

Expert workshop on “Reshaping on-the-job training for Advanced Manufacturing: 21st Century Strategy, Collaboration Patterns and Learning Environment”

Curriculum Guidelines for Key Enabling Technologies (KETs) and Advanced Manufacturing Technologies (AMT)

WORKSHOP REPORT

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Table of contents

Table of contents	3
Executive summary	4
1. Introduction	5
1.1. Workshop context, rationale and objectives, Kristina Dervojeda, PwC (Netherlands)	5
2. Reshaping on-the-job training for Advanced Manufacturing: Towards future-proof organisations	7
2.1. Key takeaways from Hannover Messe 2019, Kristina Dervojeda, PwC (Netherlands)	7
2.2. Curriculum Guidelines Analytical Framework, Kristina Dervojeda, PwC (Netherlands)	7
3. 21st Century Strategy, Collaboration Patterns and Learning Environment (Part 1)	9
3.1. Life-long learning and industrial needs of manufacturing sector, Minna Lanz, Tampere University (Finland)	9
3.2. The role of mentoring in inter-generational knowledge transfer and on-the-job training, Emir Demircan, SEMI-Europe (Belgium)	9
3.3. The Learning Garage at KU Leuven as an interdisciplinary platform for learning by doing, Peter Verbist, AGORA Learning Centre, KU Leuven (Belgium)	10
3.4. Galicia 2030: Professional profiles for the future and new university degrees and specialisations, Lucia Franco, FEUGA (Spain)	10
3.5. Discussion and feedback of participants	11
4. 21st Century Strategy, Collaboration Patterns and Learning Environment (Part 2)	12
4.1. Standards as Enablers of Innovation: ASTM International & Smart/Advanced Manufacturing good practice examples and suggestions to the three elements of the AMT-related education & training system, Pat Picariello, ASTM (United States)	12
4.2. MEMEVET: Engaging companies to develop Mechatronics CV, Fadia Khraisat, EU Desk of the Italian Chamber of Commerce in Madrid (Spain)	12
4.3. LbyT Learning by Teaching solution for companies, Giovanni Crisona, CSCS - skillman.eu (Italy)	13
4.4. Future Work Lab – Digital Technologies and Assistance Systems in the Workplace of the Future, Simon Schumacher/Ahmad Issa, Fraunhofer Institute for Manufacturing Engineering and Automation IPA (Germany)	13
4.5. Digital Catalyst Programme, Asif Moghal, Autodesk (United Kingdom)	14
4.6. Discussion and feedback of participants	14
5. Wrapping up: Towards detailed proposals for curriculum guidelines	15
5.1. Towards detailed proposals for curriculum guidelines	15
5.2. Next steps	15
Annex A: Workshop agenda	16
Annex B: Workshop participants	18

Executive summary

This document summarises the key points discussed at the fifth expert workshop focussing on “Reshaping on-the-job training for Advanced Manufacturing: 21st Century Strategy, Collaboration Patterns and Learning Environment”, organised in the context of the “Curriculum Guidelines for KETs and AMT” initiative of the European Commission.

The results of our pan-European online survey indicated that the three elements of the AMT-related education & training system that require the most substantial change include Strategy, Collaboration, and Learning Environment. The workshop aimed to specifically focus on these three elements in the context of on-the-job training for Advanced Manufacturing. The workshop featured good practice examples and suggestions for specific measures and solutions for EU/national policy makers, education & training providers and other key stakeholder groups.

The outcome of the workshop will be used for shaping the curriculum guidelines for the EU education & training providers active in the AMT domain for years to come. The curriculum guidelines will be highlighting the key points of attention when it comes to aligning the approach towards AMT education & training with the 21st Century needs. The guidelines will be developed based on the extensive state-of-play analysis and active stakeholder contribution.

The guidelines need to be applicable for both designing fundamentally new educational offers and/or advancing the existing curricula, depending on the level of required change. The objective is to offer educational and training institutions a source of inspiration, conceptual guidance and good practice examples.

