D 5.4
Organisation of national/regional sessions and associated reports- Second iteration

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[1] PU: Public, CO: Confidential, only for members of the consortium (including the Commission Services)
[2] RE: Report, OT: Other; ORDP: Open Research Data Pilot

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Abbreviations and acronyms

TERMS, ABBREVIATIONS AND ACRONYMS	
AAS	Asset Administration Shell
BMWi	Bundesministerium für Wirtschaft und Energie
CF1	ConnectedFactories
CF2	ConnectedFactories 2
CO	Coordinator
DoA	Description of Action
DoM	Degree of Maturity
EB	Executive Board
EC	European Commission
GA	Grant Agreement / General Assembly
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
RAMI 4.0	Reference Architecture Model Industrie
SCI 4.0	Standardization Council Industrie 4.0
WP	Work package
WPL	Work Package Leader

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Executive Summary

The following document presents a comprehensive analysis and compilation of the reports of the Second Iteration of National/Regional workshops organized by the partners of the ConnectedFactories 2 CSA. This iteration considers the totality of workshops organized between March 2021 [M15] and June 2022 [M31].

The objective of these workshops is two folded: Collecting input from the CF2 network, its stakeholders, and the manufacturing community in general, and disseminating and discussing the findings and outcomes of CF2 and its sister projects to the European manufacturing community. Thus, strong emphasis is given to the inputs of participants and analysis of the results of the workshops as a mean to refine the proposed pathways and cross-cutting factors to digitalization proposed by CF2.

From the overall analysis of the workshops, it is relevant highlight that:

- The Second Iteration of workshops outperformed the first one in 100%, achieving 16 workshops and, as a consequence, surpassing the target of 20 workshops throughout the CF2 project running time.
- Every topic, i.e. cross-cutting factor and pathways, was addressed at least by one workshop.
- Several participants organized more than one workshop and a small number of partners organized workshops in both iterations.
- The Second Iteration achieved a coverage of 10 countries, while all together workshops were held in 12 different countries.
- A strong participation of SMEs was identified during this iteration, as well as of larger companies, showing the relevance of the topics addressed by CF2.

Some of the main results obtained from workshops include:

- Technological progress needs to function in a dialogue, thus addressing fears and uncertainties of workers and clerical workers likewise
- Data shows that access to funding and creating business models is the largest hurdle for digitalisation of SME. Many technologies have benefits which are hard to quantify, which makes business cases difficult.
- The Pathways to Digitalization were perceived as extremely useful and interesting tools, and their application to the challenges of creating business cases was particularly emphasized.
- SMEs are wary of digitalisation without existing proven implementations that they can clearly understand and relate to their own business, i.e. clarify how they may benefit from implementing them.
- The names of some pathways may sound too futuristic and this way exclude them from consideration by SMEs, while all pathways should inherently be applicable for SMEs, without imposing that all advanced levels to be reached. For example, an SME wants a "*connected factory*", not a "*hyperconnected factory*" (nor do they know what hyperconnected means).
- Environmental data (as opposed to process data) is increasingly important to help companies meet their regulatory targets around energy use, emissions, and noise. This is often missed from manufacturing digitalisation discussions.
- SMEs are wary of digitalisation solutions that involve buying into proprietary or non-standard frameworks, since they tend to lack skills or financial resources to change from one (proprietary) solution or standard to another. Open, commonly adopted standards are seen as extremely valuable. Furthermore, SME-technology providers are incentivised to conform to open interoperable standards to encourage adoption of their technologies, as SME-technology providers are perceived as "less stable" than larger companies, and at risk of going out of business.

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- The importance of inspiring cases and examples cannot be emphasised enough.
- There is a requirement of suitable and effective standards for the creation and operation of markets.
- Digital twins are fundamentally and operationally "accepted and arrived" in successful standardization processes, and thus in many settings ready for their industrial implementation
- Companies along their value chains benefit tremendously from proposed standards for the implementation of digital twins, which make the production processes much more efficient and reliable
- The Digital Passport concept constitutes an opportunity for the AAS as an interoperability tool and paradigm.
- It is fundamental to consider the scaling of the proposed measures and technologies. It is not enough to test in demonstrations that cannot clearly transfer into industrial settings, neither for technical nor financial reasons.

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1 Introduction

The digitalization of the manufacturing industry has been increasingly recognized of strategic importance for the competitiveness of European economy during the last 15 years. Current events related to the covid-19 pandemic have only accentuated the importance of transitioning to more efficient and effective ways of manufacturing, i.e. through the implementation of digital technologies at every step of the value chain. Thus, understanding and developing formal methodologies to transition into fully digitalized and interconnected manufacturing ecosystems is essential to preserve Europe as a beacon of innovation in manufacturing and sustainability.

The first ConnectedFactories CSA (CF1) contributed to this challenge by producing a first description of key enablers and cross-cutting factors as well as four pathways to achieve the digitalization of the European manufacturing industry, in close cooperation with several industries in different fields. The ConnectedFactories 2 CSA (CF2) builds on the results and methodology of CF1 and further refines the proposed existing cross-cutting factors and pathways and including new factors and pathways. Thus, CF2 continues to capture the new developments of digitalization in different fields of manufacturing, presenting them in a methodological manner to the industrial community.

The National/Regional workshops organized under WP5 aim at tackling these challenges, contribute to the refinement process, and increasing the reach of the outputs of CF2 to a wider community of manufacturing companies across Europe. The workshops are meant to create an instance of open dialogue, dissemination, and discussion with the local manufacturing environment to the different CF2-partners. Thus, they are organized locally and in the corresponding local language, such that the necessary trust and openness to criticize and refine the pathways and factors may be set up. Availability and deployment of existing solutions on the supply side are compared with the requirements of specific manufacturing fields and end-user groups. The discussion and challenge of the CF2-outputs enables the identification of gaps in knowledge and the proposed pathways and factors. Moreover, it contributes to their refinement and the understanding of the requisites for their implementation by companies of different profile and size.

Concretely, the National/Regional workshops deepen the understanding of the pathways and factors by contrasting and discussing the formal outcomes of CF1 and CF2 in applied scenarios, involving industrial stakeholders and members of the scientific community in these specific fields and from different geographical locations.

This document reports the **Second Iteration of workshops** organized by the CF2-consortium. The rest of this document is organized in the following manner: Section 2 describes the overall context under which the Second Iteration of workshops were organized, including an analysis of both iteration, geographical coverage, and participants profile. Section 3 summarizes the knowledge extracted from the workshops particularly results that may directly contribute to the refinement of the existing pathways and cross-cutting factors. Section 4 provides the compilation of reports of the Second Iteration of workshop.

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2 Context, analysis, and overview of the workshops

2.1 Context

The CF2 National/Regional workshops have three main objectives: (1) Disseminating and discussing the findings and outcomes of CF2 and its sister projects to the European manufacturing community, with an special focus on bringing these results in local/regional communities in their own language; (2) Collect inputs from the CF2-network, its various stakeholders, and particularly of local manufacturing communities on the applicability and viability of these results, as well as potential *blind spots* in the proposed pathways and cross-cutting factors that might require further refinement; (3) Sharing information from the local stakeholders/communities towards the local community and herewith also make European players aware of activities and relevant information at local levels (This was explicitly addressed by SIRRIS, in Subsection 4.14). This is partially also reflected in the point that is already included about cross-fertilisation. In summary, the CF2 National/Regional workshops aim at engaging different local stakeholders from the manufacturing landscape in their own ecosystems to discuss and enhance the: "*pathways to digitalisation of manufacturing*", "*cross-cutting factors*", "*successful use-cases"*, and "*trends and challenges"* in the digitalization of European manufacturing.

The workshops also aim to foster cross-fertilisation between different industrial platforms and stimulate knowledge transfer between academia and industry, serving as platforms to:

- enhance openness and mutual sharing of knowledge and experiences,
- identify industrial needs and requirements, trends, successful existing practices, and obstacles,
- present the most relevant developments and outcomes of related EU-projects, to facilitate and foster the uptake of results,
- evaluate the implementation of current solutions and present further use cases, and
- involve developers, suppliers and users of digital technologies and digital platforms for manufacturing in the CF2-workflow.

The original strategy for the organization and execution of the CF2 National/Regional workshops considered two iterations of 10 workshops each, organized by each of the consortium partners in different European countries and in the language of the corresponding country. Workshops addressed different cross-cutting factors and pathways in correspondence to the specific area of expertise of each hosting partner.

The conditions imposed by covid-19 crisis forced a drastic change in the original plan for the organization and execution of the workshops. In consequence, during the first iteration all workshops were organized in a virtual environment[3]. Therefore, *Deliverable 5.1 – Workshop methodology and common information package* (D5.1) was adapted and permanently updated to provide recommendations to organizers for the organization of the National/Regional workshops in an online format including several tools and alternatives to facilitate the engagement of participants in a virtual environment.

The first iteration of workshops considered 8 events, which were compiled and reported in D5.3 [M14]. The present document compiles the workshops organized during the second iteration and provides an overall

[3] This decision was previously discussed with the CF2-Project Officer and included the flexibilization and reduction, if necessary, in the number of workshops to be organized during the first 14 months of the CSA.

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analysis of the experiences and transferable results produced by these workshops, while also presents an analysis of the overall performance of both iterations.

2.2 Overview and analysis of the two iterations of workshops

The first iteration of National/Regional workshops produced 8 workshops addressing different cross-cutting factors and pathways toward digitalization (Figure 1). These workshops were compiled and documented in Deliverable 5.3[4] and addressed a wide variety of topics related to the digitalization of manufacturing, refining, and finding gaps in the existing knowledge developed during CF2. As mentioned before, workshops also focused on further enhancing the number of pathways to digitalization as well as cross-cutting factors, which translated in the proposal of three new pathways: *Circular Economy*, *Human Factors*, and *Data Spaces*.

Partner	VTT	TECNALIA	IPA/S2i	LSEC	MTC	INESC TEC	EIL
Number of workshops	1	1	1	1	1	2	1
Cross-cutting Factors							1
Added Value and Business Models						1	
Interoperability and Standardisation		1	1				
Cybersecurity				1			
Industrial Agreement and Legal Aspects							
Humans in Manufacturing							
Pathways							
Circular Economy	1	1					
Human Factors							
Autonomous Smart Factories							
Hyperconnected Factories							
Collaborative Product-Service Factories							
Data Spaces	1						
Skills					1	1	
Successful use-cases			1			2	
Trends, needs, challenges and barriers			1			2	1

Figure 1. Summary of the topics and organizers of workshops during the first CF2 CSA iteration[5]. Numbers in the cells reference number workshops that address a specific topic by a specific organizer.

The second iteration of National/Regional workshops followed the same strategy as the first in terms of addressing and further refining the results produced by CF1 and CF2. In this case, the second iteration outperformed the first iteration in 100% by producing 16 workshops in total, which translated into a drastic increase in the impact and reach of the results. As a consequence, the feedback obtained by the manufacturing community was more diverse and extensive, resulting in a wider set of usable transferable results and recommendations. The topics addressed during the second iteration can be observed Figure 2 and it is worth noting that many of the consortium partners organized more than one workshop during the second iteration, i.e. INNOVALIA, EIL, I4.0, and IMR, and that a small number of partners organized workshops in both iterations, i.e. F-IPA/S2i, MTC, and EIL.

Figure 1 and Figure 2 also show that every cross-cutting factor and pathway has been addressed by at least one National/Regional workshop. This is very relevant, especially considering the three new pathways for the digitalization of manufacturing proposed by CF2 i.e. *Circular Economy*, *Human Factors*, and *Data Spaces*.

[4] https://www.connectedfactories.eu/sites/default/files/d5.3_national_and_regional_sessions.pdf
[5] A single workshop may touch more than a single topic, i.e. cross-cutting factor and/or pathway to digitalization

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 873086.

Partner	IPA/S2i	INNOVALIA	LMS	CEA	MTC	UNOTT	IVF	SIRRIS	EIL	I4A	IMR
Number of workshops	1	2	1	1	1	1	1	1	2	3	2
Cross-cutting Factors											
Added Value and Business Models		2					1			1	
Interoperability and Standardisation	1	2		1						1	
Cybersecurity				1				1			2
Industrial Agreement and Legal Aspects										1	
Humans in Manufacturing									2	2	
Pathways											
Circular Economy							1				
Human Factors					1				1	2	
Autonomous Smart Factories			1			1					2
Hyperconnected Factories						1				1	
Collaborative Product-Service Factories							1			1	
Data Spaces		2							1	1	
Skills		2	1		1				1	1	2
Successful use-cases	1	2	1	1		1		1	2	2	1
Trends, needs, challenges and barriers	1	2		1	1		1	1	1	3	

Figure 2. Summary of the topics and organizers of the workshops during the second CF2 CSA iteration. Numbers in the cells reference number workshops that address a specific topic by a specific organizer.

If we also analyse the number of times each topic has been addressed during the two iterations of workshops (Figure 3), two conclusions can be drawn: (1) a sharp increase in the number of topics that are discussed during the second iteration, which is explained by the larger number workshops, and (2) a steep increase in the number of workshops that included the topics of *Skills*, *Trends, needs and barriers to digitalization* and especially, *Successful use-cases*. The latter can be explained by the strong emphasis set during the second iteration to include industrial cases and successful examples of digitalization in the workshops. This was one of the main results of the first iteration, i.e. participants highly valuing concrete examples of companies that have begun their path to digitalization highlighting their experience and lessons learnt.

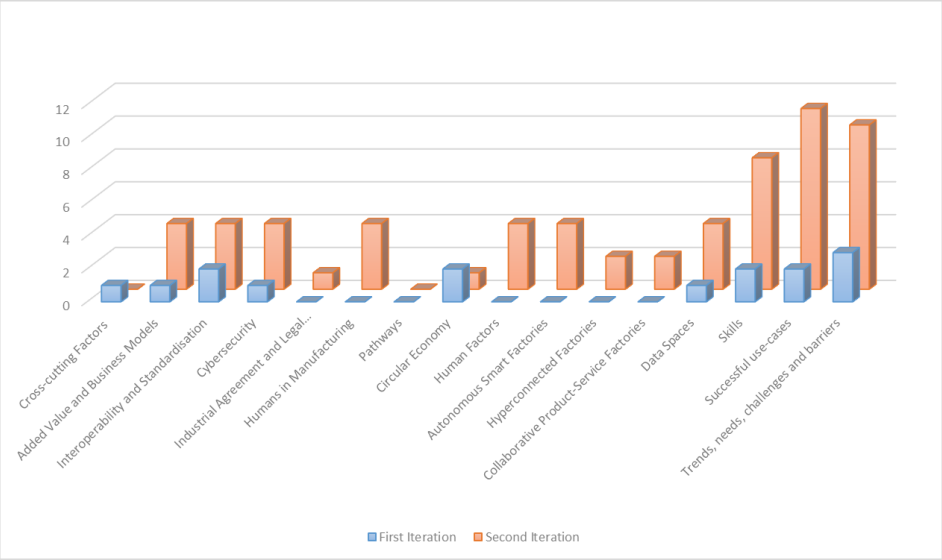


Figure 3. Number of times each topic was the focus in a workshop per iteration.

If we focus only on the pathways and cross-cutting factors (Figure 4), we can also observe that the new pathways, i.e. *Circular Economy*, *Human Factors*, and *Data Spaces*, performed exceptionally well, being one of the main topics addressed in 12 workshops. Two conclusions can be derived from these results. Firstly, the CF2-consortium has CF2 successfully extended the pathways developed by the CF1 CSA, in the form of the

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three new pathways, and refined its proposal accordingly. Secondly, these new pathways have been identified by the European manufacturing community as very relevant and hence, this has been reflected by the higher-than-average number of workshops addressing them.

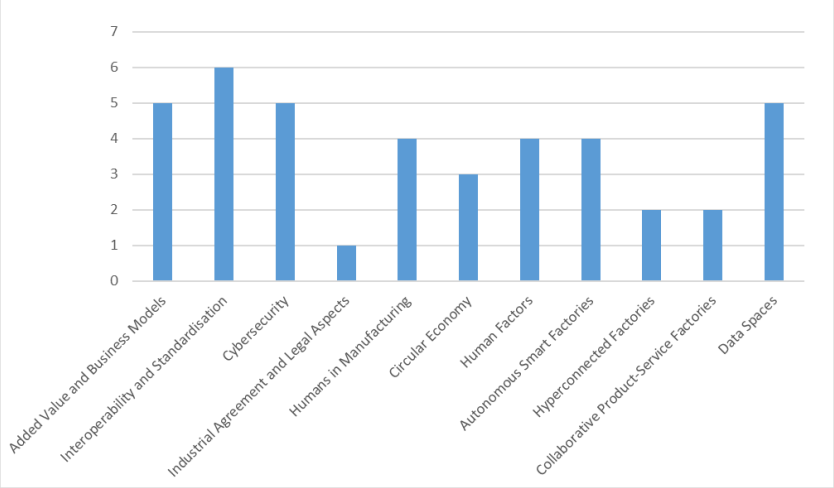
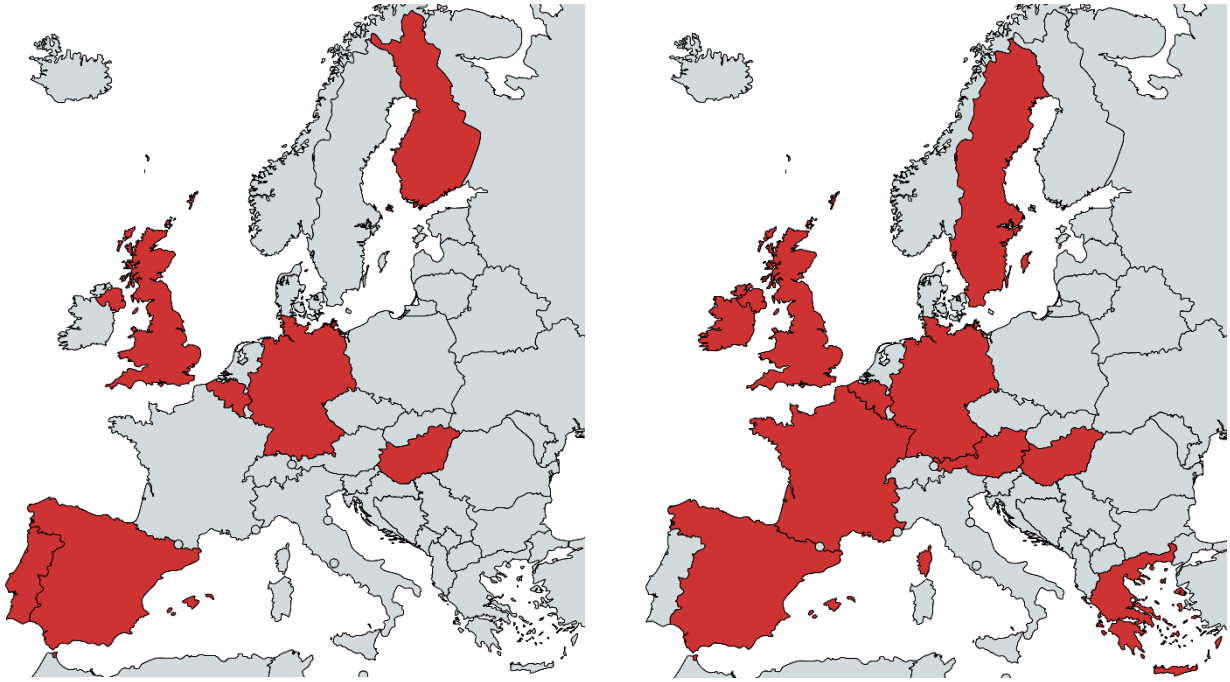


Figure 4. Total number of times each cross-cutting factor and pathway was the focus in a workshop

A very relevant aspect in the context of the National/Regional workshops is also the European coverage of these activities. Figure 5 shows the geographical coverage of each iteration of workshops across Europe. Naturally, given the larger number of workshops during the second iteration, the corresponding coverage is larger. Moreover, if both iterations are considered it is observed a total of 12 countries held a workshop, some of them more than once and in different topics. This extensive coverage enables CF2 to achieve a quality refinement and improvement of its pathways and cross-cutting factors, i.e. by collecting valuable insights from a wide variety of actors from the manufacturing landscape across Europe.



(a) Coverage during the first iteration of workshops *(b) Coverage during the first iteration of workshops*

Figure 5. Coverage of the National/Regional Workshops of the CF2 CSA during its first and second iterations

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2.3 Profile of participants and local impact in the manufacturing landscape

Understanding the profile of the participants and attendees of the National/Regional workshops is essential to assess the impact and effectiveness of these activities. Figure 6 shows the total number of participants of the workshops grouped according to the type of institution each participant represented. Here it can be observed that European SMEs from the manufacturing landscape were the main group of participants of these workshops, which was the main target group. Moreover, it is relevant to highlight the high participation of larger and multi-national companies, which also shows the transversal interest of the topics and outputs proposed by CF2.

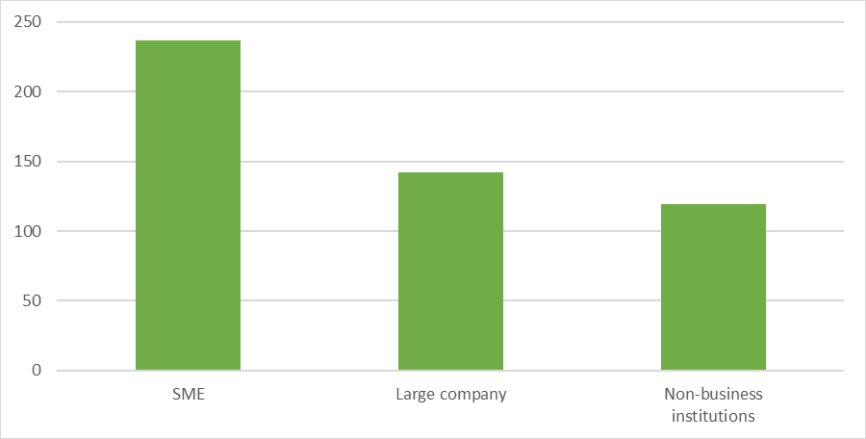


Figure 6. Profile of the participants of the National/Regional workshops[6][7]

Figure 7 shows the number of times each topic was visited by a participant. This means that a single participant in a workshop that addressed more than a single topic, which was always the case, is counted once in each of the topics addressed in such workshop. Here we can see the outlier of the Successful use-cases topic, which can be explained by the fact that every workshop organized during the Second Iteration included this topic, as it was explicitly requested by participants during the First Iteration as a means to understand and concretize the pathways and cross-cutting factors, as well as their implications for their business processes.

Interestingly, the number of times each topic was *visited* by a participant of a workshop (Figure 7) does not easily correlates with the number of workshops organized for topic (Figure 4). This is because some workshops focused on topics that are rather a niche, and not as widespread. Consequentially, even if more workshops were organized addressing a specific topic, e.g. *Added Value and Business Models* or *Cybersecurity*, this does not necessarily translated into higher participation. Furthermore, since the workshops are meant to address local ecosystems in their own language, and each the workshop focused on different topics, the number of participants cannot be directly compared. Nevertheless, the information serves to understand the reach of each of these activities and the penetration of the CF2-Partners network in the EU-manufacturing landscape.

[6] The information of the workshop organized by CEA is not considered.
[7] The category *Non-business institutions* considers public and policy organizations as well as RTOs, universities, chambers of commerce, and public/private associations.

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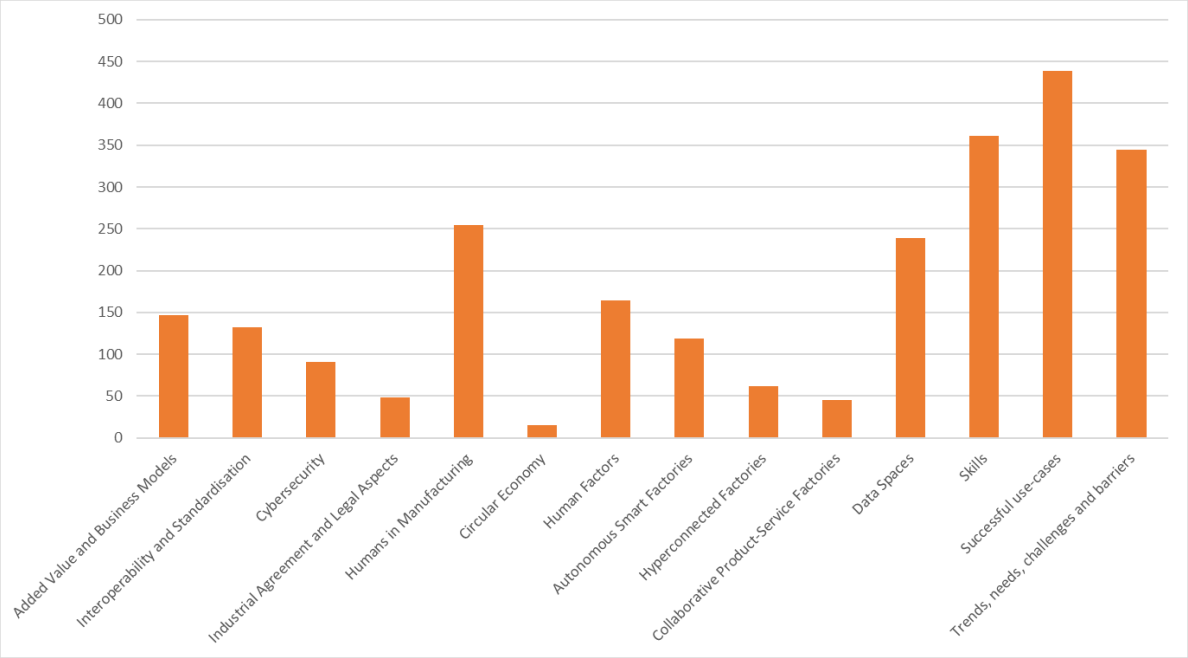


Figure 7. Accumulated number of participants on each of the topics in addition to the "Skills development", "Successful use-cases", and "Trends, needs, challenges and barriers categories"[8]

Finally, Figure 8 increases the granularity of the information shown in Figure 7 by considering the type of organization of the participants. In this case, it can be observed that SMEs were the dominant set of participants in most of the topics addressed during the workshops, with the exception of *Cybersecurity*, *Humans in Manufacturing*, *Human Factors*, and *Collaborative Product-Service Factories*.

Once more, this shows the successful reach and penetration of the events in its main target group, and also the involvement and interest of larger companies. This way, a diverse and complementary set of results were obtained, which contribute directly to further refining the Pathways and Cross-Cutting Factors to digitalization of the manufacturing European industry.

It is also worth emphasizing as before that these results are only informative and cannot lead into conclusions regarding the perceived importance of these topics across Europe, since workshops were organized in drastically different settings, with different audiences, and in different ecosystems which inevitably influence the ability of participants and institutions to participate.

[8] The participation of the attendees is reflected in all the topics addressed by the corresponding workshop. I.e. a participant attending a workshop on Circular Economy and Data Spaces will be counted in both categories

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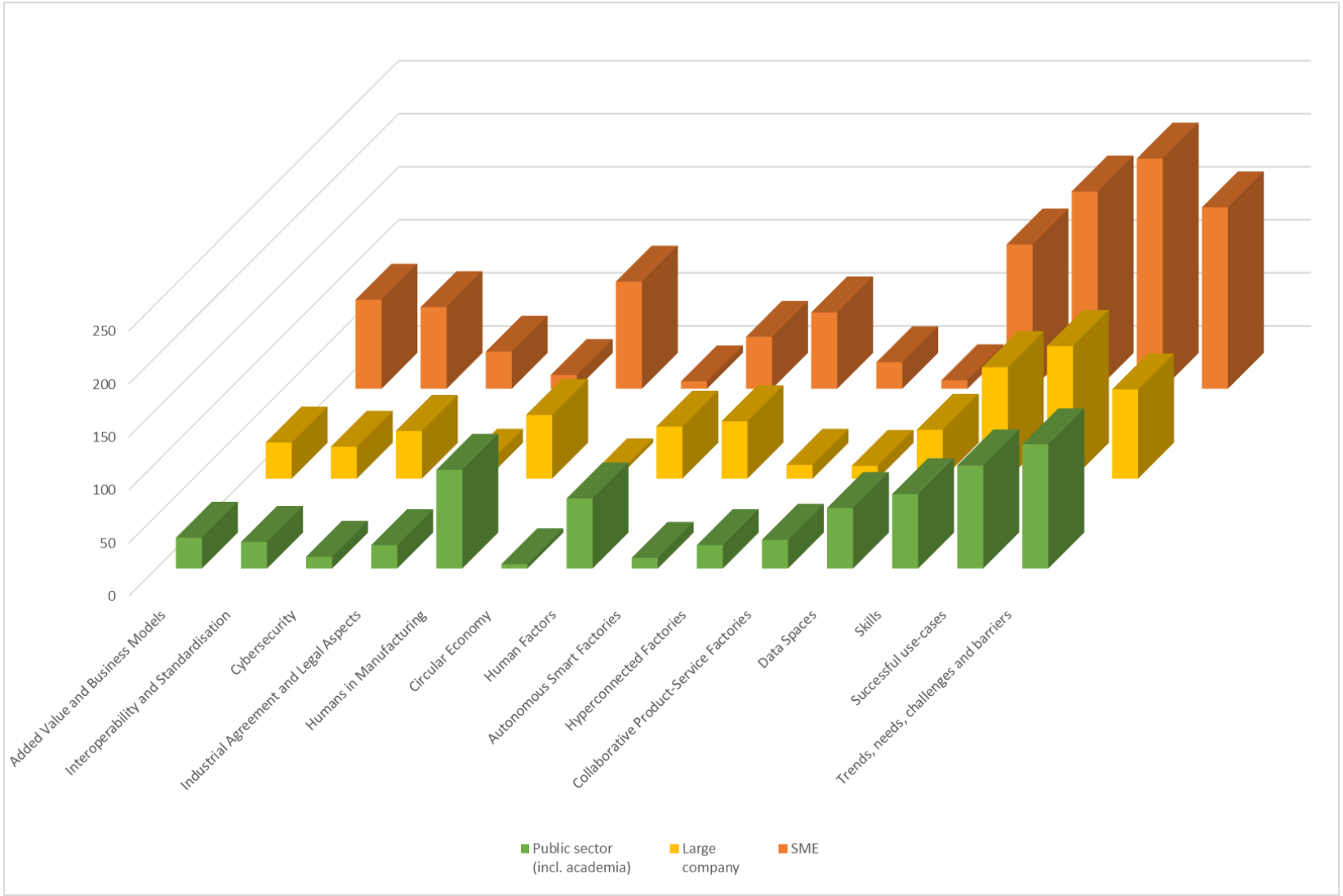


Figure 8. Participation in each of the topics according to the type of institution by attendee

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3 Experiences and Transferable Results

This section provides a comprehensive summary of the main results of the workshops as well as experiences from the organizers that may be of valuable for the organization of future workshops in similar settings.

