



Learning Factory 5.0. A Blueprint for Human- Centric and Sustainable Industrial Transformation in Europe.

BRIDGES 5.0 Policy Brief #4

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Key points.

European industry faces a pivotal transformation, guided by Industry 5.0 principles: human-centricity, sustainability, and resilience. The Bridges 5.0 project explored how education-focused interventions, especially Learning Factories, can drive this change. Learning Factory 5.0 moves beyond technical training, integrating values and collaboration between schools, businesses, and stakeholders. Seven educational ecosystems piloted new models, each adapting Industry 5.0 to local needs. These experiments fostered innovative pedagogy, stronger ties with companies, and new learning outcomes. Trainers and trainees recognised the importance of aligning technology with human capabilities. Companies benefited from improved employee retention, new job profiles, and access to emerging technologies. The project highlighted the need for cultural and organisational change, not just curriculum updates. Scaling up requires cross-institutional collaboration and targeted investment. Ultimately, Learning Factory 5.0 offers a blueprint for sustainable industrial transformation, but success depends on strategic cooperation between education and industry.

For Policymakers (EU, national, regional).

- **Promote Awareness:** Increase understanding of Learning Factory and Industry 5.0 concepts among companies and vocational education providers.
- **Support Innovation:** Encourage pedagogical innovation and provide in-service learning opportunities for trainers and educators.
- **Invest Strategically:** Allocate targeted funding to support the development and scaling of Learning Factory 5.0; companies alone cannot bear the cost.
- **Enable Benchmarking:** Facilitate evidence gathering and benchmarking to guide intervention design and delivery.

For Educators.

- **Embrace Ecosystem Collaboration:** Foster partnerships between education, businesses, and intermediary organisations for curriculum alignment.
- **Innovate Pedagogy:** Implement interdisciplinary project work, laboratory-based education, blended learning, and values education.
- **Focus on Human-Centricity:** Integrate human-centric, sustainable, and resilient values into training programs.
- **Adapt Curriculum:** Regularly review and update curricula to reflect Industry 5.0 requirements and feedback from trainers and trainees.

For Companies.

- **Engage with Education:** Collaborate with educational institutions to co-develop relevant training and innovation pathways.
- **Prepare for Change:** Recognise that transformation requires cultural and organisational adaptation, not just technical upskilling.
- **Benefit from Innovation:** Leverage Learning Factory 5.0 to access new technologies, improve employee retention, and develop future-ready job profiles.
- **Support Scaling Efforts:** Participate in cross-institutional networks to share methodologies and frameworks for broader impact.

Lessons from Learning Factory 5.0 experiments.

European industry must commit to a new form of industrial transformation. The Industry 5.0 industrial policy, with its focus on human-centricity, sustainability and resilience, outlines a path for companies to follow. The Horizon Europe project Bridges 5.0 has conducted research into the extent to which an education-focused training intervention can be converted or prepared to enable education and businesses to work on the necessary change.

The starting point for the development work in the project is the Learning Factory as an existing training intervention (Pittich & Ten Berg, 2013). The Learning Factory was developed as a method that reproduces real industrial environments integrating advanced manufacturing technologies, automation, and digital tools. It looks at the possibilities of applied practices in solving real world challenges in such environments. When students encounter these technologies and are allowed to experiment with them, they not only bring relevant expertise to companies, but also the ability to help innovate within those companies.

Over the past decade, all educational institutions or ecosystems have invested in Industry 4.0 training courses. This mainly involved teaching the latest connected technologies to new generations of students. It is important to note that the Learning Factory represents a significant change in the way education as an institution operates in the field. Schools are no longer closed institutions that produce students or graduates in isolation from the external environment. The Learning Factory is one of the methods that focuses on broad collaboration between education, businesses and other stakeholders. This ecosystem approach allows the demands of businesses and the possibilities of education to be aligned.

The subject of Industry 5.0 is completely new to the education system. The Bridges 5.0 project aims to provide research material and experimentation in learning methods designed to enhance the possibilities for innovation. The outcome, known as **Learning Factory 5.0** has been designed to support the transition to Industry 5.0. Unlike traditional Learning Factories, which primarily focused on simulating industrial processes for skill development, Learning Factory 5.0 integrates human-centricity, sustainability, and resilience as core values, empowering student and trainees with the knowledge, skills and understanding required to adapt and thrive in an Industry 5.0 environment.

This Policy Brief looks at the key results of the Bridges 5.0 project (WP6) and what they mean for the industrial transformation that Europe needs, and what that means for the policies of governments and other stakeholders.

