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Abstract
This document presents the FIT4FoF scenario on the future of work in advanced manufacturing which was elaborated during the project. It also includes the individual scenario aspects of the FIT4FoF piloting activities and outlines both the background of the future of work in smart manufacturing and the use of scenarios to prepare for it and to sketch out how this future can look like.

Legal Disclaimer

Abbreviations and Acronyms

Acronym	Definition
AI	Artificial Intelligence
AR	Augmented Reality
ARCTIC	Arctic SA
BSL	Boston Scientific Limited
CEAGA	Fundación Cluster de Empresas de Automoción de Galicia
CNC	Computer numerical control
DL	Deep learning
EC	European Commission
EQF	European Qualifications Framework
EU	European Union
FIT4FoF	Making our Workforce Fit for the Factory of the Future
GA	Grant Agreement
HMI	Human-machine interaction
ICoED	Industrial Collaborative Educational Design
ICT	Information and communication technology
IIoT	Industrial Internet of Things
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.
ML	Machine Learning
MNE	Multinational Enterprise
MOOC	Massive Open Online Course
MR	Mixed reality
MTS	Meccanica Tonel Sergio S.r.l.
MTU	Munster Technological University
NLP	Natural language processing
PC	Personal Computer
PESTLE	Political, economic, societal, technological, legal and environmental
PO	Project officer
R&D	Research and development
RPL	Recognition of prior learning
RTDI	Research, Technological Development and Innovation
S2i	Steinbeis 2i GmbH
SME	Small and medium-sized enterprise
SQDCME	Safety, Quality, Delivery, Cost, Morale, Environment
UCN	University College of Northern Denmark
UR	Universal Robot
VOC	Voice of Customer
VR	Virtual reality
WP	Work Package

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Executive Summary

This report brings together all major activities conducted in the framework of the EC-funded FIT4FoF project and presents the FIT4FoF Scenario depicting the Future of Work in Advanced Manufacturing as well as seven FIT4FoF personas created in during the implementation of the FIT4FoF pilot projects. The human-centric approach which was at the heart of FIT4FoF and its major field of exploration is also an important cornerstone of the Industry 5.0 notion. It especially points out that the needs of society and the workforce need to be comprehensively taken into account throughout all industrial and production processes, that technology needs to be applied for the benefit of and tailored to the needs of the worker and finally, that technologies used need to be in-line with core European values such as ethics and privacy. In addition, if applied in the Industry 5.0 mindset technology will be able to contribute considerably to resource optimization, efficiency, robustness and resilience. These three notions of resilience, sustainability and human-centricity constituted important framework conditions for the development of the FIT4FoF scenario.

Following a general introduction into the policy-level context of future skills needs in advanced manufacturing in Chapter 1, the approach applied to develop the Scenario for Work in the Factory of the Future is comprehensively outlined in Chapter 2 and includes the participatory scenario workshop conducted, its preparatory and follow-up activities as well as all information collected during this process.

The FIT4FoF Scenario in Chapter 3 depicts a positive and technology-embracing vision of the future as we assumed 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 a 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 which 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 which will 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 take into account when preparing for future challenges and opportunities. The FIT4FoF Scenario built the basis for the piloting partners' development of a persona which they envision will be working in their pilot company in a few years' time. These seven personas can be found in Chapter 3 as well.

Finally, Chapter 4 gives some conclusion 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 endeavour 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 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.

1. Introduction

1.1 Purpose of Document

The development of the FIT4FoF Scenario is one of the last steps in the FIT4FoF project implementation. It takes stock of and brings together all previous project activities, such as the identification of technology trends, relevant future technical and non-technical skills and related future job profiles, the results of ICoED (the FIT4FoF educational approach), and its implementation in the FIT4FoF pilot activities. Taking stock of these, the publication at hand outlines the approach to the FIT4FoF scenario development and describes in detail its implementation which took place in 2021, i.e. the information gathering, the workshops and the results compilation. Then, the FIT4FoF scenario itself is depicted in the last part of the publication. The report also includes the individual scenario aspects of the FIT4FoF piloting activities and outlines both the background of the future of work in smart manufacturing and the use of scenarios to sketch out how this future can look like.

1.2 About the FIT4FoF project

In the last two decades, the 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 about how employees and employers can cope with changing skills needs in future labour markets and industrial environments. In particular, employees need to anticipate new skills in decreasing time intervals and become more flexible in certification of skills and adaptation of new competencies.

To support this transition to a fully digitalized European industry, the EU-funded FIT4FoF project[1] aimed at identifying future skills requirements and new job profiles as well as developing and piloting a unique yet transferable education and training framework able to answer those needs. This so-called ICoED approach (Industrial Collaborative Educational Design) 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, the employer/learner and the training provider.

In a first step technology trends were identified and analysed across the areas of robotics, additive manufacturing, mechatronics/machine automation, data analytics, cybersecurity and human-machine interaction. In a second step, those identified trends were used to facilitate the analysis of future skills needs and the elaboration of over 100 new job profiles relevant for future manufacturing. In addition, the ICoED educational approach was developed and tested in seven regional pilot applications, both in large MNEs as well as in SMEs and industry clusters. To broaden the approach, enabling educational/training design and development practices to be transferred between stakeholders and communities across Europe, during the whole lifetime of the project FIT4FoF engaged in the development of a network of stakeholders. Bringing together all of the above activities, a FIT4FoF Scenario for the Future of Work in Advanced Manufacturing was developed.

[1] www.fit4fof.eu

1.3 Background: future manufacturing and skills needs in Europe

The analysis which led to drafting of the FIT4FoF project, namely that the increased introduction of digital and related key enabling technologies (KETs) has in the past two decades and will even more so in the coming years pose both an increased challenge for European manufacturing companies and for the manufacturing workforce, is still true. 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 to-date. At the same time, it is obvious that, if these challenges are handled proactively, they will be a prime opportunity to increase competitiveness and innovation of European industry for many years to come. During the implementation of the FIT4FoF project, the project partners aimed to take a step towards both analysing the future skills needs in advanced manufacturing by sketching out how work in future factories might look like and by identifying viable roads to future training and educational approaches to optimally meet these future skills requirements.

Furthermore, during the past few years it was increasingly realized that economic growth without taking into account 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 on European, but also on national and regional levels. Based on, among others, this notion of twin transition, the Industry 5.0 paradigm has raised quite some attention in 2021. It builds on the concept of Industry 4.0 coined in Germany between 2011 and 2013 which comprises 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 and applications at the same time coping better with global technological and economic transformations.

This approach entailed not only big hopes and expectations in industry and policy but also uncertainties in large part of society as to how this will impact on their 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 made an effort to explore what the Industry 5.0 concept 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, those three notions 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 and its major field of exploration. In this respect the Industry 5.0 paradigm especially points out that the needs of society and the workforce need to be comprehensively taken into account throughout all industrial and production processes, that technology needs to be applied for the benefit of and tailored to the needs of the worker and finally, that technologies used need to be in-line with core European values such as ethics and privacy. In addition, if applied in the Industry 5.0 mindset technology will be able to contribute considerably to resource optimization, 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 worker shortages, rising inequalities and fast technological advances.

FIT4FoF made an effort to investigate into some of these aspects, namely to identify future technologies and skills needs in smart manufacturing and, based on these, to develop a new education

and training framework, which places workers at the centre using a co-designed process to recognise and address worker's 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 to be further tested and implemented in companies across Europe. The work in FIT4FoF, especially the pilot applications finally resulted in the development of a FIT4FoF Scenario on the Future of Work in Advanced Manufacturing.

In the following chapters, we will outline the approach to and the building blocks of this scenario and illustrate this FIT4FoF 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 closes giving conclusions on what we have learned during this endeavour. Additional background information gathered during the process can be found in the Annex.

2. Approach

As indicated above, the FIT4FoF findings were condensed and transferred into an illustrative scenario and seven personas reflecting the pilot applications' view on future jobs in advanced manufacturing.

In general, scenarios are illustrative 'pictures' which 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 made aware of potential challenges which 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 to display and analyse (hidden) assumptions, potential risks and alternative development paths.

In FIT4FoF, it was initially foreseen to develop the scenario by way of a collaborative process of 2-3 physical workshop jointly with the FIT4FoF partners, pilot application representatives and additional stakeholders. Due to the outbreak of the Covid-19 pandemic, firstly, the piloting activities were considerably delayed and, secondly, no physical workshops were possible. Thus, the scenario approach had to be adapted considerably and we opted for an approach to scenario development which is frequently used in case of time constraints, and which still yields very good results, namely the customization of existing scenarios. As a basis for the FIT4FoF scenario, we collected the information available in two existing scenarios on the future of work, compiled and adapted this information to the need of FIT4FoF and used it as the input to a virtual workshop where this information was enriched with FIT4FoF contents.

Concretely, firstly, we decomposed the existing scenarios (see following section for more information). The information was collected along the well-known PESTLE categories: political, economic, societal, technological, legal and environmental aspects relevant to the issue in question. Secondly, this information, together with overall information on the underlying scenarios were supplied as background information for the virtual FIT4FoF scenario workshop which took place in

June 2021. The workshop was divided into two sessions and used a comprehensive Miro virtual whiteboard to support information-gathering and clustering. The first session aimed to discuss with participants the pre-identified scenario aspects and identify relevant points which needed to be removed/added/modified from the FIT4FoF point of view. The second session collected in a tabular manner information about how the scenario aspects which were discussed in the first session impact on future skills and jobs in advanced manufacturing. The categories tackled included which qualifications/skills will workers need, how are working relationships between employers and employees, which technologies will workers use, which job profiles will be there/more prominent in the future, which training needs and programmes will evolve. Following, the information generated during the virtual workshop was edited and compiled to result into an enriched PESTLE table which contained all information for the FIT4FoF scenario.

Thirdly, the relevance of the FIT4FoF scenario for the FIT4FoF pilot applications was identified and assessed, and a pilot mini-scenario developed. To this end, we used a design-thinking approach resulting in one persona description per pilot. To start, 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 along a number of pre-defined categories, including, among others, technologies used, skills levels, skills needs and upskilling activities in place. Sketching out the future state of the pilot resulted in the development of a 'persona' that works in the respective pilot in 10 years from now. The persona development took into account in addition to the categories usually used in design-thinking a number of aspects related to his/her work environment, context and future skills, e.g. tasks, existing skills, skills to be acquired, challenges and opportunities encountered. The complete information for all FIT4FoF pilot applications can be found in Chapter 3 and Annex 4.

Finally, the last step of scenario development was the visual representation of the overall scenario and the seven pilot personas which was done by a visual designer based on the information generated during the FIT4FoF scenario workshop and the pilot's design-thinking exercise. All of these visuals can be found in Chapter 3 below.

2.1 Scenarios used as basis for the FIT4FoF scenario process

As described above, two scenarios were identified and used as the basis for the FIT4FoF scenario. These scenarios were:

- The Millennium Project Work 2050 Scenarios[2]. The report includes three scenarios that are covered quite extensively and include developments until 20520. The scenarios are polarized, i.e. including one negative, one positive and one mixed scenario. For the FIT4FoF scenario, we used the mixed scenario only because we assumed that this is the one to most realistically reflect the future which we will encounter and to best fit the FIT4FoF pilot conditions. The scenario is called "It's complicated – a mixed bag" and its main features are: Technological change will be much more rapid than most people believe and it will radically change the way people work, especially as the collaboration between humans and machines will be much closer in the future than it is today. Furthermore, the scenario shows the need for redistribution of opportunities, income and wealth as well as far-ranging political measures for a new definition of the social and economic systems. Thus, what is needed for this scenario to materialise are targeted long-term visions of a sustainable economic and social system in which technology serves as a means for solving global societal challenges. This in turn will

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

enable good and meaningful work for a much larger part of world population than today.

- Shaping the Future of Production: Four Contrasting Perspectives in 2030[3]. The World Economic Forum commissioned a White Paper to investigate into the future of production in 2030 aiming to initiate a discussion about common visions on how the future of production can be shaped by all relevant stakeholders in a way that it enables inclusive and broad-based prosperity, equal opportunities and environmental sustainability beyond mere technological advances. The four scenarios developed are called Disrupted, Deterred, Damaged and Devolved. For the purpose of FIT4FoF scenario development, we decided to use the Disrupted: production transformed-scenario because, again, it included the most favourable vision for the future of both production and the workforce. Key aspects of this scenario are:
  - Technological breakthroughs came much faster than anticipated and hyperconvergence of key technologies is a reality in 2030;
  - These new technologies were embraced as a means for solving global challenges;
  - At the same time, they radically changed the way people work;
  - A redistribution of opportunities, income and wealth made those changes a big opportunity for all people on the globe.