3.1 Transferable results on the pathways and cross-cutting factors to digitalization

3.1.1 Cybersecurity

The four workshops addressing cybersecurity produced the following results:

- The "*Software Integrity"* component of Level 4 should rather refer to "*Platform Integrity"* such that conceptually the component is closer to the hardware and corresponding firmware that might be integrated to improve cybersecurity
- The linearity of the pathway in real life is not obvious and it is difficult to define clear priorities. Cybersecurity consists of multiple small components. We must try to move forward in parallel on all subjects rather than focusing on a single brick and improving bringing that brick into the state-of-the-art.
- Setting "*Penetration testing*" at Level 1 seems unrealistic, since systematically operating this type of tests is beyond the scope and technical sophistication of SMEs at such level. Instead audit mechanisms could be set up in place.
- Companies often do not know how to begin a plan for cybersecurity. The structured approach proposed by CF2 was a valued alternative to set up such a plan, including different aspects of relevance for improving cybersecurity components of SMEs.
- Larger companies, e.g. Picanol Group, only started to elaborate such plans after they experienced cyber-attacks. The implementation of their plan is still on-going showing the intricacies of the process. Moreover, this successful use-case was highly valued and appreciated by participants.
- Cybersecurity is not only about technology and not all risks can be addressed with limited budgets. Hence, a risk-based cybersecurity strategy should be set up before cyber-attacks are experienced.
- The draft cybersecurity pathway attracted a lot of attention, and inquiries about when a finalised version was expected.

3.1.2 Added Value Business Models

Four workshops addressing this topic were organized during the second iteration of National/Regional workshops. It is worth noting that as a topic, specific technologies and fields guide the development of business models. The main transferable results obtained include:

- Regarding business models applied to the *data economy*, the general impression is that this is still an R&D topic. However, participants are aware that it will reach them soon enough. Most agree on the value of data and that soon data is going to become a central part of their businesses.
- A need for additional information (high level-business related) was identified, particularly in the context of *data economy*.
- The transition to business models and product-service systems for *circular economy* in the Swedish industry is an ongoing process that has already begun and continues in diverse national networks and communities.

- Digitalization, sustainability, and circularity: business models for circular economy are narrower and move in the limits of ecology and economic sustainability. Hence, it is important specify that differences between them two exists, and which are those differences, since they reflect on the business models.

3.1.3 Interoperability and Standardisation

Five workshops were organized dealing with this topic. The main transferable results include:

- It was identified that typically OT and IOT devices are designed to complete a task. However, no standards are specified for: no embedded security, live update mechanisms to guarantee availability and resilience, security standard or compliance, etc.
- In the context of *data economy*, it was identified that the interest in using data from others sources/partners/institutions/organizations/etc. highlighted the need to standardize and set rules regarding the quality of data.
- The benefits of using standards and interoperable technologies in the conception of the *data spaces* was highlighted. Workshop-participants work for different customers with different data sharing systems, and that is very inefficient. Finding common tools that can be interoperable would be a major improvement for the improvement of productivity.
- Several interoperability challenges were identified during the workshops. Specifically[9], (1) Interoperability between proprietary solutions; (2) Interoperability between sectors: cross-sectorial reference architectures; (3) Cloud-IOT interoperability: Edge, fog, cloud; (4) Data interoperability: B2B data exchange, Data integrity: Facilitate storage in common repositories; (5) Semantic interoperability: AAS; (6) HMI-SCADA interoperability: interoperability of real-time process control and visualization software with larger number of devices; (7) Interoperability for the implementation of a digital twin: Data exchange between physical and virtual assets.
- The correct technical interpretation of standards is of vital importance for the success of the technologies that they norm and the standards themselves.
- AAS is a well-accepted international standard that is gradually becoming one of the branding solutions for digital twins, answering and guaranteeing different inquiries regarding interoperability, reliability, etc.
- National colouring, i.e. different countries utilizing different non-compatible standards, should be prevented. Global work is the major priority now.
- Standards and norms should facilitate the interaction between technologies and markets. Standards should aim at international acceptance and specify pathways to compatibility.
- It is essential to achieve common solutions (as e.g. AAS standard and its submodels) especially for sematic interoperability, even if specific technologies or standards change. This type of approach towards semantic definitions is also key to achieve cross-interoperability also on global level.
- Tools and trainings are currently available as open source. Moreover, these are not abstract but practical, e.g. concrete problems that may be adapted to specific user-case, which may also be tried it out with individual product.
- Companies as a whole need to join and grow, self-assess, etc. A simple and interesting hands-on starting point may be the digitalization of products and services, in compliance with standards, e.g. article numbers to URL.
- The FabOS project provides interesting basis for the practical implementation of standards in a digital twins set up. In particular, FabOS middleware provides the necessary framework to establish

[9] These challenges refer to the workshop organized by CEA, Subsection 4.1.

interoperability between by different users and adopt AAS concepts including submodels, recipes, integration of devices, etc. This should provide SMEs stock-up container in a low-threshold manner.
- Open-source standards: Their operation of such global standards as digital twin should be fast but also practice oriented. Following challenges were discussed in this concern: e.g. paywall, user association, without royalty fee, as user time advantage, accessibility given, all standards freely accessible and accompanying software.
- The Digital Product Passport constitutes an opportunity for the AAS as an interoperability tool and paradigm for the recently promoted European Green Deal.
- There is a need for integration of *solo* actors and stakeholders, such that the contribution to overall interoperability and standardisation efforts can be follow a coherent strategy.
- It is fundamental to consider the scaling of the proposed measures and technologies. It is not enough to test in demonstrations that cannot clearly transfer into industrial settings, neither for technical nor financial reasons.
- An interesting future perspective may be given by the integration of blockchain, which may help identifying white spots, and complement interoperability particularly in the field of digital twins..

3.1.4 Industrial Agreement and Legal Aspects

This topic was addressed by one workshop focused mainly on the issue data spaces. In this context, the legal aspects related to sovereignty of data, processes, and value and supply chains for the manufacturing process were comprehensively discussed.

A relevant outcome is that, from a legal perspective, it should be feasible and guaranteed that efficiency may be increased within a supply chain in industry, even if between manufacturers of a product and producers of the required raw materials many different suppliers exist. In this context, a fundamental aspect to facilitate the legal safeguards to achieve that increase in efficiency depends on the existence of suitable and robust standards.

3.1.5 Humans in Manufacturing and Human Factors

The cross-cutting factor Humans in Manufacturing and the pathway Human Factors were touched in four and three workshops correspondingly. Since both topics are very closely related, the transferable results and presented together in the following:

- There is an increasing focus on human-centred aspects of digitalisation, particularly considering the arrival of Industry 5.0, which places it humans at the centre of the concept. One aspect of human-centricity are digital assistance systems. Digital assistance systems are increasingly becoming mainstream and are encompass a broad range of different devices, e.g. cobots, exo-skeletons, HoloLens, etc.
- Given the increasing labour shortage, digital assistance systems not only support workers and improves quality and production processes but also might be an component of employer branding.
- Design thinking approaches are important to address possible barriers and add to successful technology implementations. By doing so, job profiles can also be designed taking into consideration needs of employees at an early stage.
- Current technologies enable manufacturing processes at velocities in which humans cannot cope with. Therefore, a rise sick leaves it is expected. Hence, effective, and complementary ways of putting humans (back) in the centre of the manufacturing process need to be sought out, designed and tested.
- Co-determination, i.e. closer collaboration and synergies between employers and employees, proved to be successful in the past. Before the pandemic, regular meetings where organised on the shopfloor

where information was exchanged between different shift groups. An organisational culture based on trust and open communication is essential for the adaptation and acceptance of new technology developments being rapidly implemented in the European manufacturing landscape.

- Shift the paradigm of "*humas adapting to new manufacturing technologies*", to "*technologies facilitating the job of humas in manufacturing*". An example reviewed was a use case from the automotive industry where the chassis of the car was turned by 90 degrees so that it was not necessary for the workers to work above their head[10].
- A clear understanding of the differences between clerical worker and shopfloor workers should be made. Shopfloor workers often do not have the time to read emails and do not use devices such as tablets for operational reasons as simple as oily hands. The challenge is understanding how digitalization can help and be effectively incorporated into shopfloor activities, instead of just implementing fancy tools. Moreover, industry workers are not coding experts. Effective communication and techniques to improve acceptance of new technologies, e.g. co-creation, can be very meaningful in incorporating digitalization.
- Employees want to communicate to each other. There is clear feedback from various companies that workers do not solely want to use devices like mobile phones to exchange information, but they would like to communicate with colleagues and exchange views, experience etc. For some of the participants this is also an expression of appreciation. Young workers embrace these devices better than older ones.
- Participants highlighted situations in which company workers could not adapt to the incorporation of digital technologies, e.g. tablets, and measures to improve their acceptance. In a specific company workers averaged 50 years of age and received tablets for processing their orders. Nevertheless, 85% of them refused to use the tablets because they were afraid of being monitored. Consequently, every department someone was nominated to show the added value of these devices, offered help, including recommendations on how to improve shopfloor processes. This led to a rethinking of the usage of these tablets as most workers realized their improved working situation and productivity[11]. An important conclusion was that technological progress needs to function in a dialogue, this addresses fears of workers and clerical workers likewise.
- Innovative shopfloor design is necessary. Human-centred design focuses on human needs. If there are fears, communication needs that are needed but not used, we need a design process where technology can provide solutions. Human-oriented technology design is important and can provide solutions. This implies that these design-features should be considered at early stages.
- Techniques to improve acceptance are essential. This involves recognizing once the new innovative technologies may underperform as a mean to create trust with workers in the shopfloor. Moreover, if trustworthiness is imbedded in the corporate culture, it is easier to implement new technologies because workers trust the technologies, systems, and handling of data.

3.1.6 Circular Economy

One workshop addressed the topic of Circular Economy (CE) during the second iteration. This workshop was organized by IVF (SIRRIS) in Sweden. Its main results include:

- The Circular Economy pathway was mostly understandable. However, the pathway could greatly benefit from considering that CE is not created (nor possible) by individual companies. It rather requires collaboration in ecosystem and value-creating networks. The pathway should reflect these facts.

[10] Results refer to the *Digital Workplace of the Future* workshop, Subsection 4.3.
[11] For details, see Digital Workplace of the Future, Subsection 4.3.

- The current perspective for CE is dominated by a product-wise perspective. Conversely, life cycle or value-chain perspectives would be easier to be implemented and understood.
- Radical innovation and complete rethink are needed to create realistic new circular offerings.
- The transition towards CE should be based on customer and consumer requirements.
- Investments made in Stages 1-3 of the pathway may hinder progress towards Stages 4 o 5. This shows a lack of compatibility between Stages.
- As a whole, the Circular Economy pathway may also need to be clarified and synchronized with other frameworks for sustainable transition such as the Paris Agreement[12].

3.1.7 Autonomous Smart Factories and Hyperconnected Factories

The Autonomous Smart Factories pathway was addressed in four workshops by three CF2-Partners while the Hyperconnected Factories in two workshops. The main outcomes of both pathways include:

- Companies are aware of the level of smartness and data connectivity in their factories, and they are in principle convinced on the benefits Industry 4.0 digital technologies could bring to them. The Autonomous Smart Factories pathway description was clear and helped them to position themselves in the proposed landscape without any difficulty. Additional discussion with the companies might be needed for depicting the required skills (e.g. multi-stakeholders' teams) and/or barriers that need to be overcome to progress through different phases of the Pathway.
- All SMEs understand the importance of digitalisation, but in many cases the scope of digitalisation is too big. It's easy to focus on the state-of-the-art digital technologies, but for many (possibly most) companies, focusing on the fundamentals is more important.
- Environmental data (as opposed to process data) is increasingly important to help companies meet their regulatory targets around energy use, emissions, and noise. This is often missed from manufacturing digitalisation discussions.
- For SMEs, leadership and guidance is critically important. C-level executives of a company will have many responsibilities, and understanding digitalisation is a critical pre-requisite for effective implementation of digital solutions in a business.
- Data showed very clearly that access to funding and creating business models is the largest hurdle for SME digitalisation. Many digitalisation technologies have benefits which are hard to quantify, which makes business cases difficult.
- SMEs are also wary of digitalisation solutions that involve buying into proprietary or non-standard frameworks. They often lack the skills or financial resources to be able to transition from one standard to another. Open, commonly adopted standards are seen as extremely valuable.
- Conversely, SME technology providers are incentivised to conform to open interoperable standards to encourage adoption of their technologies, as SME-technology providers are perceived as "less stable" than larger companies, and at risk of going out of business.
- Pathways were perceived as extremely useful and interesting tools, and their application to the challenges of creating business cases was particularly emphasized.
- SMEs will often focus on the lower levels of a pathway, and thus the names of some pathways may exclude them from consideration by SMEs. An SME wants a "*connected factory*", not a "*hyperconnected factory*" (nor do they know that hyperconnected means) for example.

[12] https://unfccc.int/sites/default/files/resource/parisagreement_publication.pdf

- The draft cybersecurity pathway attracted a lot of attention, and inquiries about when a finalised version was expected.
- The importance of inspiring cases and examples cannot be emphasised enough.
- SMEs are also wary of digitalisation without existing proven implementations they can understand and relate to their own business.

3.1.8 Collaborative Product-Service Factories

Two workshops dealing with this topic were held during the second iteration. The main outcomes include:

- The pathway is heavily dependent on the specific industrial and manufacturing field for its implementation. It is relevant for its understanding to improve its scalability and generalization.
- There are difficulties in funding new and suitable partners to transit from linear value chains to collaboration in ecosystems. For example, recycling actors are moving towards a much more strategic role, new type of player that fills a very important role for many business models.
- New types of collaborations outside the traditional value chains are needed, e.g. in recycling, upgrading, etc. This extends to building up new types of customer engagement, i.e. from transaction to relationship.

3.1.9 Data Spaces

Four workshops organized by three different partners dealt with the new pathway on Data Spaces. The outcomes of these workshops include:

- A gap of knowledge exists in the community, which leads into a need for communication and dissemination of the most basic information, e.g. what are data spaces? Why do we need them and how can a company/organization/administration benefit about it?
- Moreover, it is important to adapt the communication, especially when explaining to non-IT people. This includes simplifying the message to essential and understandable terms. Similarly, it is important to create a culture of data sharing that includes the main concepts around it.
- Mobilizing the sectoral associations and encourage them to manage or administrate data spaces would be really an intelligent move, as they would guarantee the impartiality and transparentness
- The legal consideration of developing and implementing data spaces-related services is a big concern for companies, although not crucial for initial incursions since most companies exploring data spaced initially would develop infrastructure with current collaborators[13].
- It is crucial to define new job profiles, specifying the required skills to implement and maintain data spaces. Also specifying a certified training program to achieve those skills. Both for the development and maintenance of components and for the operation of the data spaces within the verticals. Training and skills development must be a priority to be able to adopt a data-driven paradigm. A large need for data-skilled workers was identified.
- The topics of data sharing and data spaces are very interesting for [Austrian] companies as many of them are highly specialized in their fields and would, therefore, directly profit from exchanging more information within their supplier networks in trustworthy ways. Examples of functioning data spaces are still quite rare [in Austria], which is why collaboration with European partners was chosen as the means of delivering the right content to the interested target group[14].

[13] This output also relates closely to Subsection 3.1.4.
[14] See Subsection 4.4

- The importance of data handling and the preparation of reliable data sets, e.g. for usage of digital twins (e.g. collection, cleaning, integration, and grouping), need professional data experts/analysers who are the key to reach good result. This further highlights the importance of developing suitable skills before the implementation of such digitalization technologies in manufacturing.

4 Compilation of reports

This section presents the reports delivered at the time of writing this report.

4.1 Interoperability and Cybersecurity – 01/04/21, CEA (FR)

4.1.1 Topics Addressed in the Workshop

	Topics adressed (X)
Trends, needs, challenges and barriers	**X**
Successful use-cases	**X**
Cross-cutting Factors	**X**
Added Value and Business Models	
Interoperability and Standardisation	**X**
Cybersecurity	**X**
Industrial Agreement and Legal Aspects	
Humans in Manufacturing	
Pathways	
Circular Economy	
Human Factors	
Autonomous Smart Factories	
Hyperconnected Factories	
Collaborative Product-Service Factories	
Data Spaces	
Skills	

4.1.2 Executive Summary

The Interoperability and Cybersecurity French Workshop, which took place online on April 1st 2021, focused on two main topics: **interoperability challenges** and the **cybersecurity pathway**. One industrial successful use-case, respectively from the DIMOFAC (Sculpteo) and COLLABS (Renault) European Projects, illustrated an approach for each topic. An interactive session with the participants (mainly industrial end-users and machine providers) then allowed discussion and feedback on the associated key challenges and pathways.

4.1.3 Introduction

The Interoperability and Cybersecurity French Workshop, which took place online on April 1st 2021, focused on two main topics:

- **Interoperability challenges**
- The **cybersecurity pathway**.

One industrial successful use-case illustrated an approach for each topic, respectively:

- From the DIMOFAC European Project (https://dimofac.eu/), Sculpteo, a French company offering a leading 3D printing service, for on-demand 3D printing of individual products and short-run

manufacturing, presented their use-case focused on a more flexible and modular post-production line for additive manufacturing, along with other interoperability challenges faced by the company.
- From the COLLABS European Project (https://www.collabs-project.eu/), Renault, the French car manufacturer, presented the different cybersecurity challenges tackled in COLLABS.

The participants of the workshop (around 25 people) were mainly French industrial end-users and machine providers (production machines, robots), along with a few researchers.

An interactive session with the participants then allowed discussion and feedback on the key challenges and pathways linked to interoperability and cybersecurity

The workshop was held online using the Act&Match webinar platform (https://actandmatch.com/) for the keynotes and live exchanges during the meeting. The draft.io tool (https://draft.io) allowed for a more interactive session using virtual post-its to collect feedback.

Hour	Topics
09:30	**Keynote Connected Factories 2 (Chris DECUBBER, EFFRA)**
10:00	**Introduction on interoperability and cybersecurity (Juan CADAVID, CEA)**
10:10	**Interoperability Challenges (Felix NADIN, Sculpteo)**
10:40	**Cybersecurity (Erwan LE DISEZ, Renault)**
11:10	**Game : getting familiar with the interactive session tool**
11:20	**Break**
11:30	**Interactive session**
12:30	**Conclusions and Farewell**

Table 1. Agenda

4.1.4 Workshop Organization and Preparation

4.1.4.1 Participant invitation

The following invitation was sent on March 3rd 2021 and again on March 18th to more than 350 industrial end-users, machine providers, and software providers.

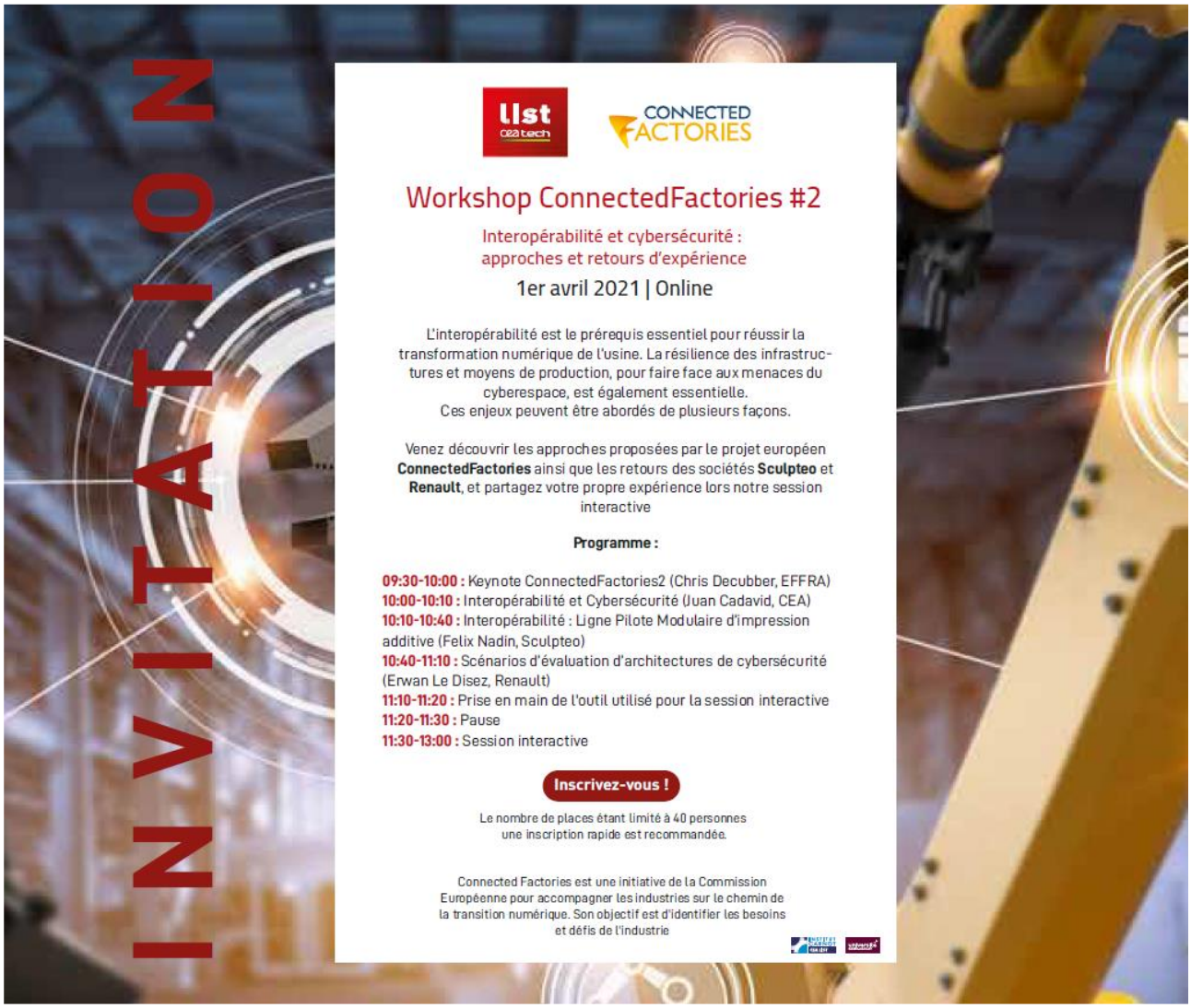


Figure 9. Participant Invitation

The event was also relayed on social networks through the CEA List accounts:

- LinkedIn : https://www.linkedin.com/feed/update/urn:li:activity:6780451644921389057/
- Twitter: https://twitter.com/cea_list/status/1374685856934547456

4.1.4.2 Tools used

Due to the Covid crisis, the workshop had to be help online.

Two tools were used:

- The Act&Match webinar platform (https://actandmatch.com/) for the keynotes and live exchanges during the meeting.
- The draft.io tool (https://draft.io) allowed for an interactive session using virtual post-its to collect feedback. A simple game was organised to familiarise the participants with the tool. After that, two interactive sessions were organised one after the other, firstly on the Sculpteo use-case and

interoperability challenges, secondly on the Renault use-case and cybersecurity pathway. Participants could contribute with post-its and vote to prioritise challenges.

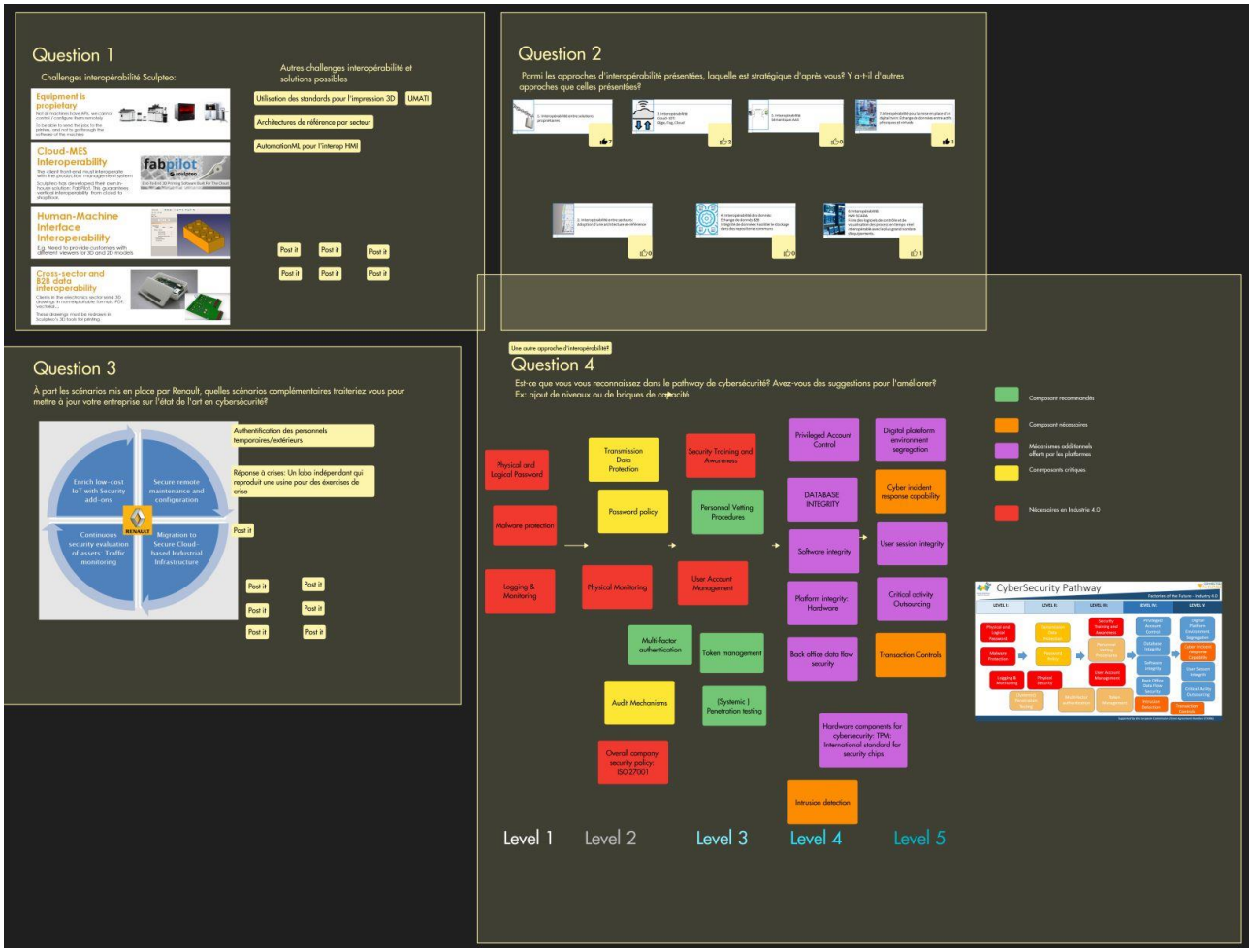


Figure 10. Draft.io board with post-its collecting participants' feedback

4.1.5 Keynote Speakers Session

Three keynotes were presented:

- An introduction by Chris DECUBBER (EFFRA) on Connected Factories and the relevant pathways,
- The presentation of a use-case from the DIMOFAC EU Project by Felix NADIN from Sculpteo, illustrating the interoperability issues faced by 3D printing company Sculpteo.
- The presentation of use-cases from the COLLABS EU Project by Erwan LE DISEZ from Renault, illustrating cybersecurity challenges tackled by Renault in the COLLABS project.

