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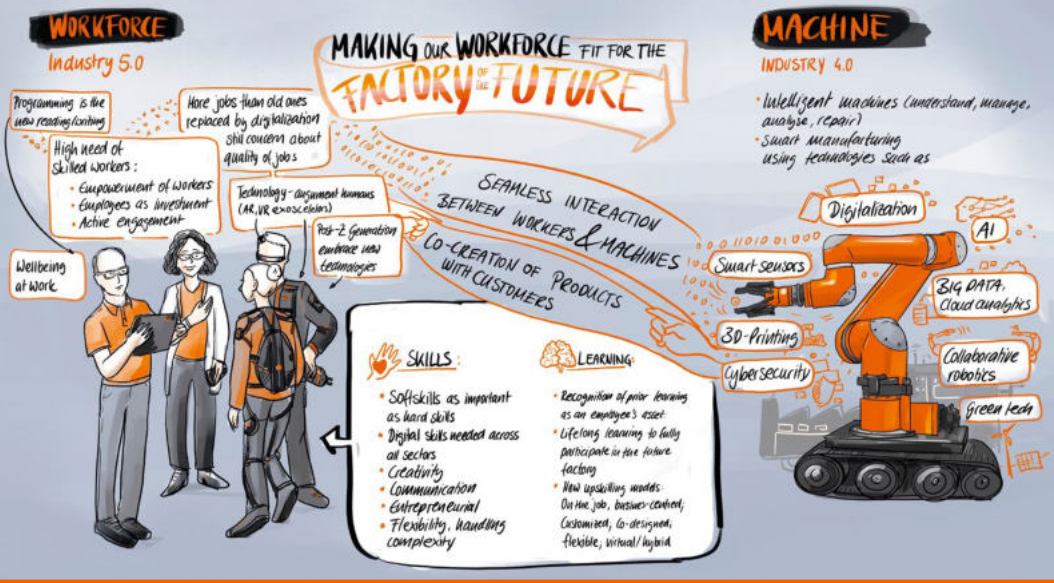

Sabine Hafner-Zimmermann, Laura O'Donovan, Anders Vestergaard

Preparing for future skills needs in European manufacturing industry

Steinbeis Europa Zentrum

FIT4FoF

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Authors

Sabine Hafner-Zimmermann *(S2i)*

Laura O'Donovan *(MTU)*

Anders Vestergaard *(UCN)*

Contributors

Kieran Delaney *(MTU)*

Jacqueline Kehoe *(MTU)*

Susan Rea *(MTU)*

Roger Fonwe *(S2i)*

René Bennyson *(UCN)*

Ann Lilith Kongsbak Pors *(UCN)*

Borja Dapena *(CEAGA)*

Carla Jiménez *(CEAGA)*

Sonia Piñeiro *(CEAGA)*

Ioana Eliana Avanu *(Arctic)*

Mihai Aurel Galis *(Arctic)*

Gabriela Ion *(Arctic)*

Bogdan Marinescu *(Arctic)*

Florbela Fernandes *(IPB)*

Carla Geraldes *(IPB)*

Paulo Leitão *(IPB)*

Paolo Dondo *(MESAP)*

Fabrizio Fallarini *(MESAP)*

Serena Zerbinati *(MESAP)*

Ronan Emmett *(BSL)*

FIT4FoF

Sabine Hafner-Zimmermann, Laura O'Donovan, Anders Vestergaard

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Executive Summary

This publication brings together the major activities conducted within the framework of the EC-funded FIT4FoF project between 2018 and 2022 and presents the FIT4FoF educational approach, the FIT4FoF Scenario depicting the Future of Work in Advanced Manufacturing as well as seven FIT4FoF personas created as part of the FIT4FoF pilot projects.

The human-centric approach, which was at the heart of FIT4FoF, is an important cornerstone within Industry 5.0. This concept in particular highlights the needs of society and that the workforce must be thoroughly considered as part of the industrial and production processes, technology must be applied for the benefit of and tailored to the needs of the worker and finally, that the technologies used must be aligned with the core European values of ethics and privacy. In addition, if applied in the Industry 5.0 concept, technology should heavily contribute to resource optimisation, efficiency, robustness and resilience. The three principles of resilience, sustainability and human-centricity informed the development of the FIT4FoF Scenario and the implementation of the FIT4FoF project as a whole.

The introduction in Chapter 1 is followed by a general outline of the policy-level context of future skills needs in advanced manufacturing in Chapter 2. Chapter 3 depicts the co-creation approach called ICoED, used to develop the FIT4FoF educational programme. ICoED as a tool challenges the current approach of planning and creation of learning courses using pre-defined learning objectives, where the educator plans the course with no external input to the learning principles, learning activities, learning resources and their infrastructure. The ICoED method is a three-phase process facilitated by three workshops, each of them with a focal point: the learning objectives, learning approach and course structure. Throughout the three participatory workshops, a broad range of stakeholders, including the learners/workers, educators and managers use an eight-step approach to collaboratively develop a tailor-made structure for the educational activity.

Chapter 4 starts with briefly outlining the approach applied to develop a scenario for Work in the Factory of the Future, including a participatory scenario workshop and the information collected during this process. This is followed by the FIT4FoF Scenario, which depicts a positive and technology-embracing vision of the future, based on the assumption that the application of future Industry 4.0 technologies will entail opportunities for solving existing and future challenges – if applied and framed accordingly – thus encompassing considerable potential to benefit companies, workers, society and the environment. The scenario consists of two main blocks, which are closely intertwined as well as a set of framework conditions that impact on them. The most important building blocks of the Factory of the Future are the technologies used, which manifest in a large set of machinery and tools operating in the respective company/industry environment, and the workforce that will (still) be of utmost importance for the successful operation of the Factory of the Future. Finally, there are a number of framework conditions that impact on the future manifestation of manufacturing and that companies will need to consider when preparing for future challenges and opportunities. The FIT4FoF Scenario has built the basis for the pilot partners' development of a persona, which they envision will be working in their company in the near future. These seven personas are also discussed in Chapter 4.

Chapter 5 summarises the lessons learned during the implementation of the project. These mainly relate to the novel elements introduced, i. e. the co-design approach to develop upskilling activities, the implementation of the pilot activities and the participatory scenario development and gives recommendations on how to act upon these lessons in the future.

Finally, Chapter 6 presents the conclusions derived from FIT4FoF and the scenario development conducted. The Covid-19 pandemic impacted heavily on the project but actually reinforced the relevance of the project approach as the timely and tailored acquisition of relevant skills for advanced manufacturing is now needed more than ever before. Thus, the FIT4FoF project consortium is happy to share with the widest possible European and global audiences the outcomes of its endeavours to develop a tailor-made, participatory approach to upskilling. This co-design approach applied in FIT4FoF encouraged a broad

discussion on the needs, challenges and opportunities that workers will face in the future factory and how these can be tackled for the benefits of both workers and employers. The future scenarios depicted in this report reflect these discussions and we would like to invite stakeholders to enter into a dialogue on how these future scenarios can become a reality, enabling workers to make the most of their interests, wishes and aspirations in the future.

FIT4FoF consortium during the FIT4FoF final even in Lisbon 11/2021

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Abbreviations and Acronyms

AI	Artificial Intelligence
AR	Augmented Reality
Arctic	Arctic SA
BSL	Boston Scientific Limited
CEAGA	Fundación Cluster de Empresas de Automoción de Galicia (ES)
CPD	Continuous Professional Development
CNC	Computer numerical control
DL	Deep learning
EC	European Commission
ES	Spain
EQF	European Qualifications Framework
EU	European Union
FIT4FoF	Making our Workforce Fit for the Factory of the Future
GA	Grant Agreement
HEI	Higher education institution
HMI	Human-machine interaction
ICoED	Industrial Collaborative Educational Design
ICT	Information and communication technology
IE	Ireland
IoT	Internet of Things
IPB	Polytechnic Institute of Bragança
KETs	Key enabling technologies
LEA-CFI	Chambre de Commerce et D'Industrie de region Paris Ile-De-France
MESAP	Centro Servizi Industrie S.r.l.

MTS	Meccanica Tonel Sergio S.r.l.
MTU	Munster Technological University
PESTLE	Political, economic, societal, technological, legal and environmental
RTDI	Research, Technological Development and Innovation
S2i	Steinbeis 2i GmbH
SME	Small and medium-sized enterprise
UCN	University College of Northern Denmark
VR	Virtual reality

1. Introduction

Over the last two decades, workplaces in Europe and globally have been subject to substantial changes due to increased automation and new and emerging digital technologies. In this context, the challenges associated with changing dynamics in the work environment and increased mobility within and between workplaces raise new questions on how employees and employers can cope with changing skills needs in future labour markets and industrial environments. In particular, employers and employees need to anticipate new skills needs in decreasing time intervals and become more flexible in certification of skills and adaptation of new competencies.

To support the transition to a fully digitalised European industry, the FIT4FoF project aimed at identifying future skills requirements and new job profiles as well as developing and piloting a unique yet transferable education and training framework to answer those needs. This so-called ICoED approach places workers (women and men) at the centre of a co-design and development process that recognises and addresses their skills needs. The development and implementation of this approach reflected the need to provide a pathway by which agile and responsive training and education programmes can be made available to support timely and sustainable continuous professional development for workers in advanced manufacturing. The project centred on close collaboration between training and industry partners and was intended to provide a blueprint for an ongoing process by which needs would be identified or anticipated and solutions co-designed in a tri-partite arrangement involving the worker/learner, the employer and the training provider.

This publication and the information given therein were developed during the implementation of the EU-funded FIT4FoF[1] project between November 2018 and April 2022. FIT4FoF, i. e. Making our Workforce fit for the Factory of the

1 More information can be found at www.bit.ly/FIT4FoF

Future, very generally aimed at identifying future skills that will be needed in Advanced Manufacturing and will enable companies and industry clusters to develop tailor-made training and upskilling programmes to satisfy these future skills needs. This work culminated in the development of a FIT4FoF Scenario on the Future of Work in Advanced Manufacturing. The development of the scenario outlined in this publication took stock of and brought together all project activities: 1) the identification of technology trends across the areas of robotics, additive manufacturing, mechatronics/machine automation, data analytics, cybersecurity and human-machine interaction, 2) the analysis of relevant future technical and non-technical skills and the elaboration of more than 100 related future job profiles, 3) the development of ICoED (the FIT4FoF educational approach), and 4) its implementation in the seven FIT4FoF pilot activities and 5) the collaboration with a broad range of regional, national and European stakeholders and communities.