While studying and assessing these two scenarios, it became apparent that the assumptions and outcomes of both were quite similar and fit very well with the FIT4FoF context. Thus, we decomposed the two scenarios and transferred them into one joint table to be used as the basis for the FIT4FoF scenario.

The main features of this baseline scenario are:

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

2.2 Implementation: Developing the FIT4FoF scenario and the pilot personas

As outlined above, during a participatory scenario workshop with the FIT4FoF partners in July 2021, the baseline scenario was customized to the FIT4FoF context and requirements using a comprehensive Miro virtual whiteboard. During this workshop, the participants defined and discussed those issues which were most relevant in their views for the future of advanced manufacturing and the manufacturing workforce. The picture below gives an impression of how Miro was used and how the results were gathered virtually.

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

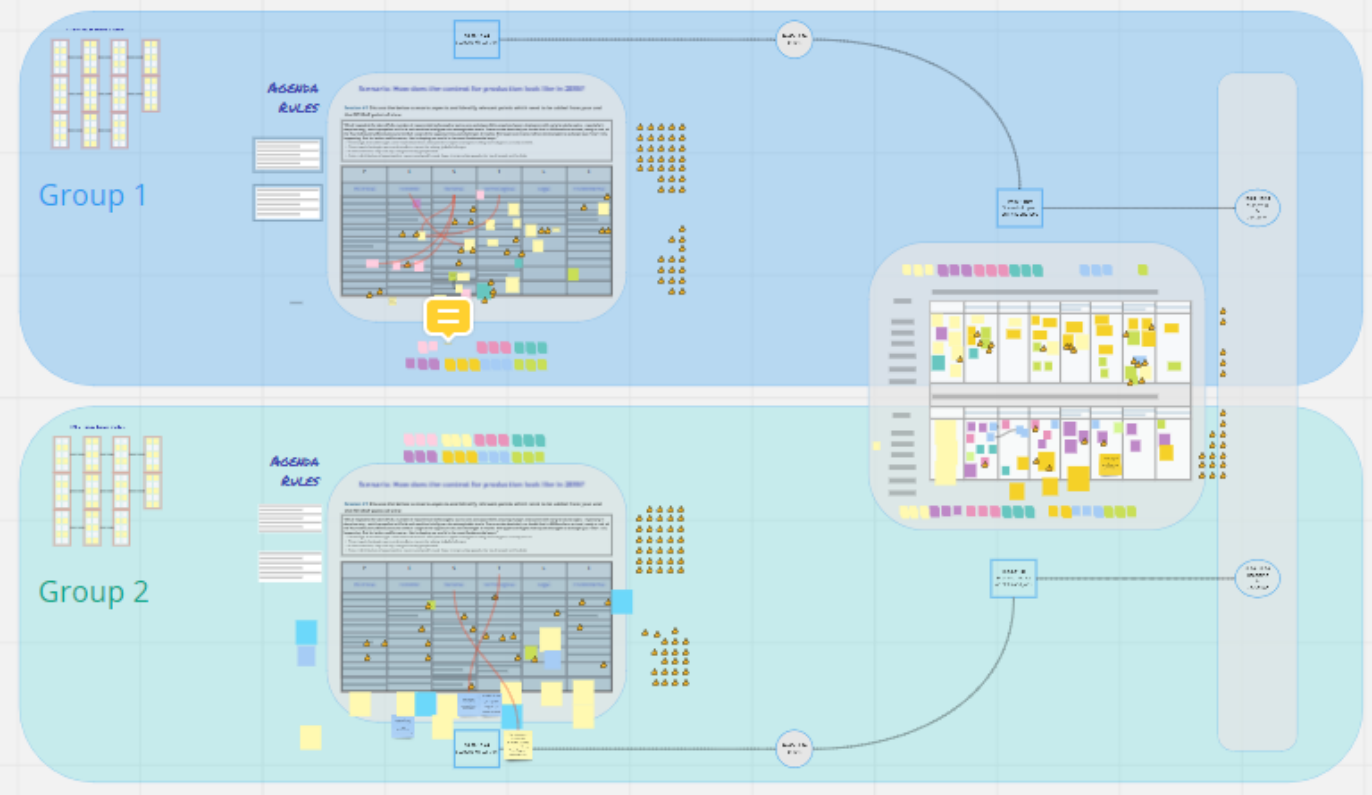

Figure 1 – Miro board used during FIT4FoF Scenario workshop

The following table presents the synthesis of the combined baseline scenario and FIT4FoF adaptations elaborated during the first workshop session. This table built the basis for the overall FIT4FoF scenario which was sketched by a visual designer based on this information and is presented in Chapter 3.

Political	Economic	Societal	Technological	Legal	Environmental
• multipolar world, several countries fight for predominance in AI • but transnational organisations gain in importance • global security threats, organized crime, state espionage -> 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	• Revival of globalization • 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 (-> redefinition), adaptable production capacity and flexible business processes to avoid pertaining problems with raw material 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	• 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 advanced led to increased wealth but not all countries benefit to the same extent	• 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 customized 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, digitalization, cybersecurity	• 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)	• Circular economy realized by way of technical/technological solutions such as AI-empowered ubiquitous and connected IoT devices; Radical change in consumer behaviour (Gen Z) facilitated faster green transformation • Renewable energies, dedicated transformation of mobility and O2 emission industry enabled to control global warming

Table 1: Synthesised Pestle-Table from FIT4FoF Scenario Workshop

During the second session of the scenario workshop, the participants identified potential impacts which the scenario aspects discussed during the first session might have on future skills and jobs in advanced manufacturing. Table 2 shows the main take-aways from this exercise. The complete list can be found in Annex 2.

Impact categories	Future qualifications/ skills needs	Future technology needs	Employer – employee relationships	Job profiles available/ needed/ more prominent than today; Jobs not existing any longer.	Future training needs	Future training programmes. Educational partners roles; Future/ new business models	Other aspects
Main take-aways	• 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.	• Green tech; • Augmentation technologies & initiatives; • 3D simulation; • Recognition of prior learning; • Proactive identification of companies's future tech & related skills needs.	• 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.	• Skills profiles expressed as part of lifelong learning practices; • More generalists than specialists; • Quickly changing job roles; • Active collaboration between educational partners and industry.	• Human centric upskilling linked to innovation; • Lifelong learning, highly modularized, e-learning, flexible; • AI-supported truly virtual training environments.	• On the job, learning by doing; • Modularized & customized training programmes; • More company-centred, internal training programmes; • Co-designed programmes; • Close industry-education collaboration, incl. certification.	• Make diversity the norm; • Generative earning models; • Cluster organisations as agents and drivers of upskilling.

Table 2: How the FIT4FoF scenario might impact skills & jobs by 2035: main take-aways

Following the FIT4FoF Scenario workshop, the outcomes were synthesized and compiled in a way to be an easy-to-use reference for the piloting partners when designing their pilot-specific mini-scenario. As indicated, we used a modified design-thinking approach to support the pilots in developing this scenario and asked them to describe both the present state of their pilot and its envisioned future state along a number of pre-defined categories. The information supplied to the piloting partners to support the development of their pilot persona can be found in Annex 3. The development of the seven pilot personas was supported by a virtual training in August 2021 to inform the partners on the approach and how they could best implement it in their pilot. Most importantly, the partners were asked to concretely think about the issues that they expected will be most relevant for their pilot in the next 5-10 years and describe them as concrete and comprehensive as possible, based on the information gathered during the ICoED process, the pilot implementation and their vision of the future of their pilots.

As said, due to the constraints imposed by Covid-19 and the related timing issued in pilot implementation, it was not possible to develop comprehensive pilot scenarios. Nevertheless, we wanted to source the outcomes of the pilot activities and how piloting stakeholders envisioned them to develop in the future in a way that would be visually appealing and thus easy to grasp both for the involved stakeholders and for external audiences. To this end, we asked a visual designer to sketch out these personas graphically, including the most relevant information related to the respective pilot persona.

The complete information collected by the piloting partners is available in Annex 4. The visuals of both the FIT4FoF framework scenario and each persona can be found in the following chapter.

3. The FIT4FoF Framework Scenario and FIT4FoF Pilot Personas

Again, due to Covid-19, the visual facilitator who sketched the FIT4FoF scenario could not be present during the elaboration of the different parts of the development of the FIT4FoF scenario. Thus, she was consulted with later-on and was presented the complete set of information which the scenario and the pilot personas are based on, namely, the baseline scenario, the customized FIT4FoF scenario elaborated during the workshop, the skills & jobs-related aspects that are impacted by the scenario, the future technologies and future job profiles identified as well as the information compiled for the pilot personas. This resulted in one overall FIT4FoF scenario and seven persona visuals which can be found below.

3.1 FIT4FoF Scenario

The FIT4FoF Framework Scenario depicts a positive and technology-embracing vision of the future as we assumed 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 a 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 which 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 (i.e. Industry 4.0), and 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 to be satisfied and challenges to master in the coming years that relate to skills needs and technology applications but also 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, has 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 require to retain older workers for longer, to enable women to increase overall working hours, and to optimally upskill both lower- and higher-skilled workers. Finally, there are a number of framework conditions that impact on the future manifestation 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 of increasing innovations in EU industry.

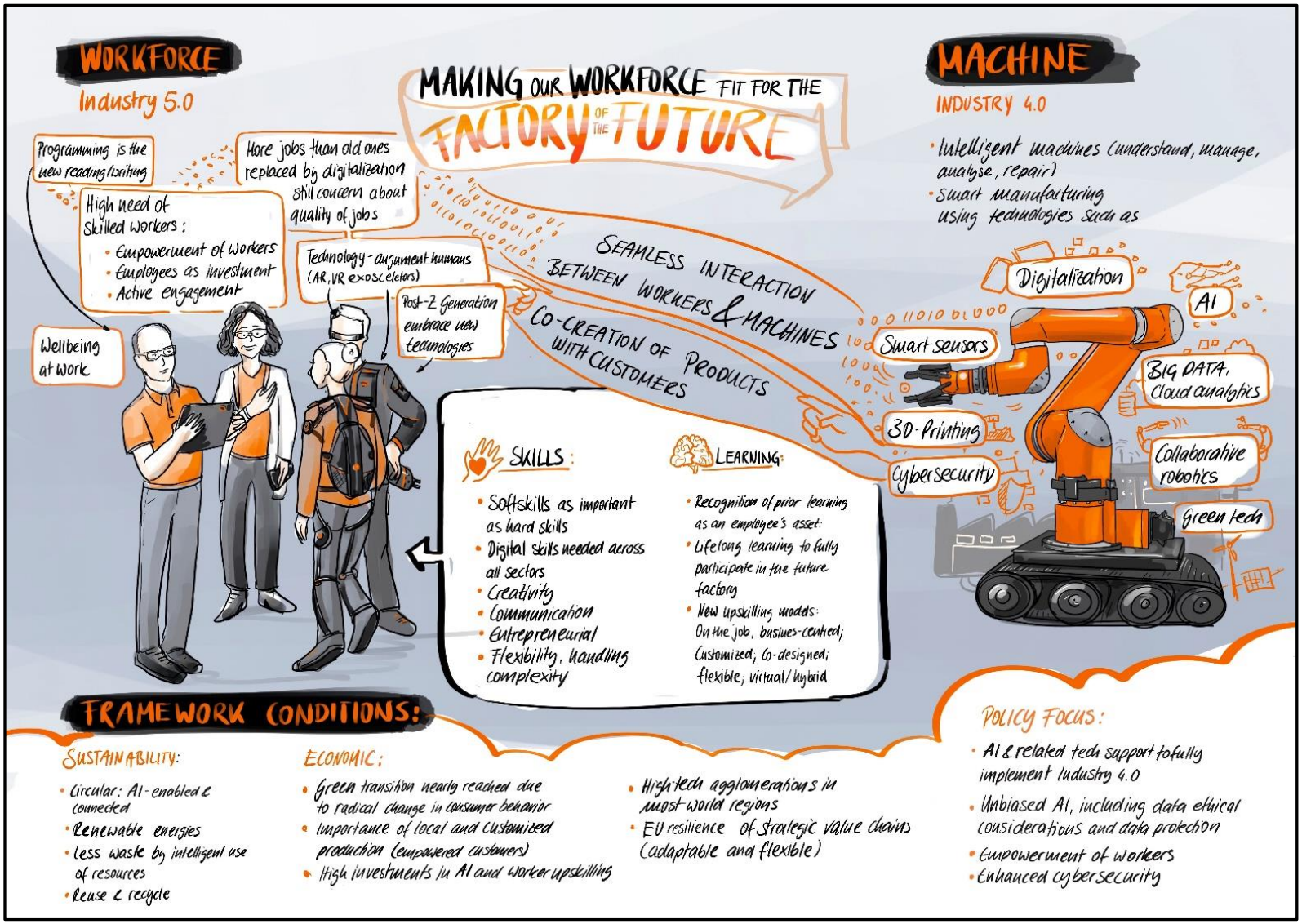

Figure 2 – Overall FIT4FoF Framework Scenario

3.2 FIT4FoF pilot personas

The above FIT4FoF Framework Scenario built the basis for the piloting partners to develop a persona which they envision will be working in their pilot company in a few years' time. Firstly, the partners identified those aspects that they expected to be most relevant for their pilot company in the next 5-10 years and, based on these, sketched out a concrete person to work in this company. Below, the seven personas developed by the piloting partners can be found. 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 with regard to the implementation of future technologies and skills.