The presentations are provided as annex to the report.

4.1.5.1 Keynote Speaker 1: Connected Factories and Pathways, Chris DECUBBER (EFFRA)

As an introduction to the workshop, Chris Decubber, from EFFRA, presented the Connected Factories initiative, with the **pathways** to digital manufacturing, enablers, and critical success factors:

- Autonomous Smart Factories
- Hyperconnected Factories

- Collaborative Product-Service Factories
- Cybersecurity
- Circular Economy
- Data spaces

Interoperability is a central challenge on the road to digital manufacturing, including interoperability with legacy systems. This challenge is strongly linked to the question of standardisation, as was mentioned by Mondragon in the introduction of a webinar on Standards for Digital Manufacturing held on Oct. 20th 2020 (https://www.effra.eu/news/standards-digital-manufacturing-webinar-recordings-and-presentations-are-now-available). Collecting illustrative use-cases is necessary to help companies choose and apply standards, as undertaken in Connected Factories. Mondragon points out different standardisation contexts: modelling, IT/OT convergence, reference models to allow a system (including legacy systems) to communicate with other systems (Asset Administration Shell – AAS), communication protocols (OPCUA, etc.).

Cybersecurity challenges were recently detailed in a workshop held on Jan. 20th 2021 (https://www.connectedfactories.eu/events/cybersecurity-workshoppresentations-and-recordings). The introduction of IIoT is creating a transformation from a more hierarchical organisation to a more intertwined structure as illustrated in Figure 11, which introduces emerging cybersecurity issues. There is a large number of cybersecurity standards, with a significant amount of overlap. Connected Factories leads ongoing work on mapping these standards on projects.

To conclude, a link to **AI**: implementing AI is only possible when the organisation is transforming towards digital manufacturing in general; connectivity, interoperability and cybersecurity enhance its potential impact.

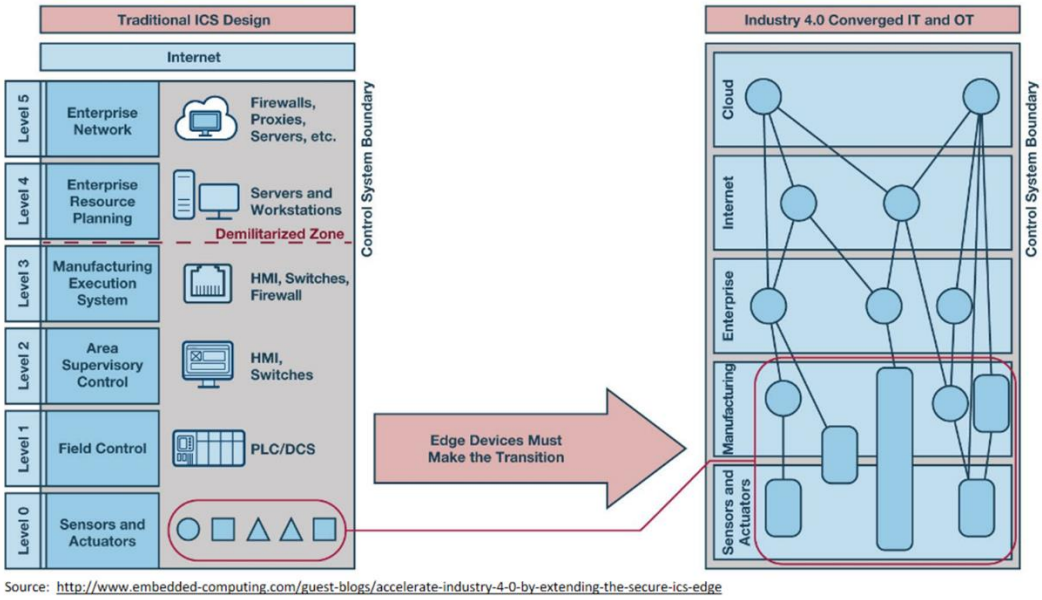


Figure 11 Organisation transformation linked to IOT and OT convergence

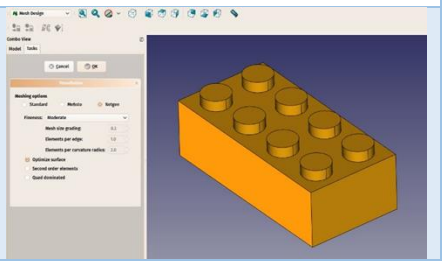
4.1.5.2 *Keynote Speaker 2: Interoperability issues in Scuplteo use-case from DIMOFAC project, Felix NADIN (Sculpteo)*

Sculpteo offers a leading 3D printing service for on-demand printing of individual products and short-run manufacturing. It is a small French company founded in 2009 and recently bought by BASF.

Sculpteo faces challenges linked to individualised manufacturing for continuous post-processing reconfigurations. In the framework of the DIMOFAC EU Project for Digital Intelligent Modular FACtories, Sculpteo ambitions the creation of new post-processing and quality control modules to secure easy and smooth reconfiguration of the production line for each printed product. The aim is to improve individualised manufacturing through automated reconfigurations.

In particular, Sculpteo identified four interoperability issues as presented in Table 2.

Table 2. Interoperability issues faced by Sculpteo

Interoperability issue	Description	Illustration
Equipment is proprietary	Not all machines have APIs, Sculpteo cannot control / configure them remotely. To be able to send the jobs to the printers, and not to go through the software of the machine.	
Cloud-MES Interoperability	The client front-end must interoperate with the production management system. Sculpteo has developed their own in-house solution: FabPilot. This guarantees vertical interoperability from cloud to shopfloor.	
Human-Machine Interface Interoperability	E.g. Need to provide customers with different viewers for 3D and 2D models	

Cross-sector and B2B data interoperability	Clients in the electronics sector send 3D drawings in non-exploitable formats: PDF, vectorial… These drawings must be redrawn in Sculpteo's 3D tools for printing	

4.1.5.3 Keynote Speaker 3: Renault use-cases on cybersecurity and link to cybersecurity pathway

4.1.5.3.1 Presentation

Renault started by observing the recent evolutions linked to industry 4.0 and cybersecurity, as evoked in the first keynote, and as illustrated in Figure 12:

- Factories now become widely connected to allow for more collaborative manufacturing, with RF communications in industrial processes (WiFi, Lora, RFID…), use of mobile and IoT devices, use of cloud services.
- The rise in IoT devices and networks increases cybersecurity attack surface.
- The risk has also increased due to widely used legacy IT solutions and open design protocols, with known vulnerabilities.
- OT and IOT devices are designed to complete a task, there is no security by design (no embedded security, no live update mechanism to guarantee availability and resilience, no security standard or compliance).

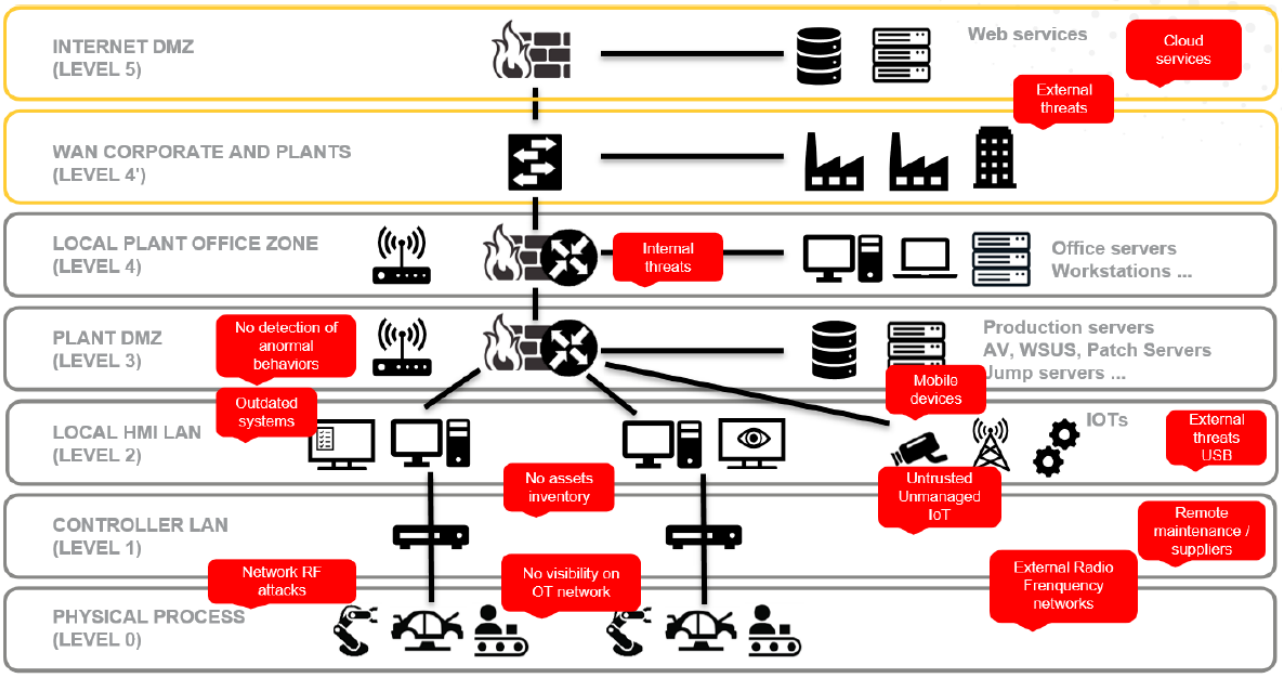


Figure 12. Cartography of cybersecurity risks on plants

Renault suffered from the WANNACRY ransomware in 2017, which created an electroshock in the company where a certain number of plants were paralyzed for a weekend. Cybersecurity was well managed at

corporate level but less in the industrial environment where more specific efforts had yet to be made. This resulted in the implementation of internal and external audits which conducted risk analysis and a remediation plan. A cybersecurity program was created for all Renault plants, starting with a pilot plant in France, with Schneider Electric as a partner. The program is currently under deployment in all factories. The objectives are to make attacks more difficult, reduce attack impacts, and optimize return-to-service time.

In parallel, a longer-term strategy is also put in place through R&I programs such as the COLLABS EU Project.

The idea is to switch from a flat network where all equipment can communicate with all the others, and malware can thus easily propagate, to a segmented architecture with filtering means.

The strategy is built on four pillars, for which several solutions are already identified:

- Organizational: in the continuity of the group's security policy (ISSP), strengthen the human organization, adapt the ISSP to the specificities of the industrial environment, train staff.
- Protection: protect sensitive means of production, IT and OT architecture, deploy state of the art cybersecurity solutions.
  Solutions: NextGen Firewall to ensure segmentation between areas, NAC (Network Access Control) to fight against “shadow IT” with the implementation of equipment authentication, Remote Access control for staff and partners to connect to equipment within the production network, Gateway for secure file transfer.
- Detection: address the issue of visibility on "shadow IT", implement detection means.
  Solutions: Assets management and protection with malware detection, continuous threat detection.
- Recovery: BackUp (robots, automates…) for quick restart.

In this context, Renault created an Industry 4.0 Experimentation Lab to reproduce real manufacturing plants, to validate and evaluate solutions in a real-world collaborative manufacturing environment. It will invest in ICS/SCADA, IT, OT and network equipment’s to reproduce a real plant architecture. Indeed, it is difficult to carry out testing, experimentation, and exercise operations in the actual factories themselves because of their production rate.

In the COLLABS project, the following four use-cases have been identified:

- Security of connected devices
- Assets management, conformity assessment and threat detection (IT but also OT networks)
- Controlled and secured remote maintenance
- Cloud-based architecture for industrial process

The cybersecurity pathway steps which are tackled by Renault are identified in Figure 13 by thumbs. The green thumbs identify more specifically the steps tackled in the COLLABS project and which will thus be at the state of the art.

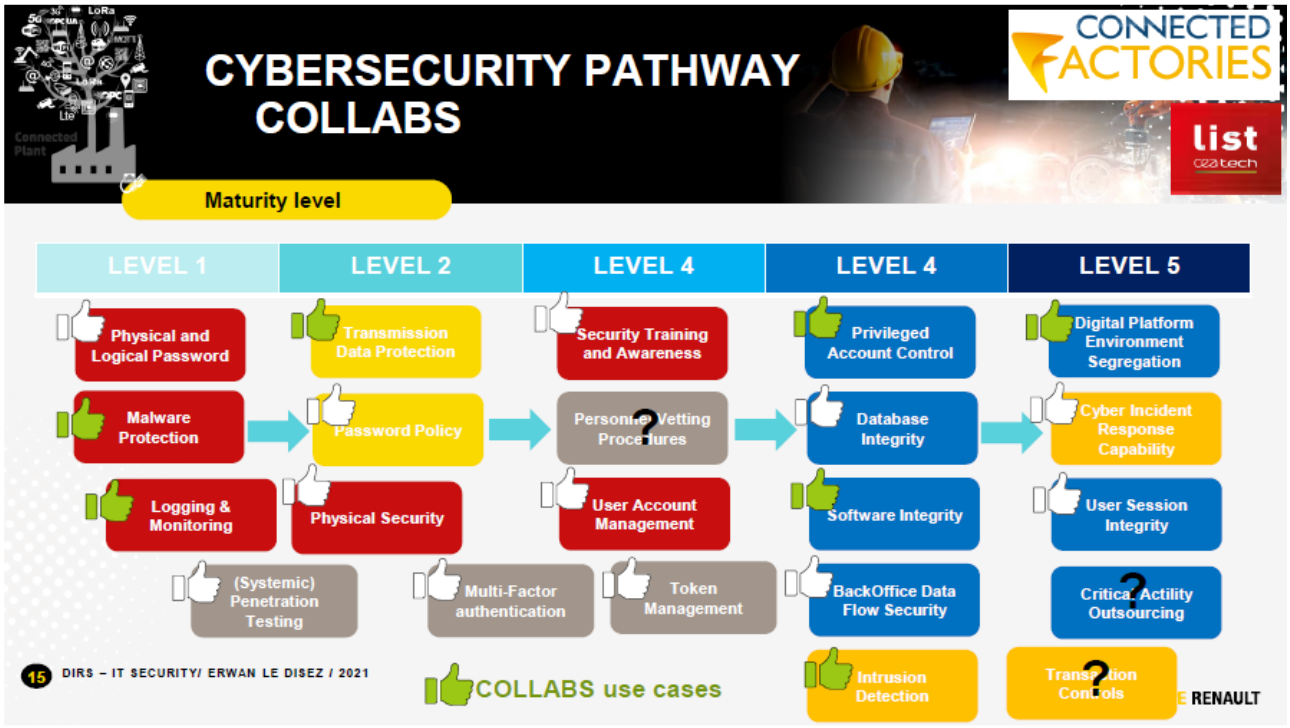


Figure 13. Items in Cybersecurity Pathway tackled by Renault (in green when tackled in COLLABS)

4.1.6 Questions

How does Renault work on cybersecurity issues with its machine suppliers, how can Renault accompany its suppliers on this question?

Collaboration is key. Renault offers recommendations and support in the cybersecurity process. Also, Renault carries on safety audits on equipment and shares the results with suppliers so that they can build a common roadmap.

4.1.7 Interactive Sessions

The interactive session was subdivided into two parts, one dedicated to interoperability, and the other to cybersecurity. The aim was to collect feedback on exposed use-cases and on key challenges linked to both subjects. As specified in Sect. 4.1.4.2, the tool draft.io was used to facilitate the involvement of all participants.

4.1.7.1 Interactive Session 1: Interoperability and Sculpteo 3D printing use-case

With regard to the four interoperability challenges identified by Sculpteo, a first question asked to the participants was to point other possible interoperability challenges and possible solutions. The use of standards was widely advocated.

Seven interoperability approaches were presented:

1. Interoperability between proprietary solutions
2. Interoperability between sectors: cross-sectorial reference architectures
3. Cloud-IOT interoperability: Edge, fog, cloud
4. Data interoperability: B2B data exchange, Data integrity: Facilitate storage in common repositories
5. Semantic interoperability: AAS

6. HMI-SCADA interoperability: make real-time process control and visualization software interoperable with the largest number of devices.
7. Interoperability for the implementation of a digital twin: Data exchange between physical and virtual assets

The participants were to vote for the most strategic interoperability facet(s). The first item (interoperability between proprietary solutions) collected most votes (almost all participants). Items 3, 6 and 7 closely followed.

4.1.8 Interactive Session 2: Cybersecurity and Renault cybersecurity use-cases

4.1.8.1 Next steps for Renault?

A first item was to identify what next steps could be tackled by Renault after the COLLABS project.

This is a complex question.

For instance, there is the question of the authentication of temporary staff. There are many temporary workers in factories: it makes it difficult to provide them with authentication means on equipment. They are currently equipped with read-only or auto-login sessions so that stakeholders do not have to log in.

The use of single-use tokens is complicated for staff who work at the edge of the line all day because there is for example a rule that a session must close by itself after a certain time. A single-use token would therefore result in a waste of time. An ergonomic and secure solution is needed.

In the cybersecurity lifecycle, there are for the moment mainly actions on prevention. The setting up of RACI matrix would be another step, to define escalation diagrams in the event of a crisis. The Industry 4.0 Renault Experimentation Lab is the perfect framework to test such crisis exercises.

4.1.8.1.1 Feedback on cybersecurity pathway

Feedback was then asked on the cybersecurity pathway (pertinence of steps, missing levels or steps):

- Concerning the item on software integrity: we could go a little further by talking **about platform integrity** (and be closer to the hardware and to the firmware that could be integrated into the hardware), with for instance hardware components for cybersecurity such as TPM components to address platform integrity issues.
- **The linearity of the pathway in real life is not obvious**, it is difficult to define clear priorities. Cybersecurity consists of multiple small components, we must try to move forward in parallel on all subjects. Focusing on one brick and being at the state of the art on that brick alone is not necessarily the best strategy.
- **Putting "Penetration testing" at level 1 might be optimistic**, systematically operating this type of test does not seem to be of level 1. This type of test is usually rather done once a certain number of bricks have been set up. Audits on procedures will first be conducted before hurrying technical teams who will go into too much details. In this line, **an audit mechanism could be added to the pathway as a first step at level 1**. Auditing around the company's security policy is highly recommended. It is important to outline such a security policy which will define the security rules and the rights and duties of each person, and on which the audit may be based. Note that this new audit mechanism is brick as such in the pathway, but it will actually analyze the "as is" and the "to be" of all the other bricks in the pathway.

4.1.9 Conclusion

4.1.9.1 Transferable results

- The two industrial use-cases presented in keynotes 2 and 3 (Sections 4.1.5.2 and 4.1.5.3) offer excellent concrete and industrial illustration of interoperability and cybersecurity challenges.
- The interactive session brought up interesting suggestions for the cybersecurity pathway (see details in Section 4.1.8.1.1) :
    - Enlarging software integrity to platform integrity.
    - The linearity of the pathway is not obvious since it is difficult to prioritize.
    - “Penetration testing” might be of a higher level than level 1.
    - An “Audit” step might be added to level 1 instead.

4.1.9.2 Relevant Experiences

Conducting the workshop online maybe allowed to reach more audience than with a physical event, since part of the audience might not have taken the trouble to come physically, but it is clear that the interaction was less rich than what would have been possible with a physical event, even though specific interactive tools were used.

In this context, it might be interesting to consider to conduct one-to-one interviews with selected industrial contacts to collect individual feedback on pathways and cross-cutting factors, rather than organising a workshop.

4.2 Industry 4.0 community days: Digital transformation of Manufacturing Industry – 19/04/21, LMS (GR)

4.2.1 Topics Addressed in the Workshop

	Topics addressed (X)
Trends, needs, challenges and barriers	
Successful use-cases	**X**
Cross-cutting Factors	
Added Value and Business Models	
Interoperability and Standardisation	
Cybersecurity	
Industrial Agreement and Legal Aspects	
Humans in Manufacturing	
Pathways	
Circular Economy	
Human Factors	
Autonomous Smart Factories	**X**
Hyperconnected Factories	
Collaborative Product-Service Factories	
Data Spaces	
Skills	**X**

4.2.2 Executive Summary

The workshop was organised on 19 April 2021 as an online workshop with duration of 2 hours. The agenda included keynote presentations and a feedback session. The invitations were sent to several manufacturing industry's mailing lists and some selected company representatives directly.

The main objective was to a) present successful cases in digital transformation and Industry4.0 projects in the industry and b) to collect feedback to the Autonomous Smart Factory pathway developed in ConnectedFactories CSA. In addition, the workshop covered views on digital transformation use cases and funding opportunities in national and European level including those in the context of EIT Manufacturing.

There were all together 27 registered participants (including the organisers): 22 industry participants and 5 representatives of academy. The organisers (Sotiris Makris, Panagiotis Stavropoulos and Kosmas Alexopoulos) from LMS coordinated the discussions.

The event has provided an excellent opportunity to disseminate CF2 project in the Greek manufacturing community and also has helped gathering valuable feedback on the Autonomous Smart Factories pathway.

4.2.3 Introduction

The Greek CF2 workshop discussed on current trends and success use cases of Industry4.0 technologies. With regards to CF2 the main objectives have been to a) collect feedback on the Autonomous Smart Factory and b) disseminate the work of CF2 in the Greek manufacturing industry. Apart from these topics the workshop

discussed on future funding opportunities from EU and especially from EIT-Manufacturing. Prof. Panagiotis Stavropoulos presented the activities of the Greek EIT Hub in manufacturing as well as funding opportunities offered by EIT-Manufacturing. Dr. Sotiris Makris presented use cases of applications of advanced manufacturing and digital technologies offered by MANUHUB DIH. Two cases of robot assisted production processes were presented. Dr. Kosmas Alexopoulos provided an overview of the Connected Factories II project and presented in detail the Autonomous Smart Factory pathway. The phases within the pathway were presented and the links to the cross-cutting factors especially skills. Finally, an open discussion with industry members followed and at the end workshops participants were requested to provide feedback on the topic of smart factories.

Because of the Covid-19, the workshop was organised remotely using MS Teams meeting to share both audio and presentations. Google forms were used to facilitate to collect feedback to the pathway and skills issues.

Table 3. Agenda

Hour	Topics
15:00	**EIT Manufacturing RIS Hub. Activities and Funding Opportunities**
15:15	**Use Cases** - **Production enhancement using human robot collaboration technology** - **Advanced intralogistics**
15:45	**Digital transformation – Smart and Autonomous Factories**
16:30	**Open discussion on digital transformation and feedback**
17:00	**Closing and farewell**

4.2.4 Keynote Speakers Session

Research Engineer, Kosmas Alexopoulos (Figure 14), PhD, works at the Laboratory for Manufacturing Systems and Automation (LMS). He presented CF2 project to the participants and then explained in detail the Smart Autonomous Factory pathway as well as the cross-cutting factors related to the pathway (see slides below). Then he guided the discussion on the topic of digital transformation and guided the workshop participants on providing feedback.



Figure 14. Kosmas Alexopoulos (LMS)

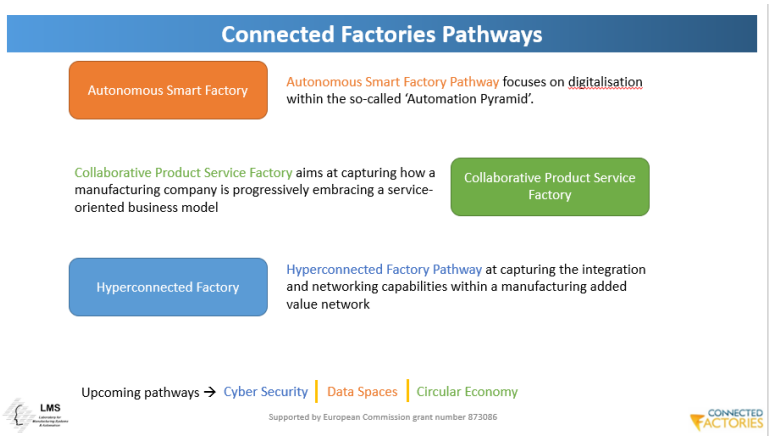


Figure 15. Overview of CF pathways

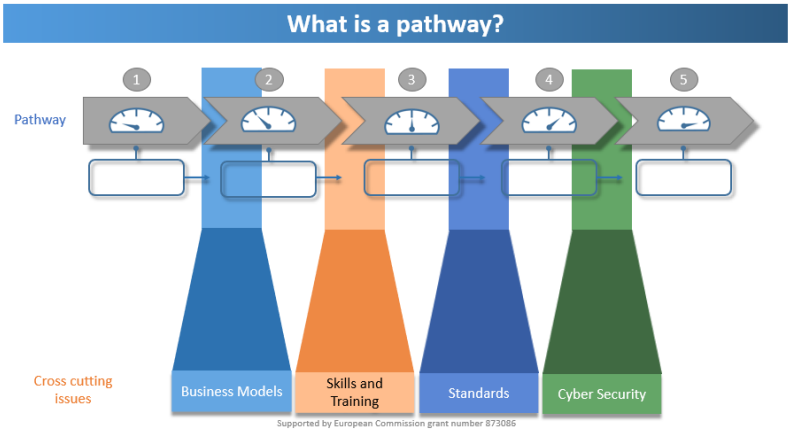


Figure 16. Explaining a pathway

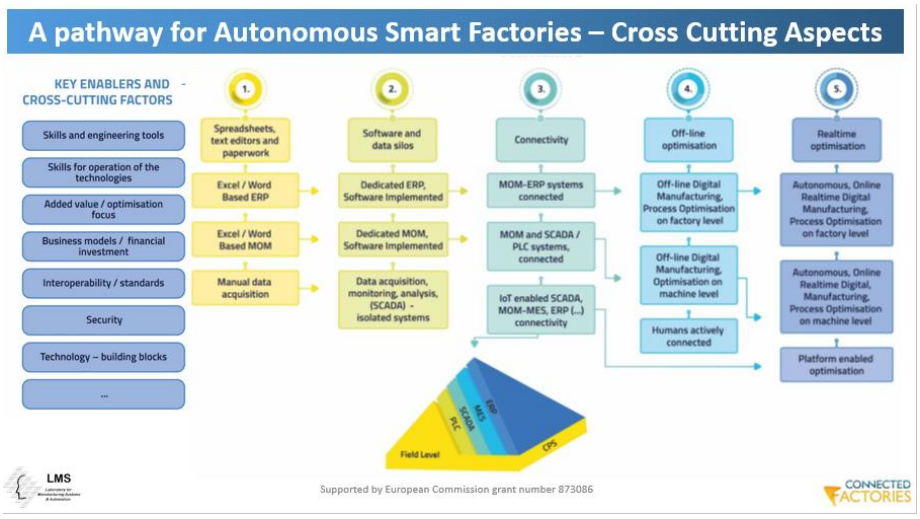


Figure 17. Autonomous Smart Factories pathway

4.2.5 Interactive Session on Smart Autonomous Factories and Skills

The objective of the workshopping session was to gather comments and feedback on the pathway of Autonomous Smart Factories pathway. Google forms tool and Teams were used to facilitate the needs.

The participants were asked to provide three types of information:

- Profile data including size of industry
- Feedback on the smart autonomous factory pathways.
- Feedback on the role of skills.

In the following pages the feedback from the workshop participants is provided.

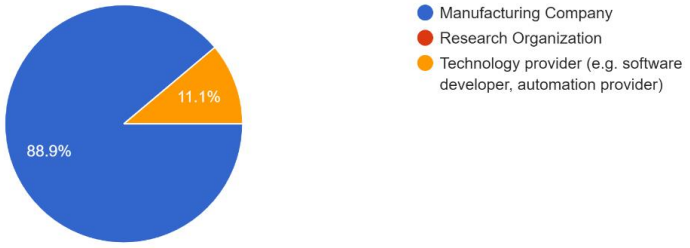


Figure 18. What type of organization are you affiliated to?

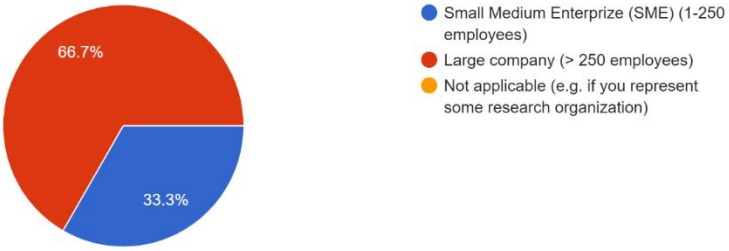


Figure 19. What is the size of your company?

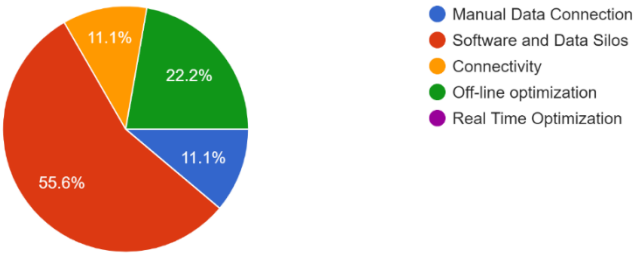


Figure 20. At what level does your factory align with the Autonomous Smart Factories Pathway?