The FIT4FoF Scenario itself as well as the individual scenario aspects of the FIT4FoF piloting activities, are depicted in this publication in detail. In addition, it outlines both the background of the future of work in smart manufacturing and ICoED, the Industrial Collaborative Educational Design approach applied in the project. In the following chapters, we will present the building blocks of this scenario as well as the manifestation of the basic assumptions of this scenario in individual personas developed in the seven FIT4FoF pilot applications. The report concludes by giving policy recommendations and the lesson learned during the course of this project.

2. Future manufacturing and skills needs in Europe

The analysis that led to drafting of the FIT4FoF project is still true more than four years later, namely that the increased introduction of digital and related key enabling technologies (KETs) has in the past two decades and will do even more so in the coming years both pose an increasing challenge for European manufacturing companies and for the manufacturing workforce. This challenge is reinforced by the fact that future skills needs are not adequately assessed, and not enough targeted training and educational programmes are available at present. At the same time, it is obvious that, if these challenges are addressed proactively, they will have the opportunity to increase competitiveness and innovation of European industry for many years to come. During the implementation of the FIT4FoF project, the project partners analysed the future skills needs in advanced manufacturing by sketching out how work in factories of the future might look like and identified viable pathways to future training and educational approaches to optimally meet future skills requirements.

Furthermore, during the past few years, it has been increasingly realised that economic growth without considering measures to preserve our natural environment will not be future-fit. Thus, the so-called twin transition, i. e., fostering digital and green technologies, became a benchmark for RTDI activities at European level but also at national and regional levels. Based on this and other policy drivers, the Industry 5.0 paradigm has been receiving considerable attention since 2021. It builds on the concept of Cyber-Physical-Systems coined in Germany between 2011 and 2013 and follows on from Industry 4.0[2], which is a techno-economic vision of a new industrial revolution bringing manufacturing and industrial processes to a new level of efficiency and growth by applying digital, data-driven and highly connected technologies

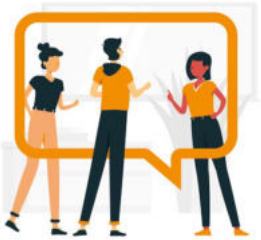
2 See e. g. Geisenberger, Broy 2015 (https://www.acatech.de/publikation/agendacps-integrierte-forschungsagenda-cyber-physical-systems/)

and applications while at the same time being able to effectively manage global technological and economic transformations.

This approach encompassed not only big hopes and expectations in industry and policy but also uncertainties in large parts of society as to how this will impact on peoples' future working and living conditions. This, reinforced by challenges such as climate change, biodiversity collapse and the Covid-19 pandemic led to the need to more comprehensively re-think how economic development can be better aligned with environmental and societal issues. Thus, European policy-makers and scientists have explored what the Industry 5.0 concept[3] could look like and how it can be applied in the coming years to enable European industry to become more future-proof, i. e. more resilient, sustainable and human-centred. In addition to the key enabling technologies needed to make smart manufacturing a reality in the coming years, the three principles of resilience, sustainability and human-centricity constituted important framework conditions for the development of the FIT4FoF Scenario. Of course, the human-centric approach was at the heart of FIT4FoF as this was the main field of exploration within the project. In this respect, the Industry 5.0 paradigm stresses the needs for society and the workforce to be comprehensively considered throughout all industrial and production processes, technology needs to be applied for the benefit of and tailored to the needs of the worker and finally, that the technologies used must be in-line with core European values of ethics and privacy. In addition, if applied in the Industry 5.0 mindset, technology will be able to considerably support resource optimisation, efficiency, robustness and resilience, thus contributing to the EU twin transition and strategic autonomy ambitions. The question remains – and becomes even more pressing in view of the Covid-19 pandemic, how this concept can be put into practice given the major challenges society and industry are facing in terms of demographic change, predicted workforce shortages, rising inequalities and fast technological advances. The educational approach developed in FIT4FoF, in our opinion, can be one building block in addressing these challenges.

3 See e. g. European Commission 2021 & 2022

3. ICoED: a novel collaborative approach for successful educational programmes



The education and training framework developed and implemented in FIT4FoF places workers at the centre and makes their views explicit using the co-designed ICoED process to recognise and address their skills needs early on and in a tailored way. This framework was successfully tested in a large number of workshops in the FIT4FoF pilot applications and received much positive feedback from both companies and employees. It can, in our view, be regarded as a good practice to reinforce human-centred skills development in future manufacturing and is recommended for further testing and implementation in companies across Europe.

ICoED as a tool challenges the typical approach of planning and creation of learning courses, with preset learning objectives, where the educator plans the course with no external input to the learning principles, learning activities, learning resources and the related infrastructure. The main objective of ICoED Online is a democratic facilitation of discussions and dialogues building towards a common understanding of the learners, industry managers and educators preferred learning principles, learning activities, learning resources and infrastructure. This insight gives a deeper understanding of the stakeholders' view of the learning and motivation for learning, and this contributes to a stronger foundation for the further creation of the pilot learning courses.

The ICoED method is a three-phase process facilitated by three workshops, each of them with a focal point: the learning objectives, learning approach and course structure. Throughout the three workshops, eight steps are used in the progression toward achieving the final goal of creating a complete structure for the educational activity. The objective of each of the 8 steps over the course of the 3 workshops can be seen in Figure 1 below.

Prior to the first ICoED workshop, comprehensive lists of preconditions affecting the learning environment, hard skills and soft skills are created and used as the input for the workshop 1. These lists are the foundation for the first workshop's activities, with a focus on the important preconditions and specific learning objectives. Important preconditions could refer to level and age of trainees, duration of training programme, location of training etc. The output of the workshop is a well-defined list of conditions, a selected list of hard skills and soft skills. This is used to set the scene for workshop 2, where the focal point is the learning approach. The output of workshop 2 is a list of learning principles, activities, resources and infrastructure that the participants of the workshop find most valuable for learning in the specific pilot/education activity. The third and final workshop is compiling and structuring the outputs from the two previous workshops into one structured constellation and works as the foundation for the further creation of the specific learning courses. At the end of workshop 3/step 8, the facilitator hands over the results to the educational partners (in the case of FIT4FoF, the pilot projects) for them to continue working on the creation and planning of the specific learning programme in detail.

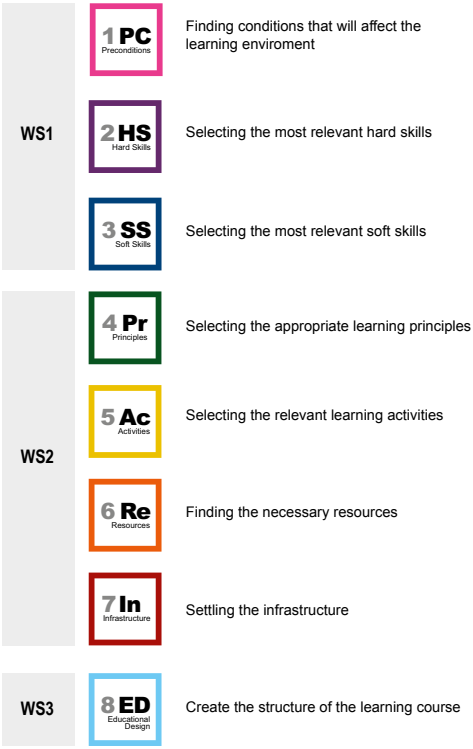


Figure 1: 8 Steps in ICoED

An essential part of the ICoED method is the dialogue among the participant to find a common understanding. Every participant contributes to the dialogue from their point of view and based on their specific expertise. Each participant must get the opportunity to express their opinion on the subjects discussed, hence a democratic process takes place. In each of the workshops, a facilitator makes sure all participants are given the option to contribute to the dialogue. Furthermore, the facilitator supervises the process and contributes to the dialogue with challenging and reflective questions according to the participants' priorities.

The learnings and the feedback from implementing the ICoED method in FIT4FoF have shown that we have developed a very strong and easy-to-use co-

design process that supports the composition of training solutions with a strong learner voice inherent in the process. Even in situations where the learners are not represented in workshops themselves, the entire mindset, framing and facilitation of the ICoED process highlights the voice of the learner. All participants will have the learner perspective in mind, and this will be reflected in the final pilot design. This perspective on applying a "learners' mindset" for all stakeholders might be a more important result of the ICoED process than the initial ambitions of having the actual workers present. And with a very hands-on and well-structured process like the ICoED the preconditions for imposing a learner's mindset have proven to be very effective.

A comprehensive assessment of the ICoED workshops conducted in FIT4FoF as well as the lessons learned during this process, can be found in FIT4FoF Deliverable D4.3[4]. This Deliverable also includes an ICoED Method Guide containing all the information required to implement ICoED and conduct the related workshops for others who are interested in testing the approach. As outlined, the easy-to-use ICoED process makes it possible for companies, clusters, and other stakeholders to design and execute their own ICoED workshops adapted to their industrial context, language, culture and needs.

4 See literature list and project website (https://www.fit4fof.eu/media/deliverables)

4. Scenario on the Future of Work in Advanced Manufacturing

The work with ICoED laid the foundations for the FIT4FoF Scenario development as it familiarised the project partners with collaborative practices and co-design activities and has resulted in a strong proposal on how a future upskilling activity should look like (including soft and hard skills, the learning environment etc.). Thus, during the last year of the project, this knowledge and experience were condensed and transferred into an illustrative scenario and seven personas reflecting the pilot applications' views on future working environments and jobs in advanced manufacturing.

In general, scenarios are illustrative 'pictures' that show visually or textually future development paths, the impacts and effects of current trends and decisions on the envisioned future state, and possible ways of realising future visions or developments. Scenarios can be developed to challenge strategies which were developed in a specific context and check if they are "future-proof" and if these strategies will be subject to certain risks due to developments that may occur in the future. Based on the results of this analysis, strategies can be adapted, and decision-makers can be made aware of potential challenges that one might face when implementing the strategy. Also, scenarios are frequently used to bring together a broad range of insights about potential future developments and trends, be they technological or non-technological, high-level or small-scale, general or specific. This will lead to a broader-based view and increased awareness of future developments and will allow the display and analysis of (hidden) assumptions, potential risks and alternative development paths.

As a basis for the FIT4FoF Scenario, we collected the information available in two existing scenarios on the future of work, we compiled and adapted this information in the context of the need of FIT4FoF and used it as the input to a

virtual workshop where this information was enriched with FIT4FoF-specific insights and built the basis for the FIT4FoF Scenario on the Future of Work.[5]

Following that, the relevance of the FIT4FoF Scenario for the FIT4FoF pilot applications was identified and assessed and seven pilot mini-scenarios were developed. To this end, we used a design-thinking approach where the piloting partners were asked to have another look at the scenario workshop inputs and outcomes and based on these, describe both the present state of their pilot and its envisioned future state. This resulted in one 'persona' description per pilot that will work in the respective pilot in 10 years from now. The persona development considered, in addition to the categories usually used in design-thinking, several aspects related to his/her work environment, context and future skills. Finally, the last step of the scenario development was the visual representation of the overall scenario and the seven pilot personas, which was done by a visual designer.