1. Arctic persona

FIT4FoF partner Arctic is producing whiteware and has established a fully automated factory to assemble washing machines in Romania. Their challenge is and will be in the future to upskill new and existing employees to operate this factory. Thus, Eva Popescu, aged 35 is an operator in this future factory who has important soft skills already but who will need to upskill to keep track with technology advances. Especially challenging for her is the handling of AI in a way she feels comfortable with.

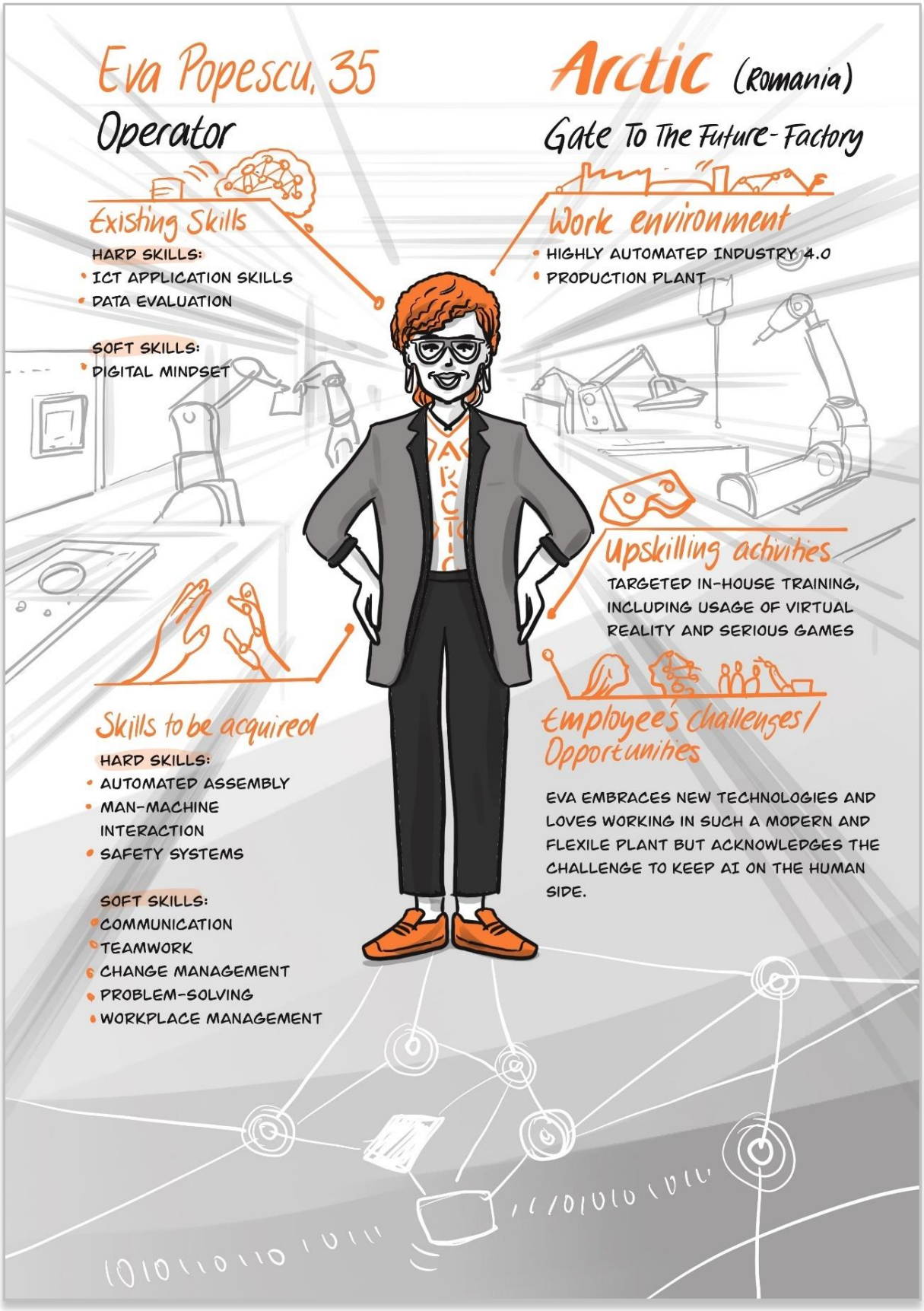

Figure 3 – Arctic persona

2. AutoComponents persona

FIT4FoF partner CEAGA, a Galician 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, is working in this company for a few years already. She has quite advanced hard skills in in programming, HMI and data analysis 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.

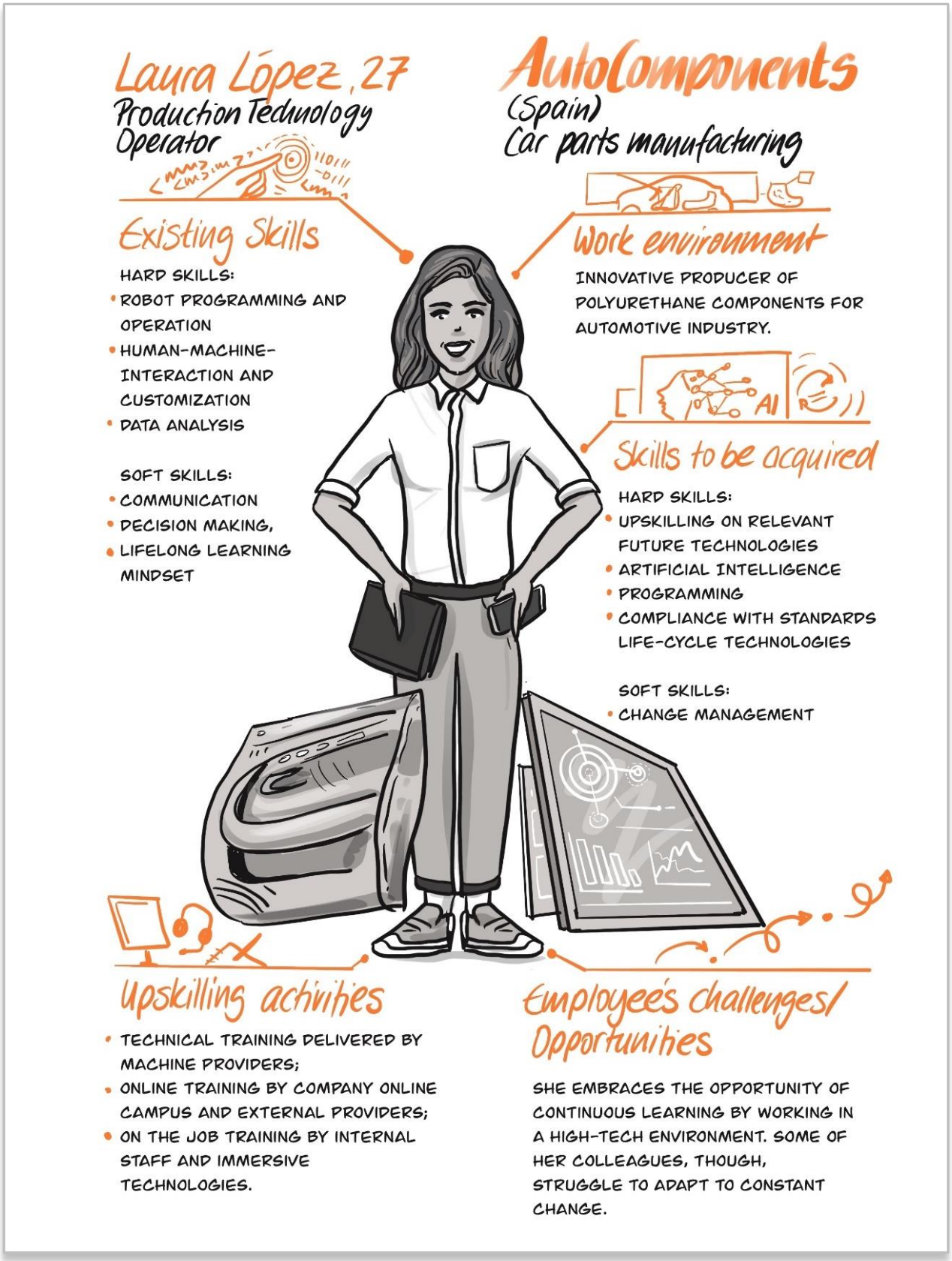

Figure 4 – AutoComponents persona

3. Boston Scientific persona

FIT4FoF partner Boston Scientific Limited (BSL) is a medical technologies company needing to further increase automation of its Cork factory to improve efficiency. This is in line with Boston Scientific global strategy around Digital 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 especially need to upskill in computer hardware and software as well as in understanding basic automation and robotics applications. Upskilling mainly takes place on the job using the company-internal skills development (GROW Program) approach 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 (Level 6,7,8 awards on European framework of qualifications) utilizing our Further Education program for employees.

Figure 5 – Boston Scientific persona

4. Catraport persona

FIT4FoF partner IPB developed its persona together with the Portuguese SME named Catraport, a manufacturing company producing traditional car parts, that will need to scale-up and implement Industry 4.0 technologies in the coming years 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.

Figure 6 – Catraport persona

5. Modis persona

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 on data analytics and machine learning systems. As tailored external training solutions are not yet available, Modis mainly relies on internal training and upskilling activities.

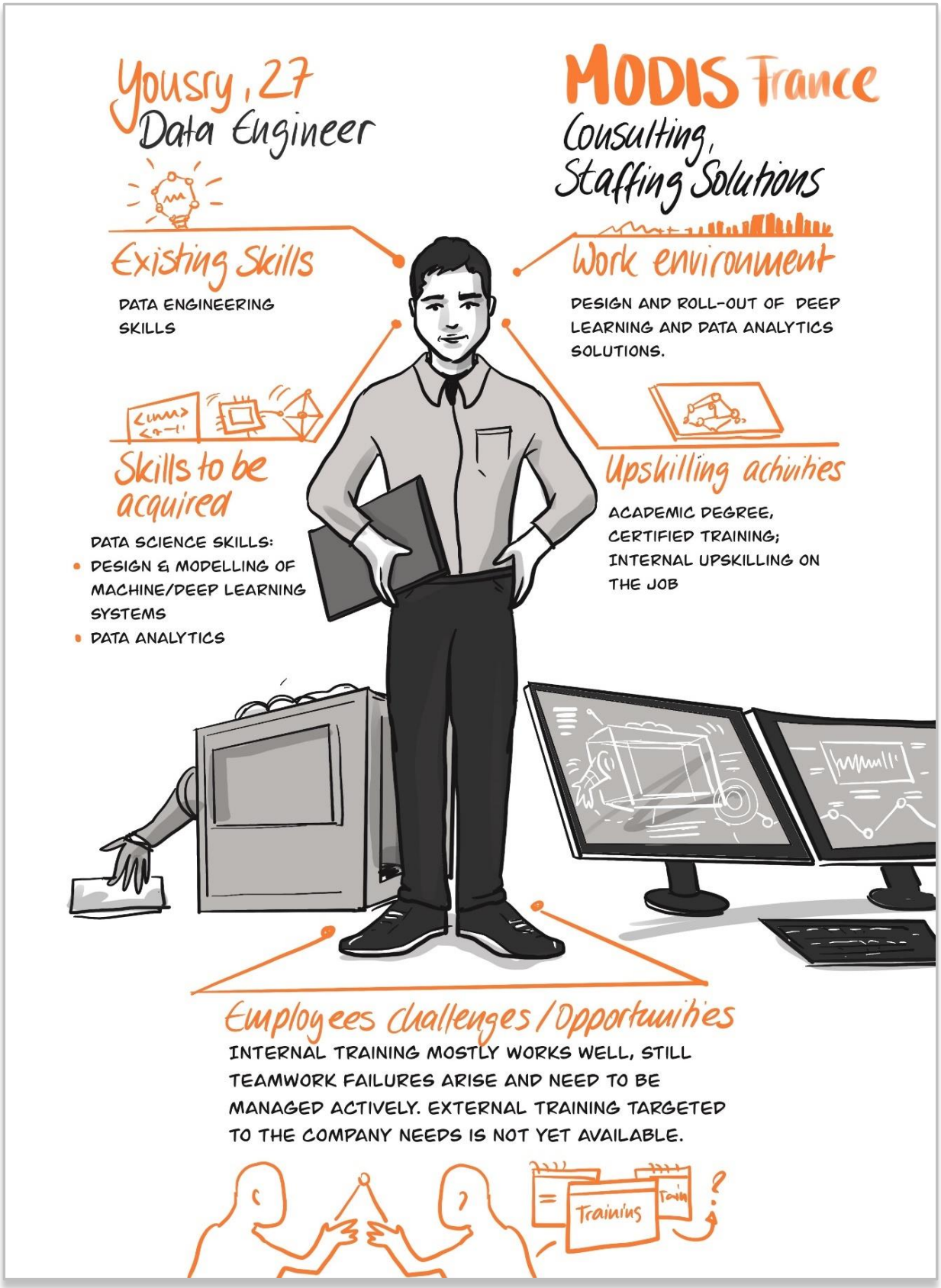

Figure 7 – Modis persona

6. MTS persona

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. By training 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 trouble-shoot at many stages of the production process.