The key outcomes of the discussion are as follows:

- Education cycles are increasingly getting shorter, and accreditation processes can hardly catch up.
- Learning and working should not be viewed as two separate processes.
- While learning & teaching factories represent promising solutions, a systematic approach is still missing.
- Co-creation and collaboration spaces prove to be effective, and there is a need for more initiatives supporting them.
- Collaboration can be challenging both due to strict competition between companies, and due to requirement of regional funding to focus on regional collaboration only.
- At the same time, several good practices show that integrating collaboration and interdisciplinary aspects in training is feasible. Training can thus also play important part in promoting innovation in European manufacturing.
- Digitalisation should not be viewed as a means to cut costs and displace workers, but as a means of enhancing worker’s creative capabilities and providing them with more time for value adding activities.
- Technology is less relevant; it is what one does with it that matters.
- Future initiatives need to address both the innovative forerunners with intrinsic motivation and the larger masses of workers, to close the skills gap. Achieving scalability and critical mass is crucial.

1. Introduction

This document represents a workshop report for the expert workshop on “Reshaping on-the-job training for Advanced Manufacturing: 21st Century Strategy, Collaboration Patterns and Learning Environment”. The workshop was organised in the context of the “Curriculum Guidelines for Key Enabling Technologies (KETs) and Advanced Manufacturing Technologies (AMT)” initiative (contract nr. EASME/COSME/2017/004), that is coordinated by PwC EU Services (PwC), under the auspices of the Executive Agency for Small and Medium-sized Enterprises (EASME) and the Directorate General for Internal Market, Industry, Entrepreneurship and SMEs (DG GROW) of the European Commission (the Commission). The workshop took place at Thon Hotel EU in Brussels (Belgium) on 7 May 2019. It is the fifth out of the six workshops that are foreseen in the context of the abovementioned initiative.



Figure 1-1 Participants of the workshop

The introduction session of the workshop included a brief presentation of the workshop context, rationale and objectives, as well as an introductory round of participants.

1.1. **Workshop context, rationale and objectives, Kristina Dervojeda, PwC (Netherlands)**

Dr. Kristina Dervojeda briefly addressed the context of the workshop, its rationale and objectives.

EASME and DG GROW of the European Commission have recently launched a new initiative for developing “**Curriculum Guidelines for Key Enabling Technologies (KETs) and Advanced Manufacturing Technologies (AMT)**”. This initiative aims to contribute to increasing the quality and relevance of existing curricula and to promote better cooperation between industry and education and training organisations in order to align AMT education and training with the 21st Century needs. It involves data collection and research, design of guidelines, testing and validation, taking into account industry and market needs and best practices, based on contributions from key stakeholder groups. The guidelines need to be applicable for both designing fundamentally new educational offers and/or advancing the existing curricula, depending on the level of required change. The initiative focusses on **VET, higher education and on-the-job training for AMT**.

The objective is to offer educational and training institutions a source of inspiration, conceptual guidance and good practice examples.

The outcome of this initiative will play a prominent role in forming the EU policy making regarding upskilling of the AMT workforce.

The **Interim Report** for this initiative has been published online¹. The Interim Report contains preliminary findings and conclusions elaborated during the first phase (January-November 2018) and is made public for stakeholder consultation, and specifically for collecting feedback and additional inputs that can be used in the second phase. The workshop participants were invited to provide their feedback on the report.

The results of our pan-European online survey (conducted in the end of 2018) indicated that **the three elements of the AMT-related education & training system that require the most substantial change include:**

- **Strategy:** What are promising strategies and conceptual principles for developing a 21st Century curriculum for Advanced Manufacturing? (including strategies for assessing learner's needs, developing curriculum goals and intended learning outcomes);
- **Collaboration:** What are promising collaboration practices for facilitating the exchange of knowledge and resources with a view to improve the educational offer for Advanced Manufacturing? (e.g. engaging companies throughout the whole curriculum development & implementation trajectory, empowering learners to collaborate with each other and with the institution and community etc.);
- **Learning environment:** What types of environment lead to the most effective learning for Advanced Manufacturing? (e.g. stimulating multidisciplinary orientation, design thinking, team spirit, collective problem-solving, risk-taking behaviour, experimental approaches etc.).

To this end, the current workshop aimed to specifically focus on these three elements. These elements were further explored in the context of **on-the-job training for Advanced Manufacturing**. The workshop particularly aimed to offer a discussion platform to address key challenges and actions that would need to be introduced at the EU level, and identifying best practices. This workshop brought together key practitioners, researchers and policy makers active in the field of AMT education & training in Europe. **The outcome of the workshop will be used for elaborating the curriculum guidelines for education & training providers** active in the AMT domain.