Each pilot application was implemented with a manufacturing company or a manufacturing cluster under the following themes to test and validate the ICoED approach and to develop the Future of WorkScenario and a pilot persona:

1. Smart Manufacturing of Appliances with Arctic in Romania.
2. Automotive Advance Manufacturing with CEAGA cluster in Spain.
3. Medical Devices Smart Factory with Boston Scientific in Ireland.
4. Industry 4.0 in car parts manufacturing with Catraport and Polytechnic Institute of Bragança (IPB) in Portugal.
5. Artificial Intelligence with Modis and LEA-CFI in France.
6. Smart Products and Manufacturing with MESAP cluster in Italy.
7. The Value Chain in Practice with University College of Northern Denmark (UCN).

5 For more information on the development of the FIT4FoF scenario, please refer to the respective project deliverable D2.3 available here: https://steinbeis-europa.de/en/projects/making-our-workforce-fit-for-the-factory-of-the-future?file=files/steinbeis/dist/img/Projekte/FIT4FoF-scenario_FINAL.pdf

4.1. Baseline Scenario

As described above, two scenarios were identified and used as the basis for the FIT4FoF Scenario as the assumptions and outcomes of both were quite similar and fit very well with the FIT4FoF context.

These scenarios were:

- The Millennium Project: Work 2050 Scenarios[6].
- World Economic Forum: Shaping the Future of Production: Four Contrasting Perspectives in 2030[7].

As a result, the following issues were identified as the most relevant features of the FIT4FoF baseline Scenario:

- Global view, but with a specific focus on the EU (including the twin digital and green transition);
- Positive future vision focusing on opportunities associated with technological advances, technologies as a means for solving global challenges;
- Very rapid/accelerated technological change and hyperconvergence of key technologies (HMI, AI, big data etc.);
- Focusing on production/advanced manufacturing and work/technology futures;
- Industry addressing also societal goals beyond economic growth;
- Accelerated economic and social change but policy is actively shaping a sustainable social and economic system;
- Workers are actively supported in coping with technological change even though technologies radically change the way people work;

6 Work 2050: Three scenarios. New findings of an International Delphi Study by the Millennium Project. Cornelia Daheim & Ole Wintermann. Gütersloh 2019

7 Kearney, A. T., Shaping the Future of Production: Four Contrasting Perspectives in 2030. World Economic Forum. Geneva 2017

- Transversal (non-technical and soft) skills are more important than purely technical skills;
- More new jobs are generated than jobs lost;
- Wealth disparities (both nationally and worldwide) gradually decline.

During a participatory scenario workshop in July 2021, the baseline scenario was customised for the FIT4FoF context and requirements. During this workshop, the participants defined and discussed those issues that were most relevant in their views for the future of advanced manufacturing and the manufacturing workforce. These issues were categorised using a PESTLE analysis, i. e. Political, Economic, Societal, Technological, Legal and Environmental, and can be found in Table 1. This table built the basis for the overall FIT4FoF Scenario presented in section 4.2 below. Furthermore, the participants identified potential impacts that the scenario aspects might have on future skills and jobs in advanced manufacturing. The main takeaways from this exercise can be found in Table 2.

Political
▪ Multipolar world, several countries fight for predominance in AI ▪ But transnational organisations gain in importance ▪ Global security threats, organised crime, state espionage lead to loss of trust in policy ▪ New decision-making processes in place to cope with complexity ▪ Far sighted policies adopted by governments worldwide to embrace new technologies and counter related challenges
Economic
▪ Revival of globalisation ▪ High-tech, digital clusters/agglomerations in many/all world regions, but missing access to digital technologies increases poverty levels ▪ High investments in AI ▪ Existence of sufficiently resilient strategic value chains, adaptable production capacity and flexible business processes to avoid pertaining problems with raw materials and key components ▪ Increased importance of local production for circular economy/sustainability value chains → empowered customers ▪ Giant corporations elude state control ▪ Convergence of hardware and software reduces marginal production costs to 0
Societal
▪ Will programming become the new reading/writing? ▪ How are we preparing people to participate in this new AI driven society? ▪ Post-Z generation embraces tech advances ▪ New models of lifelong learning, upscaling of new upskilling models (but also: lifelong working) ▪ Changing role of worker addressed proactively, empowerment models in place: new roles of trade unions in collaboration with policy and industry ▪ More (new) kinds of jobs were created than replaced but concerns persist on the nature and quality of jobs ▪ Tech advances led to increased wealth but not all countries benefit to the same extent
Technological
▪ Large-scale automation: transform production, save time, and automate heavy tasks ▪ Focus is on comprehensive and ubiquitous human-machine interaction ▪ Workers (tech-augmented humans): seamless communication and integration of AI and workers, “Empowered workers” with information coming from AI ▪ The end of mass anything: fully customised products with very short time to market; human centered products ▪ Co-design & co-creation to connect all stakeholders to innovation practices ▪ Technologies (hyperconvergence) have transformed production: machines are able to understand, manage, analyse and repair ▪ Green tech enabled by: AI, AR, VR, big data/cloud analytics, blockchain, 3D printing, robotics, brain augmentation, quantum computing, digitalisation, cybersecurity

Legal
▪ Socially responsible and unbiased AI in place (including comprehensive ethical considerations and data protection (also when training/learning)) ▪ Favourable taxation and regulatory policies enable comprehensive uptake of AI and related technologies in Europe (socially responsible and unbiased)
Environmental
▪ Circular economy realised by way of technical/technological solutions such as AI-empowered ubiquitous and connected IoT devices ▪ Radical change in consumer behaviour (Generation Z) facilitated faster green transformation ▪ Renewable energies, dedicated transformation of mobility and 0-emissions industry enabled to control global warming

Table 1: Synthesised PESTLE-Table from FIT4FoF Scenario Workshop

Impact categories	Main take-aways
Future qualifications/ skills needs	▪ Adequate assessment of needs (including employee-centred ones) ▪ More flexible/targeted trainings ▪ Training needs focusing on emergent digital skills (transversal to sectors) and soft skills (critical importance) ▪ Inter-/multidisciplinarity
Future technology needs	▪ Green tech ▪ Augmentation technologies ▪ 3D simulation ▪ Recognition of prior learning ▪ Proactive identification of companies' future tech & related skills needs
Employer-employee relationships	▪ Better insights into employees' prior learning/knowledge ▪ Employer-employee relationships will need to be built (pro)actively ▪ New engagement models to enhance productivity ▪ employees as investment ▪ Higher employees' flexibility, active engagement needed ▪ Trade union involvement in change
Job profiles available/ needed/more prominent than today	▪ Skills profiles expressed as part of lifelong learning practices ▪ More generalists than specialists ▪ Quickly changing job roles ▪ Active collaboration between educational partners and industry
Future training needs	▪ Human-centric upskilling linked to innovation ▪ Lifelong learning, highly modularised, e-learning, flexible ▪ AI-supported, truly virtual training environments
Future training programmes; Educational partners' roles; Future/new business models	▪ On the job, learning by doing ▪ Modularized & customised training programmes ▪ More company-centred, targeted internal training programmes ▪ Co-designed programmes ▪ Close industry-education collaboration, incl. certification
Other aspects	▪ Make diversity the norm ▪ Generative learning models ▪ Cluster organisations as agents and drivers of upskilling

Table 2: How the FIT4FoF Scenario can impact skills & jobs by 2035

4.2. FIT4FoF Scenario: Making our Workforce fit for the Factory of the Future

The aspects collected and discussed during the FIT4FoF Scenario development process were condensed and visualised to enable the widest possible utilisation of the scenario by a variety of audiences from the FIT4FoF project but more importantly, beyond the project participants. The visual scenario can be found in Figure 2 below.

The FIT4FoF Scenario depicts a positive and technology-embracing vision of the future as we assume that the application of future Industry 4.0 technologies will entail opportunities for solving existing and future challenges – if applied and framed accordingly – thus encompassing considerable potential to benefit companies, workers, society and the environment. The scenario consists of two main blocks that are closely intertwined as well as a set of framework conditions which impact on them. The most important building blocks of the Factory of the Future are 1) the technologies used, which manifest in a large set of machinery and tools operating in the respective company/industry environment (i. e. Industry 4.0), and 2) the workforce which will be of utmost importance for the successful operation of the Factory of the Future but which has a number of requirements that must be satisfied and challenges to master in the coming years. These mainly relate to skills needs and technology applications but also to the work environment, attitudes and broader societal needs (i. e. Industry 5.0).

The need to consider these two main aspects more equally than was the case in many companies and industry areas in the past is based on a number of reasons: application of key enabling technologies requires more advanced and fast-changing skills (both soft and hard skills) to be made available when needed, reinforced by more and more seamless interactions between workers and machines; fast-changing and individualised customer demands need to be satisfied and new business models need to be explored to stay competitive; and increasing skilled labour shortages push to retain older workers for longer, to enable women to increase their overall working hours (where they

are working part-time) and to optimally upskill both lower- and higher-skilled workers. Finally, there are a number of framework conditions that impact the future of manufacturing and that companies will need to take into account when preparing for future challenges and opportunities. These range from policy requirements that need to be satisfied regarding values, ethics, norms and standards; to economic ones such as the establishment of resilient value chains and answering global competition; and sustainability aspects which will need to be met to counter climate and resource challenges we are facing, and which have a high potential to increase innovation in EU industry.

All of these aspects were condensed, resulting in a vivid, easy-to-understand picture of how the future of work in advanced manufacturing might look like in 10 to 15 years' time. The FIT4FoF Scenario can be found in Figure 2 below.