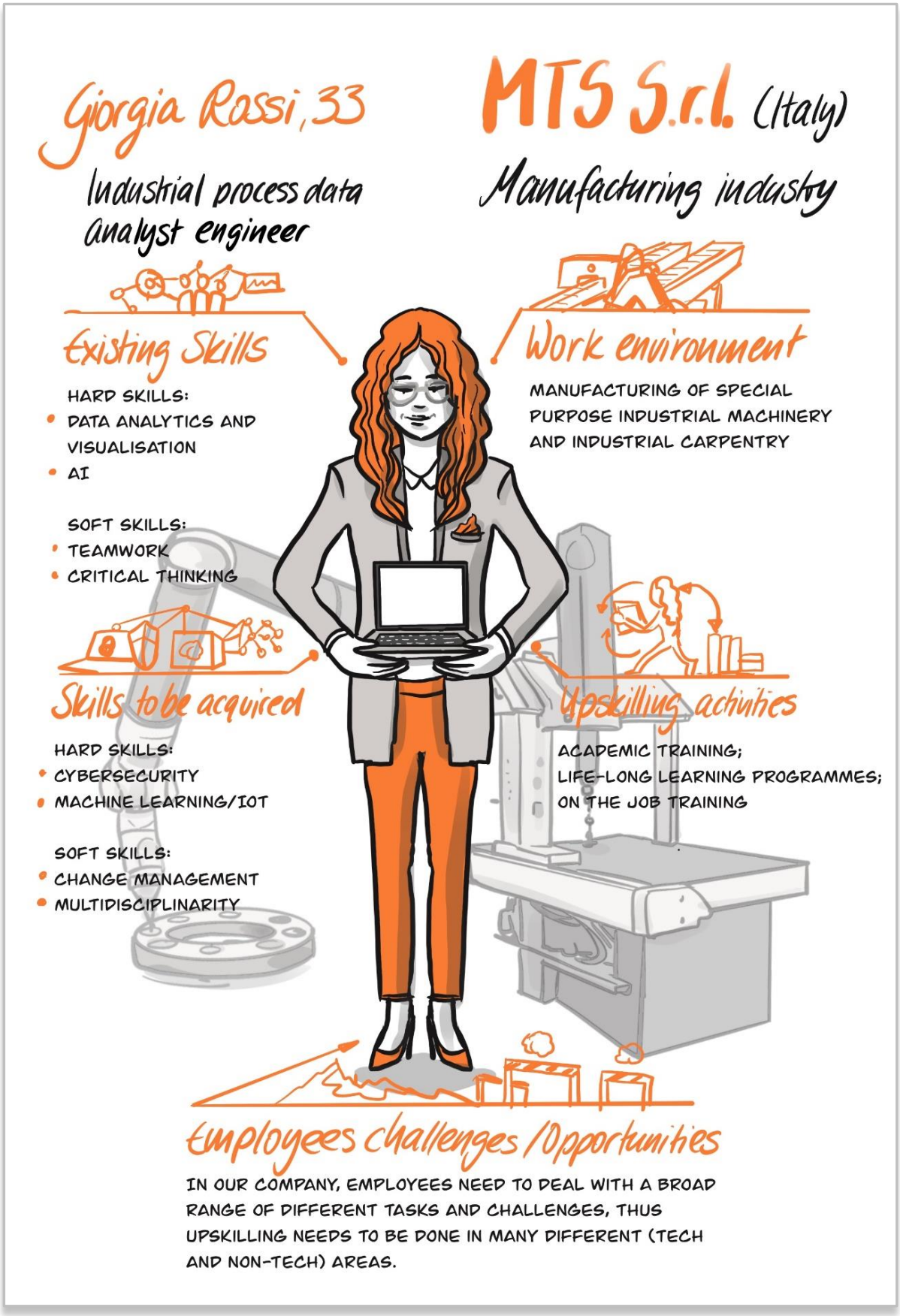

Figure 8 – MTS persona

7. TEKAVIA persona

FIT4FoF partner UCN supplies targeted training to companies, mainly SMEs, in northern Denmark. TEKAVIA is a fictional company reflecting the main feature 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 to work for the company but feels the need to further upskill towards new ICT, automation and robotics technologies. As he is optimally supported in his upskilling demands by tailored courses designed by UCN, he is confident that he even as an older worker will be able to contribute to the success of his company for several years to come.

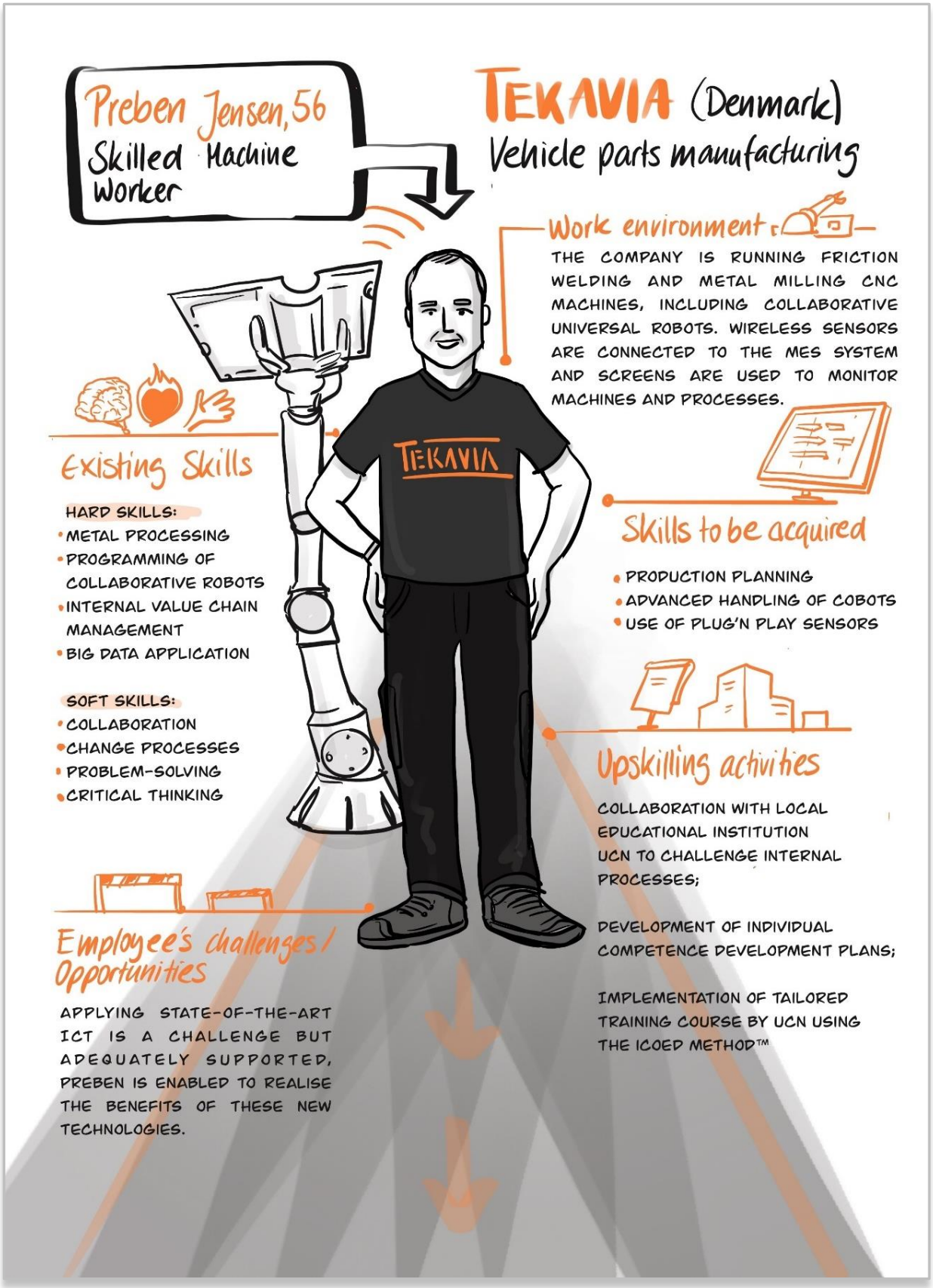

Figure 9 – TEKAVIA persona

4. 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 as barely anyone would have imagined or foreseen back then. The Covid-19 pandemic caught most of us rather unprepared for the challenges that back then still lay ahead of us. Still, looking back at the two 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 conferences have become major parts of the working days of 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 two years vulnerabilities of 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 endeavour 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 future scenarios depicted in this report reflect these discussions and would like to invite stakeholders to enter into an ongoing dialogue on how these future scenarios can become a reality, enabling workers to make the most of their interests, wishes and aspirations.

Whereas 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 that industry has to accept its major role in these transformations. As discussed in chapter 1 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 being part of the answer to the future challenges Europe is facing. Of course, in FIT4FoF we were only able to test and highlight one possible approach to co-designed upskilling of workers in future factories, but exactly this kind of "cross-pollination" within and between organisations, stakeholders and ecosystems we implemented on a small scale is needed to foster an open, future-, sustainability- and resilience-oriented mindset we will urgently need to achieve a resilient, sustainable and human-centred manufacturing industry in Europe.

5. Literature

Daheim, Cornelia, et al. Work 2050: Three scenarios. New findings of an international Delphi study by the Millennium Project. Bertelsmann Stiftung, 2019, http://hdl.voced.edu.au/10707/518041.

European Commission, Directorate-General for Research and Innovation, Breque, M., De Nul, L., Petridis, A., Industry 5.0 : towards a sustainable, human-centric and resilient European industry, Publications Office, 2021, https://data.europa.eu/doi/10.2777/308407.

European Commission, Directorate-General for Research and Innovation, Renda, A., Schwaag Serger, S., Tataj, D., et al., Industry 5.0, a transformative vision for Europe : governing systemic transformations towards a sustainable industry, 2022, https://data.europa.eu/doi/10.2777/17322.

Kearney, A. T., Shaping the future of production: Four contrasting perspectives in 2030, Geneva: World Economic Forum, 2017.