¹ The report is available on EU Publications at: <https://publications.europa.eu/en/publication-detail/-/publication/4dcaeee3-29c2-11e9-8d04-01aa75ed71a1/language-en/format-PDF/source-87225354>

2. Reshaping on-the-job training for Advanced Manufacturing: Towards future-proof organisations

The morning session of the workshop was continued by the presentation on key insights gathered in the context of on-the-job training.

2.1. Key takeaways from Hannover Messe 2019, Kristina Dervojeda, PwC (Netherlands)

Dr. Kristina Dervojeda shared key takeaways from Hannover Messe 2019. Hannover Messe is the world's leading trade fair addressing the future of manufacturing. In 2019 (1-5 April), it had more than 6,500 exhibitors and more than 220,000 visitors. This year, the key theme was “Integrated Industry – Industrial Intelligence”, focusing on digital networking between humans and machines in the age of Artificial Intelligence (AI). The fair underlined the growing importance of AI and machine learning in the production and energy industries, including such areas as energy efficiency and autonomous production processes, as well as challenges in terms of interfaces, protocols and security.

For many companies, Industry 4.0 is already an operational reality, not just a fuzzy vision. However, it is an evolving process and even forerunners report that they are “not completely there yet”. While both large and small companies drive the process, intensive inter-company collaboration is essential. Large companies are particularly reported to play a vital role in creating **Industry 4.0 ecosystems**, and mentioned examples were SAP Industry 4.0 Startup Programme and Solid Edge by Siemens.

A further evident trend reported at Hannover Messe is the **changing role of industry leaders** (Leaders 4.0). Their role is shifting towards facilitation rather than control. Hierarchies and centralised decision-making are increasingly being replaced by decentralised organisational structures, based on close cooperation between leaders and employees. It was also pointed out that younger generations tend to be much better in organising themselves when it comes to upskilling and exchanging experiences. When developing curriculum guidelines we must therefore consider differences between SMEs and sectors, but also between workers and learners.

Finally, success is hardly possible without failures, so occasional failure needs to be allowed. At the same time, **acceptance of failure should not be equated to tolerance for incompetence.**

2.2. Curriculum Guidelines Analytical Framework, Kristina Dervojeda, PwC (Netherlands)

Dr. Kristina Dervojeda also gave the workshop participants an update on the analytical framework for the curriculum guidelines and the relating insights gathered in the pan-European survey in the end of 2018.

The current initiative aims to produce curriculum guidelines for education & training organisations, highlighting the key points of attention and good practice examples, when it comes to aligning their approach with the 21st Century needs. The aim is to follow a holistic approach covering a broad spectrum of dimensions relevant to curriculum design and implementation. Specifically, the following eight dimensions will be considered by the analytical framework:

- (1) **Strategy:** defining core values, commitments, opportunities, resources and capabilities of an educational/training institution;
- (2) **Collaboration:** promoting practices that move beyond the typical institutional collaboration patterns and engaging individuals and communities;
- (3) **Content:** defining the nature of educational content, including specific principles related to the actual content of the curricula;
- (4) **Learning environment:** types of environment that is created during the program, e.g. stimulating multidisciplinary orientation, design thinking, team spirit, collective problem-solving, risk-taking behaviour, experimental approaches etc.;
- (5) **Delivery mechanisms:** means by which learners experience and access education/training; special attention to technology-enabled learning;
- (6) **Assessment:** identifying most appropriate forms of assessment, including advantages and disadvantages;
- (7) **Recognition:** exploring appropriate formal and informal ways of recognition;
- (8) **Quality:** identifying the determinants of education & training quality: what makes students' and employers' perception different?

The three key directions for action that according to the survey responders would be most impactful in stimulating the required change in the current education & training system, include the following:

- **Regularly updating the skills of teachers/trainers:** sending the educational personnel to companies to get insights into the latest developments, while inviting people from companies to regularly teach in the classroom;
- **Actively involving companies** in the development and implementation of education & training curricula, including the identification of desired learning outcomes, curricula design, actual teaching/training, assessment and recognition;
- **Promoting innovation in teaching/training:** rewarding educational institutions and teachers/trainers for introducing innovative approaches; embedding these aspects in the assessment schemes for both organisations and individuals.

These points were followed by the need to organise education & training around learners, i.e. developing education & training ecosystems where learners and their needs are put in the centre, with the focus on learning rather than teaching.