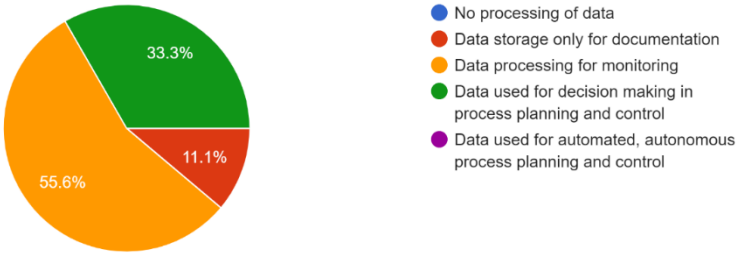


Figure 21. What is the level of data processing in your production?

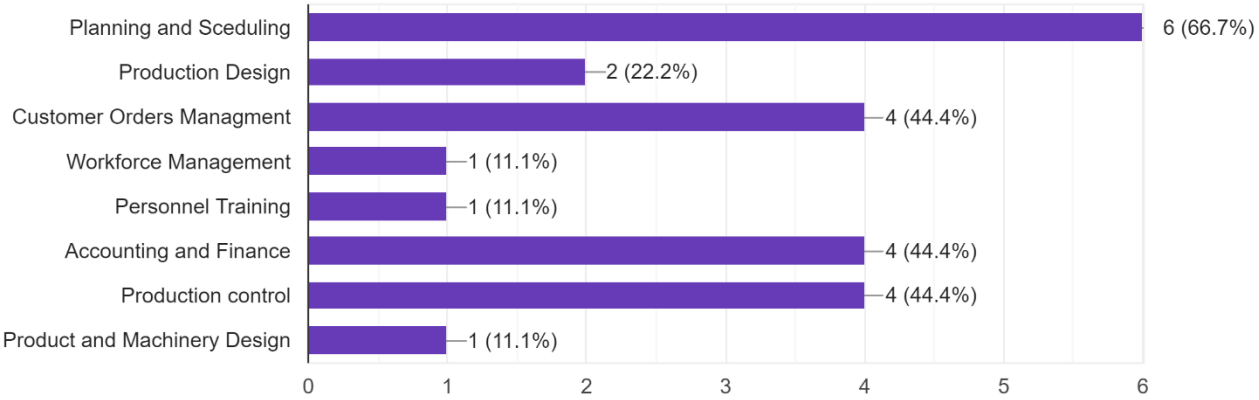


Figure 22. What do you use digital technology for in your company?

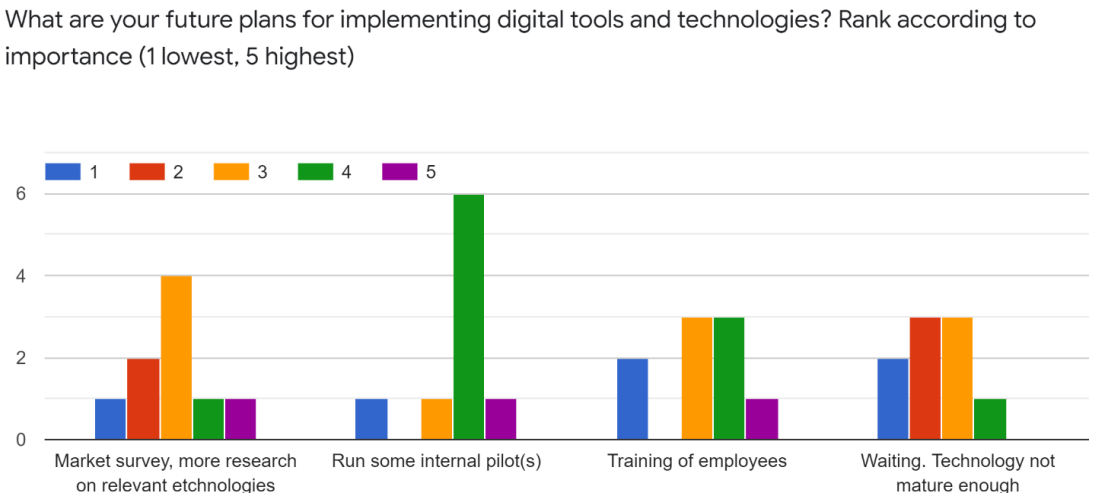


Figure 23. What are your future plans for implementing digital tools and technologies? Rank according to importance (1 lowest, 5 highest)?

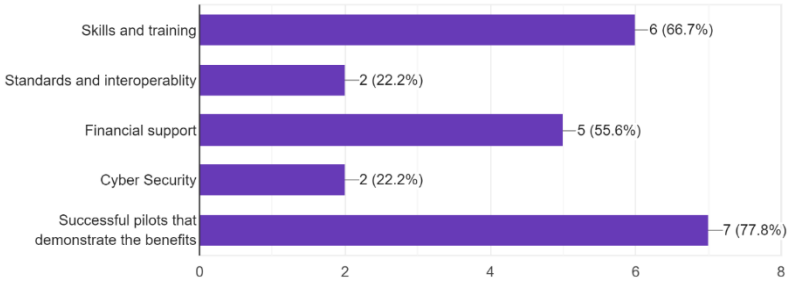


Figure 24. What do you think would be the most important enablers to accelerate your digital transformation journey? (Select top 3)

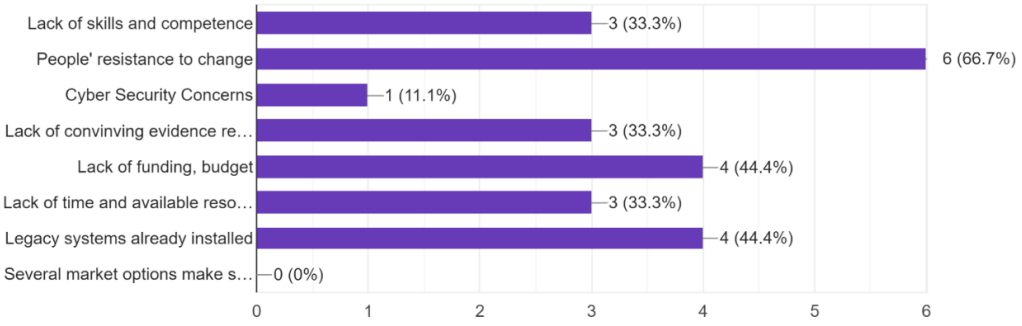


Figure 25. What are the main barriers that impede you from adopting digital technologies? (Select top 3)

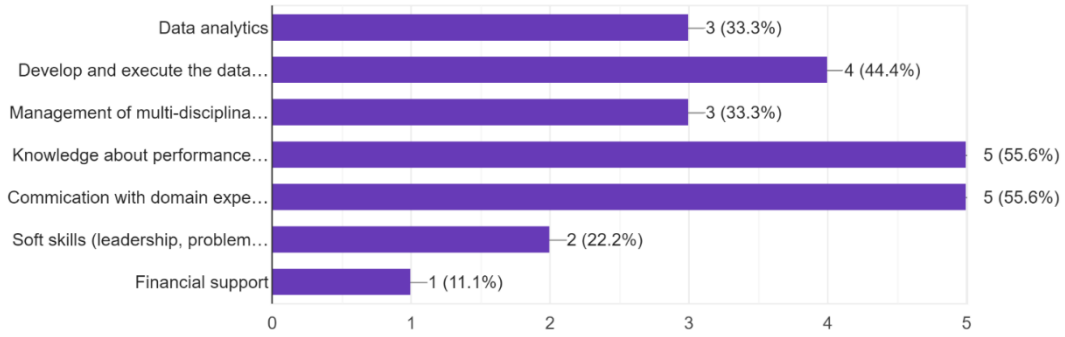


Figure 26. What skills do you think are missing in order to introduce new digital technologies in your company? (Select top 3)

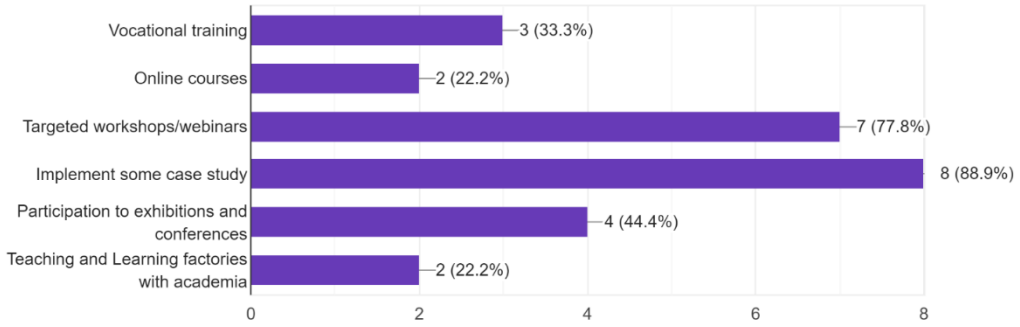


Figure 27. What are the best mechanisms to train your personnel and get them ready for digital transformation projects? (Select top 3)

4.2.6 Conclusion

Overview of the results and description of the engagement strategy after the workshop is summarized in this section.

4.2.6.1 Transferable results

The workshop aim was to collect feedback to the Autonomous Smart Factories pathway. The results are summarised below. In addition to the feedback on pathways, the participating organisations learned about funding opportunities and industrial pilot cases.

In the Autonomous Smart Factory pathway workshop the following results can be drawn:

- Data silos is the dominating status in most of the companies participated in the workshop with offline optimization following in second position.
- Data processing for monitoring is the main category of data usage among the workshop participants.
- Production planning and scheduling, customer orders management, financing and production control prevail the use of ICT technologies.
- Use cases and application of digital technologies seems to be the most popular strategy for implementing digitalization plans. This makes CF2 activity of searching and highlighting interesting case an activity that is absolutely relevant for the companies.
- Skills and training of personnel for supporting the deployment and adoption of new digital technologies.
- In terms of skills missing "knowledge about performance indicators" and "communication with domain experts (e.g. with shop floor managers)" have received the main the attention by the participants. This highlights the importance that the people involved in the digital transformation project should be aware of company's strategic objectives as well as the access to expert's knowledge. Multi-stakeholder teams should be formulated in order to support digital transformation projects.
- People resistance to change and brown field installations (i.e. installed legacy systems) are considered as main barriers for successful digitalization plans.
- The steps/phases of the pathway were clear to the participants and they had no issues to position their organization in any of the proposed steps. Autonomous Smart Factories is an important aspect which all participants are discussing internally in their enterprise either SMEs or large ones. From that perspective the classification provided by the pathway was pertinent for all participants.

Following the workshop, the participants were encouraged to continue the discussion on the bilateral basis or ad-hoc basis to discuss specific topics such.

4.2.6.2 Experiences

Companies are aware of the level of smartness and data connectivity in their factories and they are in principle convinced on the benefits Industry4.0 digital technologies could bring in this aspect. The Autonomous Smart Factories pathway description was clear and has helped the companies to position themselves in the proposed landscape without any difficulty and the cross-cutting factors approach also got participants' attention. More discussion with the companies might be needed for depicting the skills needed (e.g. multi-stakeholders' teams) or barriers that need to be overcome to support the different steps/phases. For example, legacy systems installation was mentioned as a significant factor that may become a barrier in digital transformation activities however this is not considered in the pathway description.

4.3 Digital Workplace of the Future – 15/04/21, I4.0 (AT)

4.3.1 Topics Addressed in the Workshop

	Topics adressed (X)
Trends, needs, challenges and barriers	x
Successful use-cases	
Cross-cutting Factors	
Added Value and Business Models	
Interoperability and Standardisation	
Cybersecurity	
Industrial Agreement and Legal Aspects	
Humans in Manufacturing	x
Pathways	
Circular Economy	
Human Factors	x
Autonomous Smart Factories	
Hyperconnected Factories	
Collaborative Product-Service Factories	
Data Spaces	
Skills	

Table 4: Topics Addressed in Workshop

4.3.2 Executive Summary

The following report will outline the results from the workshop, “Digital Workplace of the Future” which was a virtual event, hosted by the Platform Industry 4.0 on the 15th of April 2021.

The workshop allowed delegates to explore the concept of connected factories pathways, and how they can be applied.

The workshop itself was a free two-hour workshop giving delegates the opportunity to:

- Discover more about the ConnectedFactories project
- Identify the skills and experience required alongside the technology
- Highlight funding opportunities for manufacturers
- Hear a manufacturer discussing their journey

Furthermore, the aims of the workshop were:

- Promote the ConnectedFactories project and its resources
- Highlights the importance of people and skills when implementing digital manufacturing
- Understand the blockers and challenges when implementing digital technologies
- Identify the skills gap and shortages within digital manufacturing

4.3.3 Introduction

This report describes the execution of the workshop *Upskilling for Digital Manufacturing*, organized by The Manufacturing Technology Centre on the 19th of November 2020.

The topics addressed in the workshop where primarily**, Humans in Manufacturing and Human Factors** with a focus on how we could design the digital workplace on the shopfloor in the future.

The specific objectives of the workshop were:

- Promote the ConnectedFactories project and its resources to delegates who may be interested in getting involved.
- Highlights the importance of people and skills when implementing digital manufacturing otherwise known as "Humans in Manufacturing".
- Understand the blockers and challenges when implementing digital technologies, tools and techniques.
- How to design the workplace of the future on the shopfloor (design thinking aspects)
- Discussions with contributions from Academia, Industry and Trade Unions



INDUSTRIE 4.0 ÖSTERREICH

Plattform Industrie 4.0 – Workshop Mensch in der digitalen Fabrik

Digitaler Arbeitsplatz der Zukunft

15. April 2021, 15:00-17:00

online via Zoom

https://us02web.zoom.us/j/84836871395?pwd=d0xSN1RTKy93dlpvejFscERqV29sdz09

Im Rahmen des EU-geförderten Projektes Connected Factories 2 widmen wir uns bei dieser Veranstaltung ganz dem Thema Arbeitsplatz der Zukunft. Manfred Tscheligi, AIT, präsentiert uns die design thinking Ansätze des Arbeitsplatzes der Zukunft und beantwortet die Frage, was die neuesten technischen Entwicklungen dazu sind. Sabrina Sorko, FH Joanneum, berichtet über die ganzheitliche Gestaltung eines digitalen, smarten Arbeitsplatzes aus Forschungssicht. Einblicke in die Praxis und Erfahrungen mit Mensch-Maschine Kollaborationen gibt es anschließend aus Betriebsratssicht.

TOP 1	**Begrüßung durch Roland Sommer, Plattform Industrie 4.0 und Kurzvorstellung des Projekts Connected Factories 2**
TOP 2	**Manfred Tscheligi, AIT**
TOP 3	**Sabrina Sorko, FH Joanneum**
TOP 4	**Kerstin Repolusk, PRO-GE**
TOP 5	**Gruppendiskussion**
17:00	**Ende des Workshops**

Link zur Teilnahme:

https://us02web.zoom.us/j/84836871395?pwd=d0xSN1RTKy93dlpvejFscERqV29sdz09

Meeting-ID: 848 3687 1395

Kenncode: 312362

Schnelleinwahl mobil

*+431206093072,,84836871395#,,,,*312362# Österreich*

*+4312535501,,84836871395#,,,,*312362# Österreich*

CONNECTED FACTORIES

Figure 28: Workshop Agenda and Invitation

4.3.4 Workshop Organization and Preparation

The workshop was promoted through several channels:

- Direct Emails to members and partners of the Platform Industry 4.0, the Trade Unions and the Austrian Institute of Technology
- Word of mouth

4.3.5 Keynote Speakers Session

4.3.5.1 Keynote Speaker 1, European Factories of the Future Research Association– ConnectedFactories Project and introduction to the workshop

The first keynote session was delivered by Roland Sommer who introduced the topic of ConnectedFactories and pathways. As most of the audience was new to ConnectedFactories it was crucial to introduce the project and its aims, to set the scene for the rest of the workshop.

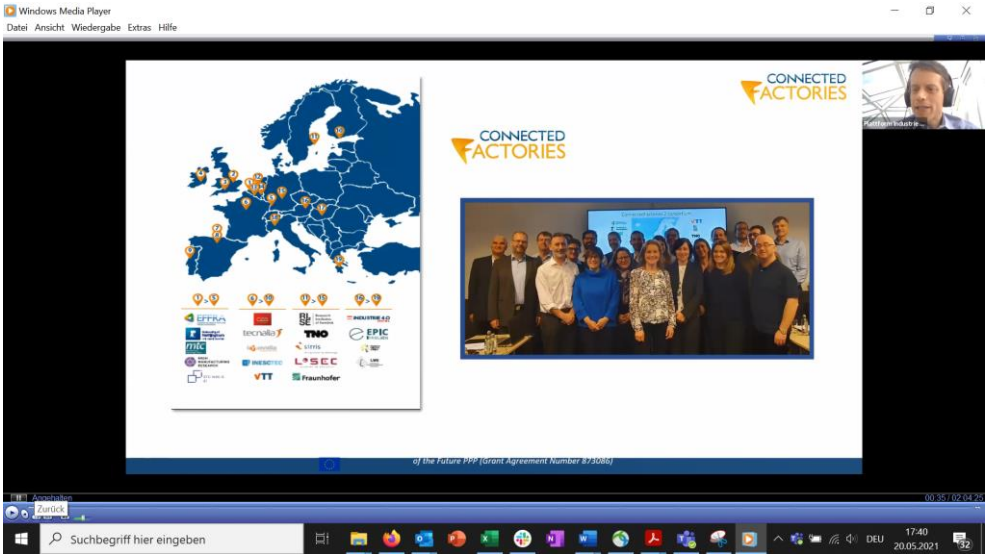
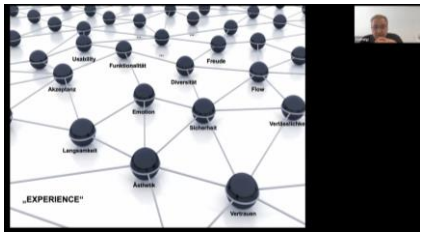
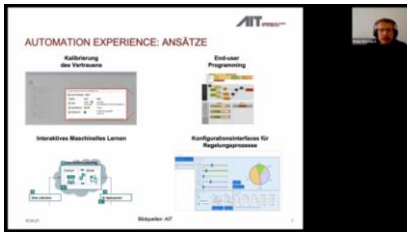


Figure 29: Screenshot from Keynote 1



(a) Screenshot 1



(b) Screenshot 2



(c) Screenshot 3

Figure 30: Screenshot from Keynote 2

4.3.5.2 *Keynote Speakers 2, "Humans in the Digital Factory, and Impulse"*

Following an introduction to the ConnectedFactories project, Prof. Manfred Tscheligi, Markus Murtinger and Peter Fröhlich from the Austrian Institute of Technology then introduced the topic of Humans in the Digital Factory – an Impulse.

4.3.5.3 *Keynote Speaker 3, Digital Workspace of the Future, Insight in Facets and Initiatives on the Shopfloor"*

The third keynote came from Sabrina Sorko, Senior Lecturer of the FH Joanneum, Institute of Industrial Management. She puts the digital workplace of the future in the centre of her presentation. She gives an insight on facets and new approaches on the shopfloor.



Figure 31: Screenshot from keynote 3

4.3.5.4 *Keynote Speaker 4, Why it makes sense to regard workers as the centre of the workplace of the future*

The fourth keynote came from Kerstin Repolusk, from the Production Trade Unions



Figure 32. Screenshot from keynote 5

4.3.6 Interactive Session

4.3.6.1 Interactive Session 1 on, challenges in Digital Manufacturing

As the workshop was virtual due to Covid-19 restrictions, it meant we had to conduct the interactive part of the session differently. In the case of this workshop, a shared screen on Zoom was used. In the first discussion round, the question was asked to the whole audience how does the workplace of the future look like?

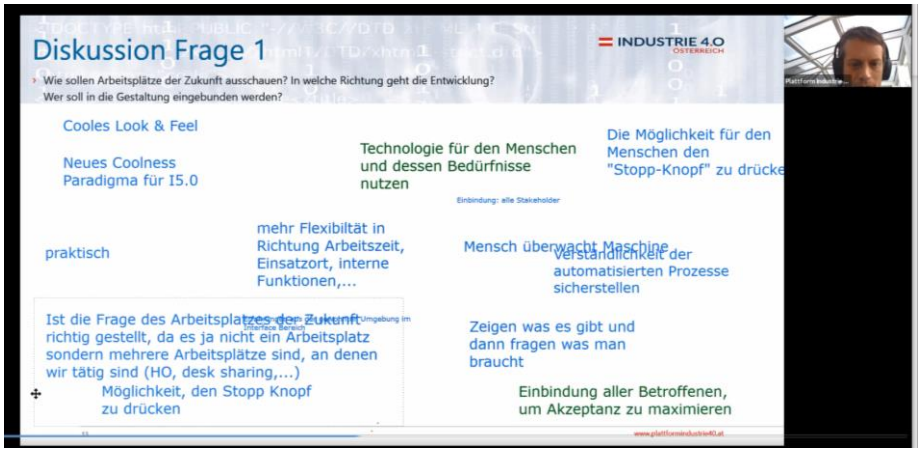


Figure 33: Screenshot from the interactive part

Some of the contributions included:

- Cool new look and feel is necessary
- It needs more flexibility with regard to working time, internal functions and where to work
- The human supervises the machine
- There should be the possibility for humans to press the “stop” button
- Integrate all affected people to raise acceptance
- If systems are based on experiences with familiar surroundings, the acceptance tends to be higher

Key discussion points were

- We have to think about how to use technology in the future and at the same time put humans (back) in the centre. Current technologies enable processes at such velocities that humans cannot cope with that any more; we see rising sick leaves
- Employers and employees should work together for the benefit of all, co-determination proved to be successful in the past. Before the pandemic regular meetings with organised on the shopfloor where there was an information exchange to the different shift groups. Humans need humans! We have to come back to an organisational culture based on trust and open communication to be able to cope with the technology developments that take place at breath-taking speed.
- There is a strong trend that humans need to adapt to new technologies. One of the participants pointed out that also technology could support the workers and cites a use case from the automotive industry where the chassis of the car was turned by 90 degrees so that it was not necessary for the workers to work above their head.

- The discussions show that we differentiate between workers and clerical workers. Workers often do not have the time to read emails, what should I do when I have tablets, when my hands are oily. The challenges is how digitisation can help
- A donkey is no racehorse, we have to think about in which jobs do we want to employ or need to employ humans? Industry workers cannot be a coding expert. Yet, we need employment for these humans! What do I need to do that the workers feels comfortable, does he want to communicate with others? This adds also to a certain coolness factor to work in industry.
- There is support to the discussion point that employees want to communicate to each other. There is clear feedback from various companies that workers do not solely want to use devices like mobile phones to exchange information, but they would like to communicate with colleagues and exchange views, experience etc. For some of the participants this is also an expression of appreciation. Young workers embrace these devices better that older ones.
- Another participant told that in the company he works for the average age of the workers is around 50. They have all received tablets for processing their orders. 85% of them refused to use the tablets because they were afraid of being monitored. The solution was that in every department someone was nominated who showed the added value of these devices, offered help, also with regard to improving processes. This led to a rethinking of the usage of these tablets as most workers had the impression that these devices improve their working situation.
- Technological progress needs to function in a dialogue, this addresses fears of workers and clerical workers likewise.
- Cool shopfloor design is necessary. Human-centered design focuses on human needs. If there are fears, communication needs that are needed but not used, we need a design process where technology can provide solutions. Human-oriented technology design is important and can provide solutions. This is being done too little. Human-centered design means be innovative, all together and include them at an early stage. It is too late, when the technology is already implemented. You get the investment back, less sick leaves, more work satisfaction, etc.
- Technology acceptance is an important aspect, many companies do not have strategies for new workers, esp. those that are still in training
- Discuss, interact and ask raises the acceptance of technologies. If robots make mistakes and they admit it, the trust in the system will be raised, according to a study in Salzburg. Acceptance can also be measured.
- Trust is an important topic. If trustworthiness is imbedded in the corporate culture, it is easier to implement new technologies because workers trust the technologies, systems and handling of data.
- Acceptance research clearly states, if a new technology is implemented, is there a benefit the one who uses it. Accompanying communication is extremely important. (1:42)

4.3.7 Conclusion

The workshop was a perfect opportunity to reach out to various stakeholders and spread the word about the ConnectedFactories project and Digital Manufacturing opportunity. Furthermore, we were able to collect valuable discussion feedback from participants.

4.3.7.1 Transferable Results

The workshop focussed on the pathway of “Human Factors” which corresponds to WP2. This is believed to be an integral component of implementing digital tools and technologies, as technology is only as good as

the people using it. To support findings, Manfred Tscheligi and colleagues (Austrian Institute of Technology), Sabrina Sorko (Fachhochschule Joanneum) and Kerstin Repolusk (Trade Unions for Production) gave their experiences and insights into some of the issues around people within his organisation.

Following the results from the workshop, our recommendations are as follows.

Trends:

1. A close interaction between management and work councils/employees is not only necessary but also helps introducing new technologies successfully
2. Design thinking approaches are important to address possible barriers and add to successful technology implementations. By doing so, job profiles can also be designed taking into consideration needs of employees at an early stage.

Needs/Barriers:

3. Create a communication culture.
4. Skills are crucial; skills came out as being one of the biggest enablers, but also one of the biggest barriers. This emphasises why we need to focus on a skills framework to educate manufacturers on the skills they need, where to find them, or even how to create them – from training etc…

4.3.7.2 Lessons Learnt

The workshop was a perfect opportunity to get to know the views from academia, industry and employees associations.

Attendees were interested in intensive discussions and sharing their views.

Furthermore, there were requests for Interactive “brainstorming” sessions within the workshops. These sessions allow attendees to share their opinions, problems and experiences. This can then foster thought-provoking conversations and information to use as part of ConnectedFactories.

The conclusion is around the importance of gathering attendee feedback. Gathering feedback allowed the project partners to identify where they could make improvements to their respective workshops. We believe a more formalised structure in obtaining these would be beneficial

4.4 Data Sharing: Best Practice Netherlands – 11/11/21, I4.0 (AT)

4.4.1 Topics Addressed in the Workshop

	Topics adressed (X)
Trends, needs, challenges and barriers	X
Successful use-cases	X
Cross-cutting Factors	X
Added Value and Business Models	X
Interoperability and Standardisation	X
Cybersecurity	
Industrial Agreement and Legal Aspects	X
Humans in Manufacturing	
Pathways	X
Circular Economy	
Human Factors	
Autonomous Smart Factories	
Hyperconnected Factories	X
Collaborative Product-Service Factories	
Data Spaces	X
Skills	

4.4.2 Executive Summary

Data Spaces are currently regarded as important innovation drivers for the European industry. Activities for data exchange in value networks are being pursued in different sectors. The Catena-X network, for example, wants to create a Data Space for the automotive industry. The EU Commission is also promoting the creation of Data Spaces (e.g., in manufacturing). An overview of the various initiatives and implementation examples is provided by the Data Space Radar of the International Data Spaces Association (IDSA).

The potential of Data Spaces is regularly discussed at the political and media level. However, many companies still ask themselves the question: What advantages do Data Spaces actually bring and what does their implementation look like in practice?

To answer this question for Austrian industry, Plattform Industrie 4.0 organised a workshop together with the Federation of Austrian Industries as part of the “Connected Factories 2”-project, funded by the European Union. The guest was Peter von Harten, Smart Industry Ambassador Platform Smart Industry NL, Head of Isah Germany and expert for the SCSN. The abbreviation SCSN stands for the "Smart Connected Supplier Network", an active data space in the Netherlands.

In his presentation and in the subsequent discussion, Mr. van Harten introduced the SCSN, went into the background of the project, its implementation and the resulting advantages for companies.

Tool for better collaboration

The SCSN was created in the environment of the Dutch technology company ASML. ASML builds machines for the production of semiconductors and is an important part of the European high-tech industry. Its products are correspondingly complex - a machine comprises more than 50,000 components. The components are often bought in from other companies, so it is important for ASML to maintain relationships with suppliers and with the value-added network.

In 2016, the SCSN was created as a "Fieldlab" around the central question of how cooperation within such a value network can be improved. Fieldlabs are an initiative of the Dutch Smart Industry strategy and aim to create industrial test and experimentation environments. In 2020, there were more than 45 such Fieldlabs in the Netherlands, where more than 10,000 people have been able to learn how to use technology so far.

Digital and sovereign relationship management

Between the manufacturer of a product (OEM) and the producers of the raw materials required for it, there are usually different suppliers. These are connected to each other through business relationships. The goal of SCSN is to increase efficiency within such a supply chain in industry - with the help of the exchange of production and process data.

Traditionally, data is exchanged between two companies via interfaces (e.g., email, FTP...) or with the help of central platforms (e.g., via cloud computing). It can be time-consuming for companies to set up individual interfaces for individual partners or to find a central solution that is accepted by all partners.

This is where the SCSN comes in: Based on the reference architecture model of the IDSA, a communication standard was created that links to the already existing systems and standards in the supply chain and connects them with each other. Through a common language (based on UBL) and building on the principle of data sovereignty, existing software components (especially ERP systems) are interoperable connected. This establishes the digital link within the supply chain of a product.