Annexes

Annex 1: Miro-boards from FIT4FoF Scenario workshop, 06/2021

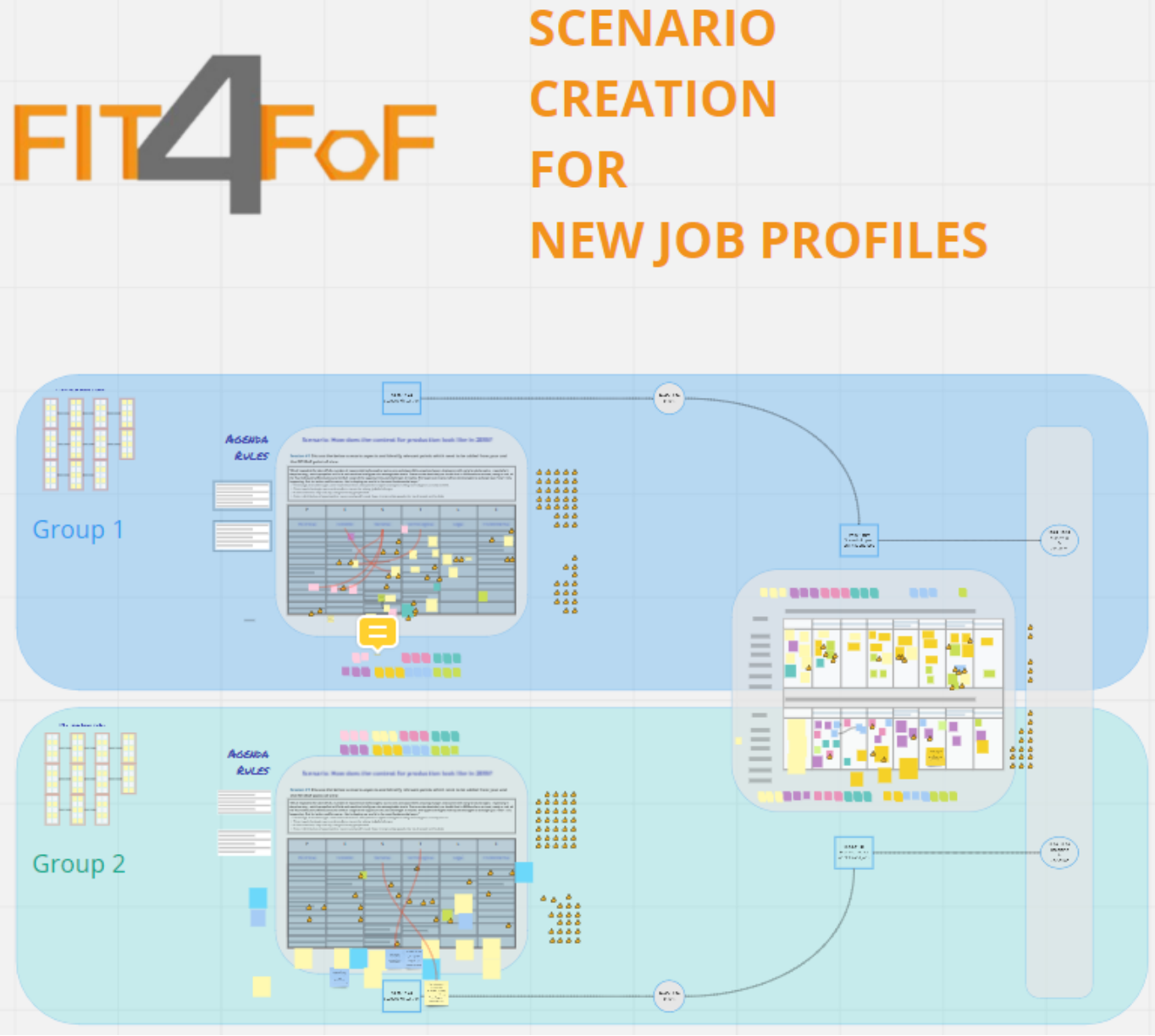

Figure 10 – Overall Miro virtual whiteboard used during Scenario workshop

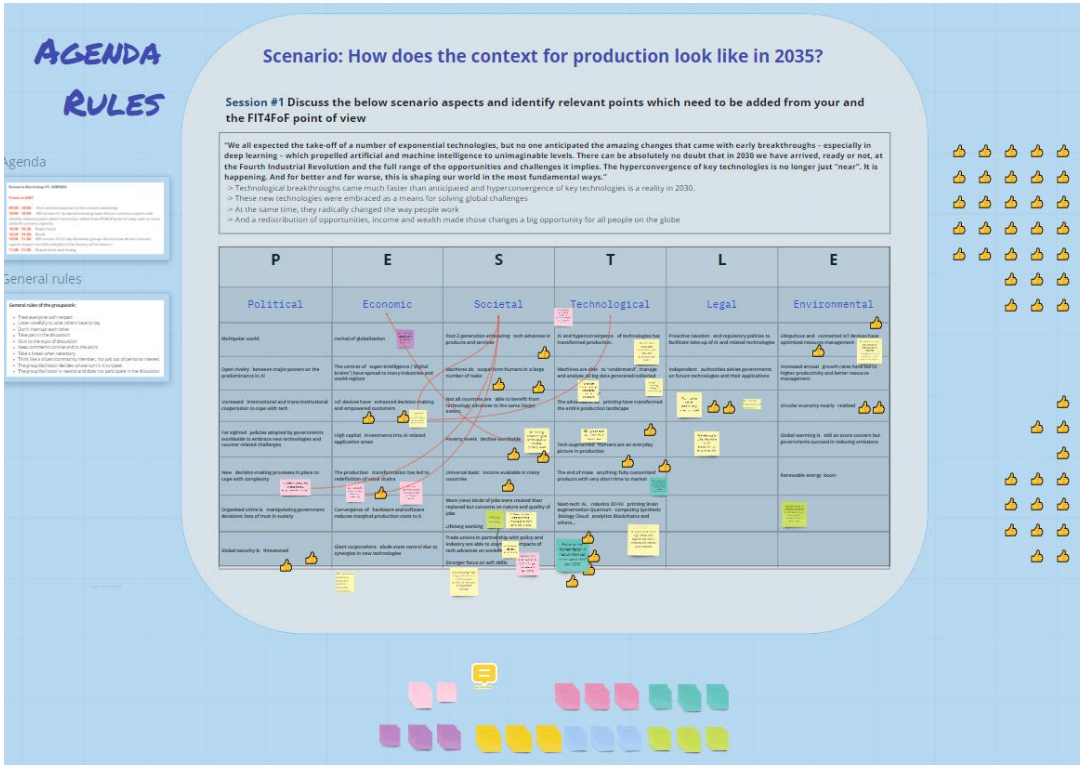

Figure 11 – Session 1, Group 1 Miro template to collect scenario aspects most relevant for FIT4FoF

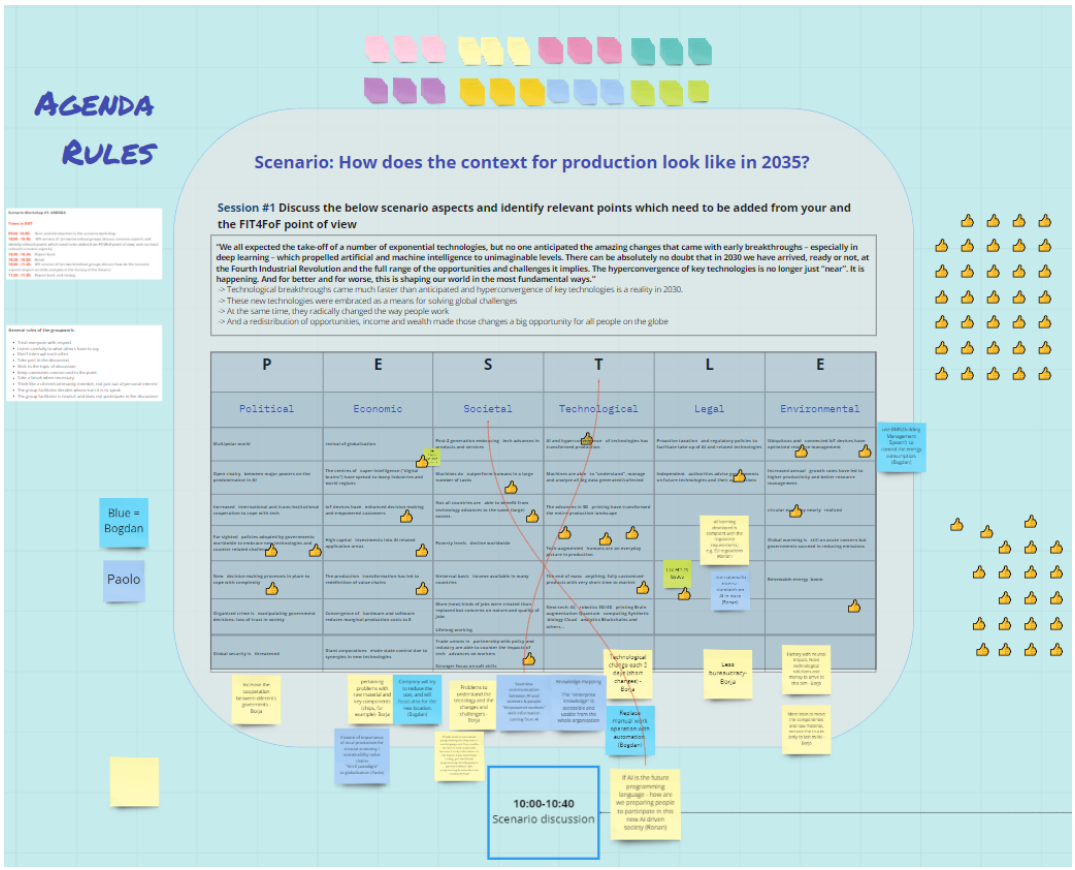

Figure 12 – Session 1, Group 2 Miro template to collect scenario aspects most relevant for FIT4FoF

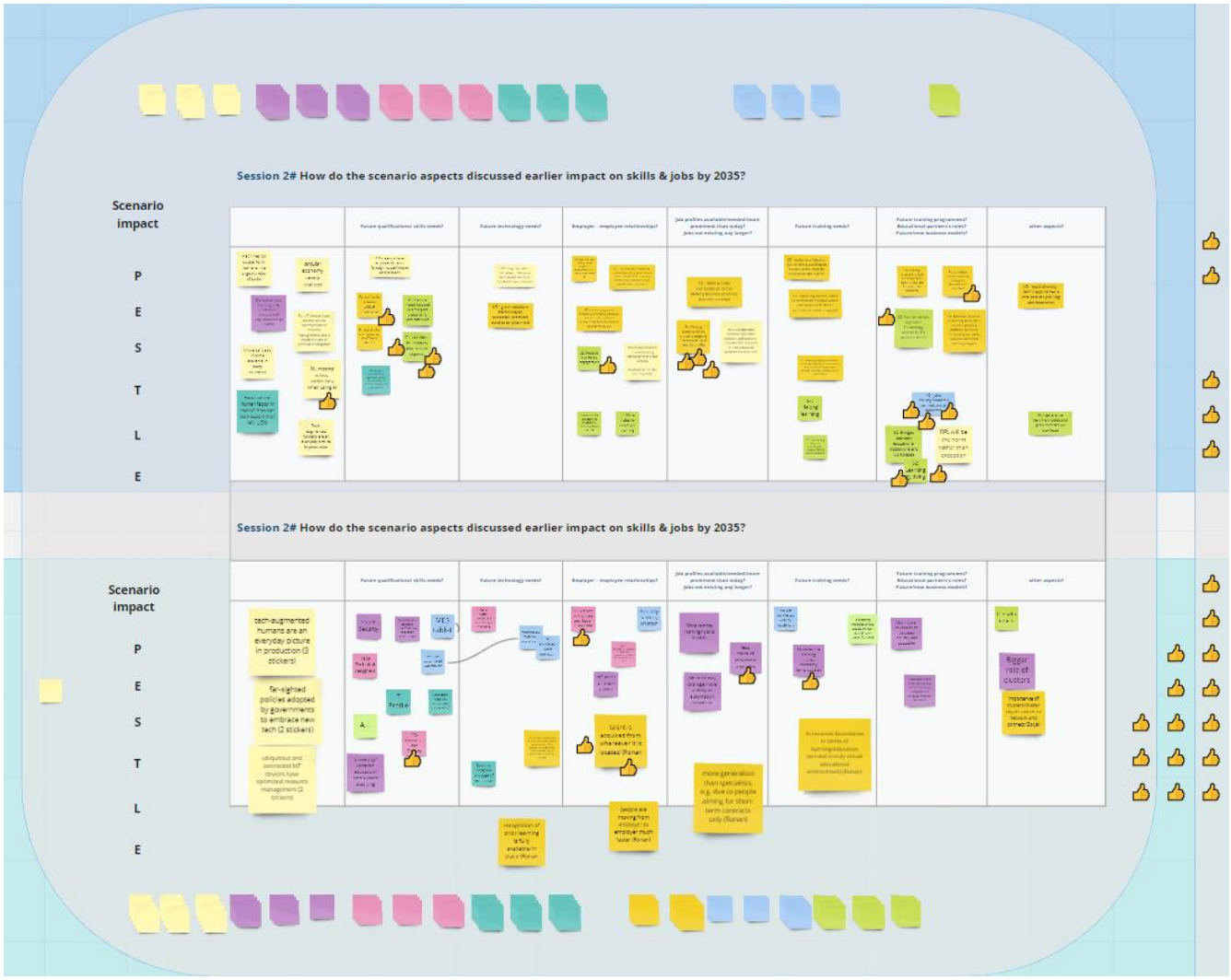

Figure 13 – Session 2, Groups 1 & 2 Miro template to collect impacts of scenario on skills and jobs by 2035