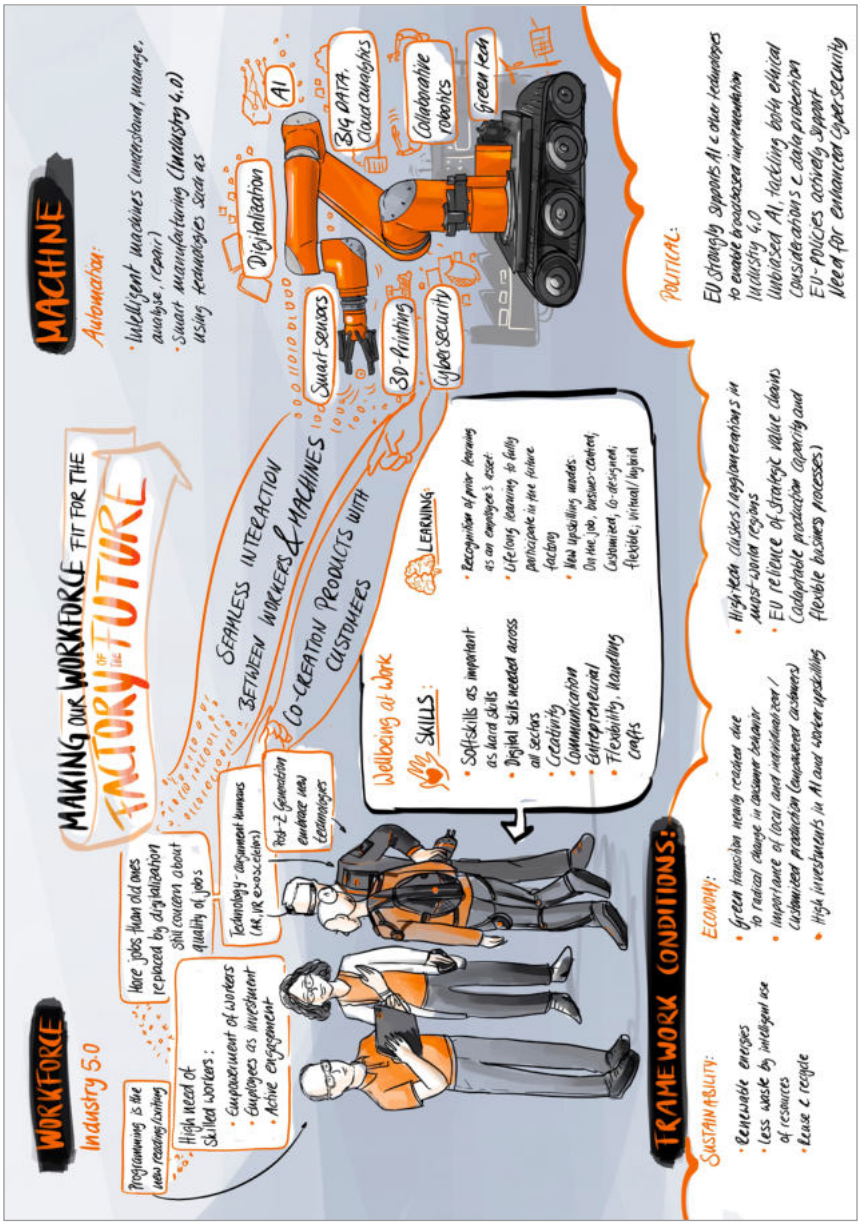


Figure 2: FIT4FoF Scenario

4.3. FIT4FoF pilot personas

The above FIT4FoF Scenario was used in building the basis for the piloting partners to develop a persona which they envision will be working in their company in the coming years. The project partners were asked to think about the issues that they expect will be most relevant for their company in the next 5–10 years and to describe them as comprehensively as possible, based on the information gathered during the ICoED process, the pilot projects' implementation and their vision of the future for their pilots. This information was used to sketch out the profile of a person they expect to work in this company. Below, the seven personas developed by the pilot partners are displayed. They all include basic information on the company, name and age of the respective worker, his/her existing skills and skills needs as well as upskilling activities the worker is offered by his/her company and the challenges and opportunities the worker is facing regarding the implementation of future technologies and skills.

1. Arctic persona

The FIT4FoF partner Arctic is producing whiteware and has established a fully automated factory to assemble washing machines in Romania. The challenge is and will be in the future to upskill new and existing employees to operate this factory as worker shortage is acute in the production site's region already. Thus, Eva Popescu, aged 35 is an operator in this future factory who has important soft skills already but who will need to upskill in order to keep up to date with technological advances. Especially challenging for her is the handling of AI in a way she feels comfortable with.

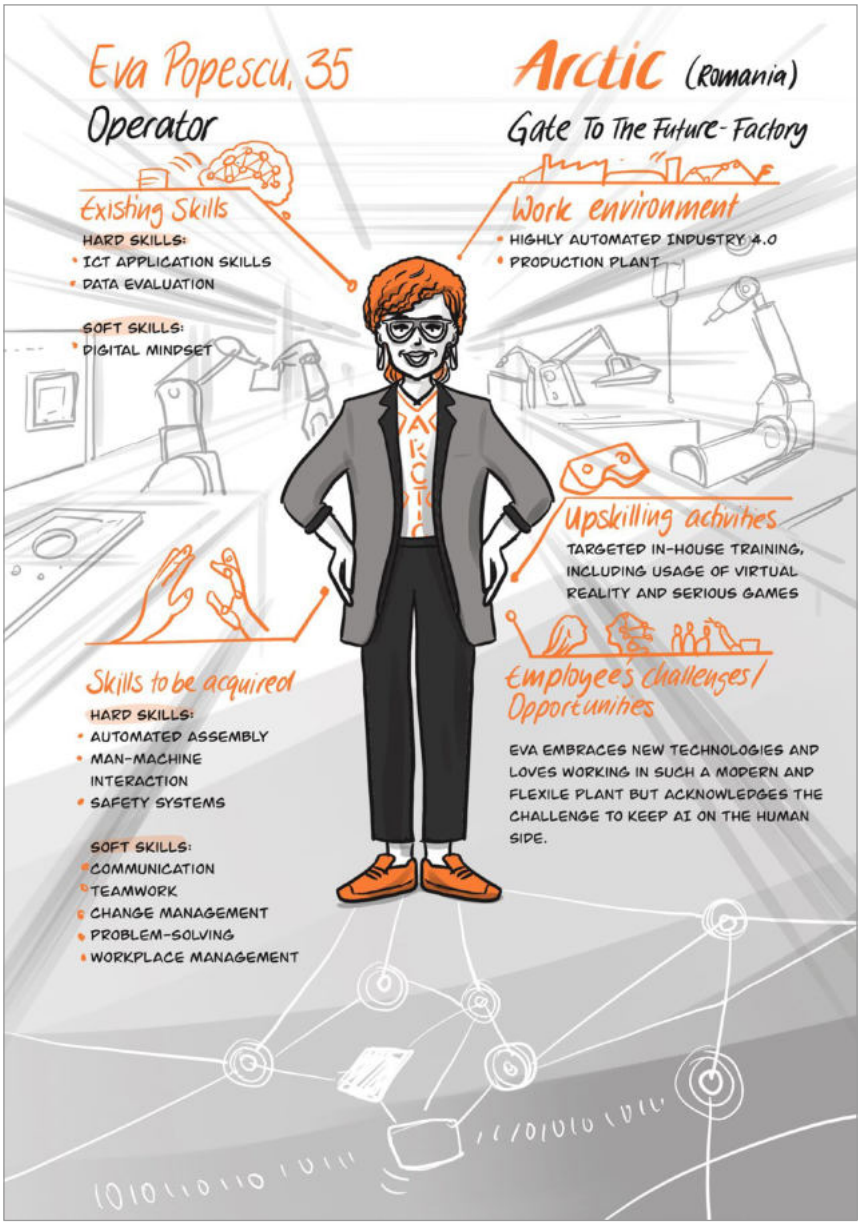


Figure 3: Arctic persona

2. AutoComponents / CEAGA persona

The FIT4FoF partner CEAGA, a Galician (ES) automotive cluster, has developed its persona to be working in a fictional company, AutoComponents, developing and producing innovative car parts. Laura, a young production technology operator, has been working in this company for a few years already. She has quite advanced hard skills in programming, human-machine interaction and data analytics already but needs to upskill on AI and other related future technologies as well as on change management to sustain innovation in the company. She is eager to support innovation and embraces change but some of her colleagues struggle to do so and need to be supported in this.

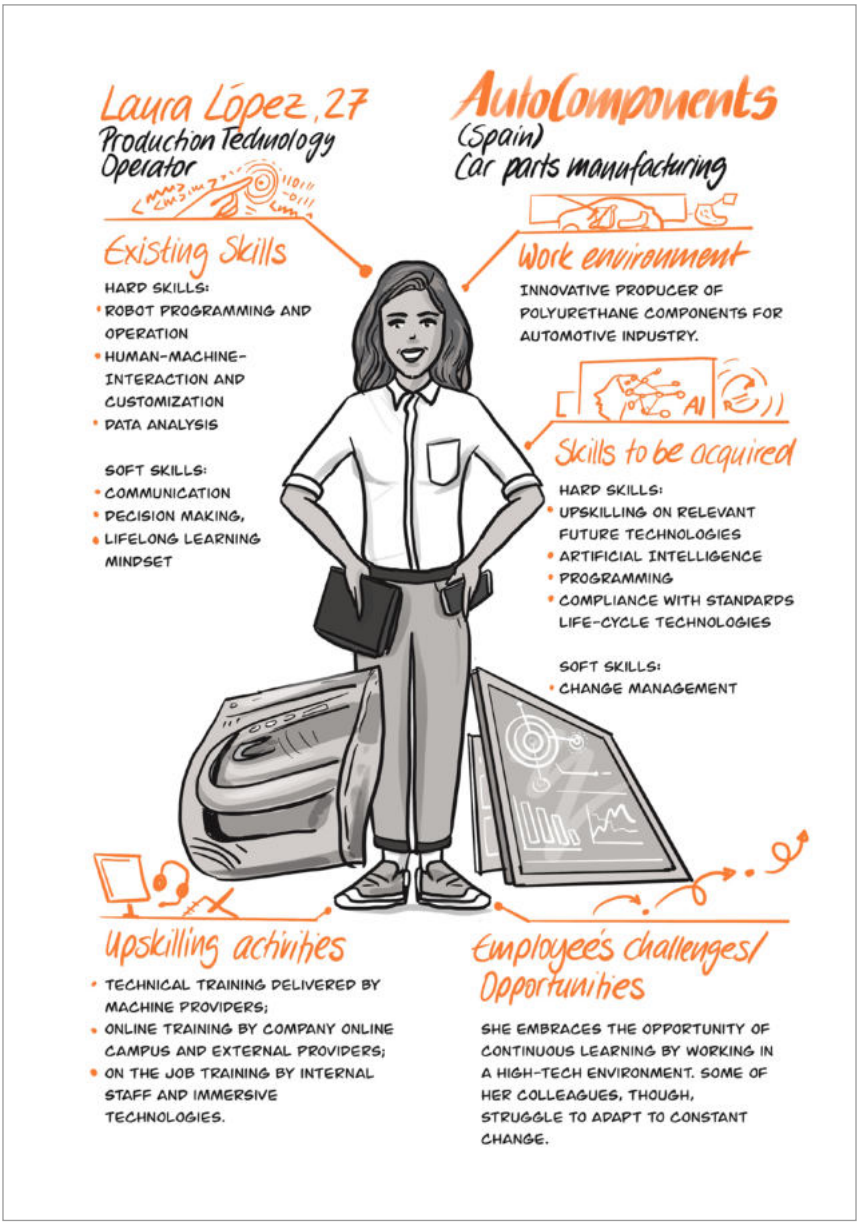


Figure 4: AutoComponents persona

3. Boston Scientific persona

The FIT4FoF partner Boston Scientific (BSL, IE) is a medical technologies company that needs to further increase automation in its Cork factory to improve efficiency. This is in line with Boston Scientifics global strategy around Digitalisation and Automation. The availability of talent with automation & robotics skills is an ongoing concern. Thus, Peter O'Neill is a product builder in the factory who will need to work in partnership with the new automated machines and who will thus need to upskill in computer hardware and software in particular as well as in understanding basic automation and robotics applications. Upskilling mainly takes place on the job using the company-internal skills development approach (the GROW Program) to optimally enable Peter to deal with a broad range of automation issues across a number of different areas in the company. The company will focus on developing internal employee talent using classroom-based learning followed up with on-the-job practical training. This will be complemented with further accredited study utilising the company's Further Education program for employees.