Efficiency increases and objectives

The SCSN enables direct data exchange between the different levels of a value network. This results in various advantages. Enquiries can be answered more quickly, requests can be responded to more quickly. Companies can decide for themselves which data they want to make available to whom. Sources of error can be avoided through direct communication.

The results so far speak in favour of the Dutch approach. The SCSN has so far achieved productivity increases of 20% within the participating value network. Meanwhile, 300 companies are already part of the initiative. The goal of the independent foundation that administers the SCSN standard is to increase this number to 2000 companies in the coming years.

Opportunities for Austrian companies

At the end of his input, Mr. van Harten went into the possibilities of interacting with the SCSN. He concluded by explaining to the participants what "homework" they can do today to potentially participate effectively in activities such as the SCSN. Important here are, for example, an existing data management and its structure as well as the Industrie 4.0 capability of the systems used (e.g., the ERP system). Experiments with digital twins can also contribute to the necessary competence building in industrial companies.

4.4.3 Introduction

Discussion points within the workshop as described above:

- Presentation of the "Smart Industry" programme of the Netherlands, the "Fieldabs" and the "Smart Connected Supplier Network" (SCSN).
- Explanation of the links to IDSA, Gaia-X, digital twin.
- Open discussion on data sharing: why should we do it, what do we need for it, what is the benefit, what is still to come, where are there concrete examples and what do they bring?

4.4.4 Workshop Organization and Preparation

The workshop was organised by the Platform Industry 4.0 Austria (PIA) together with the Federation of Austrian Industries. Both organizations promoted the event among their communities.

The topic of data sharing is very interesting for Austrian companies as many of them are highly specialized in their fields and would, therefore, directly profit from exchanging more information within their supplier networks in trustworthy ways.

Examples for functioning data spaces are still quite rare in Austria, which is why collaboration with European partners was chosen as the means of delivering the right content to the interested target group.

4.4.5 Keynote Speaker

Peter van Harten was chosen as the speaker of the event due to his extensive experience with data sharing. He is a partner at Isah International and an expert on ERP software, which can be considered a major component of the “digital transformation portfolio” of the Austrian industry. Therefore, companies can relate to it.

Apart from that, Peter van Harten serves as the Smart Industry Ambassador of the Netherlands and aims to promote European collaboration in manufacturing. The Netherlands themselves, in particular the SCSN (as mentioned above) can be considered a European lighthouse in the area of data sharing.



Figure 34. Invitation to workshop

4.4.6 Conclusion

Although the SCSN has a focus on the Dutch high-tech industry, the network is highly interesting for Austrian and European companies in the area of manufacturing. The lessons learned from the SCSN, in a technical and in an organizational setting, can be transferred to Austrian and European companies that are interested in setting up a Data Space. This is also in the interest of the SCSN as its 300 member companies have decided to put the Intellectual Property created into a foundation that's accessible for European partners as well.

The participants of the workshop received an overview on the whole topic and its implementation in the Netherlands. Also, they were able to discuss their questions with an expert in the field.

Specifically, next steps were discussed and agreed upon:

- The Plattform Industrie 4.0 will organize a workshop with companies potentially interested in adopting the SCSN and its software in Austria.
- The Netherlands will be the official partner country at the Summit Industry 4.0 in May 2022 in the Viennese city hall.

Peter van Harten and the SCSN will support Austrian efforts in the area of data sharing and connect them with their European partners.

4.5 The MTC Digitising Manufacturing Conference 2021 – 11/11/21, MTC (UK)

4.5.1 Topics Addressed in the Workshop

	Topics addressed (X)
Trends, needs, challenges and barriers	X
Successful use-cases	X
Cross-cutting Factors	
Added Value and Business Models	X
Interoperability and Standardisation	X
Cybersecurity	X
Industrial Agreement and Legal Aspects	
Humans in Manufacturing	X
Pathways	
Circular Economy	
Human Factors	X
Autonomous Smart Factories	
Hyperconnected Factories	
Collaborative Product-Service Factories	
Data Spaces	X
Skills	X

*Table 5. Topics addressed within the MTC Digitalising Manufacturing Conference and ConnectedFactories workshop. Key: Red **X**'s highlight all the topics addressed at the Digitalising Manufacturing Conference 2021. Black **X**'s are for the subjects covered on Day 3: 'Skills for a digital world' of the Digitalising Manufacturing Conference 2021.*

4.5.2 Executive Summary

This report outlines the results of day three of the Digitalising Manufacturing Conference 2021, this session was being used as a larger 'workshop' for *ConnectedFactories 2*. The event was a hybrid conference (virtual and in-person) hosted by The Manufacturing Technology Centre on the 11th November 2021.

The specific objectives of the workshop were to:

- Promote the ConnectedFactories project and its resources to attendees who may find it of interest and of future use.
- Discuss the subject of digital skills from both skills and company driven perspectives.
- Highlight the fractured nature of skills frameworks and infrastructure, and why this needs targeted action.
- Support the findings of Work Packages 1-4 of *ConnectedFactories 2.*

All the sessions focused on digital skills, including how to identify what skills are necessary and actions that are being taken at various levels (company, national, international). The interactive sessions highlighted:

- Communication and people management (training, feedback) were the most common digital skill needed by organisations.
- Hybrid sessions require more time for interactive activities to support larger engagement.

Overall, the conference day three offered (unknown number of) delegates a look at a wide range of ongoing digital skill activities, however they did not allow as many interactions as planned. Whilst keynotes sessions highlighted the fractures in Digital Skill support in the UK and the possible activities to resolve this, and the *ConnectedFactories 2* video was well received, the workshop did not have the same level of impact or interactive opportunity as the MTC's November 2020 virtual-only workshop. It is recommended that any future sessions revert to small workshop with an invited audience, as opposed to within a hybrid conference/expo environment.

4.5.3 Introduction

The MTC hosts an annual Digitalising Manufacturing Conference (DMC), this year's 7th annual conference focuses on many of the aspects and cross-cutting factors that are covered within ConnectedFactories 2. The decision was made to hold the second workshop for ConnectedFactories 2 at the conference to enable a wide engagement profile. This report describes the execution of the workshop (day three of the DMC) "Skills for a Digital World", organised by The Manufacturing Technology Centre on 11th November 2021.

Topics addressed across the whole conference (in red) and those specific to the workshop are highlighted in black in Table 1. The Digital **Skills** workshop primarily focused on the **human factors** of what skills are needed and the approach that will help increase the necessary skills across manufacturing. The **trends, needs, challenges and barriers** of digital skills will be discussed throughout the keynote speaker sessions on the individual, national and international level.

The specific objectives of the workshop were to:

- Promote the ConnectedFactories project and its resources to attendees who may find it of interest and use in the future.
- Discuss the subject of digital skills from skills and company driven perspectives.
- Highlight the fractured nature of skills frameworks and infrastructure, and why this needs targeted action.

These supported the Work Package 5 objectives which were to:

- 5.2 Organise a workshop at national level on the topics from Work Packages 1-4.

5.3 Feedback the findings to the ConnectedFactories 2 project for reporting.

Table 6. Topics addressed within the MTC Digitalising Manufacturing Conference and ConnectedFactories workshop

Hour	Topics
10:00	**Welcome**
10:05	**Key Note: *Inspiring a great Journey* by Emma Wiggs**
10:25	**What do we mean by Digital Skills? – interactive session**
10:30	***Demand driven skills initiatives taking a lead from industry* by Paul Shakespeare & Martin Dury**
11:00	**Break (and moment of silence for Remembrance Day)**
11:10	***The Company Approach (incl. DRAMA & CF2)* by Klaas Ardinois, Faraz Shahid & CF2 (video)**
11:40	***International perspective on Skills* by Eurico Assuncao**
11:50	***Audience Check-in* – interactive session**
11:55	***Panel session – Q&A***
12:25	**Conclusions and Farewell**

4.5.4 Workshop Organisation and Preparation

4.5.5 Keynote Speakers Session

The entire day is available to watch again on the website: Digitalising Manufacturing Conference.

4.5.5.1 Keynote Speaker 1: Emma Wiggs MBE

The first key speaker was Emma Wiggs MBE, the double Paralympic gold medal canoeist, who discussed the transformational journey she has been on, the skills she has developed and how digital technologies enabled her to win Gold at Tokyo 2020 Paralympic.



Figure 35. Screen shot of the presentation slide used at DMC 2021

4.5.5.2 Keynote Speaker 2: Demand driven skills initiatives taking a lead from industry

Following the first interactive session, Paul Shakespeare – Leader of Gatsby Foundation at High Value Manufacturing Catapult and Martin Dury – Head of Future Skills at the MTC, presented the demand driven skills initiatives being used to support the development of a work force with the right skills.

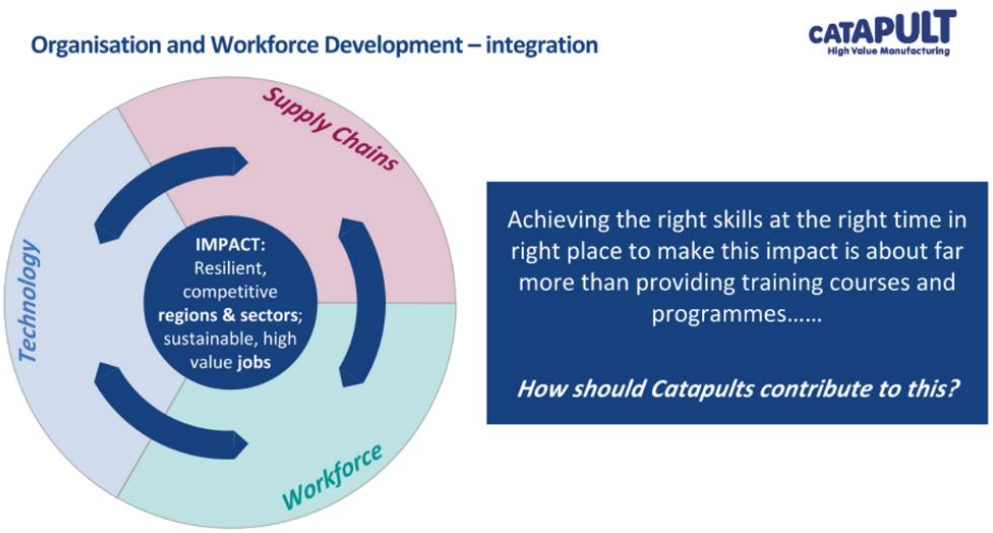


Figure 36. Screen shot taken from the presentation of Keynote 2

4.5.5.3 Keynote Speaker 3: The Company Approach (incl. DRAMA & CF2)

The third keynote session highlighted the company approach to adoption of digital skills beginning with a presentation from Klaas Ardinois – CTO at CloudCall. The presentation focused on changes to the way skills are view within the company and how these are helping get ready for the future. The discussion also focused on the cultural impact for both technical and non-technical roles, and how this affects progression, planning and recruitment.

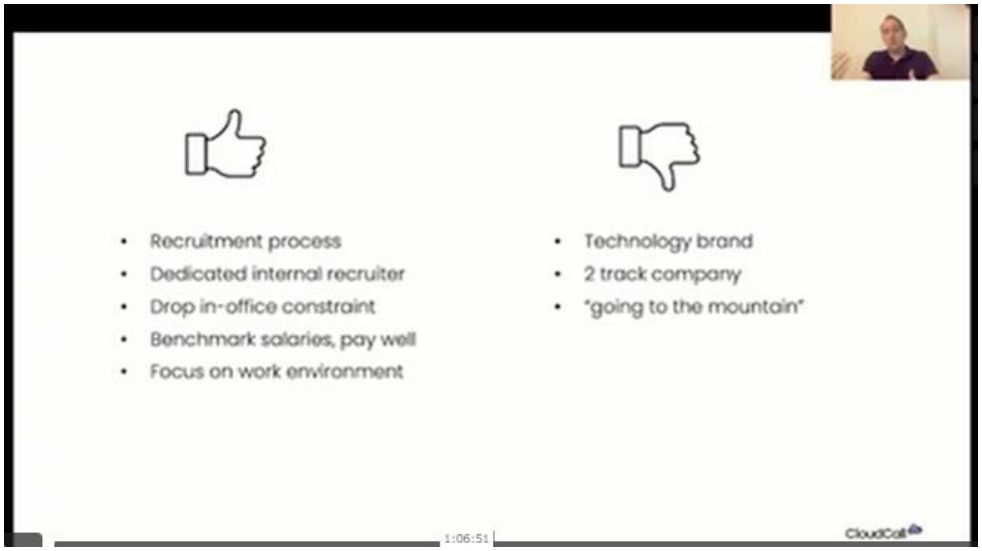


Figure 37. Screen shot from Klaas' presentation, highlighting pros and cons of CloudCall culture at present as related to digital skills and recruiting the skills

This was then followed by Faraz Shahid – Senior Research Engineer at MTC, presenting the skills aspects of the DRAMA project. This presentation highlighted the open knowledge sharing area for UK manufacturing (Knowledge Hub), specialist training courses, the linking in to apprentice schemes as well and dedicated support packages.



Figure 38. Screen shot of the DRAMA slides presented

The final part of this section was the viewing of the ConnectFactories 2 video (https://youtu.be/AT78aMMyS2s) this further highlighted the projects that have been undertaken to support the introduction of digital skills into businesses.

4.5.5.4 Keynote Speaker 4: International perspective on Skills

The final speaker session focused on an international perspective, presented by Eurico Assuncao – Deputy Director at EWF. This presentation highlighted the work the welding community have done to create internationally recognised standards for welding qualifications and how this is being expanded to other areas such as Additive Manufacturing.



Figure 39. Screen shot from keynote speaker 4

4.5.6 Interactive Sessions

4.5.6.1 Interactive Session 1 on: What do we mean by Digital Skills?

Being a hybrid event (virtual and in-person), it was decided that the Mentimeter tool would be used again after the success in the first MTC workshop in 2020. We used Mentimeter to ask the audience questions and view the answers in real time. The first activity was to review a definition of digital skills to build consensus before the rest of the sessions. The following definition was proposed:

> *"Digital skills range from basic essential competencies that allow an individual to operate successfully within a digital environment, such as accessing the internet, using emails and participating in virtual calls, to competencies and capabilities for programming robotics and coding AI systems, through to defining and managing fully integrated and connected digital systems and identifying future technologies.*
>
> *Digital skills are the foundation for any digital transformation programme. Continually upskilling individuals is critical for any business to be competitive, safeguarding jobs and valuing employees by enhancing existing capabilities and competencies to meet future requirements. Digital skills allow individuals to make informed decisions on new digital technologies and realise the benefits these technologies provide."*

The session length was 5 minutes and the maximum number of interactions during this interactive session was 13 participants. Questions and results can be found in, Annex 1: Results from Mentimeter.

Key outcomes include:

- That individuals understanding of 'digital skills' is wide ranging, and in most cases linked to the idea of being capable of using tools.
- Communication and people management (training, feedback) were the most common digital skill needed by organisations.
- Interactive sessions for hybrid audiences are significantly more difficult to get engagement than with wholly in-person or wholly virtual audiences. As a consequence it was not possible to get a true reflection of the participant views. The session time may not have been long enough to support the interactive element.

4.5.6.2 Interactive Session 2 on: Audience check-in

The second interactive session, also 5 minutes in length, also utilising Mentimeter, focused on asking the audience about their company's skills capabilities and what actions they would take after the conference. This was intended to be a short self-reflective activity just before the Q&A session; it may also be used to feed into the topics for the Q&A.

The maximum number of interactions during this interactive session was 5 participants. Questions and results can be found in, Annex 1: Results from Mentimeter.

Key outcomes include:

- The second interactive sessions for hybrid audiences saw fewer interactions, in part due to unstable Wi-Fi within the in-person venue. As with session1, the short time allowed may have affected the number of responses from the audience.
- Of the respondents, most gave no indication of problems hiring the necessary skills or deemed the question, not applicable.

- Most felt that there was 'some' potential within their existing workforce for digital skills.

4.5.6.3 Interactive Session 3 on: Digital Skills day review (Q&A)

The final interactive session (3) was a Q&A held with many of the keynote speakers and additional guest speakers:

- Verity Davidge – Director of Policy at Made UK.
- Rob Tabb – Policy Lead for Employment & Skills at Liverpool City Region Combined Authority.
- Riikka Virkkunen – Professor of Practice at VTT.

Questions asked during the Q&A session include:

- Going forward, how does digital skills fit with the Made in Europe funding call?
  - Asked to Riikka Virkkunen.
- What could organisations/businesses do to support each other to up-skill their workforces?
  - Asked to Rob Tabb.
- How can we engage with getting more females into the [digital] industry? How do we help in education to promote digital related roles?
  - Open to all panellists.
- How do we inspire the future generations?
  - Open to all panellists.
- How can digital skills help solve issues like climate change? And what are programmes like MakeUK doing to support this?
  - Open to all panellist, Verity Davidge to answer the MakeUK part of the question.
- How do we encourage those who want to adopt digital skills to access the right equipment and support needed (on an individual level)?
  - Open to all panellists.
- What is the hardest part of increasing digital skills?
  - Open to all panellists.

One comment that kept arising was the quote from Keynote speaker 3, Klaas Ardinois, "*Today's best practices are tomorrow's bad ideas*."

4.5.7 Conclusion

Utilising the Digitalising Manufacturing Conference 2021 as a hybrid event allowed the opportunity to engage a wide range people from across the UK and aboard; both to inform about *ConnectedFactories 2* and to discuss the overarching Day theme (digital skills). We were able to collect a small amount of data from the audience during the two interactive sections to understand:

- General understanding of the definition of '*digital skills*' within the audience.
- Barriers to employing digitally skilled people.

The keynote speakers highlighted the fractured nature of digital skills within the UK and offered suggestions to repair and make progress in this area. Additionally, the project was showcased using the *ConnectedFactories 2* video produced for Work Package 6. However, with an unverifiable number of attendees, this method of running a workshop did not have the same level of impact of the first MTC

workshop held in 2020. This is due in part, to allocating insufficient time for interactions with participants, a problem not faced with a dedicated workshop.

4.5.7.1 Transferable results

With the small attendee numbers, the possible transferable results for work packages 1-4 are also limited. The transferable results are as follows:

- Trends, needs, challenges, barriers:
  - That there is need for further connected collaboration and sharing of best practice across the manufacturing sector at all levels, within companies, on national and international scale.
  - Starting engagement at a younger age (below 15 years old).
- Pathways (human factors):
  - Employers are willing to look internally for digital skills, but need guidance on how to identify the required skills.
- Skills:
  - There was general agreement of the overall definition of 'digital skills' from the audience when presented with a definition.

4.5.7.2 Relevant Experiences

The inherent risk of Covid-19 during the event, was a threat that may have impacted the in-person attendance regardless of registration numbers. Conducting the event as a hybrid allowed for those unable to attend in person to attend virtually.

Further improvements include:

- Longer time for interactive sessions during hybrid events to allow for logging on / connecting to the interactive platform by participants prior to beginning the activities.
- Consideration of additional needs during the workshop, e.g. British Sign Language interruptor and/or closed captions for future hybrid workshops.

Any future sessions should revert to small workshop with an invited audience, to improve attendance and engagement.

4.6 Digitalisation for SMEs – 12/02/2022, UNOTT (UK)

4.6.1 Topics Addressed in the Workshop

	Topics adressed (X)
Trends, needs, challenges and barriers	
Successful use-cases	X
Cross-cutting Factors	
Added Value and Business Models	
Interoperability and Standardisation	
Cybersecurity	
Industrial Agreement and Legal Aspects	
Humans in Manufacturing	
Pathways	
Circular Economy	
Human Factors	
Autonomous Smart Factories	X
Hyperconnected Factories	X
Collaborative Product-Service Factories	
Data Spaces	
Skills	

4.6.2 Executive Summary

This report describes the execution of the workshop *Digitalisation for SMEs*, organised as part of the Institute for Advanced Manufacturing's (IfAM) monthly breakfast event for local industry. The workshop took place on the 12th of January 2022 and was a 2-hour hybrid physical / virtual event between 7:30am and 9:30am. The workshop was organised in conjunction with IfAM, and the Aerospace: Unlocking Potential project[15] funded by the European Regional Development Fund.

The workshop focused on disseminating the ConnectedFactories2 project, and discussing the pathways on Autonomous Smart Factories and Hyperconnected Factories; specifically, how they relate to SMEs which are part of larger value chains and / or support manufacturing operations of other companies. The presentation also discussed other ways in which SMEs can find advice on digitalisation.

The workshop was a free two-hour event hosted at the Advanced Manufacturing Building in Nottingham, and also streamed online for a hybrid audience. The five major components of the workshop were:

1. A keynote speech by Martin Rigley, Managing Director of Lindhurst Engineering on his company's digitalisation journey.
2. Introduction of the ConnectedFactories2 project, and the pathway concept.
3. Introduction of the Autonomous Smart Factory and the Hyperconnected Factories pathways, and discussion on where companies would position themselves.

[15] https://www.aerospaceup.com/

4. A discussion and feedback session on the pathways, and how participants can learn from Martin's experience and exploit the pathways concept.
5. Discussion of other avenues by which SMEs can be supported on their digitalisation journey.

The key aims of the workshop were:

1. Dissemination of ConnectedFactories2 and the pathways to regional SMEs within the UK midlands area.
2. Receive feedback on SMEs' status with respect to the pathways, and where they want to go from here.
3. Showcase a successful digitalisation case study, showing how digitalisation is not out of reach of SMEs and is an attainable and beneficial objective.
4. Highlight the support available to companies seeking to start or continue their digitalisation journey.

4.6.3 Introduction

This report describes the execution of the workshop: "*Institute for Advanced Manufacturing – Breakfast Event Number Three – Digitalisation for SMEs*", organised by the University of Nottingham's Institute for Advanced Manufacturing in conjunction with the Aerospace: Unlocking Potential project, to disseminate the ConnectedFactories2 project to regional Small and Medium Enterprises (SMEs), and receive feedback.

The topics addressed in the workshop were primarily the Autonomous Smart Factories pathway, and the Hyperconnected Factories pathway. Additionally, a successful SME digitalisation case study was presented. Lastly, ways in which SMEs can seek assistance for digitalisation in their companies were discussed.

The workshop had four key objectives:

1. Dissemination of ConnectedFactories2 and the pathways to regional SMEs within the UK midlands area.
2. Receive feedback on SMEs' status with respect to the pathways, and where they want to go from here.
3. Showcase a successful digitalisation case study, showing how digitalisation is not out of reach of SMEs and is an attainable and beneficial objective.
4. Highlight the support available to companies seeking to start or continue their digitalisation journey.

Table 7. Agenda

Time	Topic(s)
7:30 – 8:00am	Arrival and registration. Refreshment and breakfast. Informal discussion with delegates.
8:00 – 8:30am	Keynote speaker - Our Digitalisation Journey by Martin Rigley, Managing Director of Lindhurst Engineering[16].
8:30 – 9:00am	Interactive hybrid presentation session - Pathways to Digitalisation of Manufacturing by Dr Jack Chaplin.
9:00 – 9:30am	Discussion session, feedback, and close of workshop.

[16] https://lindhurstengineering.co.uk/

4.6.4 Workshop Organization and Preparation

The workshop was arranged as a joint venture between the ConnectedFactories2 project (represented by Dr. Jack C Chaplin), the Institute for Advanced Manufacturing's business engagement team as part of the Precision Manufacturing Centre (represented by Dr. Daniel Symes), and the Aerospace: Unlocking Potential project (also represented by Daniel Symes).

Aerospace: UP is funded by the European Regional Development Fund (ERDF) project, which aims to support SMEs in the aerospace supply chain in the Midlands region of the UK. The Midlands of the United Kingdom has a rich history in aerospace manufacture and is home to a quarter of the UK's aerospace industry, and 3% of the global aerospace industry[17]. Rolls-Royce - the world's second-largest manufacturer of aircraft engine – is the major driver of the regional manufacturing cluster, and supply chains into Rolls Royce stretch across the region, from parts manufacturers to materials producers. Many of these suppliers also supply other original equipment manufacturers (OEMs) in the UK, such as Airbus, BAE Systems, and Boeing.

Aerospace: UP has £20M of funding to work with SMEs within this region who are part of the aerospace supply chain. This includes the organisation of events (including the breakfast event series this workshop is part of), placement of students and graduates in companies, and grants to support the development of new technologies.

The workshop was organised within the existing breakfast event series to maximise engagement and interest from the regional SMEs. The meeting is early in the morning, allowing delegates to attend and still return to their businesses to complete a day of work – a formula which has proven successful pre-Covid. The workshop has been delayed multiple times and wavered between fully online and fully in-person formats. The decided approach was for a hybrid meeting, maximising the benefits of in-person attendees, but also allowing others to join remotely.

The presentations were developed with the online polling tool PollEverywhere to enable the voices of remote attendees to be heard and represented. Less structured discussion within the workshop was also noted down and analysed within this report.

The workshop was promoted through several channels, including Aerospace UP's website, social media channels, and mailing lists.

[17] https://www.midlandsaerospace.org.uk/aerospace

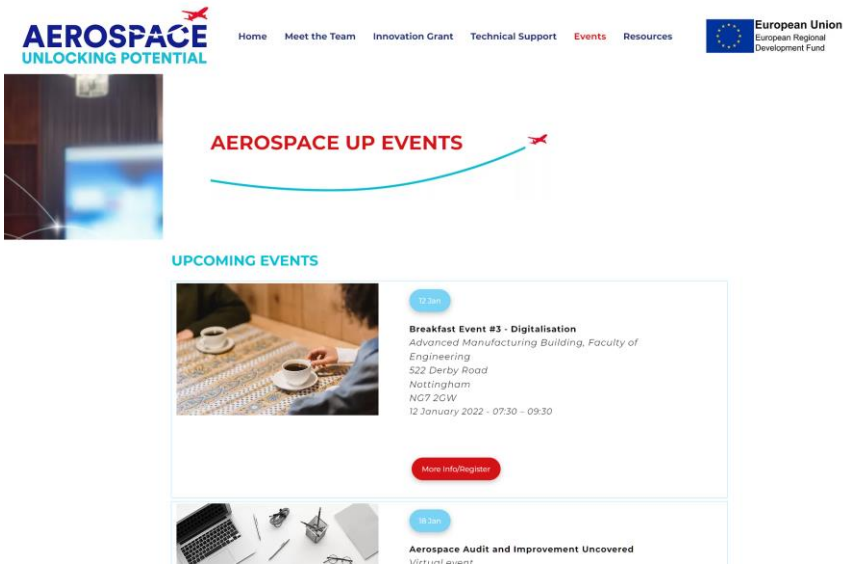


Figure 40. The workshop advertised on the Aerospace UP website's event's page.

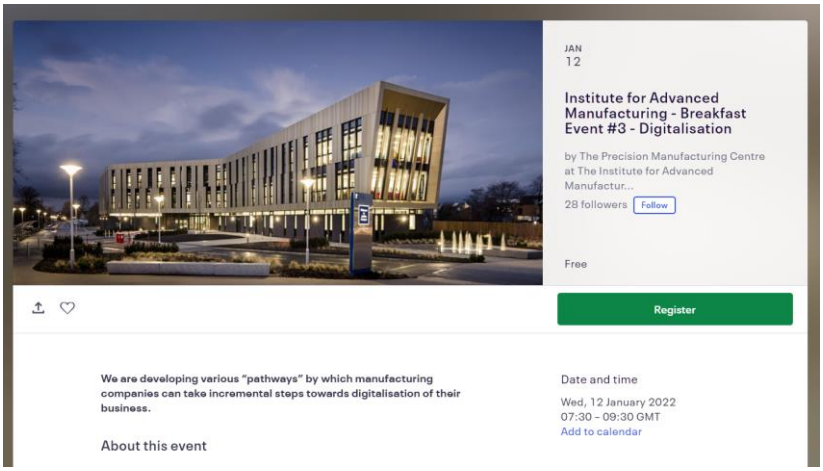


Figure 41. The workshop advertised on the Institute for Advanced Manufacturing's Eventbrite page.



Figure 42. The workshop advertised on the Nottingham Precision Manufacturing Centre's Twitter feed and retweeted by the IfAM Twitter account.

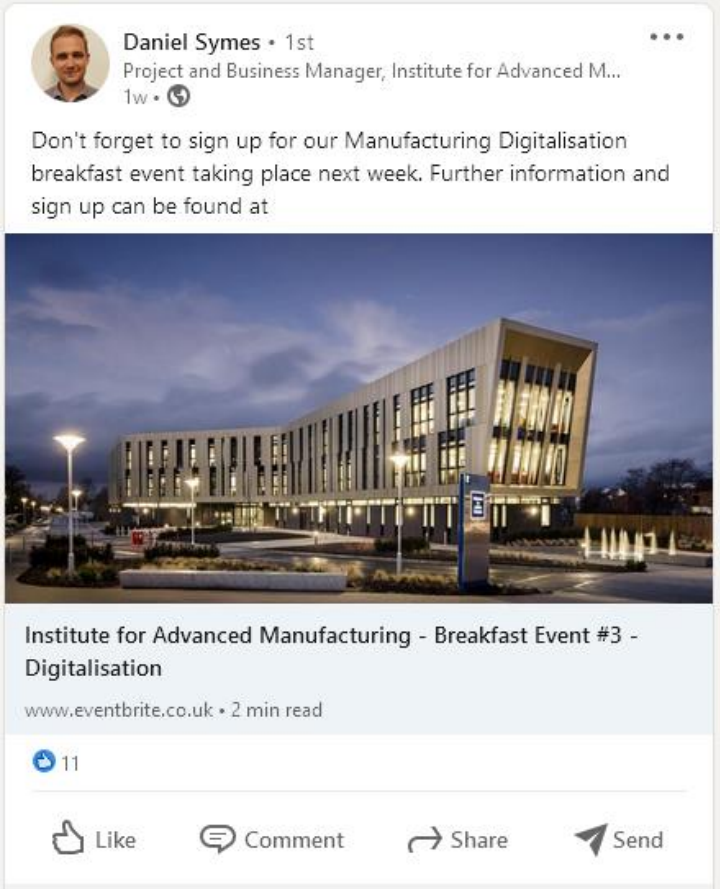


Figure 43: The workshop advertised via LinkedIn.