Annex 2: How the FIT4FoF Scenario might impact skills & jobs by 2035

Impact categories	Future qualifications/ skills needs	Future technology needs	Employer – employee relationships	Job profiles available/ needed/ more prominent than today. Jobs not existing any longer.	Future training needs	Future training programmes. Educational partners roles. Future/ new business models	Other aspects
Main take-aways	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	Green tech; Augmentation technologies & initiatives; 3D simulation; Recognition of prior learning; Proactive identification of companies's future tech & related skills needs	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;	Skills profiles expressed as part of lifelong learning practices; More generalists than specialists; Quickly changing job roles; Active collaboration between educational partners and industry;	Human centric upskilling linked to innovation; Lifelong learning, highly modularized, e-learning, flexible; AI-supported truly virtual training environments	On the job, learning by doing; Modularized & customized training programmes; More company-centred, internal training programmes; Co-designed programmes; Close industry-education collaboration, incl. certification;	Make diversity the norm; Generative earning models; Cluster organisations as agents and drivers of upskilling;
	Regions have accurate, dynamic foresight capabilities to assess needs	Augmentation initiatives to balance human and machine capabilities are common	Manager will need to have better insights to employeers prior learning/knowledge	Skills profiles expressed as part of lifelong learning practices become common	Evolution of Industry 5.0. Achieving upskilling in human-centric, resilient, sustainable approaches	Training programs should be customized, short, in-site and focusing daily problems	Make diversity-centric approaches a core part of upskilling and innovation

	Soft skills assume critical importance	Green solutions (technologies, processes, practices) need to be prioritised	The employer-employee relationship will need to mature in the context of the company community (regional, virtual, supply chain, customers)	Life-long learning will be crucial to respond the emergence of new job profiles	Upskilling directly linked to innovation within companies with all S/H, particularly learner engaged	Co-design process involving managers, learners and educators	Generative learning models and grow mindset will dominate
	Training needs focused in emergent digital skills and soft skills	Faster broadband and stronger networks	New engagement models will need to empower workers and enhance productivity (20-80 will need to become 80-20)	More collaboration between education partners and industry - Industry VOC is a given in new education program development	Learning highly modularised. Use of learning maps common place, Assessment of competences through learning pathways within these maps	Business centered in learning paths for a certain upskilling problem, each one comprising re-usable, modular and short learning nuggets	Importance of clusters/cluster organisations to network and connect
	Digital skills are transversal to different sectors	3D simulated work operation	Positive workforce engagement	More remote working/hybrid models	Lifelong learning	Learning by doing	Life with robots
	Manage automated warehouse	Automated materials warehouse	More inclusive employer training	Less manual jobs more analytics	People connected with the machinery	Joint industry/academic certified course dominate	Bigger role of clusters
	Consider multi/inter-disciplinary aspects	recruitment: people hired fit to the company's future enhancement. The company has identified these company needs proactively/in advance)	Potential resistance to new working methods from Trade Unions. Involve them in the journey early	Job roles may change more quickly as automation broadens	New learning consortia maturing that empower lifelong learning practices	Bridges between educational institutions and workplaces	
	Learn to program	Recognition of prior	Influence of trade	More generalists than	E-learning modules	Human-centric	

	any type of technology	learning is fully available/in place	unions	specialists, e.g., due to people aiming for short-term contracts only	allows people to learn at their own pace	approach: Technology aligned to the workers 'needs	
	Having an employee-based approach. give a responsibility to identify competences to be upskilled		Co-creation S/H engagement models will dominate best practice		More flexible training modes, constantly being updated	Recognition of prior learning (RPL) will be the norm rather than exception	
	More flexible targeted qualifications to support rapid changes		Workers will not be a cost, but an investment		AI removes boundaries in terms of learning/education (arrived in truly virtual educational environment)	Potentially more internal training departments in companies to keep up with the demands	
	University? vocational education? not 4 years studying		Talent is acquired from wherever it is located			Much closer collaboration between Industry and education	
	Innovation and Creativity		Flexibility working program				
	Connection with the ecosystems (cooperation)		People are moving from employer to employer much faster				
	Cyber Security		The employer should comfort the employee and make the employees feel safe				
	Technical designers						

Table 3: How the FIT4FoF scenario might impact skills & jobs by 2035, complete workshop information

Annex 3: Information for Piloting partners to support the development of their scenario and persona

Information and templates supplied to the piloting partners to be used as basis to collect the relevant information necessary to describe the pilot scenarios and personas.

Step1: Your pilot – how does it look like at present?

Please describe the present state of your pilot along the following dimensions/categories using the table below (take note of the comments I have made on some dimensions):

Name of organization	
City/Country	
Large-medium-small company	
High- or low- tech	
Main field of operation (car parts manufacturing etc)	
Main products/services sold	
Main technologies used	
Example(s) of integration of (high-)tech into production process	
Skills level of personnel	
High or low need of upskilling of personnel	
(Types of) upskilling/reskilling activities/programmes implemented at present (not detailed but overview is sufficient)	
Other relevant aspects of your pilot that come to your mind which we should take into account	

Step 2: How do you envision the pilot to look like/have evolved in 10 years' time?

Now, we want to find out how your pilot activity will look like in 10 years' time!
We will use some design thinking elements here, thus: Develop a person ("persona") that works in your pilot context in 10 years identified along the categories below, focusing both on his/her private and working life and of course especially taking into account your pilot context.
Questions you can ask yourself can be:

- How does her workday/week look like? In which company/division/etc does the person work? How?
- Which interests does the person have (both with regard to her job and to her private life)?
- How long hours does she work? What about work-life balance?
- What needs does the person have? Is she satisfied with her job, her environment, her family

life etc?

- Which values does she have and how is this reflected in her professional and private life?
- What would she like to further develop (aspirations)?

We would recommend taking a future-friendly/-positive and technology-embracing attitude when thinking about your future persona as we assume that the application/implementation of future Industry 4.0 technologies will by and large benefit companies, workers, society and the environment (if applied and framed accordingly).

Please use the categories shown in the persona profile table down below to complete the first part plus additional ones explicitly dedicated to future work/skills in the second part (again, please take note of the comments I have made on some categories).

FIT4FoF partner name:	
1) Overall persona description	
Name	
Profession	
Age	
Personal Background	
Interests	
Needs	
Values	
Powers	
Behaviors	
Aspirations	
2) Work-related persona description	
Company name (can be fictional or real) and location (city/country side)	
Work environment (including technologies/technical solutions)	
Tasks (what she does in her job)	
Skills he/she has (soft and hard skills; how she does her job)	
Skills he/she wants to acquire	
HOW and WHERE does he/she acquire these skills?	
How does she/her job contribute to protect the environment (sustainability/circular economy)?	
Challenges/opportunities (what works well in her job and what not so much)	

Annex 4: Complete Information from Pilot scenarios and personas

Below, the completed information for all pilot partners can be found describing the respective pilot scenario and persona.

1. Arctic – Gate To The Future-Factory

Name of organization	**Arctic S.A**
City/Country	Romania
Large-medium-small company	Large Company
High- or low- tech	High-tech
Main field of operation (car parts manufacturing etc)	White goods consumers
Main products/services sold	Washing Machines
Main technologies used	MES (manufacturing execution system), SAP
Example(s) of integration of (high-)tech into production process	Collaborative Robots, Smart Sampling
Skills level of personnel	medium
High or low need of upskilling of personnel	high
(Types of) upskilling/reskilling activities/programmes implemented at present (not detailed but overview is sufficient)	Qualification of the operators on the spot; Main qualification are cooling system operator, assembly operator, welder; Target is for 660 operators/y2023 ➔ Both existing and new personnel
Other relevant aspects of your pilot that come to your mind which we should take into account	Smart matching human – MES tablet

FIT4FoF partner name:	ARCTIC
1. **Overall persona description**	
Name	Eva Popescu
Profession	Technical abilities / digital interaction
Age	25-35
Personal Background	Married, 2 kids
Interests	Personal development in the new technology field
Needs	Clean and no stress environment
Values	Respectful and learning needs
Powers	Energy, team player
Behaviors	Calm, patience and oriented to details
Aspirations	Grow, Respect, Lead
2. **Work-related persona description**	
Company name (can be fictional or real) and location (city/country side)	Gate to the future factory/ Romania
Work environment (including technologies/technical solutions)	Green environment, flexible location, artificial intelligence
Tasks (what she does in her job)	Control automated productivity

Skills he/she has (soft and hard skills; how she does her job)	Connectivity, digital mentality, Data evaluation
Skills he/she wants to acquire	Automated assembly Man-machine interaction Safety systems Communication Teamwork Change management Problem-solving Workplace management
HOW and WHERE does he/she acquire these skills?	Working/ Enjoying the time in 4.0 factory In-house on the spot training done by existing personnel
How does she/her job contribute to protect the environment (sustainability/circular economy)?	As production efficiency rise, the energy consumption/product decrease. Increase quality can give longer live of the product. A product which is friendly with the environment.
Challenges/opportunities (what works well in her job and what not so much)	Opportunities like working in clean factories with flexible time from anywhere. Challenge to keep artificial intelligence on human side. Make operators continuously communicate with IT and what they need to do his/her job better. Because much worker shortage their needs need to be taken into account.

2. Boston Scientific Limited

Name, age	Peter O Neil, 30
Profession	Product Builder
Company name, Industry sector	Boston Scientific, medical technology
Work environment	Manufacturing medical devices using a combination of manual and automation enabled technologies. A Cobotics approach.
Existing Skills	Manufacturing assembly Problem solving Critical Thinking Quality focus – attention to detail Verbal & written communication skills Organisational and planning Intermediate PC Skills Team Collaboration
Skills to be acquired	Understanding a Digital Factory and the Internet of Things (IoT) Basic Computer Hardware skills Basic Computer Software skills Understanding basic Systems – Automation, Robotics and Security
Upskilling activities	Classroom training - Academic

	On the job training
Employee's challenges/opportunities	Automation is not confined to one particular area, it is cross functional. We automate where it makes sense. Employees need to deal with a broad range of different tasks and challenges, thus upskilling needs to be done in many different areas. These are skills that the organisation needs

Product Builder Automation Profile

- Dancers not wrestlers!
- Not afraid to embrace new technology. No fear of the machine.
- Curious about computer hardware
- Prerequisites for success:
  - Problem Solving orientation
  - Patience, tolerance with the machine
  - Mechanical aptitude

- Training Requirements and previous experience
  - Previous experience (Encore assembly)
  - On the job training: Go See / Shadowing
  - Captured learning– how do we build tacit knowledge?
  - Mechanics of the machine: Product Builders need to be involved in installation
  - Vendor training on the machine for classroom based / OJT

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3. CEAGA - AutoComponents

Name of organization	**AutoComponents, s.l**
City/Country	Vigo (Spain)
Large-medium-small company	Medium size industrial plant, belonging to a international big company
High- or low- tech	Medium-High Tech
Main field of operation (car parts manufacturing etc)	Car parts, tier1 provider.
Main products/services sold	seat fillings
Main technologies used	Manufacture of polyurethane components. Foam production (producing their own raw material).
Example(s) of integration of (high)tech into production process	Improvements in the foam filler manufacturing processes by using innovative chemical formulations. Incorporation of embedded sensors (still basic level, testing and piloting). Smart materials application (test phase).

	Big data analytics of both, the production process and the product through its whole lifecycle. Modelling (Digital twin of the production process and logistics) Rapid prototyping (3D printing and VR) Human Machine interaction (HighTech wearables and AR systems) Cobots and exoesceletons. Artificial Vision to ensure quality.
Skills level of personnel	The minimum level required for new hires is EQF 4.
High or low need of upskilling of personnel	Senior (older) workers with qualification level under 4 and/or difficulties to adapt to new technologies go through a reskilling programme. Younger workers are more qualified. All the staff participates in the company's upskilling training program, which is reviewed on an annual basis.
(Types of) upskilling/reskilling activities/programmes implemented at present (not detailed but overview is sufficient)	The main training activities are: • Technical training given by the technology providers on new systems/equipments ad hoc. • Online training, permanently available to all employees, through a platform containing: technology trends and KETs' skills, soft skills and English language. • On the job training (for new hires and new processes and products) using AR and VR. • Face to face workshops and courses, based on the regular assessment of skill gaps.
Other relevant aspects of your pilot that come to your mind which we should take into account	All employees go through the training programme "Professional of the Factory of the Future", which evolved from the Fit4FoF pilot. It combines: on-class training, demonstrations and complementary online materials.