Figure 5: Boston Scientific persona

4. Catraport/IPB persona

The FIT4FoF partner Polytechnic Institute of Bragança (IPB) in Portugal developed its persona together with the Portuguese SME named Catraport, a manufacturing company producing traditional car parts. Catraport will need to scale-up and implement Industry 4.0 technologies in the coming years in order to stay competitive. Mary Doe is 28 years old and has a master's degree in industrial engineering already, including a broad range of related hard skills. Still, she needs to further upskill in machine learning, IoT and other data-based processes and technologies. Mary likes working in such an innovative environment, enabling her to actively contribute to the advancement of processes and the implementation of future technologies for the benefit of her company.

Figure 6: Catraport persona

5. Modis persona

The FIT4FoF partner LEA-CFI collaborated with Modis France, a consulting and staffing solutions company. Yousry, a young data engineer, lives in Paris and is part of a team of young engineers motivated and passionate about the possibilities that data science and analysis entail. The AI team he is part of designs deep learning and data analytics solutions for a broad range of customers. Yousry already has a university degree but needs to further upskill in data analytics and machine learning systems. As tailored external training solutions are not yet available, Modis mainly relies on internal training and upskilling activities to upskill its employees and to be able to expand the AI team and the related customer services offers in the future.

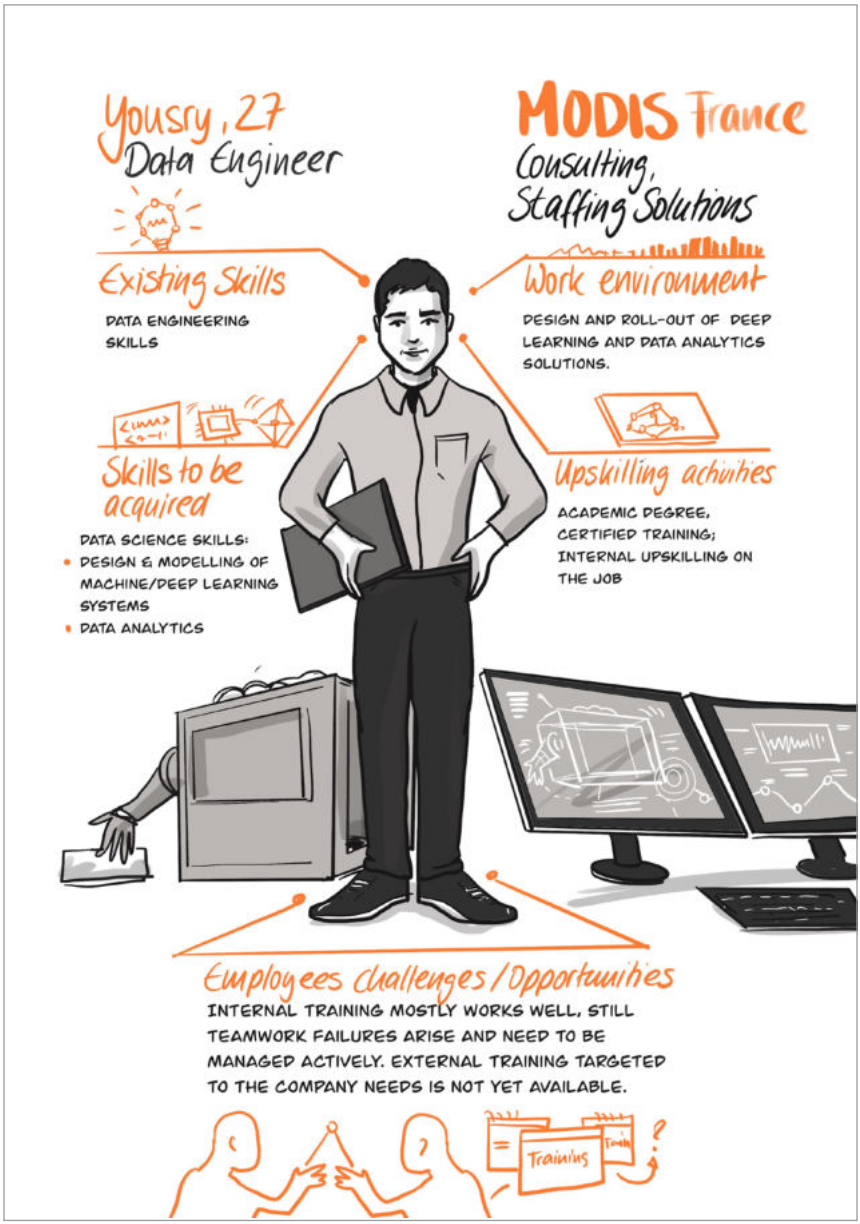


Figure 7: Modis persona

6. MTS/MESAP persona

The FIT4FoF partner MESAP, the Innovation Cluster in the fields of Smart Products & Manufacturing located in the North-West of Italy, collaborated with its associate MTS S.r.l., a medium-sized enterprise producing industrial machinery and carpentry and using state-of-the-art technology already. Giorgia Rossi will be working at MTS in a few years. She is an industrial process data analyst but needs to deal with a broad range of different tasks in many company areas. Thus, she needs to upskill on both hard and soft skills to be able to support and troubleshoot across many stages of the production process.

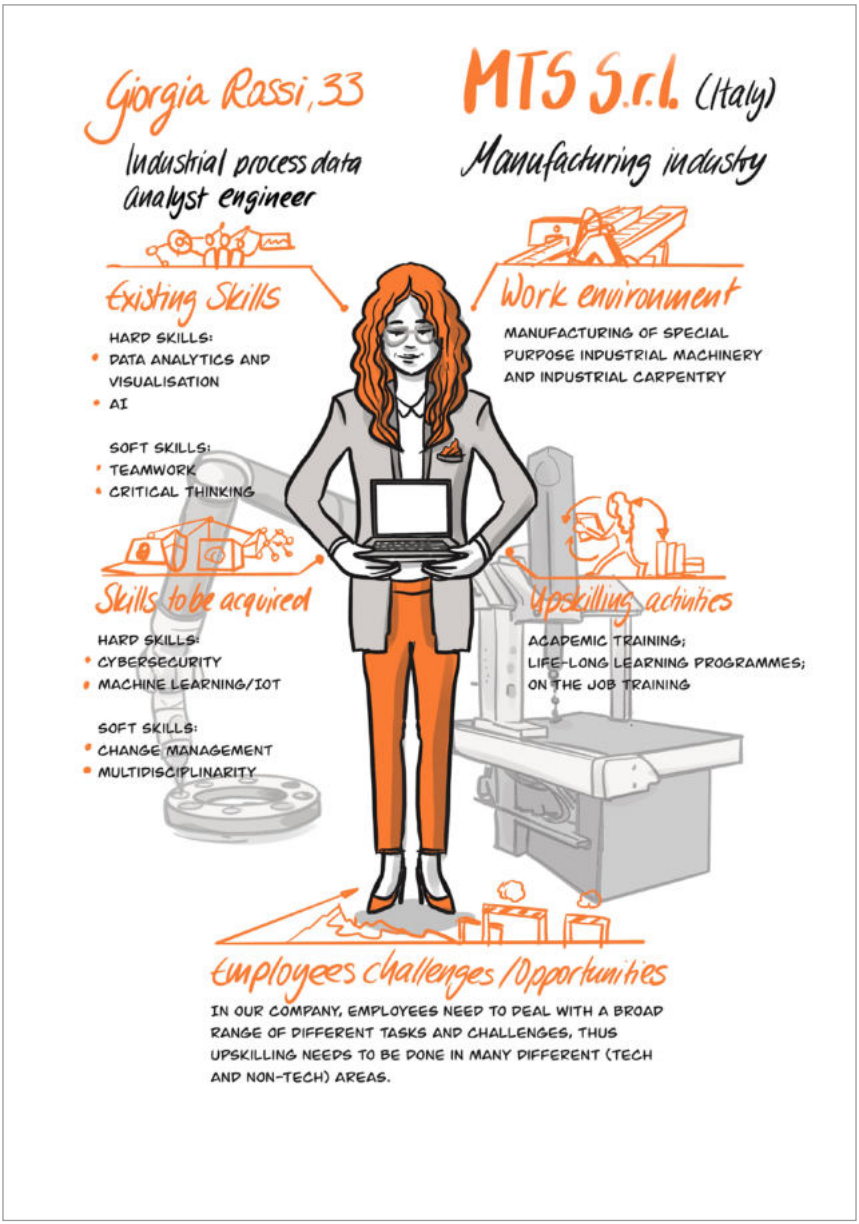


Figure 8: MTS persona

7. TEKAVIA/UCN persona

The FIT4FoF partner University College of Northern Denmark (UCN) supplies targeted training to companies, mainly SMEs, in northern Denmark. TEKAVIA is a fictional company reflecting the main features of companies that are supported by UCN. TEKAVIA is using CNC machines to produce car parts but will broaden its product portfolio beyond vehicles due to increased competition and reduced demand in the future. Preben Jensen is a skilled machine worker working in the company for 22 years already. He is proud of his technical skills and is passionate about his work within the company but feels the need to further upskill in relation to new ICT, automation and robotics technologies. As he is effectively supported in terms of his upskilling needs through tailored courses designed by UCN, he is confident that even as an older worker, he will be able to contribute to the success of his company for several years to come.