Taking the Learning Factory to the next level.

In general, research into the effectiveness of training interventions such as the Learning Factory is still limited (Pittich & Ten Berg, 2013). The Learning Factory gives companies the opportunity to view schools as a testing ground for all the latest technologies that are constantly emerging. It is no longer the case that schools lag behind companies in terms of technology. Experiments have been conducted in the various countries participating in the project, with new technologies being tested in the school environment. In the Netherlands, for example, the Sharehouse¹ was developed in collaboration between the Scheepvaart en Techniek College Rotterdam (STC), the logistics sector, the City of Rotterdam and TNO. Students were able to work with the latest logistics technologies. They later moved on to

¹ www.sharehouse.nl

these logistics companies. The Learning Factory is relevant as an intervention because it mobilises a broad set of stakeholders to help shape this technological impulse in the business community. Companies are keen to embrace this innovation, but they need to have methodologies in place to work with schools. The subject of the training must also be relevant: it is no longer just about the latest technology, but also about organisational innovations such as Industry 5.0.

The project examined how **seven educational ecosystems** are and were able to introduce Industry 5.0 as a new domain in their education. To bring about this innovation, a process model was developed with the schools and implemented over a period of two years (see Figure 4 in Ziarsolo et al., 2025).

Bridges 5.0 monitored the development of the adapted Learning Factory interventions from the outset. The research was focused on what the ecosystems actually accomplished, starting from the ambition to enrich existing trainings with an Industry 5.0 perspective. The experiments changed pedagogy, created new relationships with companies, and generated all kinds of benefits. In this Policy Brief, we focus primarily on the possibility of this transformation for education ecosystems and the benefits for companies.

Which Learning Factories 5.0 are we talking about?

Table 1 provides an overview of the most important Learning Factories in the project. The results of the study are described in Ziarsolo et al. (2025). We also investigated an intervention in Lithuania, but the results will be included in an update of the final report.

Table 1. Overview of the Learning Factory 5.0 interventions

DEGV/Tknika (Basque Country) represents a strong case of institutional embedding, demonstrating the effective integration of Industry 5.0 into education demands alignment across curriculum, infrastructure, and policy. Tknika's approach included updating the Smart Manufacturing specialisation and creating the Interdisciplinary Learning Factory and Kiribil Lab, where students and teachers engage in collaborative, problem-based learning. This illustrates a broader lesson: **embedding innovation institutionally—and aligning it with regional and European policy instruments—is crucial for sustainable curricular reform.** The depth and stability of this initiative would be difficult to achieve without coordinated, multi-level governance.

FH Joanneum (Austria) similarly advanced a model of structural integration by redesigning physical and pedagogical learning spaces within the Smart Production Lab. Its focus on offboarding practices and the development of a broader range of job profiles reflects an understanding that Industry 5.0 is not merely a technological shift, but a call to **rethink organisational learning and professional development.**

Sharehouse (The Netherlands) took a more values-driven approach by focusing explicitly on sustainability, student engagement, and ethical reflection. Through a combination of gamified learning and systems thinking, Sharehouse moved beyond technical upskilling to support learners in **critically engaging with the societal and environmental implications of technology.** Students were encouraged to link abstract concepts to personal values, helping them develop a more holistic understanding of their role in future work environments. This illustrates the important lesson that **Industry 5.0 must be framed not just as a technological agenda, but also as a normative project—requiring active value formation and critical engagement.**

Smart Makers Academy (SMA) (The Netherlands) demonstrated how methodologically grounded approaches can lead to **system-level change.** Rather than targeting isolated curricular elements, SMA developed entire thematic “metrolines”—innovation hubs focused on domains such as battery technology and circular construction. Using its proprietary methodology, SMA catalysed organisational transformation across a network of actors. The result is a shift from isolated interventions to **ecosystemic innovation**, where new tools and learning formats reshape institutional

cultures and governance practices. This case underscores that **systemic change depends on both methodological clarity and the capacity to operationalise values across institutional structures.**

University of Agder (UiA) (Norway), while adopting a more incremental strategy, highlights the importance of **long-term vision and phased implementation**. Rather than rushing to deploy ready-made solutions, UiA used the pilot to lay the groundwork for more sustained transformation. Its deliberate pace allowed for internal reflection, capacity-building, and gradual integration of new principles into course design and organisational planning. This demonstrates that **transformative change often requires careful sequencing**, especially when attempting to integrate abstract principles—such as human-centricity and sustainability—into existing institutional routines.