Finally, the **key types of content** that were suggested to be most valuable for the target group of the curriculum guidelines include good practice examples, key implementation challenges and possible solutions and conceptual curriculum design principles.

3.21st Century Strategy, Collaboration Patterns and Learning Environment (Part 1)

The morning session continued with specific presentations featuring good practice examples with regard to the 21st Century Strategy, Collaboration Patterns and Learning Environment. The session consisted of four presentations followed by a detailed discussion and feedback of participants.

3.1. *Life-long learning and industrial needs of manufacturing sector, Minna Lanz, Tampere University (Finland)*

Prof. Minna Lanz presented challenges of shorter re-education cycles and the emergence of learning factory initiatives to facilitate academia-industry collaboration.

As the introduction of new technologies is speeding up, the (re-)education cycles are shortening. While the modern information and communication technologies (ICT) allow us to shorten the development cycles, the end-result may not be fully validated before taking it into use. This severely affects the skills and the quality of re-education.

Previously, the educational institutes in the technology field could be relatively certain that the specific technologies they teach are still relevant after the students graduate, and have reasonably long lifetimes afterwards. Today, the cycle is short, especially for the ICT sector. The technologies taken into testing and production may not be mature enough. If we consider the timeline, this means that the educational institutes should have been familiar with the emerging technologies 5-10 years before industry in order to train capable workers. The ICT skills, problem solving skills and decision-making capability are not the only needs of the future; there is also a need for higher-order thinking and collaboration skills.

During the past decades, sets of continuous education concepts combining academia and industry efforts have emerged. The learning factories for education, training and research have been built up in industry and academia. In recent years, learning factory initiatives have been elevated from a local to a European and then to a worldwide level. For example, a fablab concept for robotics, **RoboLab Tampere**, has been established to facilitate the learning process for both formal and non-formal education, and academia-industry R&D&I collaboration. The RoboLab Tampere operates with similar principles as e.g. Fab Labs.

3.2. *The role of mentoring in inter-generational knowledge transfer and on-the-job training, Emir Demircan, SEMI-Europe (Belgium)*

Mr. Emir Demircan addressed the industry needs for a diverse, dynamic and talented workforce pipeline and the mentoring program initiated by SEMI-Europe to promote this development.

The semiconductor industry is growing, and the ICT sector is reported to create 120,000 new jobs each year. At the same time, the industry relies on a dynamic, diverse and global talent pipeline. Currently, 40% of companies have difficulties in finding ICT specialists, and skills in the domains of cybersecurity, AI & robotics, big data and analysis is reported to be particularly scarce. In addition, one can observe a lack of diversity and inclusion in the industry, with women being underrepresented already from the middle management level.

As a response to these challenges, SEMI has developed several workforce development initiatives and assembled a European Workforce Development Council. One key initiative that was launched is the **SEMI Mentoring Programme**. Mentoring has benefits to the individual, being more likely to make promotion and developing professional and leadership skills, and for the business, which creates a more dynamic and diverse talent pipeline and increase talent retention.

The Mentoring Programme matches mentors and mentees using algorithms to find best fit matches, and an online platform facilitate interaction and scheduling. Mentees are early in their career and receives mentoring in achieving their career goals. The programme was launched in July 2018 and have had more than 200 people enrolled to date with a high degree of satisfaction.

3.3. The Learning Garage at KU Leuven as an interdisciplinary platform for learning by doing, Peter Verbist, AGORA Learning Centre, KU Leuven (Belgium)

Mr. Peter Verbist presented the Learning Garage and how it promotes learning for motivated students and innovation in partnering companies.

The Learning Garage is an initiative by Cronos Leuven, Lcie and Agora Learning Centre KU Leuven, aiming to enable ambitious students with a passion for technology, innovation and entrepreneurship and intrinsic motivation to learn about digital technology regardless of their background. The goal is to develop a business idea using digital technology during four evenings.

The objective is to foster entrepreneurial skills, with special attention to students of Humanities and Social Sciences, to foster digital literacy in the format of learning by doing, and to set up a solid partnership between a learning community (university) and technology suppliers (society).

The feedback of all stakeholders is highly positive, and all modules are considered equally relevant. This appreciation proves a major point in active learning strategy: it is not about technology, it is not about spaces, it is about what you do with it.

3.4. Galicia 2030: Professional profiles for the future and new university degrees and specialisations, Lucia Franco, FEUGA (Spain)

Dr. Lucia Franco presented the FEUGA project on developing professional profiles for manufacturing and new university degrees and specialisations.