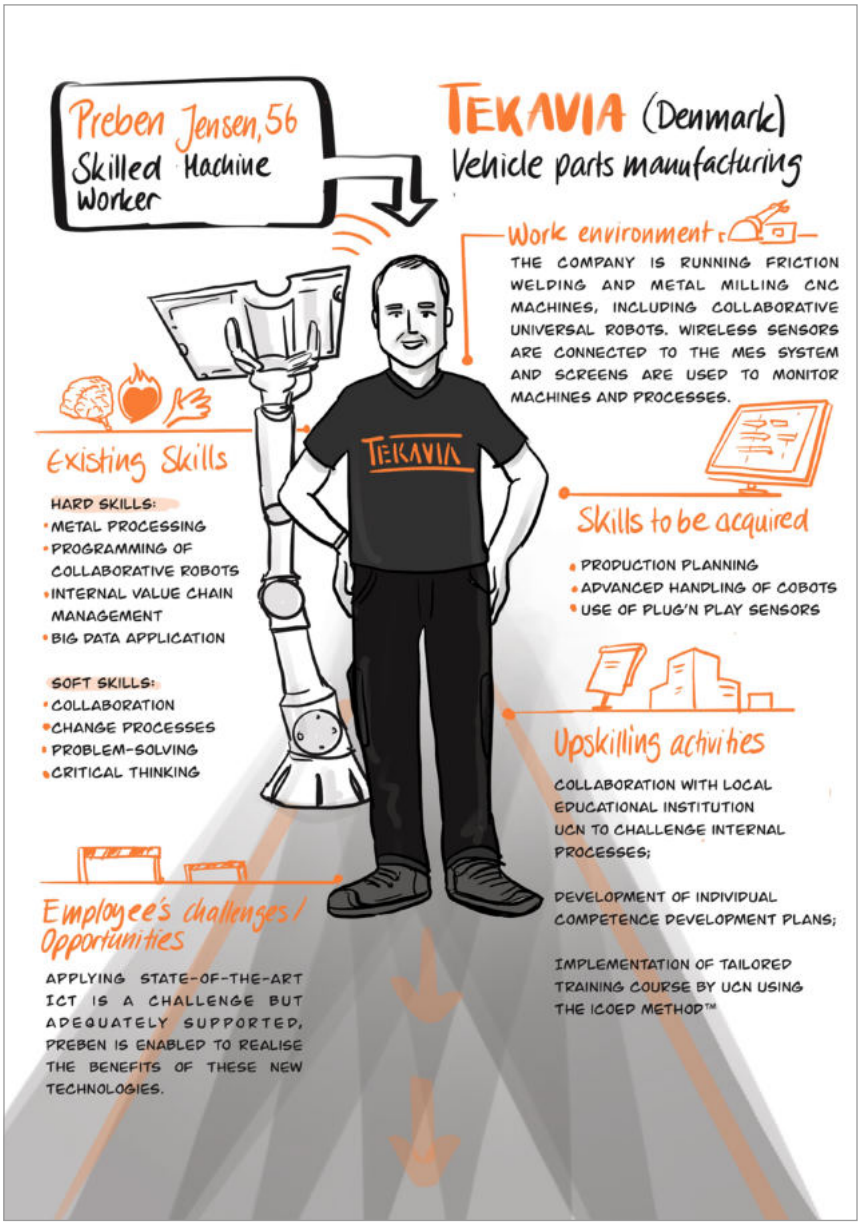


Figure 9: TEKAVIA persona

5. Recommendations for Action

The recommendations were generated collaboratively by the nine FIT4FoF project partners via collected feedback, learnings and submitted suggestions throughout the project. The extensive collaboration in developing the ICoED method and in delivering the seven training pilots using the ICoED method, particularly the evaluations by participating industry members, was used as input on which areas would benefit most from policy enhancements. All the information gathered was condensed and synthesised into considerations that can inform future decision-making on national and sub-national levels; European level; and organisational level to make the European workforce and industry more prepared and competitive in the future. The recommendations given below were grouped according to these three levels. Further details of the recommendations outlined in this Chapter can be found in the Annex[8].

A) Policy inputs for local, regional and national governments

1. Build awareness and knowledge of digitisation, the imminent need, and incentives to adopt new technologies and upskill staff, and the consequences of slow adoption of digitisation.
2. Early and effective collaboration across education stakeholders and industry organisations is needed in identifying and highlighting future skills needs and job profiles.
3. Increase efforts to engage end-users in managing their skills development and designing training programmes and initiatives.
4. Fund, support, and share examples of collaboration in identifying, delivering, and evaluating training initiatives with industry.

8 An in-depth outline of the learnings and recommendations can be found in project Deliverable D7.7

5. Support the use and development of more modularised, digitally interfacing, short, practical training courses and resources.
6. Fund, collaborate and share learnings from pilot projects in developing Micro-credentials amongst industry and HEIs.

B) Policy inputs for European level

1. Build awareness and knowledge of digitisation, the imminent need, and incentives to adopt new technologies and upskill staff.
2. Use the FIT4FoF findings to update existing tools on future skills needs and job profiles.
3. Increase all efforts to engage workers in managing their skills development and designing training programmes and initiatives.
4. Fund, support, and share examples of collaboration in identifying, delivering, and evaluating training initiatives with industry.
5. Support the use and development of more modularised, digitally interfacing, short, practical training courses and resources.
6. Fasttrack the development and pilot implementation of Micro-credentials amongst industry and HEIs

C) Policy inputs for employment agencies and trade unions

1. Build awareness amongst industry in relation to the urgency and need for support for digitisation.
2. Support the engagement of workers in managing their skills development and designing training programmes and initiatives.
3. Support industry collaborating with HEIs, training providers and employment agencies on training development and delivery.

6. Conclusion

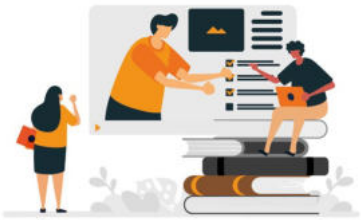
Exactly four years after the submission of the FIT4FoF project proposal to the European Commission in February 2018, the project came to an end in February 2022. During these four years, our lives have changed so profoundly that barely anyone would have imagined or foreseen back then. The Covid-19 pandemic saw most of us unprepared for the challenges that back then still lay ahead of us. Still, looking back at nearly three pandemic years which have passed since then, unprecedented advances have taken place in some areas, in medicine and health but notably also in our working lives. Video conferencing has become a major part of the working days for many people all over the globe; aligning working and private lives is often still a challenge though a different one than in pre-pandemic times; novel ICT tools have been implemented in companies at a pace which no-one would have foreseen before 2020; after more than two years the vulnerabilities associated with strategic value chains are still posing major challenges for many companies whereas some industry sectors have already surpassed pre-pandemic levels.

These developments impacted on the project implementation as in pre-pandemic times, physical meetings were the norm rather than virtual ones but actually reinforced the relevance of the project approach as the timely and tailored acquisition of relevant skills for advanced manufacturing is now needed more than ever before. Thus, the FIT4FoF project consortium is happy to share with the widest possible European and global audiences the outcomes of its endeavours to develop a tailor-made, participatory approach to upskilling which can be used by every company across Europe and which incorporates learner's interests and needs as the basis of any training programme. At the same time, the participatory, co-design approach applied in FIT4FoF encouraged a broad discussion on the needs, challenges and opportunities that workers will face in the future factory and how these can be tackled for the benefits of both workers and employers. The futures scenario depicted in this report reflects these discussions and we would like to encourage stakeholders to enter into an ongoing dialogue within and between organisations, communities and policy

levels on how these future scenarios can become a reality, enabling workers to make the most of their interests, wishes and aspirations.

While Industry 4.0 mainly focused on technological and economic transformations, the European Commission, in its latest policy brief on "Industry 5.0: A Transformative Vision for Europe", points out that the Industry 5.0 paradigm can only become a reality if transformation takes place systemically at all levels of government, economy and society and industry must accept that it has a major role in these transformations. As discussed in Chapter 2 above, the FIT4FoF approach underpins and reinforces the Industry 5.0 paradigm enabling European industry to become more resilient, sustainable and human-centred. If applied accordingly, it can contribute to a win-win-win situation for European industry, society and the environment, thus becoming part of the answer to the future challenges that Europe is facing. Of course, in FIT4FoF, the project partners were only able to test and highlight one possible approach to the co-design based upskilling of workers in future factories. This approach is the type of "cross-pollination" within and between organisations, stakeholders and ecosystems that is needed, and while FIT4FoF implemented this on a small scale, it shows that this approach can address the urgent need to foster an open, future-, sustainability- and resilience-oriented mindset in order to achieve a resilient, sustainable and human-centred manufacturing industry in Europe.

7. Literature



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8. Annex: FIT4FoF Recommendations for Action

Below, the in-depth description of all recommendations that fed into the FIT4FoF Recommendations for Action are outlined based on the distinction between relevance for A) Local, regional and national governments; B) European level; and C) Employment agencies and trade unions.

A) Local, Regional and National governments

Below are the policy inputs for local, regional, and national governments in the development and deployment of digital competencies from the FIT4FoF project.

1. Build awareness and knowledge of digitisation, the imminent need, and incentives to adopt new technologies and upskill staff, and the consequences from slow adoption of digitisation.
2. Collaborate efforts in identifying and highlighting future skills needs and job profiles to all education stakeholders and industry organisations early.
3. Increase all efforts to engage end-users in managing their skills development and designing training programmes and initiatives.
4. Fund, support, and share examples of collaboration in identifying, delivering, and evaluating training initiatives with industry.
5. Support the use and development of more modularised, digitally interfacing, short, practical training courses and resources.
6. Fund, collaborate and share learnings from pilot projects in developing Micro-credentials amongst industry and HEIs

1. Build awareness and knowledge of digitisation, the imminent need, and incentives to adopt new technologies and upskill staff, and the consequences from slow adoption of digitisation.

- Increase awareness of the imminent need for digitisation amongst all manufacturing businesses, emphasising the need to engage to survive. The pilots experienced a positive environment amongst the pilot companies engaging with the ICoED method, however, in smaller companies, there was little upskilling happening and no sense of urgency. Many industry partners believed that Industry 4.0 will live with "traditional manufacturing" for some years to come allowing the business to evolve slowly adapting to the new conditions and allowing "traditional job profiles" to naturally grow into the new job profiles. Others believed they were too small, and digitisation was for larger companies who could afford the technology and had a larger staff team.
- Create and disseminate an educational introduction video on the advantages of working with robotics for the manufacturing sector. Many workers were afraid of working with robots (safety, being replaced), requiring reassurance and education around the use and control of the same within their current role. Once workers understood how robots would help complete tasks quicker, safer, and better – adoption and upskilling were embraced.
- Through the National Digitisation Strategy, cultivate programmes to inspire and incentivise SME leaders to develop ICT competencies (Digital Competence Framework for citizens).
- Many of the pilot businesses were accessing tax incentives to engage with innovation and upskilling such as the Training 4.0 tax credit in Italy. Consider increasing financial incentives for industry to engage strongly in digital training initiatives in the form of higher tax incentives or grants. The effective deployment of upskilling and reskilling new competencies requires understanding and support from every level of a business (management to floor worker) and cannot succeed without it. Leadership is essential before, during and after training with a commitment of resources, especially time for training delivery which is often difficult to access.
- Consider using the National Digital Innovation Hubs to research cultural barriers to digitisation (especially amongst SMEs). The pilots found many cultural barriers to digitisation which were understood to be personal to each busi-

ness and insurmountable. More information on these barriers shared amongst Industry and how to address them may assist in escalating digitisation.