The overview shows that the Bridges 5.0 Learning Factories differ greatly in terms of objectives, target audiences, methods and structure. Table 2 in the report provides the details. The differences reflect differences in the ecosystems and how they aim to support developments in the business community in the regions. Four Learning Factories started with the education system. All Learning Factories focus on cooperation with intermediary organisations that form the bridge to businesses. In Austria, for example, this is Industrie 4.0 Plattform Austria, and in Lithuania it is the EDIH, among others. Two Learning Factories started from the continuing education and training of employees. For the Smart Makers Academy (SMA), for example, the customers are businesses and regional partnerships.

Not only are the ecosystems different, but the interventions implemented in the Learning Factories are also different. At DEGV, Joanneum and STC, the main focus is on updating existing Industry 4.0 training courses with Industry 5.0 values. Sometimes all Industry 5.0 values are implemented, sometimes only one component. For example, at STC, the focus was exclusively on imparting knowledge about sustainability. SMA has developed entirely new learning pathways known as “metro lines” aimed at directors, managers and employees within companies.

The research focused primarily on assessing whether the interventions within each of the pilot projects led to innovative developments in the training, the trainers, the pedagogy and the learning outcomes among the students/participants in the training programmes. No attempt was made to achieve any homogeneity in approach.

Will the Learning Factory 5.0 take us further?

We focus on two questions here: Does the renewal of education represented by Learning Factory 5.0 help businesses? And, secondly, does the Learning Factory 5.0 also help the transformation of industry? Longer-term research will be needed to determine whether Learning Factory 5.0 helps the transformation. We are already seeing various benefits of Learning Factory 5.0 for trainers, trainees and businesses, and the results of the Bridges 5.0 interventions are encouraging.

It is important to note that several groups of students/trainees/experts were involved in these interventions. They carried out a whole series of (self-) assessments and expert evaluations. Although questionnaires were used to compare the responses between the pilots, the research focused primarily on how the ecosystems themselves evolved as a result of the changes.

The assessments show that trainers in all ecosystems recognise the importance of Learning Factory 5.0. The new intervention was a reason to review the existing educational curriculum. The schools realised that they were actually contributing to the problems of Industrie 4.0, not sufficiently integrating technology and human capabilities. Greater focus on Industry 5.0 helps businesses and schools. The Bridges 5.0 experiments in particular allowed trainers to experiment with new tools such as new canvas tools (IDEIA) and different methodologies such as the metro lines for education (see SMA). New tools are crucial for conveying new types of teaching material.

The students and trainees are satisfied with the innovation. Industry 5.0 topics are considered important, although there is sometimes a lack of understanding (STC) as to why this new focus is necessary. It is precisely this hesitation that indicates that it is not always easy to draw attention to topics such as sustainability and inclusivity, and that targeted intervention is needed to introduce these ideas. It is clear that if students have not undergone this change during their education, it will be more difficult to bring them up to speed with what Industry 5.0 requires of new employees.

Companies are benefiting from the Learning Factory 5.0, both from the start of the experiments and afterwards. For example, educational institutions understand that knowledge is not static. A few examples illustrate the practical benefits of the Learning Factory 5.0 experiments. Joanneum, for example, pays a lot of attention to offboarding processes in order to prevent knowledge loss among students. It drew up new job profiles that enable companies to prepare more quickly for the necessary organisational changes. In the Basque Country, a great deal of attention has been paid to the development of Human-Centred Design and Human-Technology Integration. Students also learned what collaborative decision-making entails and gained insight into a broad set of sustainability methods (e.g., life-cycle analysis). In the SMA, the joint approach of different metro lines is a crucial step in adapting business strategies towards workplace innovation. The new methods contribute directly to improving employee retention and satisfaction. With the Learning Factory 5.0, the SMA provided a method to help companies deal with new sustainable technologies such as battery production. In this way, the Learning Factories provide a context that enables companies to connect with technologies that they do not yet have in-house. This is just a selection of the many innovations.

The project also provided insight into the requirements for the Learning Factory 5.0 and the challenges associated with its development. The Learning Factory, as an ecosystem, brings with it sufficient challenges in curriculum adaptation (administrative), skills frameworks, need for updated learning methodologies, assessing and evaluation systems. Bringing the Learning Factory to Industry 5.0 adds human centricity and resilience as new challenges, grounded in intangible and difficult-to-measure concepts—attitudes, behaviours, and values that are usually also linked to organisational practices. An important lesson that emerged, particularly in business-oriented ecosystems, was that Industry 5.0 requires a change in culture and language within companies. Boards, managers and staff need to understand what the transformation requires. This is not a given. It is not enough to simply state in policy that change is necessary. The Learning Factory 5.0 is an essential tool. The pilots show that companies and schools are already doing a lot with elements of Industry 5.0, but that they still need to take several steps to work in an integrated, Industry 5.0 way.