4.6.5 Keynote Speaker Session

4.6.5.1 Keynote Speaker – Martin Rigley MBE[18] – CEO Lindhurst Engineering – "Our Industrial Digitalisation Journey".



Figure 44. Martin Rigley MBE answering questions from the audience.

4.6.5.2 Key Points

- Inspiring cases are critical to getting companies started on their digitalisation journey. Understanding what is possible, and then considering how it could be applied to their own businesses is often the first step in the digitalisation process.
- SMEs generally do not have dedicated digital staff who both make decisions about digital strategy and implement them. C-level executives must have enough awareness of digitalisation to provide decisions and leadership, and delegate implementation appropriately.
- SMEs will not consider massive, all-encompassing digitalisation initiatives. There is neither the time nor the money. Instead, digitalisation must start small, and provide insights quickly – typically focusing on data collection and visualisation.
- The return on investment for digitalisation can be very rapid. A single insight into working pattern efficiency paid for Lindhurst's entire digitalisation programme alone.

[18] MBE – Member of the Most Excellent Order of the British Empire. Awarded to Martin Rigley by HRH Prince William for services to business and innovation.

4.6.5.3 Summary of Presentation

To maximise the ability for SMEs to attend the meeting, the workshop was kept to two hours (see section 4.6.7.2 for an explanation). As a result, it was decided a single keynote speaker was the best choice.

Martin Rigley is the Chief Executive Officer of Lindhurst Engineering, an engineering company specialising in bespoke metal fabrication and machinery. The presentation introduced how Lindhurst Engineering started their digitalisation journey as a company, working in collaboration with an IoT testing and measurement company to sensorise their production facility, gather data, and improve manufacturing efficiency.

Martin emphasised the importance of engagement with research institutions and networking, as well as presenting inspiring cases. Lindhurst Engineering's digitalisation journey began with a session on Industry 4.0 held at the University of Nottingham in 2018, which got him thinking about the possibilities of gathering and analysing data. A second chance meeting with DevTank (an SME provider of IoT measurement solutions) then began a collaboration to design and deploy sensing devices in their business to monitor a wide range of aspects.

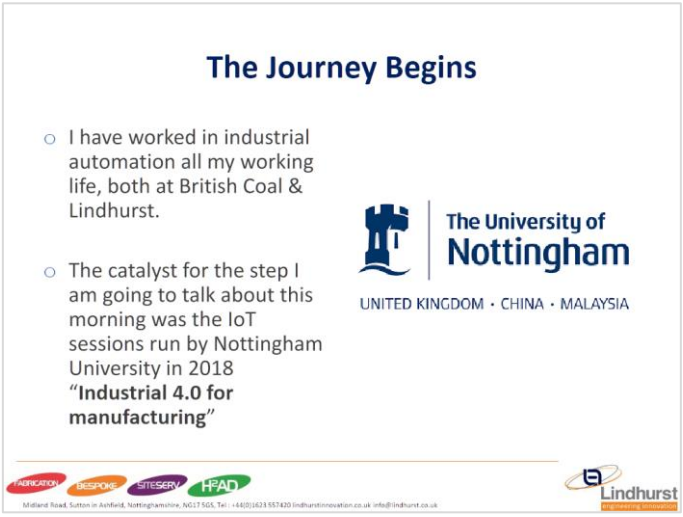


Figure 45. For many SMEs, the first step on their digitalisation journey is to be inspired.



Figure 46. The initial parameters measured by Lindhurst Engineering.

Martin also emphasised how it is important to start simple and progress a digital solution in steps. The example given was how important visualisation was to his company in identifying areas for improvement. Rather than jumping straight to a fully featured automated system that analyses data, just making the data visible to the user allows for insights that were previously hidden. The importance of open-source technologies such as Grafana were discussed that allow the developers of digital solutions to rapidly create solutions without significant cost or time investment.

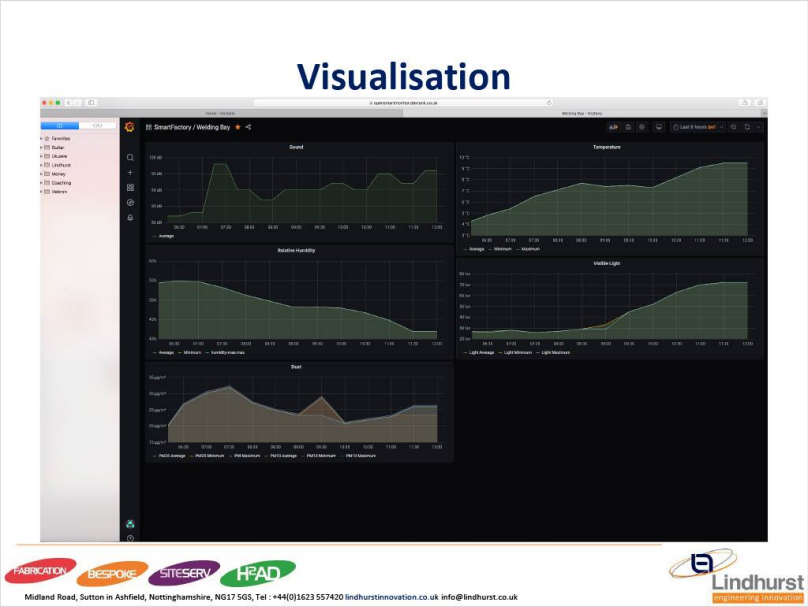


Figure 47. Visualisation of the measured parameters - even without significant analysis - allowed for actional insights very rapidly.

Discussed next were the advantages of analysing their available data. They discovered that there was a drop in productivity in the early morning shifts, and were able to correct this by changing working patterns. This insight along paid for the entire digitalisation initiative. They analysed hot water utilisation and discovered that not only was their hot water heater highly inefficient, but also that hot water taps were sometimes being left on overnight. Investing in a smart water heater and push-taps solved this. They also discovered that gas and airborne particulate level were too high during busy periods, and were able to install better ventilation.

Finally, the topic of inter-company data sharing was discussed. The concept of the “glass factory” implemented by AE Aerospace was discussed[19], where customers and supply chain partners can see where in the process their components and products are. This level of openness is “scary” to a company, but forces a company into good practises and efficient operation.

4.6.5.4 Question and Answer Session

Martin answered several questions from the crowd, with the insights summarised below.

- A question was asked about how an SME can have leadership on digitalisation, where the smaller number of staff means those who would be responsible for implementing a digitalisation initiative lack the authority to make the decisions and allocate resources. Martin responded that executives

[19] https://www.themanufacturer.com/articles/ae-aerospace-glass-factory-window-future-production/

in an SME must "wear many hats" and it is no longer possible for a CEO to be ignorant to manufacturing digitalisation. Digitalisation requires strong leadership, and that starts from the top.

- A question was asked about how expensive digitalisation is. The response was that digitalisation is an investment, and rather than thinking about it as a cost, to think about it in terms of a business case and expected return on investment. Martin discussed how the approach developed with DevTank wasn't a trivially small amount of money, but learning about morning productivity issues repaid the cost of investment in just a few months.
- A discussion was has on where Lindhurst could take the system further. Martin discussed how the welfare of his employees was critical, so introducing automated response to measured temperature, noise, particulate, and gas levels was a key step. The example given would be to start / stop a ventilation system automatically if particulate levels are too high, or open the doors to the shop floor in cases of high temperature. This also has ramifications for regulatory compliance, where the levels of particulate and the responses to it are recorded and can be used as evidence of effective response.

4.6.6 Interactive Sessions

4.6.6.1 Interactive Session – Dr Jack C Chaplin – Senior Research Fellow University of Nottingham Institute for Advanced Manufacturing - Pathways to the Digitalisation of Manufacturing



Figure 48. Dr Jack C Chaplin introducing the ConnectedFactories project to the audience both in the AMB and remotely.

4.6.6.2 Key Points

- It is identified that digitalisation is important, but also difficult.
    - Studies into SME digitalisation show SMEs are most interested in data capture and visualisation solutions to understand the state of their business better.
    - Studies into SME opinions of digitalisation show that it is perceived as complex and expensive.
- Digitalisation is a journey, not a leap. Each step should be guided by a business case and be considered incrementally.

- Guidance is available, notably the Connected Factories pathways can help understand the next step along the journey.
- Other help – funding and information – also exists and can be used to help start and understand the digitalisation journey.

4.6.6.3 Summary of Session

The aim of the interactive session was to:

1. Disseminate the ConnectedFactories digitalisation pathways (specifically the Hyperconnected Factories and Autonomous Smart Factories pathways) to regional manufacturing SMEs.
2. Disseminate other methods of support SMEs can use.
3. Gather feedback and comment on the pathways, and understand the views SMEs have of digitalisation and the challenges they face to implement digital technologies.

The interactive session of the workshop was centred around a presentation on the digitalisation challenges faced by SMEs, and support for SMEs in their digitalisation process. Although ordinarily this data gathering would be performed with dot-voting and note-posting, due to the hybrid nature of the session and the need for social distancing, instead online polling was used. This was achieved with PollEverywhere, which allowed delegates to scan a QR code and answer questions anonymously on their phone.

The session began with a discussion of studies into SME views of digitalisation. The UK government's Engineering and Physical Sciences Research Council-funded Digital Manufacturing on a Shoestring project[20] has spent years gathering data on UK manufacturing SMEs and their views on what digital solutions are most important. The results are that overwhelmingly SMEs want solutions that let them capture and analyse data, rather than solutions that are more proactive. SMEs can struggle to deeply understand their business and to make effectively make decisions, a sentiment echoed in Martin's keynote.

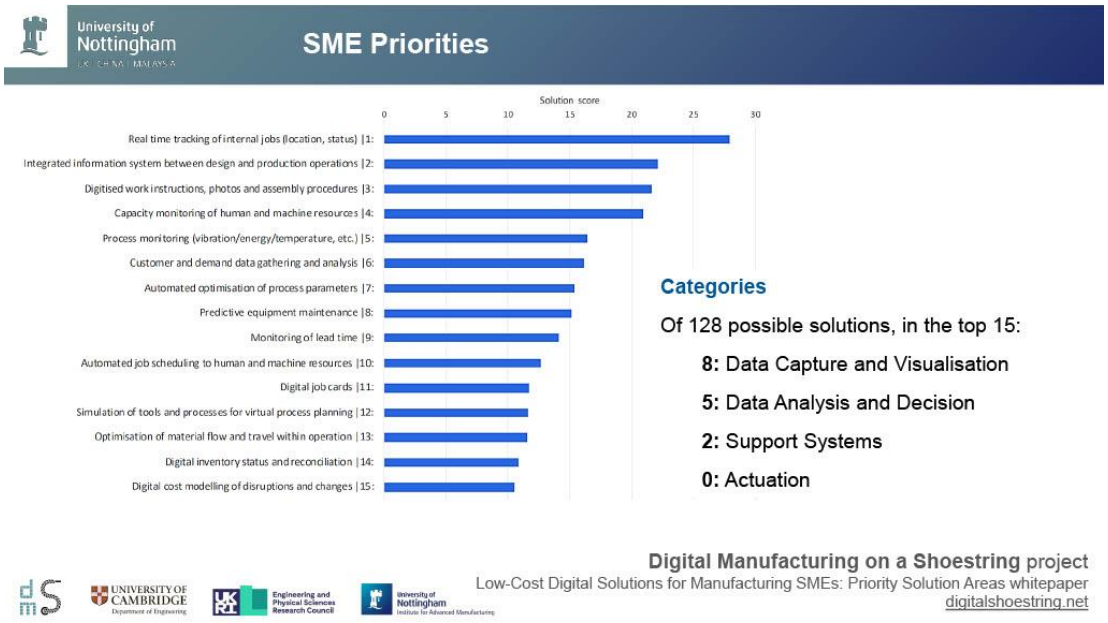


Figure 49. Top fifteen digital solutions wanted by SMEs, as determined by the Digital Shoestring project.

[20] https://www.digitalshoestring.net/

The session then described findings that SMEs view digitalisation as both expensive and complex, and proposed possible solutions to the expense issue – namely funding sources for digitalisation initiatives, and lower cost digitalisation solutions. However, the remaining point was highlighted – digitalisation is complicated, so how can the manufacturing community help with this?

The session then moved on to disseminating the Connected Factories pathways, specifically the Hyperconnected Factories and Autonomous and Smart Factories pathways. The project and its aims were briefly introduced, and before the pathways were detailed, the participants were asked questions on their current levels of digitalisation in their businesses, where they would like to be in terms of digitalisation, and the major inhibitors and potential enablers to digitalisation. Full results can be found in the appendix, but in summary:

- The majority (85%) of participants have implemented some digitalisation in their business, with most having applied it to data capture and visualisation applications (43%) and a small number to data analysis and support systems[21].
- The most popular area participants would like to apply digitalisation is manufacturing support systems (43%), with data analysis in second (29%) and data capture and visualisation (21%) in second and third place. Very few participants (7%) want to apply digital technologies that directly impact the actuation of manufacturing processes, and all participants want to apply digital technologies in some way.
- The number one perceived inhibitor to digital application is available funding / making a business case for funding (40%). However, direction and digital leadership was second (20%) and is an inhibitor for which the pathways contribute, and the data silos (13%) is covered under the hyperconnected factories pathway.
- In keeping with the previous point, the number one potential enabler would be financial support for digitalisation activities (27%). Relevant to the pathways, improved leadership (13%), direction and guidance (13%) and unbiased specific advice (7%) were also popular.

Pathways as a general concept were discussed, emphasising their importance as a guide for digitalisation, and that digitalisation is a journey and not a single leap. This workshop focused on the hyperconnected factories and autonomous and smart factories pathways. The importance of the cross-cutting factors and the cases and examples were described, followed by a more detailed walkthrough of each of the two pathways. The other pathways (complete and in development) were also briefly discussed.

The session closed with a discussion on other sources of information and support. Specifically:

- The **Connected Factories**[22] website, as a general hub of information about digitalisation in manufacturing.
- The **EFFRA portal**[23] specifically, as a hub of information on cross-cutting factors, standards, and inspiring cases.

[21] Classifications of digital technologies taken from Low cost digital solutions for Manufacturing SMEs: A Catalogue of Digital Solution Areas by Benjamin Schönfuß et al, Digital Shoestring project.
[22] www.connectedfactories.eu
[23] portal.effra.eu

- The **Digital Manufacturing on a Shoestring**[24] project, a UK-based project focusing on low-cost automation solutions for SMEs, which offers support for SMEs to begin their digitalisation journey with low cost, low skill, and low risk approached.
- The Digital Manufacturing Training training course and e-book (**Digit-T**[25]), which offers an open-source, free high-level overview of digital manufacturing concepts for SMEs. This material is available in English, Spanish, and Italian, and was funded by the Erasmus+ Programme of the European Union.

4.6.6.4 Question and Answer Session

Jack answered several questions from the crowd and facilitated a discussion between the participants both physically at the event and attending online. The insights are summarised below.

- It was commented that the titles "Hyperconnected Factories" and "Autonomous and Smart Factories" may be too elaborate, particularly for SMEs. The content of the pathways is fine, but the titles might be better changed to "Connected Factories" and "Smart Factories" respectively.
- The majority of the discussion time was devoted to the difficulty of producing business cases for digitalisation. The pathways pose an excellent opportunity for an SME to break down their digitalisation journey into smaller steps rather than large leaps, but each step still requires a business case, and there is little guidance (in general, not specifically Connected Factories) on how this can be done.
  Following on from a similar discussion after Martin's presentation, a debate was had as to if the "cost" of a digital solution is the correct term. Digitalisation was discussed in terms of monetary cost and time cost. However, even a high-cost solution may still be the best choice of a business case can be developed for it.
- Related to business cases, the importance of inspiration and demonstration was discussed. Martin's presentation on digitalisation at Lindhurst mentioned that their digitalisation journey began with a presentation at the University of Nottingham on Industry 4.0. SMEs do not have much time or money to invest in digitalisation when the benefit is unclear. Clear examples of how digitalisation has been successful and measured benefits of the implementation would significantly increase uptake of digitalisation technologies.
- The pathways are focused on manufacturers of products, which is correct. However, many of the businesses in attendance were manufacturing support services e.g., software providers and consultancy services. Are there digitalisation pathways for manufacturing-adjacent companies? This was left as an open question.
- The importance of SMEs collaborating and communicating was brought up. SMEs often established as suppliers to a common OEM (In the UK's Midlands, this would be Rolls Royce for example), and are physically co-located to facilitate supply to each other. However, SMEs often do not effectively communicate, and do not effectively share expertise. As digitalisation becomes more important, the ability for SMEs to share experiences and expertise in digitalisation becomes increasingly important.
- Standards were discussed as critically important – an SME is often unwilling to take a chance on a proprietary technology standard that would lock them in to a vendor or approach. There is a view

[24] www.digitalshoestring.net
[25] https://www.digit-t.eu/

that digital solutions are “short term” whereas SMEs expect purchases solutions to last for longer durations than larger companies. Conformity to established common standards is critical for adoption.

- Lastly, a reflection on outreach and engagement with SMEs. The SMEs in the interactive session are probably in the top 10% of informed SMEs, in that they know about digitalisation initiatives and are aware of support offered by Universities and European Projects. How can we effectively disseminate the Connected Factories pathways to the 90% of SMEs who do not know about common hubs of information?

4.6.7 Conclusion

Overall, the workshop was considered successful. The outputs of the workshop offer an interesting and useful insight into the views of SMEs on the subject of digitalisation, and the results are summarised below.

4.6.7.1 Transferable results

Transferable results from the workshop are listed here under common headings.

- **Trends**
    - All SMEs understand the importance of digitalisation, but in many cases the scope of digitalisation is too big. It’s easy to focus on the state-of-the-art digital technologies, but for many (possibly most) companies, focusing on the fundamentals is more important.
    - Environmental data (as opposed to process data) is increasingly important to help companies meet their regulatory targets around energy use, emissions, and noise. This is often missed from manufacturing digitalisation discussions.
- **Barriers**
    - For SMEs, leadership and guidance is critically important. The C-level executives of a company will have many responsibilities, and understanding digitalisation is a critical pre-requisite for effective implementation of digital solutions in a business.
    - The gathered data showed very clearly that access to funding and creating business models is the largest hurdle for SME digitalisation. Many digitalisation technologies have benefits which are hard to quantify, which makes business cases difficult.
- **Standardisation**
    - SMEs are wary of digitalisation solutions that involve buying into proprietary or non-standard frameworks. They often lack the skills or financial resources to be able to transition from one standard to another. Open, commonly adopted standards are seen as extremely valuable.
    - Conversely, SME technology providers are incentivised to conform to open interoperable standards to encourage adoption of their technologies, as SME technology providers are perceived as “less stable” than larger companies, and at risk of going out of business.
- **Pathways**
    - Pathways were perceived as extremely useful and interesting tools, and their application to the challenges of creating business cases was particularly emphasized.

- SMEs will often focus on the lower levels of a pathway, and thus the names of some pathways may actually exclude them from consideration by SMEs. An SME wants a "connected factory", not a "hyperconnected factory" (nor do they know that hyperconnected means) for example.
- The draft cybersecurity pathway attracted a lot of attention, and inquiries about when a finalised version was expected.

- **Cases**
  - The importance of inspiring cases and examples cannot be emphasised enough, with Martin's digitalisation journey presentation clearly showing the impact an inspiring case or example can have.
  - SMEs are also wary of digitalisation without existing proven implementations they can understand and relate to their own business.

4.6.7.2 Relevant Experiences

The workshop was the first hybrid workshop run by the organisers since the original Covid lockdowns, and thus some experience on how workshops can be run in the Covid era was gained. These points are discussed below:

- Hybrid events are likely to be the standard for the coming year, possibly beyond. Some delegates much prefer to attend workshops in person, others are less willing to attend meetings with large groups of people even with appropriate Covid measures in place. Hybrid events have their own challenges however:
  - Hybrid events cannot have physical interactive elements (e.g., white board, post-its, dot-voting etc) due to the inability for remote delegates to participate.
  - Digital interactive elements must be carefully considered – unless specified, physical attendees may not have laptops with them. Digital interactive elements must be achievable with a smart phone.
  - Polling software such as Kahoot, Mentimeter, and PollEverywhere are good choices for this challenge. QR codes and URLs for accessing the response forms were included on the slides and also printed on pieces of paper for physical attendees to save on typing.
  - Be mindful of limitations of free accounts for the above software. Mentimeter only allows the creation of four polls with the free account. PollEverywhere allows 40 responses per poll – fine for single answer questions, but multiple response questions (e.g., top three barriers…) will rapidly reach the limit.
  - Ensure venues are large enough to accommodate a spaced audience to comply with social distancing.
- When presenting, use of two monitors is encouraged. One for presenter view of the presentation and / or live updated of polling information, and one to monitor the remote participants, to ensure any chat messages or hands raised are not missed.
- Workshops aimed at the manufacturing sector may not only attract manufacturers. Particularly in the SME range there are a wide variety of companies which do not directly manufacture goods, but which are interested in digitalisation of manufacturing, including equipment vendors, software solution providers, consultancy services, waste and recycling management, and local government.

- SMEs will struggle to allocate large blocks of working time to attend meetings, workshops, and even training. This workshop was organised to begin at 7:30am and end at 9:30am to enable attendees to return to their businesses and still complete a full day of work. This is a significantly better approach for attracting SME delegates than a traditional 9am – 12 noon meeting patterns.

For physical meetings, small gestures such as complimentary pens, notebooks, and catering go a long way to improving perception, especially for repeating events. Many delegates cited (only half joking) that the provided bacon sandwiches were one of the primary reasons to attend.

4.7 Circular Economy Pathway related to co-creating sustainable offerings in new value-networks – 09/02/22, IVF (SE)

4.7.1 Topics Addressed in the Workshop.

	Topics adressed (X)
Trends, needs, challenges and barriers	**x**
Successful use-cases	
Cross-cutting Factors	
Added Value and Business Models	**x**
Interoperability and Standardisation	
Cybersecurity	
Industrial Agreement and Legal Aspects	
Humans in Manufacturing	
Pathways	
Circular Economy	**x**
Human Factors	
Autonomous Smart Factories	
Hyperconnected Factories	
Collaborative Product-Service Factories	**(x)**
Data Spaces	
Skills	

4.7.2 Executive Summary

The workshop was organised on 9 February 2022 as an online workshop with duration of 4+1 hours. The agenda included introduction to C2 and pathways, a keynote presentation, workshopping and (as an extra hour) idea generation for joint research projects. The invitation was sent directly to selected company representatives. 15 participants registered, mostly from industry SME: s but also, large companies and academia.

The main objective was to collect feedback to the Circular Economy Pathway developed in CF2. In addition, the workshop aimed to form a peer assist network and research projects under the theme "*new value networks for co-creation of new sustainable (e.g. circular offerings".*

Main results from the workshop were that the CEP in mostly was understandable but could benefit from taking consideration of the phenomena that CE is not created in the individual company. Life cycle perspectives could be a better way to deal with this.

As a whole, CEP may also need to be clarified and synchronized with other frameworks for sustainable transition such as the Paris Agreement[26].

The collaboration that strengthens both the transition in individual companies and the creation of new sustainable (circular) offerings in new value-creating networks (eco-systems) will continue through several

[26] https://unfccc.int/sites/default/files/resource/parisagreement_publication.pdf

activities, for example by arranging workshops for innovative co-creation as well as in research projects and the national programme “Omställningslyftet”.

4.7.3 Introduction

The Swedish National/Regional workshop discussed "What is required to succeed in the transition towards a circular economy?”

Main objective of Swedish workshop was to collect feedback from Swedish industry, especially from SME:s, to the Circular Economy Pathway developed in CF2. In addition, the workshop aimed to form a peer assist network and research projects under the theme “*new value networks for co-creation of new sustainable (e.g. circular) offerings”.*
Keynote speak (including interactive sessions) and workshop where held on-line using Zoom and digital tools as Mentimeter and Mural, where used to collect input.

The full agenda is below and included introduction to C2 and pathways, a keynote presentation, workshopping and (as an extra hour) idea generation for joint research projects.

Professor Johan Frishammar from the University of Technology, Luleå gave the keynote speech (described below) and also participated in the Interactive session 4.

Main results from the workshop were that the CEP in mostly was understandable but could benefit from taking consideration of the phenomena that CE is not created in the individual company. Life cycle perspectives could be a better way to deal with this.

As a whole, CEP may also need to be clarified and synchronized with other frameworks for sustainable transition such as the Paris Agreement.

The collaboration that strengthens both the transition in individual companies and the creation of new sustainable (circular) offerings in new value-creating networks (eco-systems) will continue through several activities, for example by arranging workshops for innovative co-creation as well as in research projects.

There will also be further collaboration in the programme “Omställningslyftet” with the goal to accelerate the climate transition and make it easier for companies and individuals to conduct competitive activities compatible with climate goals.

The initiative, which goes by the name "Omställningslyftet", is a result of the Government's collaboration programme Business Climate Transition. The work began in 2020 through an initiative by IF Metall and the Swedish Society for Nature Conservation in consultation with RISE and Fossil-free Sweden. The project is run by RISE together with Sweden's incubators and science parks (SISP), the Swedish Energy Agency, industrial development centers (IUC) and IVL Swedish Environmental Research Institute.

4.7.4 Workshop Organization and Preparation

Table 8. Agenda

Hour	Topics
12:45	**Registration and Access to Workshop (Zoom), Mural and Mentimeter**
13.00	**Welcome**
13.05	**Introduction ConnectedFactories2 and the video**
13.15	**Introduction Pathways CE & PSS**
13.30	**Keynote: ” What is required to succeed in the transition towards a circular economy?”**

	Including discussions and Mentimeter questions
14.30	**Workshop CE Pathway & PSS Pathway**
16.00	**Conclusions and discussions**
17.00	**Brainstorm, planning for research-project and mingle**
18.00	**Action list and Farewell**

Invitation was sent directly to selected company representatives. 15 participants registered, mostly from industry SME: s but also, large companies and academia. The table of participants is above. Compared to the number of invited company representatives the number of participants was rather small, but all participants were active and interested in topics.

The workshop was originally planned as a face-face meeting in 2021 but due to the uncertain conditions under the Covid 19 pandemic the workshop was postponed and was eventually the organised the 9th February 2022 as an online workshop with duration of 4+1 hours.

4.7.5 Keynote Speaker Session

The Keynote Speaker Session where highly integrated with the interactive sessions.

Keynote speaker was Johan Frishammar, Professor at Luleå University of Technology and Stockholm School of Economics. He is an innovation researcher, and his works is mostly with large companies.

Johan presented his research in circular business models, ecosystem of collaborating actors, what needs to change as one moves towards an increased degree of circularity as well as challenges and opportunities to meet.

- Learning goals for the keynote speaker session:
- Describe and define what a circular business model is
- Give examples of different types of circular business models
- Describe how the different components of the pathway figure (e.g. products, processes, partnerships) need to change as companies move towards an increased degree of circularity in their business models
- Describe and define what an ecosystem of collaborative actors is and why it is important for circular business models
- Provide examples of key opportunities and barriers in the transition to circular business models and a circular economy

The main messages from Johan's research presented was:

"*What is required for companies to succeed in the transition to a circular economy?*"

- For companies requires a shift in mental thought models: from "my company" to "our ecosystem"
- New types of collaborations outside the traditional value chain are needed: Recycling, upgrading, etc.
- New Types of Skills & Abilities: Innovation Management within Companies vs. Between Companies
- Create consensus & sync incentives in ecosystems centrally
- Circularity is not 0 or 1: All companies can take steps towards increased circularity and improved resource efficiency
- New types of customer relationships: from transaction to relationship
- Digital technologies as enablers for increased sustainability

To start with, Johan gave a short background description about:

- Global warming, one of many sustainability related problems.
- Stricter environmental legislation and development of strategy papers to enable industry to transition to a sustainable approach – roadmaps, etc. national strategies on batteries and hydrogen – key technologies for the transition
- Circular economy: a framework for thinking about this in general terms
    - Leasing, reusing and repairing products
    - Ellen McCarthy Foundation
    - Central idea: resource efficiency – doing more with less resources – optimizing production and consumption
- The CF2 CE Pathway matrix takes the individual company as a starting point and gives preliminary answers to being able to go from the linear to the circular – out on the left you will find what you expect to find
- Networks, digital ecosystems and new types of partners. The Pathway captures an event and gives a fair picture of what is required for the transition.