2. Collaborate efforts in identifying and highlighting future skills needs and job profiles to all education stakeholders and industry organisations early.

- Support the annual updating of the FIT4FoF new job profile and skills catalogue (Appendix 1), and disseminate same to HEIs, industry, government agencies and employee representatives.
- Support the continuing population of the Upskilling Analysis Tool to help industry identify the relevant training initiative available to them.
- Use the new skills and job profiles developed in the FIT4FoF project to inform national curriculum development with the support of the Digital Education Action Plan and Erasmus+ funding.
- Encourage HEIs to implement a 'future trends' section in all academic learning to facilitate the
- introduction of possible trends to learners as early as possible.
- Promote the use of the tools Euroguidance, the Europass and Electronic Platform for Adult Learning in Europe (EPALE) amongst Trade Unions, Work Councils, Clusters, industry, government agencies and HEIs in accessing crucial guidance support for workers.

3. Increase all efforts to engage end-users in managing their skills development and designing training programmes and initiatives.

- Use the Digital Europe Programme fund (limited required) for the implementation of further pilot ICoED training programmes within the manufacturing sector, focusing on SMEs. The pilot industry representatives stated that the ICOED method is best practice in involving learners and other stakeholders in co-designing training programmes and many are going to implement it in further training and amongst their international businesses. Before the FIT4FoF project, the development of training courses for companies was based on the ideas, priorities, and competencies of one or more educator(s). The ICoED method introduced a mindset of collaboration

amongst a range of stakeholders within the business in co-designing the programme. The ICoED process ensures all genders, cultures, levels, and ages participate equally, it's available online, it can be easily adapted across countries and languages, it's not time-intensive and received very positive feedback from all participants involved.

- Considering the new Industry 5.0 paradigm which aims to drive scale innovation while delivering new forms of economic and social value that effectively balance people, planet, and prosperity; more finance and support is required to engage the end-users in the development of training programmes. The pilots illustrated the involvement of the worker's voice increased interest, effectiveness, and relevance of training.
- The pilot feedback illustrated the need to have training developed in consultation with the end-user (recently), with real-world application opportunities, delivered with a practical focus, short, allow time for reflection and conversation, allow for credit accumulation and completion over a year.
- Use the Digital Europe Programme to fund competitions/programmes for workers to develop digital upskilling/reskilling videos or initiatives to increase interest and engagement amongst workers in the training arena.
- Provide better incentives for workers (and unemployed people) to access training, increase benefits parallel with the demand for skills. Potential incentives could be grant aid, cost of living support, supported savings accounts for training, tax incentives, Income Sharing Loan Agreements, or schemes such as lifelong learning insurance plans which would allow insurance for skilled workers who lose their job or want to transition to a new job.
- The FIT4FoF project partners support the proposal to introduce paid training days under action 9 of the New Skills Agenda, initiative on individual learning accounts and also recommends introducing a minimum number of hours required for Continuous Professional Development (CPD) within manufacturing.
- Provide support and training for business and workers in harnessing existing critical job-related information by storing digitised versions of all printed manuals, standards, procedures, and other documents manufacturers currently use, as well as short videos (using tools such as www.rewo.io) in a multimedia database on a cloud platform.

4. Fund, support, and share examples of collaboration in identifying, delivering and evaluating training initiatives with industry.

- Promote the submission of projects for structural reforms to increase collaboration, in line with Upskilling pathways implementation, through the Structural Reform Support Programme.
- Under the National Digital Strategy develop a framework for collaboration amongst industry and HEIs to expand the use of the ICoED method within the manufacturing sector. The pilot feedback illustrated the extensive learning gained amongst educators, staff and management through the co-design process, this shared learning can facilitate further transformation in how HEIs design and deliver learning for industry. The ICoED method builds awareness amongst all participants of the existing skills environment and the strategic needs of the business which in itself is a valuable experience while creating a relevant and tailor-made training programme. The positive feedback emphasised that the collaborative bespoke designing of the training programme increased the level of interest and engagement in training as all stakeholders felt the training was relevant and directed. Further collaboration was stimulated between HEIs and industry as a result of pilots illustrating the positive impact of the co-designing and training experiences.
- Under action 2 of the New Skills Agenda, strengthening skills intelligence, providing funding to establish national data collection from pilots of the ICoED method. This process identifies exact skills requirements within industry through a proven collaborative approach so the resulting data would be primary, precise, and comprehensive which could be used to inform further sector- specific training strategies.
- Use the Smart Specialisation Strategy (S3) to identify and support existing initiatives aimed at stimulating multi-stakeholder collaboration and engagement for the design, delivery and evaluation of training initiatives for industry.
- Encourage, support and share examples of collaboration in designing and delivering training between industry, HEI and government organisations such as CEAGA Corporate University (https://www.ceaga.com/en/ceaga-corporate-university/),

- For HEIs to play an effective role in continuously upskilling workers, they must:
  - Collaborate with industry to co-design training.
  - Delineate between education for learning and education for working, prioritise different elements within both.
  - Focus on practical real-life application of learning to remain relevant and engaging.
  - Include elements of coaching and teamwork in delivery.
- Through the National Digital Strategy provide a scheme for SMEs to benchmark their learning strategies and outcomes against similar organisations in their sector. The collection of data from pilots of the ICoED method could facilitate this.
- Under the SME Strategy and the National Digital Strategy encourage and incentivise SMEs to pool resources for training internally and externally.
- Using the European Foundation for Cluster Excellence, strengthen the upskilling and reskilling mandate for Cluster organisations within the manufacturing sector using examples such as CEAGA Corporate University, the Innovation Cluster of Smart Products and Manufacturing of the Piedmont Region in Italy (MESAP) and the Manufacturing Academy of Denmark (MADE).
- Encourage (and possibly incentivise) LMCs to open their learning systems to other industries in their value chain.

5. Support the use and development of more modularised, digitally interfacing, short, practical training courses and resources.

- Support and facilitate more pilots using the ICoED method with the Miro tool to engage participants in designing effective educational frameworks online with digital tools. The resources developed through the FIT4FoF project as well as the online delivery of the pilots developed a range of online resources for stakeholders as well as the necessity to use software to support all parts of the project, such as SurveyMonkey, Kahoot, QR codes and the Miro tool which facilitated the repetitive use of digital skills.

- Under the Digital Europe Programme finance competition for the development of digital resources to teach specific skills or knowledge applications with first-hand perspectives, encouraging the use of VR, AI, voice-response, gamification and AR and sharing of same through social media and YouTube for maximum dissemination.
- Build awareness of and share the good practices in the Digital Skills and Jobs Platform. Promoting possible additions to the platform from workers/industry.
- Build awareness amongst industry of the many European initiatives and resources available to help adults learn at their own pace and in their own space such as the EU Code Week and the Electronic Platform for Adult Learning in Europe (EPALE).
- Encourage the use of Electronic Performance Support Systems (EPSS) for just-in-time or on- demand industry training. EPSS are great tools to aid this type of learning as they're designed to deliver training at the exact moment it is needed.
- Facilitate the use of virtual reality (VR) and augmented reality (AR) technologies for industry to access external expertise and train existing staff. Workers can solve problems in real-time by sharing their views from the floor with experts in remote locations, who can then diagnose issues and guide the worker through the steps to fix them.
- Training materials and reminder resources were repeatedly mentioned as crucial to support and reinforce learning. Coordinator and support the development of visual resources for industry in key areas such as the company value chain, overall digital processes, existing technology uses, an operational overview and how to value contributions flow between different departments.

6. Fund, collaborate and share learnings from pilot projects in developing Micro-credentials amongst industry and HEIs

- Develop methodologies for validation and certification of professional qualifications under the micro-credentials concept as outlined in the European Skills Agenda and the Digital Education Action Plan.

- Develop and support collaboration between HEIs and industry in developing micro-credentials, prioritising industry with the largest skills gap.
- The ICoED method allows for upskilling in a variety of areas (those areas identified by stakeholders within business), the ability to identify micro-credentials within this training programme would facilitate the accumulation of credits towards a Diploma/Degree/Masters degree. HEIs and national legislation should consider and promote the degree programmes with flexible study plans involving the accumulation of micro-credentials and a practical industry project.

B) European level

Below are the policy inputs for EU-level decision-making in the development and deployment of digital competencies from the FIT4FoF project.

1. Build awareness and knowledge of digitisation, the imminent need, and incentives to adopt new technologies and upskill staff.
2. Use the FIT4FoF findings to update existing tools on future skills needs and job profiles.
3. Increase all efforts to engage workers in managing their skills development and designing training programmes and initiatives.
4. Fund, support, and share examples of collaboration in identifying, delivering, and evaluating training initiatives with industry.
5. Support the use and development of more modularised, digitally interfacing, short, practical training courses and resources.
6. Fasttrack the development and pilot implementation of Micro-credentials amongst industry and HEIs

1. Build awareness and knowledge of digitisation, the imminent need, and incentives to adopt new technologies and upskill staff.

- Using the European Foundation for Cluster Excellence, National Digital Innovation Hubs and government agencies develop accessible (hard and soft copy) information regarding all incentives and support for digitisation for industry.

- Increase awareness of the imminent need for digitisation amongst all manufacturing businesses, emphasising the need to engage to survive. The pilots experienced a positive environment amongst the pilot companies engaging with the ICoED method, however, in smaller companies, there was little upskilling happening and no sense of urgency. Many industry partners believed that Industry 4.0 will live with "traditional manufacturing" for some years to come allowing the business to evolve slowly adapting to the new conditions and allowing "traditional job profiles" to naturally grow into the new job profiles. Others believed they were too small, and digitisation was for larger companies who could afford the technology and had a larger staff team. Under the Digital European Programme use the National Digital Innovation Hubs to build awareness amongst SMEs of the urgency for upskilling and digitisation.
- Use the Digital Innovation Hubs to increase the availability of practical expertise for industry on the multiple ways in which industry can adopt technology in manufacturing. Industry is unsure of where to start investing and often have negative initial experiences adopting technology, which is increasing fear of, and reducing confidence in further digitisation.
- Use the Digital Skills and Jobs Coalition (DSJC) to support the introduction of capital and skills funding packages where increased funding for capital is based upon successful delivery of relevant training packages (range of T shaped skills) amongst staff.