The various Learning Factory 5.0s are largely unique and tailored to a specific environment. This seems to stand in the way of scaling up the Learning Factory 5.0. Nothing could be further from the truth. As indicated, Bridges 5.0 looked at two settings: education as a starting point for change; and retraining and further training in the business community. For both

approaches, there are plenty of starting points for other ecosystems to pick up the thread. The experience in the Bridges 5.0 collaboration has been so positive that the partners are now developing new partnerships. Participation in international networks, particularly in the new project LF4VET, enhances the organisation's ability to co-develop frameworks and share methodologies. This reinforces the lesson that **cross-institutional collaboration is critical in scaling up educational innovation** and ensuring coherence across diverse contexts.

Lessons from the project for policy, education and business.

The research has produced a whole series of recommendations. Here we focus on lessons for European, national and regional education authorities, the education sector itself, and the business community.

- The various experiments show that it is possible to innovate education/curricula. The project has embraced various pedagogical innovations such as interdisciplinary project work, laboratory-based education, blended learning, teacher engagement and support, and values education.
- Industry 5.0 is a separate and new topic for both students and other stakeholders in the education domain. Both evaluate Learning Factory 5.0 results positively. They see new opportunities for themselves in business. Yet despite these successes, experience with the interventions suggests that significant challenges must be overcome before the Learning Factory approach can be upscaled significantly.
- **Firstly**, Teaching and Learning Factory approaches need to be more widely known and better understood by companies and VET providers alike. The terminology of Industry 5.0 is also something that all stakeholders still struggle with. Public policy has a role to play in filling this gap through the encouragement of innovation in teaching methods and the provision of relevant in-service learning opportunities for trainers and educators. Moreover, the development of Learning Factory 5.0 is also a matter of targeted investment, requiring governments to open their coffers since companies will not do this alone. **Secondly**, Learning Factories enable and require institutional and pedagogical innovation in education. The interventions have highlighted the importance of multi-stakeholder ecosystems in which all actors share a vision for sustainable transformation. Educational institutions and stakeholders in ecosystems must develop and maintain long-term visions. In the report, we refer to this as “strategic pacing and sequencing matter”. In sum, preparing for Industry 5.0 requires more than technical curriculum updates. It demands an integrated strategy that links pedagogy, institutional design, and cultural transformation—anchored in collaboration, supported by policy, and responsive to the ethical demands of contemporary and future work. **Thirdly**, the Industry 5.0 community has a role to play in providing tangible guidance for the design and delivery of intervention curricula and methods. Key actors need more benchmarking results and evidence, both requiring time and attention. At the same time, the variety of approaches that has become apparent in this project should be cherished. It is important not to switch too quickly to a “single approach” to Learning Factory 5.0. This would run the risk of the intervention becoming rigid. Multiple methods work. There will never be a single Learning Factory 5.0 methodology, mainly because the needs of regions and companies will vary greatly, and there will always be scope for further improvement and innovation.

As indicated at the start of this Policy Brief, European industry must commit to industrial transformation. The experience of Bridges 5.0 with Learning Factory 5.0 makes it clear that this transformation must certainly start with cooperation between education and industry. If today's and tomorrow's employees are to contribute to Human-Centricity, Sustainability and Resilience, then focused attention on training and education is a crucial requirement. The Industry 5.0 transformation will produce winners, but only if a strict strategic course is pursued in the collaboration between education and industry.

Further reading.

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BRIDGES 5.0 PROJECT IDENTITY

Project name	BRIDGES 5.0 Bridging Risks to an Inclusive Digital and Green future by Enhancing workforce Skills for industry 5.0
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 The University of Warwick Technische Universität Dortmund Stichting Platform Beta en Techniek Mondragon Goi Eskola Politeknikoa, Jose Maria Arizmendiarieta S Coop Lietuvos Pramonininku Konfederacija Universita degli Studi di Bari Aldo Moro Universitetet I Agder Workplace Innovation Europe CLG Comau SPA Infineon Technologies Austria AG UAB Kitron Industrie 4.0 Plattform Osterreich Kriziu tyrimo centras (Hybridlab) FH Joanneum Gesellschaft MBH Kauno Technologijos Universitetas
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