Then there was an **Interactive session** (1) (see Subsection 4.7.6.1, Interactive Sessions, below) with Mentimeter on the question; "What does it take for a company to be able to transition from a linear to a circular economy?"

Followed by Johan's research about the transformation of business model.

Mitt svar: Transformation av ett företags affärsmodell (från Frishammar & Parida, 2019, California Management Review)

TABLE 3. A Framework for Circular Business Model Transformation.

Phase objective:	PHASE 1: Initiate circular business model transformation Analysis of circular business model transformation opportunities	PHASE 2: Audit the current business model Review of current business model to identify shortcomings, opportunities, and scope of circular transformation	PHASE 3: Design and develop a circular business model Design and develop a revised business model based on the design elements of circular economy	PHASE 4: Scale-up the circular business model Validate and implement new circular business model for selected customers/customer segments
Circular economy principles (What to think about)	Awareness of circular economy guidelines: - Reduction and reuse - Recycling and composting - Energy recovery - Treatment and disposal Evaluate circular economy principles to see if and how they may be building blocks for a revised business model	Targeting circular economy business model goals: - Financial benefits - Environmental benefits - Social benefits Evaluating circular business model opportunities for achieving triple bottom line	Circular business model design elements: - Regenerate - Share - Loop - Optimize - Virtualize - Exchange	Realize circular economy business model goals: - Financial benefits - Environmental benefits - Social benefits Ensure circular business model fulfills triple bottom line
Key activities (What to do)	Broad scanning of environmental trends (political, economic, social, technological, legal, and environmental factors) for circular business opportunities Understand the ecosystem in which a focal firm is embedded (partners, stakeholders, their interests and needs, tensions, etc.) for exploitation of circular business opportunities Customer analysis using circular economy guidelines: Who are at the heart of the customer base? For whom are we creating value? What are the customer dynamics?	Map the current business model by explicating - *Value creation, Value delivery, Value capture, and Customers or customer segments* Map shortcomings and opportunities with the current business model toward the triple bottom line effect: - *Key shortcomings in Value creation, Value delivery, Value capture, and Customers or customer segments* - *Key opportunities in Value creation, Value delivery, Value capture, and Customers or customer segments* Analyze scope for circular business model transformation: - *Number of business model dimensions subject to change* - *Magnitude of change within each dimension* - Analysis of the ecosystem in which a focal firm is embedded (partners, stakeholders, their interests and needs, tensions, etc.)	Mimicry/imitation: Study or benchmark innovative business models from other firms and industries Achieve sufficient internal alignment for circular business model - *Alignment of culture, logic, and incentives among internal departments* Configure the ecosystem partners for circular business model realization - *Alignment of processes, activities, contributions, roles, incentives, and perception of business model dimensions* Reach conceptual agreement on circular business model: - *Revise Value creation, Value delivery, Value capture, and Customers or customer segments* - *Ensure the different business model dimensions fit together as a coherent whole*	Small-scale pilot testing - *Evaluate positive and negative effects of the circular business model elements on the triple bottom line* - *Evaluate revenue and costs associated with each business model element* - *Reconfigure ecosystem collaboration* Large scale rollout and continuous business model adjustment - *Ongoing learning and adjustments* - *Additional changes within and across key business model dimensions*
Phase outcomes:	Mapping and understanding the circular economy transformation requirements	The current business model made explicit, including shortcomings, opportunities, and scope for circular transformation	A revised business model with circular properties	A circular business model implemented to serve a mass market

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Figure 50. Framework for Circular Business Model Transformation

A short discussion of "which customers do we have and do we get "trapped" in their opinions?"
It is important to also listen to new/potential customers.

Johan continued his presentation about What is a CBM, different types of CBM:s and gave some examples of CBM:s in ecosystems.

What is a circular business model? Create, deliver value to customer and capture value for one's own company, Dual value proposition: good for the environment but also making money.

Different types of circular business models. Not always a law of nature to go from the linear to the circular. Business models for increased circularity. To increase the elements of circularity.

Examples from industry: Scania, Komatsu Forest, Sandvik, Metso, My Epiroc, Volvo CE. Available initiatives in all large industrial enterprises. The normal thing is to have parallel business models.

Digital technologies function as enablers for increased sustainability. When industrial companies can do it smarter, they can much better predict the need for maintenance and optimize fuel consumption.

Then another **Interactive session** (2) (see Subsection 4.7.6.2, Interactive Sessions, below) with Mentimeter on the question; " *What do you think/think is most challenging when a company should transform its business model with increased elements of circularity?*"

Johan made an interpretation of CF2's pathway where he divided and related to his research

- Product – what entities are created.
- Process, platform, people, partnership – how to create and deliver value.
- Performance – how to measure and capture value

Four key challenges for moving from left to right in CEP/Framework for Circular Business Model Transformation:

• From product sales to advanced service contracts: leases and contracts for transportation: the service paradox in case of increased servizitation and it costs money but not revenue all at once,

• from linear value chains to collaboration in ecosystems: difficult to find new partners: Recycling actors are moving towards a much more strategic role, new type of player that fills a very important role for many business models.

• from value in transaction to value in use: the value lies in the transaction, value in use but arises in the use situation and add additional services,

• from measuring internal product outcomes to measuring holistic system outcomes and changing revenue models

Then the participants shared their experiences and thoughts related to the question; "*What challenges will we as a company encounter during the journey from step 1 to 5 in the CEP?*" (see Subsection 4.7.6.3, Interactive Sessions, below). After a break the participants and Johan joined the workshop focused on CEP see Subsection 4.7.6.4, Interactive Sessions, below.

4.7.6 Interactive Sessions

4.7.6.1 Interactive session 1

Interactive session 1 with Mentimeter on the question; "*What does it take for a company to be able to transition from a linear to a circular economy?*"



Figure 51. Mentimeter poll results to the question: "What does it take for a company to be able to transition from a linear to a circular economy?"

In English:

Cooperation, incentives, understanding of the basic issue, being able to – structure, cultural changes in the company, moving away from a linear thinking and that it is not "like before", that it is prioritized at management level that can spread further downwards, good cooperation with others in the circle around, willingness to change, willingness to incentivize

Dialogue:

A way of relating to it is needed.

Be able to interact with different suppliers and customers and have insight into what we are talking about. Circular economy may be what is entirely, but connected factories are more focused.

Transformation of a company's business model is important.

4.7.6.2 Interactive session 2

Then there was another **Interactive session** (2) with Mentimeter on the question; "*What do you think/think is most challenging when a company should transform its business model with increased elements of circularity?*"



Figure 52. Mentimeter poll results to the question: "What do you think/think is most challenging when a company should transform its business model with increased elements of circularity?"

In English:

Dialogue with their customers and suppliers, sharing revenue and cost in the ecosystem, old remaining structures (leaders who are schooled in how things were done in the past), customer acceptance, think completely different! The vision, to dare to ask what products / values the future needs, find the same or better profitability. Easier about coercion e.g. health requirements, it can be difficult to get started without a good foundation, to create a roadmap for transformation so that the company settles for recycling, find the right activities.



Figure 53. Mentimeter poll results to the question

In English:

ROI very hard to calculate due to the costs are hard to se

Dare to choose roads that are more expensive than today's solutions

4.7.6.3 Interactive session 3

Dialogue around the question;

"*What challenges will we as a company encounter during the journey from 1-5 in the CEP?*"

Discussion ended up in a dead end (reuse actor and recycling actor) "*no one wanted to back down on current power, revenue or position, how then to get from the value chain to the ecosystem?*"

"It is difficult to find new partners, has contacts but not the right features. Comment? Difficult to find the right part of the recipient organization, today we often get in touch through various projects.

You must be able to have several different business models, vigilant in profitability when changing business models, have started your own haulage company and logistics company to be able to sell your own products.

Digitalization, sustainability, and circularity: circular business models are narrower and moves in the borderland of ecological, economic sustainability, it is important to point out that the difference exists.

4.7.6.4 Interactive session 4

The objective of interactive session 4 was to collect feedback on the CEP from Swedish industry and contribute with these to influence the design and application of CEP.

We also wanted to hhighlight the possibilities of the CF2 Pathways in the EFFRA-portal.

The participants were asked to reflect on the headings (horizontal and vertical) in CEP with the questions:

"Can we live with these rubrics so that we can put in (in the portal) our research results, cases and lessons learned? "

"Should the headlines be called something else?"

"Other ways to detail the structure?"

We also had the ambition to start a discussion about joint projects and activities

Feedback was gathered in a Mural board and notes from dialogues, which were held both in pairs and throughout the group.

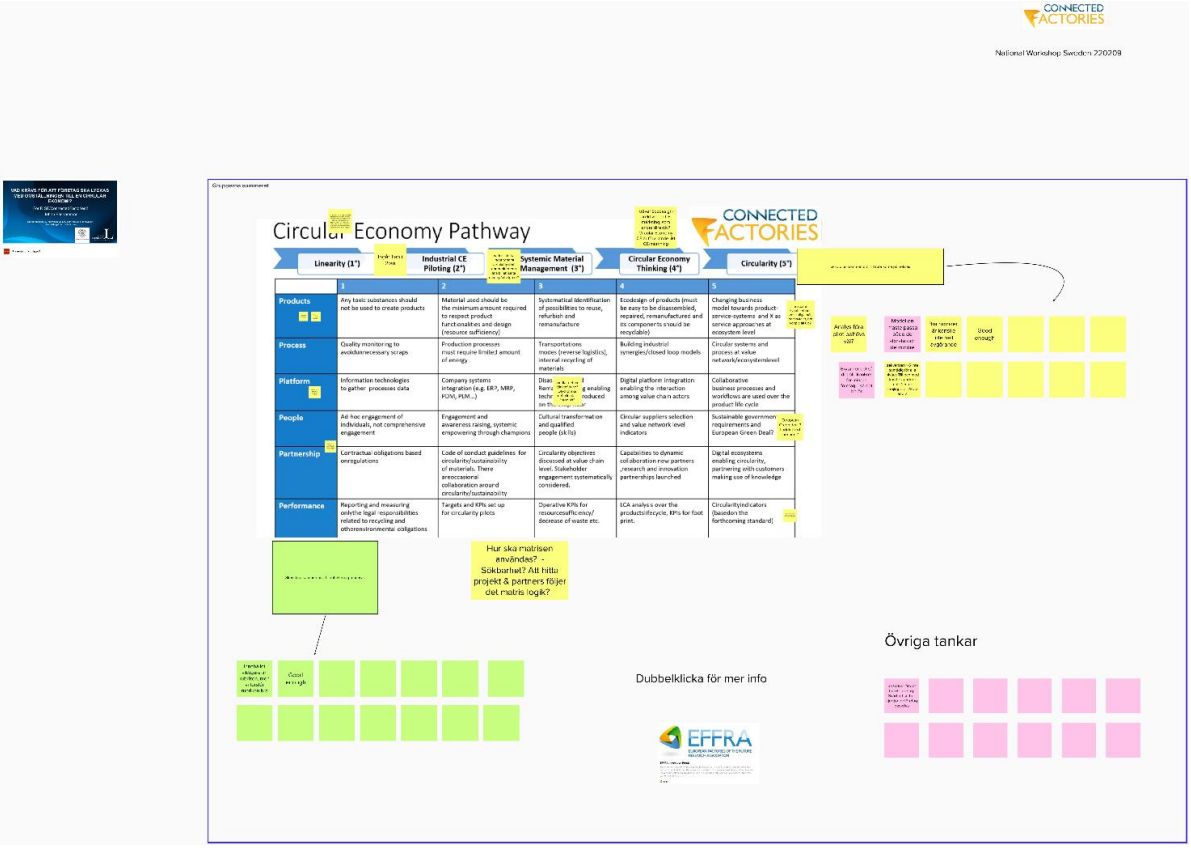


Figure 54. MURAL board for the fourth interactive session

The feedback highlighted:

- The CEP levels are described good enough
- Levels 1-5 need to be better defined, especially step 5 must be fully definable in relation to the Paris Agreement.
- Has to be measurable
- Product; goods, services, and combinations of these or just hardware?
- A value chain perspective could be better
- Explain EU Green Deal
- We miss the target; circular economy is not created in a company but in ecosystems/networks. The pathway needs to reflect this.
- A lifecycle perspective would be better

Facilitators: Barbro Lagerholm and Maria Landqvist, RISE AB.

4.7.7 Conclusion

Conclusion, an overview of the transferable results and description of the engagement strategy after the workshop is summarized in this section.

The workshop and interviews aim were to collect feedback to the CE and PSS pathways developed in CF2 and the following observations were identified and discussed.

Main results from the workshop were that the CEP in mostly was understandable but could benefit from taking consideration of the phenomena that CE is not created in the individual company.

Most participants noted that CE is not created by or in an individual company, it requires collaboration in ecosystem, value-creating networks. CEP should reflect this.

- Life cycle or value chain perspective would be easier to apply to, instead of as now product perspective.
- Radical innovation is needed. A completely rethink is needed to create new circular offerings together
- The transition should be based on customer and consumer requirements
- Investments made in stages 1-3 can hinder progress towards 4 o 5
- As a whole, CEP may also need to be clarified and synchronized with other frameworks for sustainable transition such as the Paris Agreement.

In addition to the feedback on pathways, the participating organisations learned about challenges, barriers business models and examples from other actors in the context of circular economy.

The transition to circular business models and product-service systems in Swedish industry continues in diverse national networks and communities. In particular, the national “Omställningslyftet” with the goal to accelerate the climate transition and make it easier for companies and individuals to conduct competitive activities compatible with climate goals.

4.7.7.1 Relevant Experiences

Experiences obtained during the organization, execution, and analysis of the workshop

It is easier and more efficient to arrange an on-line workshop than a physical event. Participants from all over the country can easily gather. However, registrations came in late, and someone did not show up even though they have signed up. The now great habit of arranging and attending meetings on-line has also brought with it some lack of meeting discipline. Several participants have acquired a habit of coming and going in the meeting (e.g. for taking a phone call) which does not favor continuity and flow in the meeting.

Discussions and idea generation work well on-line. Breakout rooms are easy to manage and allow for discussions in smaller groups. Icebreaker exercise at the beginning contributes to informal mood. When conversations and discussions become dynamic and engaged, however, it is a challenge to document. Participants often forget to write those sticky-notes when they are engaged.

We therefore supplemented with a few short interviews a while after the workshop. It was a good idea to have follow-up conversations "one on one" and to capture opportunities for continued work. Just talking challenges doesn't inspire experimentation.Vi kompletterade därför med några korta intervjuer ett tag efter workshoppen.

Bra att ha uppföljande samtal ”one on one” (intervju) och att fånga upp möjligheter till fortsatt arbete.

Att bara prata utmaningar inspirerar inte till experimenterande.

4.8 Safety and Health at Work – 22/02/2022, I4.0 (AT)

4.8.1 Topics Addressed in the Workshop

	Topics adressed (X)
Trends, needs, challenges and barriers	X
Successful use-cases	X
Cross-cutting Factors	X
Added Value and Business Models	
Interoperability and Standardisation	
Cybersecurity	
Industrial Agreement and Legal Aspects	
Humans in Manufacturing	X
Pathways	
Circular Economy	
Human Factors	X
Autonomous Smart Factories	
Hyperconnected Factories	
Collaborative Product-Service Factories	X
Data Spaces	
Skills	X

4.8.2 Executive Summary

Shortage of skilled workers, shorter delivery times, legal requirements, environmental protection and increasing workloads lead us to the questions of how long employees can endure this and how companies should deal with it. This led to considerations of a repositioning and the term Industry 5.0 was mentioned more and more frequently.

Sabrina Sorko, FH Joanneum, explained that the term does not only stand for focusing on efficiency, but also on society and the environment. On the part of the European Commission, there is a concept for Industry 5.0 with three core areas: Human Centricity, Circular Production Models and Creating Resilient Value Chains.

As Sabrina Sorko clarified, Industry 5.0 is not a technological development and not a revolution, but the consideration of how to deal with the possibilities of Industry 4.0 in a meaningful and sustainability-oriented way. These approaches can already be found in industry, for example the use of collaborative robotics to support employees during stressful movements.

Tanja Zigart, TU Vienna, presented the results of the industry panel "Made in Austria: Production Work in Austria 2021" of the TU Vienna. According to the results, the importance of human labour is still considered very high. The use of assistance systems/cobots has increased in industry and the reasons given are the increase in economic efficiency and improvement of working conditions for employees.

Physical assistance systems include exoskeletons, which serve as an external support structure for movements or holding positions. Sandra Siedl, Johannes Keppler University, distinguishes between active and passive assistance systems. Active assistance systems support the user's movements by supplying external energy, i.e. electric motors. Passive assistance systems use mechanical components, such as spring forces or cable pulls, to redirect kinetic energy and relieve joints. Together with University of Technology in Graz, the Johannes Keppler University has investigated the users' perception of strain as part of a project. They asked themselves what is necessary for employees to want to use these systems at the workplace and what effects arise for employees when they use the systems.

Patrick Bauer, Production Trade Union, presented the project Augmented Reality (AR) Applications in Production, which was funded by the AK Digitalisation Fund. In this project, in which the Austrian Institute of Technology (AIT) and Magna Powertrain were involved, AR headsets were evaluated from different perspectives. Psychological workload and work requirements, ergonomics with regard to muscle strain, occupational safety and user-friendliness were taken into account.

4.8.3 Introduction

Table 9: Agenda

Hour	Topics
09:30	**Beginning**
09:45	**Sabrina Sorko, FH Joanneum – Keynote Industry 5.0**
10:30	**Tanja Zigart, Technical University Vienna - Digital Assistance Systems**
11:00	**Sandra Siedl, Johannes Keppler University - Exoskeleton**
11:30	**Patrick Bauer, Production Trade Union – Project Augmented Reality in Production**
12:00	**Discussion**
12:30	**Conclusions and Farewell**

4.8.4 Workshop Organization and Preparation

The workshop was organised by the Platform Industry 4.0 Austria (PIA). The database of PIA was used to promote the event. PIA has a focus on human-centred aspects since the very beginning of its activities in 2015 thus the interest in this topic is great and PIA is able to reach the right target group. The workshop language was German language.

4.8.5 Keynote Speakers Session

4.8.5.1 Keynote Speaker 1

Table 10. Example table in Keynote Speaker Session 1

Column 1	Column 2	Column 3
Human Centricity	Circular Production Models	Creating Resilient Value Chains



Figure 55 Screenshot of the presentation by Sabrina Sorko

Sabrina Sorko highlights in her presentation that companies find it increasingly difficult to attract highly qualified talent. She thus claims that the concept of Industry 5.0 is a necessary correction. As Sabrina Sorko clarified, Industry 5.0 is not a technological development and not a revolution, but the consideration of how to deal with the possibilities of Industry 4.0 in a meaningful and sustainability-oriented way.
Increased demands on corporate reaction times and a persistent and growing shortage of
of skilled workers in the industry is an ever increasing problem. Inclusion is one means of tackling this challenge.
Some companies understand the concept of I5.0 as a matter of course
and already fulfil some of the requirements proclaimed there. For others, the European Commission's statements are an appeal to become aware of their social responsibility:
It is not a question of completely foregoing profits, but rather of
diversity in the company, the health of the workforce and sustainable
management. To achieve this, the principles must be anchored throughout the company
from the vision, mission and guiding principles to the corporate strategies and the
operational business.

4.8.5.2 Keynote Speaker 2

The second keynote was presented by Dr. Tanja Zigart from the Institute of Management Sciences of the University of Technology Vienna. She presented the results of an industry panel about production work in Austria in 2021.



Figure 56: Screenshot of the presentation by Tanja Zigart

The panel had three rounds of questions since 2019 and consists of 103 people from the management level (top management). Overall there were 25 questions. A few highlights:

- 89% state that the number of variants in production still grow

- The range of fluctuation in staff-side capacity requirements remains almost unchanged over the last three years
- The trend towards shortening delivery times is decreasing somewhat.
- As a reaction to COVID one question was about supply chains. 20% increased their stock, 58% had more and smaller suppliers, 52% increased connectivity for higher transparency and 30% focused on regional suppliers
- The importance of human labour in production continues to be rated as high or very high by 97% of respondents.

The second part of the presentation dealt with assistance systems:



Figure 57: Screenshot of the presentation by Tanja Zigart

- The use of cobots was analysed, almost 30% use cobots in some applications whereas still 43% do not plan to use cobots at all.
- 87% of all company asked use digital assistance systems, an increase of 4,7 % from 2020 to 2021. These are the assistance systems used:

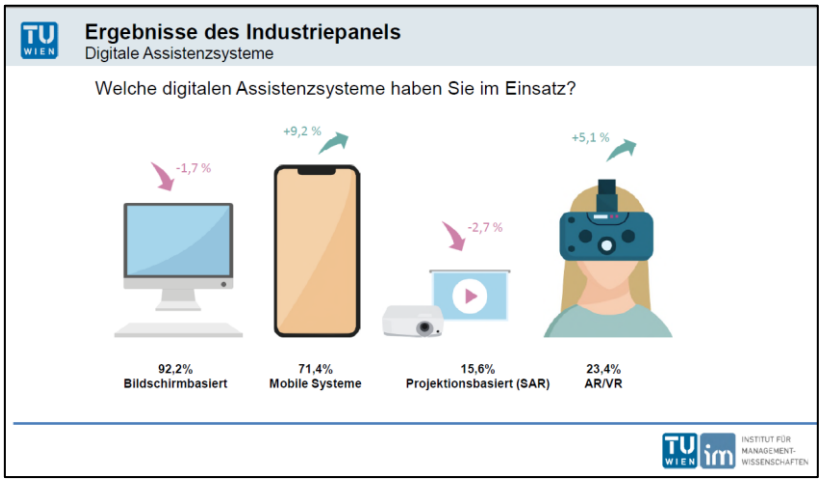


Figure 58: Screenshot by the presentation of Tanja Zigart

4.8.5.3 Keynote Speaker 3

The third keynote was presented by Sandra Maria Siedl who works a t the LIT Robopsychology Lab of the University of Linz. Her keynote was about industrial exoskeletons being used as assistance systems in the workplace.



Figure 59: Screenshot of the presentation by Sandra Maria Siedl

She talked about exoskeletons as "new" assistance systems; exoskeletons are mobile body-supported structures for the physical support of specific body regions. They originally come from rehabilitation and are driven by military developments. There are several differentiation possibilities:

- Mechanisms of action (Mode of actuation)
- Component properties (Soft vs. Rigid)
- Supported body region and
- Field of application (military, medical, industrial, entertainment, etc.)
- Passive or active exoskeletons

The following pictures show various application:



Figure 60: Screenshot of the presentation by Sandra Maria Siedl

Ms. Siedl presented a categorisation of assembly assistance systems with three sub-categories:

- Perceptual assistance (information uptake, perception)
- Decision assistance (cognition, acting)
- Execution assistance

The acceptance of exoskeletons is higher, if the following points are met:

- Relevant to work (applicability, physical strain at the workplace)
- Personally relevant (Health, well-being)
- Effective (visibility of results)
- Not impairing performance (Maintenance of flexibility, speed, safety at work)
- Usable without effort
- Comfortable to wear (hygiene, pressure points)

Then Ms Siedl presented some concrete use cases from industry.

4.8.5.4 Keynote Speaker 4

Patrick Bauer, Production Trade Union, presented the project Augmented Reality (AR) Applications in Production, which was funded by the AK Digitalisation Fund.



Figure 61: Screenshot of the presentation by Patrick Bauer

This project analysed the use of a Microsoft HoloLens in a production environment. Possible applications were quality control, training, instructions, and automated instructions. All four aspects were analysed in detail concerning the potential, possible pitfalls, and strengths of the HoloLens.

Several important aspects were identified:

- Privacy – what personal data will be used for what application should be determined before using such a device
- Safety – with a HoloLens one might not see the environment completely, thus barriers or relevant information might not be spotted

A further aspect of the project was the analysis of the HoloLens features with regard to operator ergonomics', temperature and radiation, weight and position and pressure marks.



Figure 62: Screenshots of the presentation by Patrick Bauer

Lessons learned of the project are that employees should be given enough time to get trained on the device, some people encountered stress, fear and interaction with other stresses and breaks should be planned regularly. The overall conclusion is that the HoloLens is a good assistance tool to support the work of people, there are several applications possible, and the HoloLens does not get hot, is not too heavy and easy to use.

4.8.6 Conclusion

Following the concept of Industry 5.0 there is an increasing focus on human-centered aspects of digitalisation. One aspect of human-centricity are digital assistance systems. Digital assistance systems are increasingly becoming mainstream and are encompass a broad range of different devices. In this workshop several of these assistance systems were presented (Cobots, exo-skeletons, HoloLens), their strengths and weaknesses discussed and applications identified.

4.8.6.1 Transferable results

- Trends, needs, challenges, barriers: there are several technologies already available on the market that can be used as digital assistance systems.
- Pathways (human factors, circular economy, etc.): human-centricity is a very important factor. Given the increasing labour shortage digital assistance systems not only supports workers and improves quality and production processes but might also be an aspect of employer branding.
- Skills: the use of all these technologies needs ample time for training and getting adapted to digital assistance systems. It is advised that training is offered continuously.
- Use cases: several use cases were presented where exoskeletons were used in real working environments. The MS HoloLeans was tested at a company in the automotive industry in a real production environment.

4.9 Connect to the Data Economy – 22/02/2022, INNOVALIA (ES)

4.9.1 Topics Addressed in the Workshop

	Topics adressed (X)
Trends, needs, challenges and barriers	X
Successful use-cases	X
Cross-cutting Factors	
Added Value and Business Models	X
Interoperability and Standardisation	X
Cybersecurity	
Industrial Agreement and Legal Aspects	
Humans in Manufacturing	
Pathways	
Circular Economy	
Human Factors	
Autonomous Smart Factories	
Hyperconnected Factories	
Collaborative Product-Service Factories	
Data Spaces	X
Skills	X

4.9.2 Executive Summary

This document reports on a series of three workshops that Innovalia organised in collaboration with the GAIA Cluster (the IT Cluster in the Basque Country) on the 22nd, 23rd and 24th of February. It was initially organised as a unique workshop, but due to the high demand we had to split it into three sessions.

The workshops were organised in the scope of BAIDATA, a new initiative of Innovalia and GAIA (the IT cluster in the Basque Country), with the aim of promoting the transition of the companies to the Data Economy in Spain. This initiative has the support of the Basque Government and the International Data Spaces Association, and it focuses on promoting, on one side, the development of regional and sectoral data spaces and, on the other, to help companies to prepare their data and to enhance it in order to transform it into an economic asset.

The main objective of the workshops was to introduce the concept of the Data Spaces, what are the main opportunities and benefits that companies can expect when participating in a data space, and the technologies, solutions and tools currently available to start developing these data ecosystems.

Most of the participants were from IT companies, but also there were some electronic manufacturers, business consultants and academia.

4.9.3 Introduction

This document reports on a series of three workshops that Innovalia organised in collaboration with the GAIA Cluster (the IT Cluster in the Basque Country) on the 22nd, 23rd and 24th of February. It was initially organised as a unique workshop, but due to the high demand we had to split it into three sessions.

The workshops were organised in the scope of BAIDATA, a new initiative of Innovalia and GAIA (the IT cluster in the Basque Country), with the aim of promoting the transition of the companies to the Data Economy in Spain. This initiative has the support of the Basque Government and the International Data Spaces Association, and it focuses on promoting, on one side, the development of regional and sectoral data spaces and, on the other, to help companies to prepare their data and to enhance it in order to transform it into an economic asset.

The main objective of the workshops was to introduce the concept of the Data Spaces, what are the main opportunities and benefits that companies can expect when participating in a data space, and the technologies, solutions and tools currently available to start developing these data ecosystems. Most of the participants had at least heard about data spaces previously, albeit in a very briefly.

Most of the participants were from IT companies, but also there were some electronic manufacturers, business consultants and academia.

Two of the workshops were in person, in the GAIA cluster premises. The third one took place online, although the agenda and the concept was the same.

Table 11. Agenda

Hour	Topics
15:00	**Wellcome (Tomas Iriondo, GAIA)**
15:15	**Keynote – Data Spaces and Digital Sovereignty (Oscar Lázaro/Jesus Alonso, Innovalia)**
16:00	**Open discussion**
16:30	**End of the workshop**

4.9.4 Workshop Organization and Preparation

The Cluster Gaia oversaw the logistics and the invitations for the workshop, as it was addressed to their members. The cluster has over 300 member companies, and all of them were invited through the internal channels.

Initially the idea was to have one workshop, but due the interest in this topic and the success of the call for registration we decided to provide three options (two physical events and one online) to respond to the high demand on three different days of the same week.

4.9.5 Keynote Session

After the warm welcome of Tomas Iriondo (CEO of the cluster GAIA), Oscar Lazaro, CEO if Innovalia and Jesus Alonso, Responsible of the IDSA Spanish Hub (managed by Innovalia) delivered the main keynote.

It basically introduced the concept of a data spaces, reinforced the importance and why their development is a priority for the EC. It also presented a sneak peak of the IDS Reference Architecture as the main existing technology to build this data spaces.