The Galician Enterprise University Foundation (FEUGA) is a non-profit foundation dedicated to fostering innovation and technology transfer in north-west Spain. The Galicia 2030 (Professional profiles for the future & new university degrees and specialisations, www.galicia2030.es) project, coordinated by FEUGA, aims to study the labour market in Galicia 2030, to develop a complete portfolio of professional profiles and to define a map with new degrees and specialisations at University level.

During the project, the definition of Portfolio of professional profiles (ending in May 2019) has followed three steps: research on global trends and the identification of future strategic sectors, identification of future occupations and analysis of the current offer of Galician University degrees and Development of the portfolio of future jobs. 19 trend reports, 22 sectorial reports and +150 experts in the working groups comprise the portfolio and mid-term conclusions. The latter suggest that an increment in graduated people (in STEM, social well-being and biotechnology sectors) is expected, along with an explicit need and interest from industry for transversal-disciplinary skills (SSH-STEM competences, soft skills, ICT).

A benchmark analysis from this portfolio and a preliminary definition of new degrees will lead to the definition of new degrees and specialisations for the Galician Universities in 2020. Design and planning of the roadmap

for its implementation will link the project's outputs with 'real world', leveraging the project results and broadening the multi-stakeholder approach of the study.

3.5. Discussion and feedback of participants

Dr. Kristina Dervojeda invited the workshop participants to express their feedback regarding the presentations given during the introductory session.

The key points of the discussion included the following:

- There is an extensive need for interdisciplinary teams in manufacturing. Interdisciplinary teams are shown to be beneficial to promote both learning and innovation. This aspect should be considered when developing learning environments.
- While collaboration is essential to re- and upskilling the AMT labour force, it proves to be difficult at multiple levels. SMEs can be highly competitive, and there is in general high competition in industry, therefore establishing working collaboration often requires extensive efforts. However, this might be a matter of changing a mind-set. In addition, nationally or regionally-funded initiatives are often required to seek local collaboration rather than seeking international good practices, thereby hindering international collaboration.
- Shorter re-education cycles represent a key challenge for the workforce, employers and for education & training providers. For education & training providers, updating curriculum requires great effort. However, these actors cannot succeed in tackling this challenge if regulatory and accreditation authorities are not adapting to a changing world quickly enough. Accreditation processes must be shortened, and particularly in VET, there is a large variety in national approaches to accreditation of courses and training providers.
- For learners, employers and education & training providers, it becomes increasingly difficult to assess the maturity of particular technologies, and to distinguish between the hypes vs. long-term developments that are key for remaining competitive in the future.
- Learning to learn, soft skills and problem solving have been pointed out as becoming increasingly more important. These skills enable easier adoption of new technologies, and promote worker-driven improvement. At the same time, for employers, learning is considered an investment and it needs to have evident relation to work-related challenges.
- The objective of on-the-job training is not learning for the sake of learning, but rather learning as a means to develop capabilities to do work-related tasks differently or to do different tasks.
- The motivation of learners was also discussed. It was argued that 'a regular student/worker is lazy and will not learn unless it is compulsory' and that 'ambitious and intrinsically motivated learners boost innovation in SMEs'. There is a need for a holistic approach addressing different types of learners.
- For some initiatives, achieving scale appears to be challenging. While there are several reasons, limited resources and dedicated responsibility for coordination seem to be the key barriers.

4.21st Century Strategy, Collaboration Patterns and Learning Environment (Part 2)

The afternoon session continued with specific presentations featuring good practice examples with regard to the 21st Century Strategy, Collaboration Patterns and Learning Environment. The session consisted of five presentations followed by a detailed discussion and feedback of participants.

4.1. Standards as Enablers of Innovation: ASTM International & Smart/Advanced Manufacturing good practice examples and suggestions to the three elements of the AMT-related education & training system, Pat Picariello, ASTM (United States)

Mr. Pat Picariello presented how standards can enable innovation, and demonstrated the ASTM education and workforce development (E&WD) model.

Standards are essential to accelerating the widespread commercialisation of new technologies in the global manufacturing industry. In recent years, government and private sector partners have made significant investments in strengthening the competitiveness of manufacturing. To ensure these investments yield returns as quickly as possible, industries must strive to provide an optimal environment to foster the evolution of on the job training by aligning technology and global industry standards as they pursue the fastest path to commercialisation.