FIT4FoF partner name:	**CEAGA**
1. **Overall persona description**	
Name	Laura López
Profession	Production Tech Operator (not called operator any more)
Age	25
Personal Background	Laura was born in Ourense but currently lives in Vigo (Spain) with her partner and their two years old son. After finishing secondary school, she studied Automation and industrial robotics on Dual format (vocational training).
Interests	Outdoor activities in general
Needs	Worklife balance is a key element since his partner travels frecuently and they don't have family support nearby.
Values	Living in harmony and close contact with nature and caring for the ecosystem.
Powers	Multitasking, strong interpersonal skills and leadership.

Behaviors	Laura is not afraid of speaking up and does not avoid conflict. This, combined with her integrity and good will, has gained her the respect of peers and management.
Aspirations	Laura is not ambitious when it comes to her professional life. However, she likes her job and doesn´t want to lose employability or development opportunities, that is why she strives for continuous learning.
2. **Work-related persona description**	
Company name (can be fictional or real) and location (city/country side)	AutoComponents, s.l
Work environment (including technologies/technical solutions)	Laura works in an almost fully automated environment. The very few operations that are still manual, are supported by cognitive and physical equipment (HMI and exosceletons). All the remaining production processes are carried out by robots with the support and supervision of qualified operators and engineers. Artificial vision is implemented in all lines for quality assurance purposes; VR is widely used, mostly for training purposes, AR supports most of the maintenance operations; All the process activities, as well as the product delivered, is monitored with sensors that feed big data systems.
Tasks (what she does in her job)	Job role: Technical operator As a result of the increase in technical complexity and of processes' automation, the role of Technical operator has evolved and broadened as follows: • Robot programming and operating supervision. • Production planning adjustments for the lines under supervision, based on the demand fluctuations. • Autonomous preventive and corrective maintenance, with remote support from Maintenance engineers (using VR). • Reporting for predictive maintenance, based on the analysis of data obtained from sensors. • Quality supervision based in the data obtained through Artificial Vision and other KETs. • Production analysis and reporting.
Skills he/she has (soft and hard skills; how she does her job)	Hard skills: robots programming, HMI handling (not only using but also setting-up and customizing), Data analysis software handling. Soft skills: ability to communicate, data analysis and decision making, continuous improvement mindset and learnability.
Skills he/she wants to acquire	All the evolutions to the KETs that she currently manages as well as all the new technologies to come into the automotive production environment. AI, programming Ensure compliance with standards Measures to ensure energy efficiency, waste reduction and re-use
HOW and WHERE does he/she acquire these skills?	Training delivered by the machines and KETs providers. Machine providers are becoming training providers,

	regular remote assistance and training, support from providers will be more needed than today. High-skilled employees will be able to train other employees. Training offered through the company's online campus. On the job training delivered by internal staff. MOOCs Immersive training systems (VR/AR/MR)
How does she/her job contribute to protect the environment (sustainability/circular economy)?	She has to ensure compliance with SQDCME standards (security, quality, delivery, cost, morale and environment) for the section under her supervision. The last element's KPIs (environment) are increasingly important. She has to adopt measures to ensure energy efficiency, waste reduction and reuse, etc.
Challenges/opportunities (what works well in her job and what not so much)	She has the opportunity of continuous learning by working in a high-tech environment in constant evolution. Some of her colleagues, though, struggle to remain up to speed.

4. LEA-CFI – Modis

Name of organization	**Modis France**
City/Country	Paris / France
Large-medium-small company	Large
High- or low- tech	High
Main field of operation (car parts manufacturing etc)	Modis is a staffing solutions company offering services across Information Technology, Engineering and Life Sciences sectors.
Main products/services sold	AI and Data Analytics solutions
Main technologies used	AI (Machine Learning, Deep Learning, NLP), Big Data, IoT
Example(s) of integration of (high-)tech into production process	• Design of a Machine Learning based solution, for our customer DPD group specialized on Parcel Delivery. During this project, we use Machine Learning algorithms to predict if the parcel delivery will be on delay or not. The aim of this use case is to have a proactive approach, to inform DPD customers in case of delay of their parcel delivery. • Design of a Deep Learning based solution, for our customer Orange France. The aim of this solution is to predict the number of future calls for the next 7 days, on Orange's Intelligent Network platforms. • Design of NLP and Machine Learning based solution for Adecco groups. The aim of this solution is matching job descriptions to candidate's resumes with more accuracy using AI algorithms. • Design of Deep Learning based solution for Paul Sabatier University Toulouse France. The main idea of this project is to implement an intelligent classification and recommendation system for the image database of the university. This tool is to be used by university' researchers during their R&D projects.
Skills level of personnel	Data Analysts, Data Engineers and Data Scientists

High or low need of upskilling of personnel	High need of upskilling personnel.
(Types of) upskilling/reskilling activities/programmes implemented at present (not detailed but overview is sufficient)	• Upskilling on Big Data tools needed for DPD's project. The IT environment and Databases used by the customer are different of those usually used by our Data Team. Therefore, it was necessary to quickly upskill the team on those tools. • Upskilling our Data team is necessary in the Adecco project context, because the team have only academics knowledge of NLP algorithms. Thus, our data scientists need advanced training for this project to be able to meet the customer requirements. • We need to upskill the team on graphical databases.
Other relevant aspects of your pilot that come to your mind which we should take into account	we created the datalab team within our company less than a year ago. The learning-by-doing approach enabled us to quickly increase the skills of our employees. As mentioned above, we currently producing several AI and Data projects for our customers. We are victim of our own success, the current team size is no longer sufficient to manage all the projects we have underway. We are therefore in the process of Hiring various data profiles. 2 new Data Scientists and 1 Data Analyst will join us next month. ICoED method will be used during training process.

FIT4FoF partner name:	
1. **Overall persona description**	
Name	Yousry
Profession	Data Engineer
Age	27
Personal Background	Team spirit, learning by doing attitude, curious
Interests	Reading, trips, cinema
Needs	
Values	
Powers	
Behaviors	
Aspirations	
2. **Work-related persona description**	
Company name (can be fictional or real) and location (city/country side)	Modis France (Hiring process ongoing)
Work environment (including technologies/technical solutions)	Data Analytics (Data engineering, Data Science) : • Apache Spark • MangoDB • Neo4j • InfluxDB • Openstack swift

	• Flask • Machine Learning • Deep Learning • Neuronal networks • Docker, Kubernetes • Jupyter (Hub, Lab, Notebook) • Gitlab • Kafka • Apache Streaming • S3 Storage • Cassandra Data Base • Tensorflow, • Keras, • PySpark, • Python • DataLake
Tasks (what she does in her job)	Data Engineering tasks: • Setting up a pipelines for data extraction and data transformation, • Data cleaning and analysis, • Machine Learning environment preparation in big data context, • Setting up a ML and DL testing pipelines • Deployment of Machine Learning and Deep Learning models
Skills he/she has (soft and hard skills; how she does her job)	Data engineering skills,
Skills he/she wants to acquire	Data Science skills Upskilled to data scientist (design/model machine/deep learning systems) Able to explore data
HOW and WHERE does he/she acquire these skills?	Academic degree, certified training, internal projects to do tasks more efficiently, e.g. upskilling to data scientist (learning by doing)
How does she/her job contribute to protect the environment (sustainability/circular economy)?	She will participate to implement AI solutions; conventional neural networks-based systems, which help to protect the environment. For example: She will use Convolutional neural networks for categorizing and classifying images of ecosystems
Challenges/opportunities (what works well in her job and what not so much)	What works well: • Upskilling of data engineering technologies and tools; • Be able to perform in a new data engineering environment What not works well: • Some teamwork failures: ineffective communication with the team, which can cause a loss of knowledge Challenges: • Upskilling on Data Science technologies to be able to design Machine Learning, Deep Learning Models.

5. IPB – Catraport

Name of organization	**CATRAPORT**
City/Country	Bragança / Portugal
Large-medium-small company	SME
High- or low- tech	High
Main field of operation (car parts manufacturing etc)	Metal stamping factory that produces components for automotive industry
Main products/services sold	Components for automotive industry, particularly exhaust system parts.
Main technologies used	4 punching machines which produce either through a progressive or transfer process the parts (2 with 400 tons capacity, 1 with a capacity of 600 tons and 1 with 1.000 tons) 2 manual punching machines for mechanical assembly, 1 washing tunnel, 1 welding cell, 1 cutting cell.
Example(s) of integration of (high-)tech into production process	Use of 1 cobot to support lean manufacturing in one composite cell made of the cutting machine + 1 manual punching machine. Use of fully automated transfer and progressive process in punching machines.
Skills level of personnel	Low-skilled workers (manufacturing and logistics operators). Intermediate-skilled workers (manufacturing and logistics technicians). High-skilled workers (maintenance technicians, gap leaders, shift supervisors, quality technicians).
High or low need of upskilling of personnel	High need of upskilling of personnel due to the following aspects: • Young and motivated team, with a very good technical background but lacking on specific education and skills on Industry 4.0 technologies. • Automotive sector is moving fast to Industry 4.0 and to be competitive it is necessary to adapt. • Quality, productivity and maintenance are deeply impacted by Industry 4.0. • CATRAPORT strongly believes that Industry 4.0 is centered on the human factor and this requires the upskilling of soft skills.
(Types of) upskilling/reskilling activities/programmes implemented at present (not detailed but overview is sufficient)	Training on hydraulics, pneumatics and electromechanics. Training on CNC machines. Training on Lean manufacturing.
Other relevant aspects of your pilot that come to your mind which we should take into account	CATRAPORT believes that, for some years, Industry 4.0 needs to live with “traditional manufacturing”, but recognizes the need to adapt in some ways to the new needs from Industry 4.0 and therefore adopt upskilling programs. Some current job roles in CATRAPORT will also need to evolve and incorporate new responsibilities in the area of AI moving the technician focus to monitor and control the production.

Reflection on the Catraport pilot by 2030

The production scenario for CATRAPORT will be completely different from the one of today, in fact by that date most probably the need to produce exhaust systems parts for cars will be residual. The transition to structural parts for seats, battery containers and to different types of metals as aluminum already started in the Italian plants, but it will soon start in the CATRAPORT plant (estimated for 2023-2024).
The change of produced products (particularly due to the new type of metal) requires the need to update the current production technology, namely the pressing machines.
In addition, starting next year, a second plant, focusing mainly on assembly and logistics, is being installed.

This big change in the CATRAPORT footprint, will require:

- The need to at least double the workforce.
- The need to look for new job profiles from a pure mechanical job profiles to electro-mechanical job profiles since more and more equipment incorporate significant electronics compared to the mechanical parts.
- The need to upskill the existing workforce towards the same type of electro-mechanical skills.
- Due to the expansion and the focus on the assembly and logistics, it will be required people with assembly skills and logistic skills.
- The expansion and the added complexity of the company will require to upskill technicians with some digital skills, e.g., Internet of Things, Artificial Intelligence, Human-Machine Interfaces and Virtual Reality, as well as managers and supervisors to be able to handle bigger complexity (soft skills).

FIT4FoF partner name:	**IPB**
1. **Overall persona description**	
Name	**Mary Doe**
Profession	Production Technician 4.0 /(at the moment: operator for the production)
Age	28
Personal Background	Mary is a young woman from Bragança. Mary has 2 kids (a boy and a girl), has a bachelor degree in Electrical Engineering and works at Catraport as a Production Technician 4.0.
Interests	Mary likes to travel across the country, to be with her family, and to run with her motorcycle. She also likes to play chess with her husband.
Needs	Mary needs to feel happy with her family, but also in her work. For her, it is essential to have a good work environment.
Values	Mary is honest, likes to help people around her, including work colleagues, and share her knowledge.
Powers	5 years' experience at the Maintenance Department in the automotive industry.
Behaviors	Mary takes care of her family (with the help of her husband), listen some music, plays with her kids and actually she is starting a Master degree in Industrial Engineering to improve her knowledge.
Aspirations	Mary aspires a Better World for everybody. A world where all can be HAPPY!

