resilience, directly to the workers. This is an advantage over other collaborative industry training formats. The BRIDGES 5.0 project can be seen as 'enriching' the TF-model with these values.

The results of the 'enriching' have been striking. Table 1 provides an overview of four different TFs that have been implemented and analysed in BRIDGES 5.0.

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Table 1. Overview of type of Teaching Factory, purpose and final result.

Case	Type	Purpose	Achieved Industry 5.0 result
Mondragon	Two TF's in two different companies with managers and engineers	To determine the level of digitalisation adoption and support human centric manufacturing	Mondragon management realised they need digitalisation and human centricity, change mentality and drive themselves towards a roadmap for technology adoption
Infineon	One TF (following classes) with engineers and managers	To decentralise decision making within a highly automated unit	Infineon defined and validated the key data parameters required for decentralised decision-making within the Specialised Centre and a human-centric transition. These included tool status, throughput metrics, and dispatch priorities, which were integrated into the training content and decision support workflows
Kitron	One LF (with classes)	To build a (new) human centric system towards retaining personnel	Kitron integrated Industry 5.0 pillars in internal training system.
Comau	One LF emulation with engineers One LF with welders	To adopt human centric technology through automation of welding.	Comau built LF-based "training as a service" including Industry 5.0 aspects and at the same time they augmented technology with extra capabilities for future implementations.

Across all pilots—whether in manufacturing, automation, sustainability, or digital transformation—TF 5.0 has been evaluated and compared positively to the state prior to the intervention. Companies reported not only technical upskilling but also measurable changes in organisational culture. In the Mondragon cases, companies evaluate the change in organisational context. They defined the starting point as situations where the management approach was defined as top-down. The TF 5.0 allowed managers to understand how 'traditional' their actions were, and what is needed for more human-centric ways of working. Through the implementation of TF5.0, organisations shifted from viewing training as a one-off activity to embedding continuous learning, human-centric values, and adaptive practices into their daily routines. This cultural change fostered stronger employee engagement, collaborative coordination, and an orientation toward sustainable, future-oriented innovation. In essence, TF5.0 catalysed a cultural transition where learning and resilience became integral to organisational identity, supporting the broader move toward Industry 5.0. Human-centric approaches were embedded, sustainability gained traction, and workers became co-creators in the learning process.

Evaluation data show large and meaningful impacts. Effect sizes demonstrate that TF 5.0 interventions significantly outperform traditional learning approaches. For instance, Teaching Factory interventions showed clear and stronger learning gains compared to traditional formats.

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Box 2: Strengthening Human-Machine Collaboration in Infineon

Infineon designed a structured three-part training programme to support a human-centric transition within a highly automated production setting. The training combined technical skill-building, interpersonal development, and experiential learning: (1) a technical module focused on KPIs, data interpretation, and factory systems to strengthen analytical capacity; (2) a soft skills component addressed communication, emotional intelligence, and feedback in human-machine collaboration; and (3) a Teaching Factory module allowed participants to apply their learning in real-world AI tool selection and system design.

This integrated approach improved participants' confidence and competence in socio-technical environments. The company recorded a 19% improvement in sustainability-related outcomes—above the meaningful change threshold—and reported that the intervention was straightforward to implement. Overall, Infineon's experience highlights the value of balancing technical knowledge with human-centred approaches to enable thoughtful, system-aware adoption of Industry 4.0 technologies.

These gains are not abstract; they translate into increased employee adaptability, stronger operational coordination, and enhanced innovation capacity.

In every case, the interventions were adapted to the specific realities of the workplace. This adaptability was key. From supporting digital transformation (Kitron, Lithuania) to advancing human-robot collaboration (Comau, Italy), the developed TF 5.0 methodology needed to be robust yet flexible enough to respond to specificities in context..

Notably, co-design and participation by workers turned out to be a cornerstone of success. Where workers were involved in shaping the training—rather than being passive recipients of trainings developed by others —the outcomes improved markedly. Similarly, interventions that integrated behavioural elements such as reflective learning and motivational development reported greater success in embedding Industry 5.0 values. Box 3 shows what this observation means.

Box 3: Two Organisational Interventions Towards Human-Centric Transformation at Mondragon

Within the BRIDGES 5.0 programme, two companies from the Mondragon Corporation implemented targeted training interventions aimed at reshaping organisational culture in alignment with Industry 5.0 principles. The training focused on reflecting how managerial decisions impact employee engagement and workplace meaning, particularly in contexts where automation tends to simplify and fragment tasks. Both companies identified their setting as a "classic coherent" scenario—one in which technology is perceived to prioritise performance at the expense of human involvement.