Establishing international standards in fields in which technology is advancing rapidly is not easy. In keeping with the observation that the three elements of the AMT-related education & training system that require the most substantial change include strategy, collaboration, & learning environment, partnerships with experts in standards development organisations (SDOs), such as ASTM International, offer a promising opportunity for newly forming institutes, centres of excellence (CoEs), and other research hubs. In particular, ASTM's Additive Manufacturing (AM) CoE created an education and workforce development (E&WD) model that has a dedicated team of experts in the field in order to develop various educational offerings and personnel certification programs. As a result of a sizeable landscape analysis and various road mapping exercises, ASTM has identified large gaps in the AM community, with the lack of robust offerings evident. The material in the accompanying slide deck highlights ASTM's efforts to fill the gaps via education & incorporation of ASTM's consensus philosophy & process.

4.2. MEMEVET: Engaging companies to develop Mechatronics CV, Fadia Khraisat, EU Desk of the Italian Chamber of Commerce in Madrid (Spain)

Ms. Fadia Khraisat presented the importance of collaboration between enterprises and the VET system to create professional profiles that respond to the requirements of labour market and in that way contribute to growth and jobs in line with Europe 2020 Strategy.

MEMEVET (www.memevet.eu) is a project financed under Erasmus+ programme, Sector Skills Alliance action. Currently the following countries are involved: Germany, Spain, Italy, Slovakia and Bulgaria. There is a need to better align profiles used in education and training with industry requirements, ensure recognition of soft skills, ensure mobility of students and workers in the manufacturing sector, meet high demand of specialised profiles and develop measures for fast-track integration into labour market. Therefore, MEMEVET project fosters the

creation of a suitable environment, in which representatives of Education and Training system and representatives of the labour market can work together in order to define a worker profile in Mechatronics, answering the needs labour market.

Based on the needs of the labour market in terms of skills and the status quo of VET systems, the consortium will establish a VET CV for mechatronics and develop an e-card to support the CV and enhance mobility.

4.3. *LbyT Learning by Teaching solution for companies, Giovanni Crisona, CSCS - skillman.eu (Italy)*

Mr. Giovanni Crisona presented the Learning by Teaching initiative launched by Skillman to enhance quality and volume of training on the workplace.

The current skills mismatch hinders productivity and competitiveness of European manufacturing. The New Skills Agenda for Europe by the European Commission therefore sets out to improve learning at the workplace. The **Learning by Teaching for Industry Skills (LbyT4IS)** initiative launched by Skillman will enhance quality and volume of learning at the workplace. To ensure impact, the solution will accommodate for significant volume.

LbyT4IS will be an integrated on-the-job training system using digital video technology, augmented reality and mobile technology. The main features of the solution aim to transform learners into teachers and to re-design the work environment. Learners will create and share learning videos, thus both learning themselves but also becoming teachers for other colleagues. At the same time, the work environment will also become a learning environment through the use of sensors.

The system is envisaged to allow to decide on the levels of sharing, moderations and permissions necessary to post, and to allow to rate the quality of the published content, also implementing a gamification approach.

This approach aims to address a lack of capacity that industry, in particular SMEs experience, to better anticipate and manage the transformative change with regard to skills requirements. Also policymakers and education providers could benefit from an improved skills intelligence that this approach can generate.

4.4. *Future Work Lab – Digital Technologies and Assistance Systems in the Workplace of the Future, Simon Schumacher/Ahmad Issa, Fraunhofer Institute for Manufacturing Engineering and Automation IPA (Germany)*

Mr. Simon Schumacher and *Dr. Ahmad Issa* presented the Future Work Lab.

Future Work Lab is an innovation lab for work, people and technology in Stuttgart, Germany. In manufacturing, we will observe an increase of indirect work, moving from operating to orchestrating production. Together with industrial innovators, applied researchers showcase digital technologies and assistance systems for the workplace of the future. The lab promotes an augmentation strategy, enabling workers to participate in more value-adding activities rather than using automation as a tool for cost reduction.

Various learning formats are implemented in an interactive environment of a demonstration world, learning world and idea world. The portfolio of digital learning formats ranges from e-learning and video-based training to interactive business games and virtual reality applications. Formats are customised to the different training groups' needs and combined with a unique technological environment consisting of more than 40 physical demonstrators.