2. **Work-related persona description**	
Company name (can be fictional or real) and location (city/country side)	CATRAPORT, Bragança, Portugal
Work environment (including technologies/technical solutions)	Shop floor of the company. Responsible for maintaining the stamping press cells in a fast-paced production environment and keeping the stamping presses and related equipment functional and performing all required preventive maintenance work on time.
Tasks (what she does in her job) in operating the works station	• Assures the specific quality guidelines are met and, if necessary, takes appropriate actions and measures to rectify quality issues. • Maintains a safe and clean work area. • Keeps the assigned stamping press in an operational and running condition. • Troubleshoots equipment issues, analyzes the issue, identifies root cause and implements countermeasure. • Performs and documents preventive maintenance duties. • Operates a transfer/progressive press and understands the related press, transfer, progressive and auxiliary equipment controls. • Operates specific cranes needed to safely perform work duties. • Operates industrial power truck needed to safely perform work duties. • Trains less experienced technicians. • Responsible for reporting and/or repairing equipment problems. • Loads and aligns blank stacks to de-stacker. • Follows all guidelines set forth in our 5s training (-> lean). • Other duties and responsibilities can be assigned based on company needs and skills level.
Skills he/she has (soft and hard skills; how she does her job), rather basic	• Experience in the automotive industry. • Experience on PC and PLC but also on electro-mechanics, pneumatics, hydraulics. • Industrial electrical knowledge. • Working knowledge of PLCs. • Capable to interact with smart sensors and IoT technologies (smart sensors, IoT, data analytics), only in sense of user interaction not in terms of programming. • Self-Management: ability to display a high level of initiative, effort, and commitment towards completing assignments in a timely manner. • Sound understanding of Safety, Environment, Health and Quality requirements. • Working knowledge of processes. • Basic computer skills (i.e. Microsoft Word, Excel) • Excellent communication skills, both written and verbal.

	• Troubleshooting skills.
Skills he/she wants to acquire, mainly to gather knowledge on predictive maintenance	• Enriched with real-time systems and sensors (real-time systems, sensors, control system, digital twin). • Responsible for ensuring the security and reliability of the industrial process, monitoring the smart machine's operation, as well as diagnosing and detecting failures automatically through data analysis collected from data sources, Machine Learning algorithms and IoT technologies (ML, smart machines and sensors, fault tolerance, deep learning). • Responsible to apply condition-based monitoring and health assessment in smart machines and systems (condition-based maintenance optimization, health state estimation and rule prediction, robotics and systems development). • Effective problem solving and decision-making skills. • Ability to handle multi-tasks and changing priorities. • Works well in a team environment.
HOW and WHERE does he/she acquire these skills?	Master degree in Industrial Engineering (2 years), Specific Technical courses (online), etc.
How does she/her job contribute to protect the environment (sustainability/circular economy)?	High attention to energy consumption and optimization of the work to reduce at the minimum any type of waste. Continuous 5S+S in her work cell -> lean.
Challenges/opportunities (what works well in her job and what not so much)	The continuous growing/learning of the technology is at the same time a challenge and an opportunity for her. Her capacity to interact with data driven decisions is excellent but at the same time the fact the majority of the alarms are due to electronic failures request from her a continuous learning on new technologies.

6. UCN – Tekavia

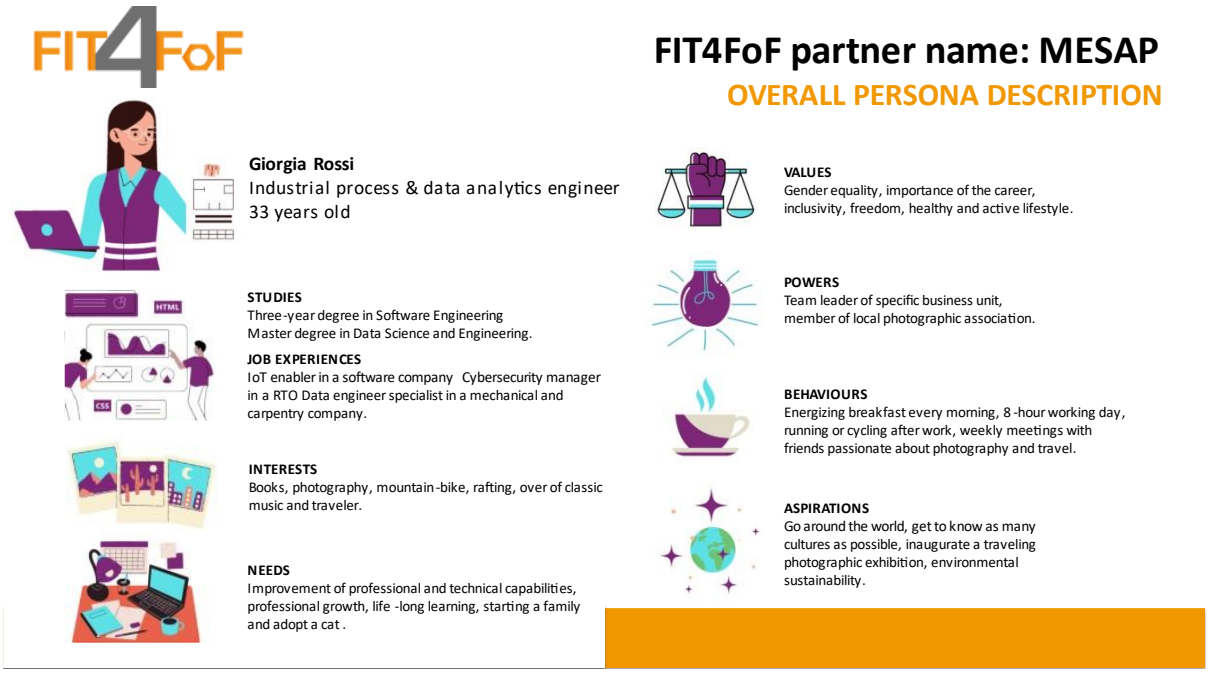
1. Overall persona description	
Name	Preben Jensen
Profession	Skilled Machine Worker
Age	56
Personal Background	Worked in the company for 22 years
Interests	Cycling (and watching football on TV)
Needs	Stable job and income
Values	Proud of his technical skills and education as machine worker; Wants to deliver quality for customers; Likes to help newcomers into the company.
Powers	Very strong technical skills on metal milling
Behaviors	Never ill, never skipping work, always working hard
Aspirations	Just wants to be a stable employee
2. Work-related persona description	

Company name	TEKAVIA (Fictive – but based on actual)
Work environment	Friction welding and metal milling CNC machines; sensors embedded and connected wirelessly to the MES System; digital twin running in the production planning division; up/down time and other productivity measures are presented at screens around the company
Job-related tasks	Feeding the machines and making sure all machines are running to maximize productivity; manually or using collaborative Universal Robots to bin pick and feed machine (CNC & welding); monitoring the screens to ensure optimum capacities and alerting on potential bottle necks.
Skills he/she has (soft and hard)	**Hard skills:** Deep knowledge to metal processing Programming of collaborative robot (UR robot) Understanding the complexity of internal value chain Understanding meaning and use of big data **Soft Skills:** Collaboration; Change processes; Problem solving; Critical thinking.
Skills he/she wants to acquire	Production planning (optimizing value chain); Better use of cobots (new functions, easier programming etc.); Use of plug'n play sensors to better capture data.
HOW and WHERE does he/she acquire these skills?	Twice a year the local educational institution challenges the processes in the company. Based on this, a competence plan for the staff is developed. Preben and his manager "sign" the plan and use it as a blueprint for Prebens future upskilling journey using the renowned ICoED Method™.
How does she/her job contribute to protect the environment?	Prebens company is CO2 neutral and all processes are being optimized to meet this goal. All waste from the company is being recycled in an industrial symbiosis program supported by the Municipality of Aalborg. The use of data ensures full traceability of all products coming out of the company.
Challenges/opportunities	It is hard for Preben to understand the new ICT programs and technologies. But he had learned and is being trained to work with younger colleagues with better ICT competencies and he now understands how ICT is affecting the metal processes which he masters in the company

7. MESAP - MTS

Name of organization	**Meccanica Tonel Sergio S.r.l. (MTS)**
City/Country	Bosconero (Turin) - Italy
Large-medium-small company	Medium Company
High- or low- tech	Low-Tech
Main field of operation (car parts manufacturing etc)	Manufacturing of industrial machineries and industrial carpentry
Main products/services sold	Production of mechanical and carpentry parts through the following production processes: Material cutting, bending

	– cold blanking, welding, milling, turning, sandblasting and painting
Main technologies used	Industry 4.0, IIoT enabling technologies, lean production, Instrumental mechanics and industrial carpentry
Example(s) of integration of (high-)tech into production process	-
Skills level of personnel	High specialized skilled workers
High or low need of upskilling of personnel	High
(Types of) upskilling/reskilling activities/programmes implemented at present (not detailed but overview is sufficient)	• Industry4.0 • IIoT enabling technologies • Lean production
Other relevant aspects of your pilot that come to your mind which we should take into account	Pilot training modules will start in September 2021. The training framework was defined thanks to the ICoED methodology.



FIT4FoF partner name: MESAP

WORK-RELATED PERSONA DESCRIPTION

COMPANY NAME

M.T.S. S.r.l.- Italy

WORK ENVIRONMENT

Stimulating work environment, co-working areas and spaces dedicated to team building.

Industry 4.0 characterized by autonomy, interoperability, data-driven business models and sustainability.

Digitisation, Artificial and Human intelligence, autonomous driving of manufacturing, smart materials, integration of physical and virtual worlds.

TASKS

Project management, analyzing data, data visualization, designing models and algorithms, forecast future performance.

SKILLS

Hardskills: project management improvement, machine learning, software architecture.

Softskills: multidisciplinarity , handling change, creative thinking, work-life balance, managing change.

HOW & WHERE DOES SHE ACQUIRE THESE SKILLS

Academic training and life -long learning programmes on the job, learning by doing, experience on the field.

HOW HER WORK CONTRIBUTE TO THE ENVIRONMENT

Stimulating work environment, co-working areas and spaces Use of analytics with circular strategies to achieve incremental efficiency towards a more sustainable and circular economy.

CHALLENGES/OPPORTUNITIES

Strenght: IoT expert, cybersecurity management

Weak: budgeting, customer relationships

FIT4FoF partner name:	**MESAP Innovation Cluster**
1. Overall persona description	
Name	Giorgia Rossi
Profession	Industrial process data analytics engineer
Age	33
Personal Background	Studies: Three-year degree in Software Engineering Master degree in Data Science and Engineering Job experiences: IoT enabler in a software company Cybersecurity manager in a RTO RTOs are important for collaboration and to transfer skills to companies Data engineer specialist in a mechanical and carpentry company
Interests	Books, photography, mountain-bike, rafting, lover of classic music and traveler
Needs	Improvement of professional and technical capabilities, professional growth, life-long learning, starting a family and adopt a cat
Values	Gender equality, importance of the career, inclusivity, freedom, healthy and active lifestyle
Powers	Team leader of specific business unit, member of local photographic association
Behaviors	Energizing breakfast every morning, 8-hour working day, running or cycling after work, weekly meetings with friends passionate about photography and travel

Aspirations	Go around the world, get to know as many cultures as possible, inaugurate a traveling photographic exhibition, environmental sustainability
2. **Work-related persona description**	
Company name (can be fictional or real) and location (city/country side)	M.T.S. S.r.l. - Italy
Work environment (including technologies/technical solutions)	Manage data and from this data build knowledge. Data: have a gold mine and have another company exploit your gold mine -> cooperation with company to utilize data Stimulating work environment, co-working areas and spaces dedicated to team building. Industry 4.0 characterized by autonomy, interoperability, data-driven business models and sustainability. Digitisation, Artificial and Human intelligence, autonomous driving of manufacturing, smart materials, integration of physical and virtual worlds
Tasks (what she does in her job)	Project management, analyzing data, data visualization, designing models and algorithms, forecast future performance
Skills he/she has (soft and hard skills; how she does her job)	Hardskills: project management, data analytics, data visualization, AI Softskills: teamwork, cross-domain, collaboration, critical thinking, work-life balance
Skills he/she wants to acquire	Hardskills: project management improvement, machine learning, software architecture Softskills (very important): multidisciplinarity, handling change, creative thinking, work-life balance, managing change
HOW and WHERE does he/she acquire these skills?	Academic training and life-long learning programmes on the job, learning by doing, experience on the field
How does she/her job contribute to protect the environment (sustainability/circular economy)?	Use of analytics with circular strategies to achieve incremental efficiency towards a more sustainable and circular economy.
Challenges/opportunities (what works well in her job and what not so much)	Strength: IoT expert, cybersecurity management Weakness: budgeting, customer relationships ➔ In SMEs, people need to deal with all/ a lot of different topics