Delivered over several sessions, the intervention covered themes such as leadership self-reflection, digital transformation drivers and consequences, and systemic organisational redesign. A Teaching Factory exercise enabled participants to explore practical ways of creating work environments that improve both performance and well-being. Evaluated at multiple stages, the training helped deepen managerial awareness and encouraged shifts in management style. Both companies are now considering how to integrate the lessons into long-term organisational development strategies.

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These cases demonstrate that when management is part of reflective, experiential learning, they can lay the groundwork for more ethical, participatory, and effective digital transitions—hallmarks of the Industry 5.0 vision.

A Shared Agenda for Stakeholders.

For employers, the value proposition is clear: TF 5.0 supports agile innovation, fosters better engagement from staff, and prepares the organisation for technological change. The adapted intervention format accomplishes two tasks in parallel: increasing workers' skills and competences, and bringing attention to sustainability and human-centricity directly to the shopfloor. For trade unions, these interventions offer a model of workplace learning that respects workers' agency, improves job quality, and builds resilience in the face of disruption. For policymakers, TF 5.0 can serve as a blueprint for achieving European goals—as put forward in the European Green Deal, Digital Europe, or regional industrial strategy. The future development of TF5.0 can become a shared agenda for these main stakeholders in the European context.

A Comprehensive Policy Agenda for Scaling TLF 5.0.

BRIDGES 5.0 has developed the Teaching Factory 5.0 (TF5.0) as an innovative training concept. In addition to the four Teaching Factories described above, the project has produced several other examples discussed in Papacharalampopoulos et al. (2025). While the concept has now been established, it is still far from being scaled up. Achieving wider uptake will require: (1) addressing obstacles to further development; (2) strengthening the promotion of the concept and increasing policy attention; and (3) exploring future opportunities for its evolution.

One of the main obstacles to implementing TF5.0 is the shortage of qualified trainers, which calls for investment in training the trainers and building regional capacity. As a new concept, TF5.0 lacks standardised templates for implementation, execution, and evaluation. Overcoming these challenges will require greater visibility among companies, social partners, and policymakers. One approach is to improve the facilitation of structured partnerships between business and education, enabling the joint development of curricula. Developing ROI measurement frameworks that link TF outcomes to skills acquisition and innovation transfer could also be beneficial. Policy attention might be further enhanced through the creation of a centralised EU TF5.0 Transformation Fund, potentially drawing on resources from Erasmus+, Horizon Europe, the European Investment Bank, and ESF+.

To strengthen and refine the concept, TF5.0 could incorporate more experience-based formats, such as gamification, and integrate simulation into its training methods. At present, the model is not sufficiently mature to support an EU-wide accreditation system to guarantee quality, inclusiveness, and consistency. Such accreditation could, in the longer term, be linked to personalised learning pathways, modular micro-credentials, and interoperable certifications in Training and Learning Factories (TLFs) (see Papacharalampopoulos et al., 2025), aligned with digital learning systems and qualification frameworks. Only after further experimentation and development could TF5.0 be formally embedded into national and EU vocational education policies. For now, it represents a valuable tool for supporting companies as they adapt to new digitalisation contexts.

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Conclusion: Investing in Europe's Industrial Future.

The shift to Industry 5.0 is not a choice; it is a necessity for companies to deal with the many demands of the twin transition. The TF5.0 is helpful to combine developing technical competencies, but also strengthening values such human-centricity, attention to sustainability and an understanding of resilience. There are still many steps to be taken to achieve the upscaling of the concept. The pilots have shown that upscaling within the organisations is feasible. The next step is outside these company settings. One other topic that must stay on the agenda is to connect the new training approach to a just and inclusive transition of companies. The Teaching Factory 5.0 model offers a powerful way forward as a new learning approach for companies. The BRIDGES 5.0 project shows that companies using and applying the approach can profit from a learning advantage. Many steps are needed to upscale the concept, but with the many competitive challenges that Europe experiences, the TF 5.0 provides an organisational innovation that is strongly needed.

Further reading.

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BRIDGES 5.0 PROJECT IDENTITY

Project name BRIDGES 5.0 **B**ridging **R**isks to an **I**nclusive **D**igital and **G**reen future by **E**nhancing workforce **S**kills for industry 5.0

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Coordinator	**Prof. Dr Steven Dhondt (scientific coordinator)** **Nederlandse Organisatie Voor Toegepast Natuurwetenschappelijk Onderzoek (TNO, Netherlands)**
Consortium	Katholieke Universiteit Leuven
	Austrian Institute of Technology
	Panepistimio Patron (Patras University)
	Conservatoire National des Arts et Métiers, Centre d'Études de l'Emploi et du Travail-Lirsa
	Departamento de Educacion del Gobierno Vasco
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	Mondragon Goi Eskola Politeknikoa, Jose Maria Arizmendiarrieta S Coop
	Lietuvos Pramonininku Konfederacija
	Universita degli Studi di Bari Aldo Moro
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	Workplace Innovation Europe CLG
	Comau SPA
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