2. Use the FIT4FoF findings to update existing tools on future skills needs and job profiles.

- Include the FIT4FoF new job profiles into the European Skills, Competences, Qualifications and Occupations (ESCO) and the EU Skills Panorama.
- Use the New Skills Agenda (action2, strengthening skills intelligence) to support the annual updating of the FIT4FoF new job profile and skills list, and disseminate same to HEIs, industry, government agencies and employee representatives. This can contribute to the 'Skills Profile Tool Kit for Third Country Nationals' to support early identification and profiling of skills and qualifications of asylum seekers, refugees and other migrants.

- Use the new skills and job profiles to inform documents such as the CEDEFOP *Curriculum Development Guidelines: New ICT curricula for the 21st century: designing tomorrow's education* and inform relevant ongoing EU research such as the INNO Industry project.
- Include the FIT4FoF project pilots in the good practices in the Digital Skills and Jobs Platform.

3. Increase all efforts to engage workers in managing their skills development and designing training programmes and initiatives.

- Use the Digital Europe Programme fund (limited required) for the implementation of further pilot ICoED training programmes within the manufacturing sector, focusing on SMEs. The pilot industry representatives stated that the ICoED method is best practice in involving learners and other stakeholders in co-designing training programmes and many are going to implement it in further training and amongst their international businesses. Before the FIT4FoF project, the development of training courses for companies was based on the ideas, priorities, and competencies of one or more educator(s). The ICoED method introduced a mindset of collaboration amongst a range of stakeholders within the business in co-designing the programme. The ICoED process ensures all genders, cultures, levels, and ages participate equally, it's available online, it can be easily adapted across countries and languages, it's not time-intensive and received very positive feedback from all participants involved.
- Strengthen the Trade Unions and Work Councils remit regarding designing and accessing training for workers.
- Examine an expansion to the Employees (Provision of Information and Consultation) Act 2006 to include the development of collaborative Work Councils amongst local SMEs (less than 50 employees).
- Strengthen the collaborative links between Workers Councils, Trade Unions, the Organising Bureau of European School Student Unions and the European Apprentices Network for information sharing and collaboration on training initiatives.

- FIT4FoF supports action 9 of the New Skills Agenda initiative on individual learning accounts and supports the introduction of bonus entitlements for skills most in need.
- Time constraints resulted in workers (in some cases) being unavailable for pilot activities. As staff shortages are pervasive, increased financial incentives and support for business is needed to encourage the engagement of workers in upskilling and digitalisation.
- Use the Digital Europe Programme to fund competitions/programmes for workers to develop digital upskilling/reskilling videos or initiatives to increase interest and engagement amongst workers in the training arena.
- The FIT4FoF project supports the proposal to introduce paid training days under action 9 of the New Skills Agenda initiative on individual learning accounts and recommends supporting the introduction of a minimum number of hours required for Continuous Professional Development (CPD) within manufacturing.
- Build awareness of the tools Euroguidance, EuroPass and Electronic Platform for Adult Learning in Europe (EPALE) amongst Trade Unions, Work Councils, European Foundation for Cluster Excellence, industry, government agencies and HEIs.
- Provide better incentives for workers (and unemployed people) to access training and increase benefits equivalent to the demand for skills. Potential incentives could be grant aid, cost of living support, supported savings accounts for training, tax incentives, Income Sharing Loan Agreements, or schemes such as lifelong learning insurance plans which would allow insurance for skilled workers who lose their job or want to transition to a new job.

4. Fund, support, and share examples of collaboration in identifying, delivering, and evaluating training initiatives with industry.

- All stakeholders found the ICoED process valuable in providing a comprehensive analysis of the skills gaps and strengths within the organisation while facilitating learning from all stakeholders. The European Commission should support a framework for supporting local, regional and national governments to employ methods such as ICoED between HEIs, industry and

government organisations. The ICoED method builds awareness amongst all participants of the existing skills environment and the strategic needs of the business which in itself is a valuable experience while creating a relevant and tailor-made training programme. The ICoED process ensures all genders, cultures, levels, and ages participate equally, it's available online, it can be easily adapted across countries and languages, it's not time-intensive and received very positive feedback from all participants involved.

- Under action 2 of the New Skills Agenda, strengthening skills intelligence, provide funding to establish an EU wide data collection from pilots of the ICoED method. This process identifies exact skills requirements within industry through a proven collaborative approach so the resulting data would be primary, precise, and comprehensive which could be used to inform sector specific training strategies.
- Identify capacity and opportunities for the Digital Innovation Hubs to coordinate, disseminate or facilitate training initiatives.
- Encourage alignment of the innovation-policy support measures with Digital Innovation Hub needs. Cooperation between various government agencies, employment organisations and trade unions should be possible.
- Use the Digital Skills and Jobs Coalition (DSJC) to establish an EU network of specialised digital experts in specific areas to create an EU wide resource for businesses. This network would facilitate sharing of learning, ideas for further skills development and training as well as inform policy development. This EU network could be linked to national networks of the same nature.

5. Support the use and development of more modularised, digitally interfacing, short, practical training courses and resources.

- Support the development and awareness of training courses that contain small, accessible, interactive modules which link together soft and hard skills (the T-shaped skills) into a complete skills development menu.
- Investigate the possibility of developing a centralised platform for training resources such as www.coursera.org/ or a 'Netflix' type platform. Short videos on specific skills could facilitate learning on the job and by aggregating offerings from all education providers workers can choose the highest

rated most relevant resource available. With a strong search engine and the incorporation of AI, this platform could offer a high level of personalisation, prompting further training or relevant resources based on past choices.

- Under the New Skills Agenda increase the initiatives and funding for implementing recognition of informal learning (e. g., European guidelines for validating non-formal and informal learning, CEDEFOP, 2015) as a wide gap remains between the recognition of formal and informal or non- formal learning.

6. Fasttrack the development and pilot implementation of Micro-credentials amongst industry and HEIs

- Develop methodologies for validation and certification of professional qualifications under the micro-credentials concept as outlined in the European Skills Agenda and the Digital Education Action Plan.
- Provide funding and support for collaboration between HEIs and industry in developing micro- credentials, prioritising industry with the largest skills gap.

C) Employment agencies and trade unions

Below are the policy inputs for employment agencies and trade unions in the development and deployment of digital competencies from the FIT4FoF project.

1. Build awareness amongst Industry of the urgency and support for digitisation.
2. Support the engagement of workers in managing their skills development and designing training programmes and initiatives.
3. Support collaborations with industry on training initiatives.

1. Build awareness amongst Industry of the urgency and support for digitisation.

- Collaborate with Industry to identify potential issues, constraints and supports. Collect and report all findings to the relevant government organisations.
- Use all networking and organisation communication pathways to build awareness of the imminent need for digitisation amongst all manufacturing businesses, emphasising the need to engage to survive. The pilots

experienced a positive environment amongst the pilot companies engaging with the ICoED method, however, in smaller companies, there was little upskilling happening and no sense of urgency. Many industry partners believed that Industry 4.0 will live with "traditional manufacturing" for some years to come allowing the business to evolve slowly adapting to the new conditions and allowing "traditional job profiles" to naturally grow into the new job profiles. Others believed they were too small, and digitisation only applied to larger companies that could afford the technology and had a larger staff team.

- Build awareness of and share the good practices in the Digital Skills and Jobs Platform. Promoting possible additions to the platform from workers/industry.
- Focus on engaging leadership in discussions around digitisation and making connections for further discussions with HEIs and government organisations.
- Share best practices, case studies on leadership engaged training and outcomes of same.
- Provide support to industry leadership on rotating workers and prioritising time to enable each worker to access training for skills development.
- Industry needs to be encouraged and supported to do the following:
  - Be proactive with both looking for relevant training materials, actively engaging in conversations with partner industries about training opportunities, experiences and available resources.
  - Actively share training materials and experiences with other SMEs via social media, joint events etc.
  - Recognise the workplace as a learning place and consider learning as an investment rather than a cost.
  - Provide basic ICT training to all workers.
  - Self-organise by joining forces with other SMEs for sharing costs and jointly developing training solutions.
  - Make sure workers' skills become visible to both the business and the outside world.

2. Support the engagement of workers in managing their skills development and designing training programmes and initiatives.

- Promote the use of the tools Euroguidance, the Europass and Electronic Platform for Adult Learning in Europe (EPALE) amongst Trade Unions, Work Councils, Clusters, industry, government agencies and HEIs in accessing crucial guidance support for workers.
- Use the Digital Europe Programme to fund competitions/programmes for workers to develop digital upskilling/reskilling videos or initiatives to increase interest and engagement amongst workers in the training arena.
- Build awareness amongst industry of the many European initiatives and resources available to help adults learn at their own pace and in their own space such as the EU Code Week and the Electronic Platform for Adult Learning in Europe (EPALE).
- Strengthen the collaborative links between employment representative agencies, Workers Councils, Trade Unions, the Organising Bureau of European School Student Unions and the European Apprentices Network for information sharing and collaboration on training initiatives.
- Support the implementation of the proposal to introduce paid training days under action 9 of the New Skills Agenda, initiative on individual learning accounts and advocate for the introduction of a minimum number of Continuous Professional Development (CPD) hours within manufacturing.
- Ensure all relevant employment agency representatives develop ICT competencies, in line with the Digital Competence Framework for Educators (DigCompEdu) to allow for fruitful discussions, support and advocacy to occur in the area of digitisation.

3. Support collaborations with Industry on training initiatives.

- Strengthen the training remit of employment representative agencies to include the voice of the worker in the development and delivery of training initiatives and support workers and Industry in the challenge of digitisation.

- Engage with the European Foundation for Cluster Excellence and other Cluster organisations to collaborate with and support training initiatives amongst Industry.
- Support Industry in accessing existing local training initiatives, resources and supports.
- Under the SME Strategy and the National Digital Strategy encourage and incentivise SMEs to pool resources for training internally and externally.
- Encourage (and possibly incentivise) LMCs to open their learning systems to other industries in their value chain.

Over the last two decades the manufacturing sector has been subject to fundamental changes due to new and emerging technologies. This ever-increasing dynamic raised pressing questions on how employees and employers can cope with changing skills needs in future labour markets and increasingly digitalised industrial environments.

The publication at hand presents a new approach to tackle these challenges using participatory tools to co-design upskilling courses tailor-made for both workers and companies.

The FIT4FoF European project developed and tested this approach, called ICoED, in a number of industrial pilot applications. Furthermore, a future scenario for work and skills in Industry 5.0, aligning technology, sustainability, and society, is sketched, including framework conditions that are relevant for its realisation. By presenting recommendations for policy, the FIT4FoF partners would like to invite stakeholders to enter into a dialogue on how to achieve this future scenario using the ICoED approach for the benefit of both the economy and society.

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