Future Work Lab functions as a digital competence centre on regional, national and European level. Listed as a Digital Innovation Hub, Future Work Lab is involved with the EU projects DIATOMIC and

KET4CleanProduction. For 2019, the research is focused on Artificial Intelligence and how it might affect industrial workplaces.

4.5. Digital Catalyst Programme, Asif Moghal, Autodesk (United Kingdom)

Mr. Asif Moghal presented the Digital Catalyst Programme launched by Autodesk.

The Design & Manufacturing industry is undergoing huge change thanks to globalisation, competitive forces and the increasing complexities of doing business. The nature of products, the way we make them and the people we employ to design & manufacture them are simultaneously a challenge to overcome, and an opportunity for growth and prosperity.

Technology clearly has a role to play, but a lack of digital skills and capabilities is cited as one of the top reasons that the industry feels unable to accelerate the adoption of digital into their businesses. The Digital Catalyst program, led by Autodesk, places student experts from leading design & manufacturing universities into SMEs for 80 hours to help them evaluate the art of the possible across their entire process all the way from design and manufacture to the end user experience and customer feedback. Both sides benefit.

The Digital Catalyst gains real world experience while studying, and will complete their course as a far more rounded individual, than if they had just followed the traditional educational process. The SME gets someone to show them what is possible through digital, and help them practically apply the right technologies to the right parts of their process. It also sets up co-mentoring relationships between the SME engineers and students, where both sides can learn from and gradually upskill each other.

Working in this way is a low cost, low risk high and impact strategy that has already delivered dramatic results in terms of productivity and innovation for the SMEs involved.

4.6. Discussion and feedback of participants

Dr. Kristina Dervojeda invited the workshop participants to express their feedback regarding the presentations given during the morning session. The key points of the discussion included the following:

- In order to upscale promising initiatives, there is often a need for new governance structures, funding models and delegated responsibility.
- To ensure open collaboration, it is crucial that the interests of all stakeholders are taken into account. By removing costs from the table during initial stages and showing benefits to multiple stakeholders, one might generate the appetite for further investments.
- In discussion on professional profiles, it was pointed out that there is a need for continuous updates. Furthermore, there is also a balance between leveraging the efforts of developing such profiles in several European initiatives and adapting to regional smart specialisation strategies.
- Finally, the recognition aspect in on-the-job training was pointed out as being important and one should look into the use of open badges.

5. Wrapping up: Towards detailed proposals for curriculum guidelines

The closing session of the workshop aimed to address the detailed proposals for curriculum guidelines, summarise the key points of discussion and identify the next steps.

5.1. Towards detailed proposals for curriculum guidelines

The workshop participants were invited to submit their suggestions and share their experiences with regard to each of the abovementioned elements of the curriculum guidelines.

5.2. Next steps

Dr. Kristina Dervojeda encouraged the participants to continue sharing their insights and suggestions for this initiative.

The sixth and final workshop for this initiative will take place in Brussels on September 17 2019, with focus on Vocational Education and Training for advanced manufacturing, and particularly discussions on co-creation of a detailed version of the curriculum guidelines, proposal for specific measures accompanied by good practice examples.

Furthermore, a high-level conference will be arranged in Brussels on November 12 2019. The objective is dissemination of the final results, including the state-of-play, best practices, curriculum guidelines and policy recommendations. It aims to inspire stakeholders at different levels to join forces and take further action.

The project team will keep the workshop participants informed about the key activities of the initiative, and further involve them in co-creating specific proposals for curriculum guidelines. The participants were also encouraged to join the initiative's LinkedIn-group that can be found at <https://www.linkedin.com/groups/8689260/>.

Annex A: Workshop agenda

Workshop agenda

10:00 – 10:30	Welcome and Introduction <ul style="list-style-type: none">• Workshop context, rationale and objectives• Introduction round of participants• Workshop setting and key expectations	<i>André Richier (DG GROW, European Commission), Kristina Derojeda (PwC)</i>
10:30 - 11:00	Reshaping on-the-job training for Advanced Manufacturing: Towards future-proof organisations <ul style="list-style-type: none">• On-the-job training in the 21st Century• Key takeaways from Hannover Messe 2019• Update on the Curriculum Guidelines Framework	<i>Kristina Derojeda (PwC), Marte Andresen (PwC)</i>
11:00 - 12:00	21st Century Strategy, Collaboration Patterns and Learning Environment (Part 1) <ul style="list-style-type: none">• Life-long learning and industrial needs of manufacturing sector, <i>Minna Lanz</i>, Tampere University (Finland)• The role of mentoring in inter-generational knowledge transfer and on-the-job training, <i>Emir Demircan</i>, SEMI-Europe (Belgium)• The Learning Garage at KU Leuven as an interdisciplinary platform for learning by doing, <i>Peter Verbist</i>, AGORA Learning Centre, KU Leuven (Belgium)• Galicia 2030: Professional profiles for the future and new university degrees and specialisations, <i>Lucia Franco</i>, FEUGA (Spain)	<i>Moderators: Kristina Derojeda (PwC), Marte Andresen (PwC)</i>
12:00 - 12:30	Discussion and feedback of participants	<i>Moderators: Kristina Derojeda (PwC), Marte Andresen (PwC)</i>
12:30 – 13:00	LUNCH BREAK	
13:00 - 15:00	21st Century Strategy, Collaboration Patterns and Learning Environment (Part 2) <ul style="list-style-type: none">• Standards as Enablers of Innovation: ASTM International & Smart/Advanced	<i>Moderators: Kristina Derojeda (PwC), Marte Andresen (PwC)</i>

	<p>Manufacturing good practice examples and suggestions to the three elements of the AMT-related education & training system, <i>Pat Picariello</i>, ASTM (United States)</p> <ul style="list-style-type: none"> • MEMEVET: Engaging companies to develop Mechatronics CV, <i>Fadia Khraisat</i>, EU Desk of the Italian Chamber of Commerce in Madrid (Spain) • LbyT Learning by Teaching solution for companies, <i>Giovanni Crisona</i>, GRUPPO SCSC (Italy) • Future Work Lab – Digital Technologies and Assistance Systems in the Workplace of the Future, <i>Simon Schumacher/Ahmad Issa</i>, Fraunhofer Institute for Manufacturing Engineering and Automation IPA (Germany) • Digital Catalyst Programme, <i>Asif Moghal</i>, Autodesk (United Kingdom) 	
15:00 – 15:30	Discussion and feedback of participants	<i>Moderators: Kristina Dervojeda (PwC), Marte Andresen (PwC)</i>
15:30 - 16:00	<p>Wrapping up: Towards detailed proposals for curriculum guidelines</p> <ul style="list-style-type: none"> • Moving forward: conclusions and next steps • Closing remarks 	<i>André Richier (DG GROW, European Commission), Kristina Dervojeda (PwC)</i>

Annex B: Workshop participants

<i>Nr</i>	<i>Name</i>	<i>Organisation</i>	<i>Country</i>
1.	<i>Peter Verbist</i>	AGORA Learning Centre, KU Leuven	Belgium
2.	<i>Minna Lanz</i>	Tampere University of Technology	Finland
3.	<i>Giovanni Crisona</i>	CSCS - skillman.eu	Italy
4.	<i>Emir Demircan</i>	SEMI-Europe	Belgium
5.	<i>Pat Picariello</i>	ASTM	United States
6.	<i>Sara Gobbi</i>	ASTM	Belgium
7.	<i>Fadia Khraisat</i>	EU Desk of the Italian Chamber of Commerce in Madrid	Spain
8.	<i>Simon Schumacher</i>	Fraunhofer Institute for Manufacturing Engineering and Automation IPA	Germany
9.	<i>Ahmad Issa</i>	Fraunhofer Institute for Manufacturing Engineering and Automation IPA	Germany
10.	<i>Asif Moghal</i>	Autodesk	United Kingdom
11.	<i>Vincenzo Renda</i>	CECIMO	Belgium
12.	<i>Ahmad Bsiesy</i>	CIME Nanotech	France
13.	<i>Bernd Rieth</i>	Festo Didactic	Germany
14.	<i>Lucia Franco</i>	FEUGA	Spain
15.	<i>André Richier</i>	European Commission, DG GROW	Belgium
16.	<i>Giovanna D'Addamio</i>	EASME	Belgium
17.	<i>Kinga Szebeni</i>	European Commission, DG EMPL	Belgium
18.	<i>Lukas Borunsky</i>	European Commission, DG RTD	Belgium
19.	<i>Kristina Dervojeda</i>	PwC	Netherlands
20.	<i>Marte Andresen</i>	PwC	Netherlands