In this context, the CF2 project was briefly introduced, and the Data Spaces Pathway was presented as one of the tools that can help companies to assess their current situation and to find out what they need to do to progress in this pathway.

Finally, a use case from the Boost 4.0 project was presented, to show one example of what benefits can dataspaces bring to the companies, and to demonstrate that the technology and the IDS standard is ready to actually implement those data spaces.

4.9.6 Interactive Sessions

To close the workshop, there was a slot dedicated to an open discussion, to answer the questions from the participants and also to get their feedback.

Although some methodologies to promote the participations were foreseen, the high level of motivation and the high number of questions and comments were enough to make the session dynamic and productive.

The interactive session started as a Q&A session, with some questions from the audience to the speakers, but it naturally turned into an open discussion, with comments from the participants regarding their own experience in data sharing, what are their current needs in terms of technology and data and also their vision about the future of data spaces.

We collected very valuable feedback on all three sessions, which turned to be quite similar in terms of what are the main concerns and the main expectations for the audience:

- Need for additional information (high level-business related)
    - Clarify what are the differences with currently existing sharing methodologies/tools
    - Data spaces as and additional sharing system (not replacing the current sharing systems)
- Need to define the required skills and the associated training program
    - Define main profiles (technical and non-technical data trained workers)
    - Setup specific training programs (business, operation and development/integration)
    - Include this kind of training since the university degrees (or even before)
- A significant barrier to “sell” data spaces to their clients is the lack of genera information to understand why they need and benefits dataspaces bring vs other solutions (that they have previously used and maybe they feel more comfortable with)
- There’s also a great concern for the legal issues. It seems that this is an aspect which is usually neglected in this kind of activities, as no lawyers usually participate. It would be very useful to involve some legal expert that could provide some light to this issue
- Also the new EU Data Strategy generates many questions on how and when it is going to finally become true. New Digital Europe Projects related with data spaces are starting soon, but there are still many doubts if this is going to reach the general public.

4.9.7 Conclusion

All three workshops where a success, both in the number of attendants and in the dynamism and the interaction between the participants. Even though it was an IT focused events, the participation of some electronic manufacturer provided the interesting view of the verticals to the discussion.

4.9.7.1 Transferable *results*

At least here, in Spain, there's a great interest on getting more information on what data spaces are, what technologies enable them, and how companies and institutions can adopt them. From this workshop, the main points we would highlight are:

- There's a huge need for communication and dissemination of the most basic information: what are data spaces, why do we need them and how can a company/organization/administration benefit about it.
- The legal aspect is a big concern for companies, although it is not crucial to take the first steps, as most of the interested companies initially only would share with current collaborators. But the general impression is that a lot needs to be done in this area.
- It is crucial to define new job profiles, specifying the required skills to implement and maintain data spaces. Also specifying a certified training program to achieve those skills. Both for the development and maintenance of components and for the operation of the data spaces within the verticals.

4.10 Industrial Internet of Things – 12/2021-03/2022, IMR (IR)

4.10.1 Topics Addressed in the Workshop

	Topics adressed (X)
Trends, needs, challenges and barriers	
Successful use-cases	
Cross-cutting Factors	
Added Value and Business Models	
Interoperability and Standardisation	
Cybersecurity	✓
Industrial Agreement and Legal Aspects	
Humans in Manufacturing	
Pathways	
Circular Economy	
Human Factors	
Autonomous Smart Factories	✓
Hyperconnected Factories	
Collaborative Product-Service Factories	
Data Spaces	
Skills	✓

4.10.2 Executive Summary

Irish Manufacturing Research (IMR) is Ireland's only independent research organisation. Its mandate is to de-mystify, de-risk and deliver high TRL technologies to its network of over 200 manufacturing companies on the island of Ireland. As part of this mandate IMR offer hands on tailored courses across a range of Industry 4.0 technologies. These courses are designed and delivered by subject matter experts with extensive industrial experience.

2 IIoT courses were completed in December 2021 and March 2022 with 47 participants from both SME and multinational backgrounds. The attendee's included both technical staff and senior management. All of the attendees were industrialists. The course was broken into a series of modules designed to provide the appropriate context and understanding to IIoT for audiences who do not have a deep understanding of IIoT. The modules were:

Module 1 – What is IIOT?

Module 2 – How can IIoT Deliver Value?

Module 3 – Who are the vendors in this space?

Module 4 – What can we sense?

Module 5 – Communication

Module 6 – Security

Due to the success of the course to-date additional courses are planned in support of the Connected Factories objective of skills enhancement and exposing workers within manufacturing environments to new technologies.

4.10.3 Introduction

IMR has created a series of courses, of which the IIoT course is one example, to enable staff from a range of manufacturing environments and skillsets to upskill and develop their understanding of Industry 4.0 technologies. The IIoT course focuses on

- introducing the subject, with a view to applications where IIoT can benefit industry
- Giving manufacturing staff expose to IIoT who would not ordinarily be familiar with it
- Supporting level 6 & 7 engineering students

The course address 6 topics over 1 day

Module 1 – What is IIOT?

Module 2 – How can IIoT Deliver Value?

Module 3 – Who are the vendors in this space?

Module 4 – What can we sense?

Module 5 – Communication

Module 6 – Security

The expected outcome of the course for students was develop their perspective in terms of

- Students obtained clarity on the terminology used in IIoT
- Students would obtain an understanding on how to search for more information
- Students develop an appreciation ad understanding of the risks and challenges of deploying IIoT technologies
- They obtain clarity on how to proceed with IIoT solutions

4.10.4 Workshop Organization and Preparation

The workshop was designed to be delivered remotely, due to the COVID restrictions in place and to ensure IMR adapted to customer needs. As highlighted module was designed to provide insights into a specific topic of IIoT.

Module 1: This described the concept of connecting industrial systems to the cloud, as shown in figure 1. Students were introduced to sensor technology and their characteristics, collecting data and platform consideration for storage. Industrial deployment examples were discussed, specifically pharma, medical device, general manufacturing, logistics and storage. A case study on cold storage of food products and the importance of temperature monitoring and validation was presented.

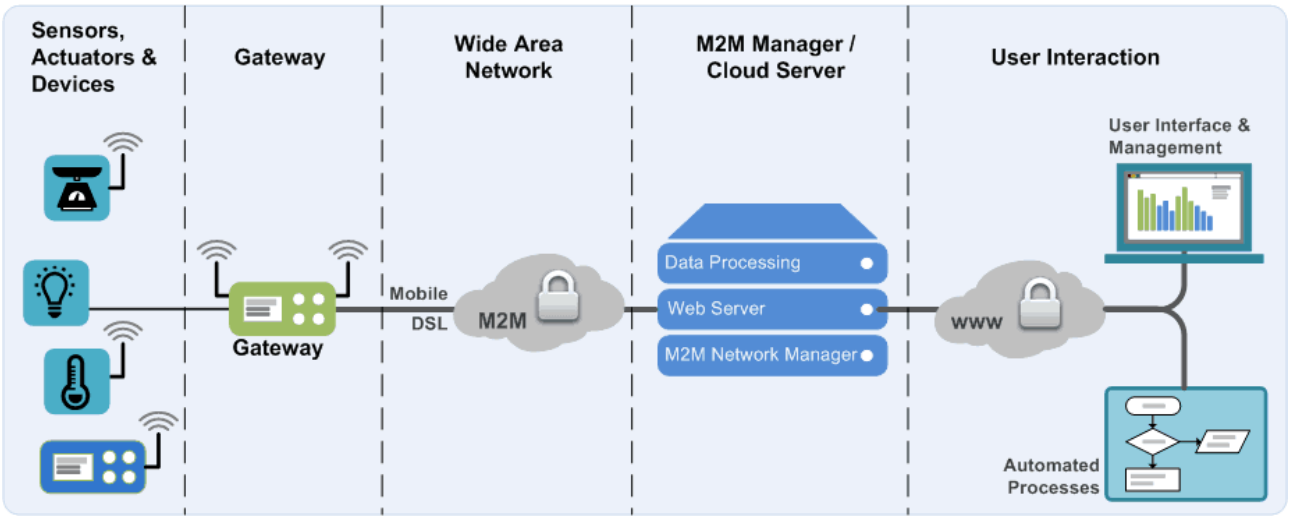


Figure 63. High level IIoT overview.

Module 2: This focused on the actual use cases, exposing students to how IIoT can deliver value, how not to approach adopting IIoT, how to approach adopting IIoT and assessing an organisations readiness to adopt IIoT. Students were coached on how to deliver value and identifying areas they need to consider such as installation costs, operational costs, development costs, compliance with regulations and safety considerations.

Module 3: Students were exposed to the range of vendors which offer different parts of an IIoT solution. This was designed to give students context into the following components: sensors, gateways, communication types, cloud storage, IIoT device management and data analytics. This allowed students to see how an overall IIoT solution can be created and how solution providers can provide part of the capabilities if necessary. Figure 2 gives an example of a cloud site reliability monitoring platform.

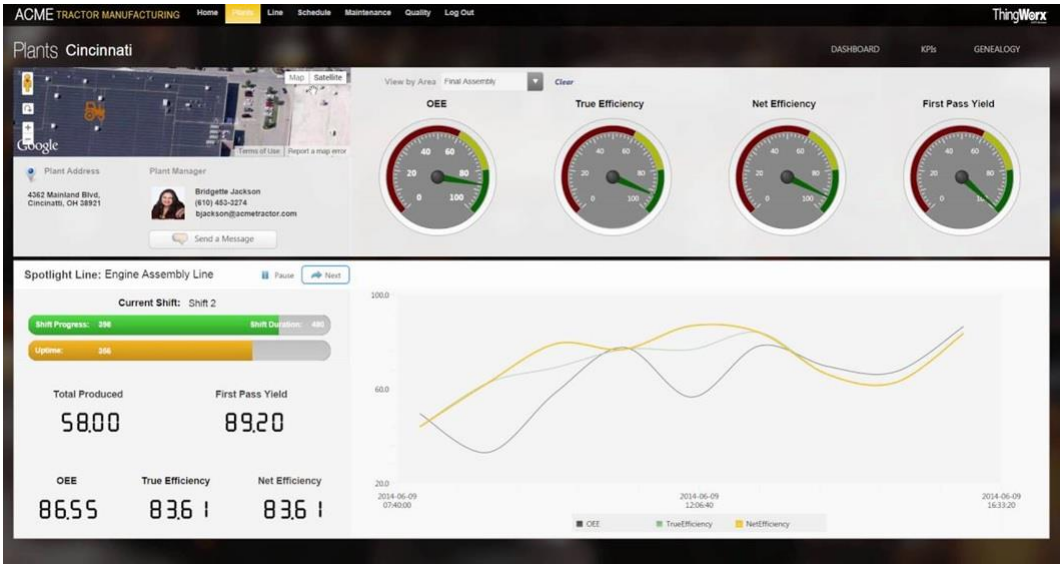


Figure 64. Example of cloud storage monitoring platform.

Module 4: Students get an understanding of the scale of sensor categories (as shown in figure 3), what conditions are suitable and unsuitable for sensing. Easy conditions were highlighted such as temp/RH, vibration as well as problematic conditions such as gas flow and gas flow. Sensor configurations were also addressed including connectivity options, power sources and sampling rates. Sensor vendors were also presented.

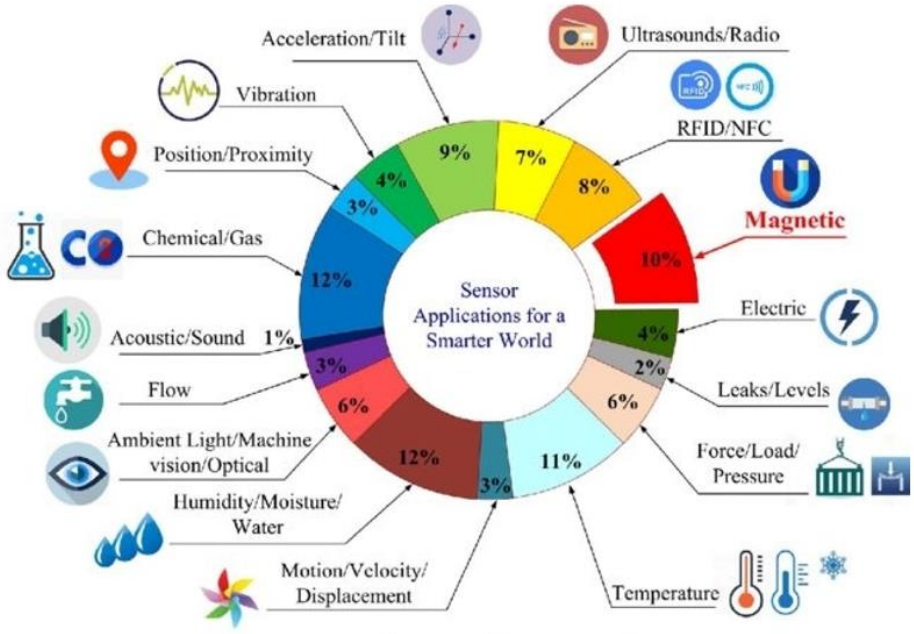


Figure 65. Sensor categories for industrial applications.

Module 5: An overview of how sensors communicate was presented highlighting to the student the configurable options which are available through both wired and wireless applications. The importance of environmental conditions and their influence on application constraints such as ATEX requirements. The student was exposed to considerations such as battery life, range, data sampling, admin requirements and costs. All of which influence connectivity options.

Module 6: Students were introduced to the concepts of security and cybersecurity and where to identify vulnerabilities can occur – architectural design, developer mistakes, malicious developer input, flaws in cryptographic algorithms and 3rd party IP. The importance of sw validation and the use of Security Development Lifecycles (SDL) exposed students to some of the standards used to mitigate these risks as shown in figure 4.

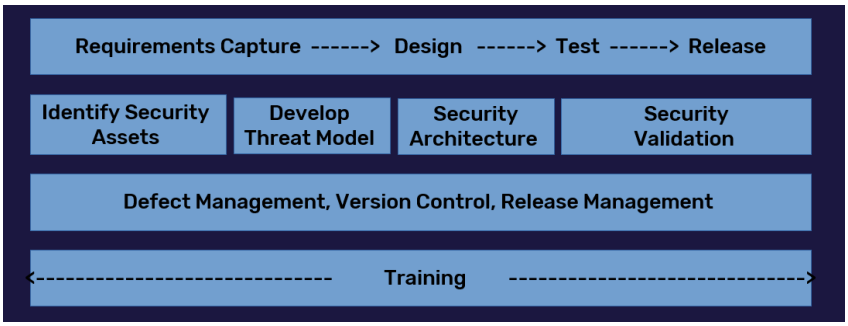


Figure 66. SDL map

4.10.5 Keynote Speakers Session

The day long workshops were highly interactive, with the instructor engaging directly with students and their questions throughout the individual modules. The course was developed by a senior technologist, Mr. Mike Hibbett working in IMR's IoT division, based in Dublin. He has 30 years of experience developing embedded systems, focusing on firmware and electronics design, and device security architecture. He has led product development teams for companies such as Intel, Philips and Thales where he led the UK high grade cryptographic solutions software group. The instructor also lectures in embedded systems to level 6 &7 students.

The course development was supported by IMR's director of IIoT and digitisation, Dr. Niall Aughney. He has been working in technology and product development for over 30 years within the ICT industry. Niall holds a M. Eng. Sc in microelectronics and Ph.D in engineering. Niall's most recent work has included 5 world-wide product launches in the IOT space including cellular sensor solutions and point of sale system development. Niall's most recent roles have included being a senior world-wide SW director for Verifone payment systems and as a senior director within the IOT group in Intel responsible for product development.

4.10.6 Interactive Sessions

As each module delivered was designed to be interactive, the instructor presented and worked through a number of examples of IIoT deployments, to give the students additional context. The links used are presented here

Discussion of IoT usecases, large selection of devices

https://www.alliot.co.uk/

Sensor suppliers

https://www.bosch-sensortec.com/products/

http://www.ia.omron.com/products/category/sensors/

https://www.srisensor.com/

https://www.te.com/usa-en/trends/iot-5g-ai.html

LoRa Radio technology

https://www.digikey.com/en/maker/blogs/introduction-to-lora-technology

IoT Gateways

https://www.thalesgroup.com/en/markets/digital-identity-and-security/iot/inspired/iot-gateway

https://www.lairdconnect.com/wireless-modules/lorawan-solutions

Prototyping an IoT sensor

https://dzone.com/articles/introduction-to-iot-sensors

4.10.6.1 Interactive Session 2 on, e.g. pathways to digitalization

To provide additional context, the Connected factories 2 consortium was presented to the audience. This was to highlight EU support available to companies' efforts in digitisation as shown in figure 5. https://www.connectedfactories.eu/pathways-digitalisation-manufacturing .



Figure 67. Connected Factories 2

4.10.7 Conclusion

Overview of the results and description of the engagement strategy after the workshop

There has been strong feedback from the participants obtained upon course completion. 88% of participants stating they would recommend the course to other organisations and 12% stating they were confident in applying the skills and knowhow. All of the participants involved have progressed to further research activities with IMR to facilitate their company digitisation programs.

4.10.7.1 Transferable results

The delivery of the 2 IIoT courses to date resulted in upskilling workers in terms of digitisation knowledge and providing context as to how and where IIoT technologies should be applied. In this respect, the primary objective of the course was met in that it presented an opportunity to upskill relevant personnel within factory settings.

Some additional results were also achieved, these included:

- The training resulted in students getting a detailed understanding of what IoT is in terms of using sensors to monitor machines, devices and/or the environment, collecting that data and acting upon it, without the need for human intervention.
- Students were exposed to the IoT ecosystem and how to identify different aspects of technology that contribute to IoT such as solution providers and device manufacturers. This resulted in students coming away with a broad understanding of the eco-system.
- Technically the courses resulted in enabling students to group sensors into types and use cases.
- The courses enabled participants to gain a deeper understanding of how to approach real world problems that IIoT can help with. This resulted in students understanding what to consider in terms of monitoring industrial manufacturing systems, machines, things and environmental considerations.

- The courses exposed students to what to consider in terms of data collection, data storage: cloud or on premise, computing resources required on the internet and intranet resulting in a more in-depth understanding for students.
- The courses introduced cybersecurity as a concept and provided guidance on cyber security considerations resulting in more aware and informed participants in terms of risk.

4.10.7.2 Relevant Experiences

Description of relevant experiences obtained during the organization, execution and analysis of the workshop

There was a broad appreciation expressed by the students on the course that the course did support their learning and understanding of IoT in general. Sample feedback from the course completed in March 2022 is referenced below. A number of these companies have or are in the process of completing additional IoT based work and projects with IMR as a result of these initial courses supporting IMR's overall objective to support companies in their own digitisation efforts.

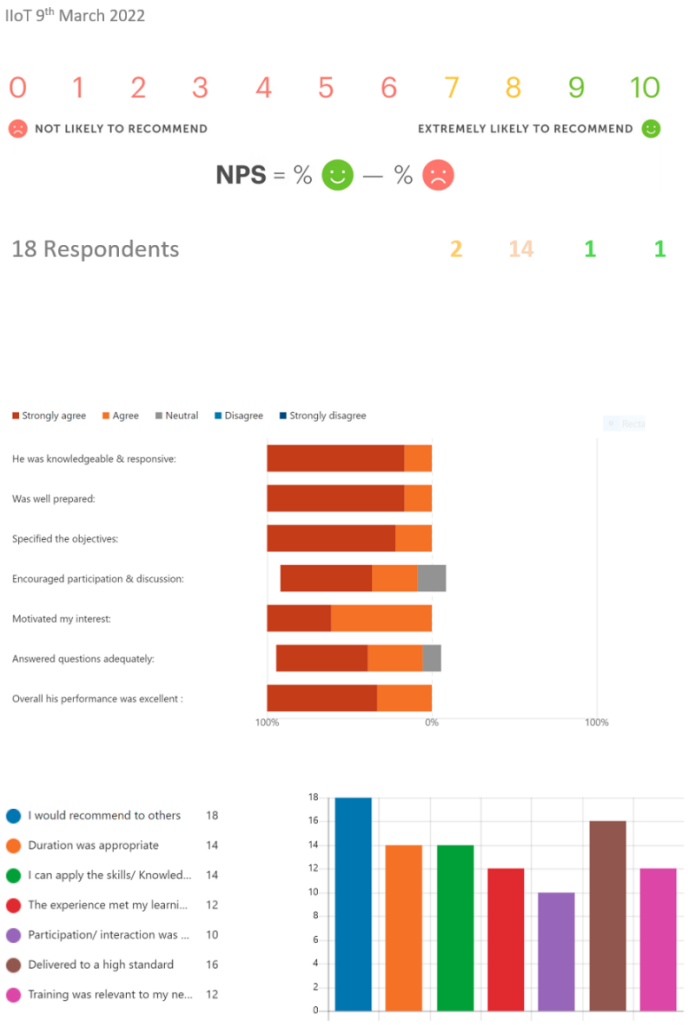


Figure 68. Interactive session analysis

4.11 Connect to the Data Economy – 07/03/2022, INNOVALIA (ES)

4.11.1 Topics Addressed in the Workshop

	Topics adressed (X)
Trends, needs, challenges and barriers	X
Successful use-cases	X
Cross-cutting Factors	
Added Value and Business Models	X
Interoperability and Standardisation	X
Cybersecurity	
Industrial Agreement and Legal Aspects	
Humans in Manufacturing	
Pathways	
Circular Economy	
Human Factors	
Autonomous Smart Factories	
Hyperconnected Factories	
Collaborative Product-Service Factories	
Data Spaces	X
Skills	X

4.11.2 Executive Summary

This document reports on a workshop that Innovalia organised in collaboration with the ACICAE (the Automotive Cluster in the Basque Country) the 7th of March 2022.

The workshop was organised in the scope of BAIDATA, a new initiative of Innovalia and GAIA (the IT cluster in the Basque Country), with the aim of promoting the transition of the companies to the Data Economy in Spain. This initiative has the support of the Basque Government and the International Data Spaces Association, and it focuses on promoting, on one side, the development of regional and sectoral data spaces and, on the other, to help companies to prepare their data and to enhance it in order to transform it into an economic asset.

The main objective of the workshops was to introduce the concept of the Data Spaces, what are the main opportunities and benefits that companies can expect when participating in a data space, and the technologies, solutions and tools currently available to start developing these data ecosystems.

Most of the participants were SMEs form the automotive sector, mainly part manufacturers.

4.11.3 Introduction

This document reports on a workshop that Innovalia organised in collaboration with the ACICAE (the Automotive Cluster in the Basque Country) the 7th of March 2022.

The workshop was organised in the scope of BAIDATA, a new initiative of Innovalia and GAIA (the IT cluster in the Basque Country), with the aim of promoting the transition of the companies to the Data Economy in

Spain. This initiative has the support of the Basque Government and the International Data Spaces Association, and it focuses on promoting, on one side, the development of regional and sectoral data spaces and, on the other, to help companies to prepare their data and to enhance it in order to transform it into an economic asset.

The main objective of the workshops was to introduce the concept of the Data Spaces, what are the main opportunities and benefits that companies can expect when participating in a data space, and the technologies, solutions and tools currently available to start developing these data ecosystems. For most of the attendants it was the first contact with these concepts.

Table 12. Agenda

Hour	Topics
12:00	**Wellcome (Ines Anitua, ACICAE)**
12:15	**Keynote – Data Spaces and Digital Sovereignty (Oscar Lázaro, Innovalia)**
13:00	**Open discussion**
13:30	**End of the workshop**

4.11.4 Workshop Organization and Preparation

ACICAE oversaw the logistics and the invitations for the workshop, as it was addressed to their members. The cluster has 300 member companies, and all of them were invited through the internal channels.

4.11.5 Keynote Session

Ines Anitua, President of ACICAE, welcomed the participants and presented the aims of the workshop. Then Oscar Lazaro, CEO if Innovalia and Jesus Alonso, Responsible of the IDSA Spanish Hub (managed by Innovalia) delivered the main keynote.

It basically introduced the concept of a data spaces, reinforced the importance and why their development is a priority for the EC. It also presented a sneak peak of the IDS Reference Architecture as the main existing technology to build this data spaces.

In this context, the CF2 project was briefly introduced, and the Data Spaces Pathway was presented as one of the tools that can help companies to assess their current situation and to find out what they need to do to progress in this pathway.

Finally, a use case from the Boost 4.0 project was presented, to show one example of what benefits can dataspaces bring to the companies, and to demonstrate that the technology and the IDS standard is ready to actually implement those data spaces.

4.11.6 Interactive Sessions

To close the workshop, there was a slot dedicated to an open discussion, in order to answer the questions from the participants and also to get their feedback. It is important to have in mind that this was the first contact of most of the participants with the concept of data spaces.

The first questions made during this interactive session showed us that, even if we have tried to simplify the concept and to explain the data spaces for non IT people, we even need to go further in this simplification effort. It took some time to clarify some basic questions.

As soon as we clarified these basic questions, we started to get feedback from the participants, in terms of their impressions on this subject, their expectations, requirements, etc. The most relevant points that came out in this discussion were:

- The general impression is that this is still an R&D topic, but most of the attendants are aware that it will reach them sooner than later. Most agree on the value of data and that in the near future data is going to become a central part of their businesses.
- In this sense, another frequent question is why are data spaces needed, and in what aspects they improve current data sharing systems.
- There's also a chicken-egg problem: there are very few (or none) commercially available data spaces solutions (connectors, etc.) because there's no demand, but demand can't grow if there are no new solutions.
- Another interesting point for manufacturers is if they have to manage the data space or who will do it. In this sense, there's general opinion that Clusters and Associations may play a significant role as Data Spaces moderators/administrators.
- Some participants that might be interested in using data from others highlighted the need to standardize and somehow set some rules regarding the quality of the data.
- The benefits of using standards and interoperable technologies in the conception of the data spaces was also highlighted by some attendants. Some of them work for different customers with different data sharing systems, and that's messy and inefficient… finding a common tool that can be interoperable would be a major improvement from their side.
- A common concern is to find qualified workers that can manage and operate data sharing systems such as Data Spaces (or any other data-sharing technology).

4.11.7 Conclusion

It was very interesting hearing the first impressions of the participants regarding the data spaces, as most of them had never heard of them. However, these first impressions are probably more interesting from the communication point of view (how we communicate and explain data spaces), especially among non-IT profiles/sectors.

4.11.7.1 Transferable results

The main lessons learned from this workshop are:

- It is really important to adapt the communication, especially when talking to non-IT people, trying to simplify the message to the maximum. It is equally important to create a culture of data sharing that includes the main concepts around it.
- It is key to break the chicken-egg circle (this is the reason why the BAIDATA initiative has been presented both to IT companies and to the vertical sectors, in an attempt to matchmake between them).
- Training and skills development must be a priority to be able to adopt a data-driven paradigm. There's a huge need for data-skilled workers.
- Mobilizing the sectoral associations and encourage them to manage or administrate data spaces would be really an intelligent move, as they would guarantee the impartiality and transparentness

4.12 Industrial Digitalization Technical Day – 12/04/2022, EIL (HU)

4.12.1 Topics Addressed in the Technical Day

	Topics adressed (X)
Trends, needs, challenges and barriers	**X**
Successful use-cases	**X**
Cross-cutting Factors	
Added Value and Business Models	
Interoperability and Standardisation	
Cybersecurity	
Industrial Agreement and Legal Aspects	
Humans in Manufacturing	**X**
Pathways	
Circular Economy	
Human Factors	
Autonomous Smart Factories	
Hyperconnected Factories	
Collaborative Product-Service Factories	
Data Spaces	**X**
Skills	**X**

4.12.2 Executive Summary

The Industrial Digitalization Technical Day called “INDIGO” was organized 4th time by the EPIC InnoLabs Ltd, subsidiary of SZTAKI and the Fraunhofer - Gesellschaft. The main topic of the Technical Day was the industrial digitalization and the “efficiency” was the keyword this year. The digitalization of companies has speed up during the COVID-19 as the productivity level could be maintain by involving new IT technologies and tools into production.

The goal of the Technical Day was to call together the potential industry partners and to introduce them emerging technologies (digital twin, machine learning, big data, and simulation) applicable in industry. The capabilities of EPIC InnoLabs Ltd. in these fields have been introduced as well, demonstrating the raising efficiency by different case studies from manufacturing and logistic. These realized digitalization examples came from different countries, from the US, Asia and from Hungary.

Because of the timely fulfilment of the continuously changing demands and short deadlines the effective organisation of manufacturing and logistic processes became a key element. By using digital twins the decisions for wide range solutions of digital manufacturing, to increase productivity, to reduce costs, and to achieve quality goals. The digital models of production systems (manufacturing lines, supporting- and storage systems) can be developed by applying digital twins that can help the recognition, the analysis, and the optimization of processes.

Most of the participants came from different sectors of industry, from SMEs but from large companies and different countries as well. The main results of the Day are the lessons learned from the industry-based

demonstrations. These demos gave the participants good examples how they can operate more effective their own processes with the application of digital twins. In the last part of the day the participants had the possibility to discuss the presentations with the speakers and change their views in an informal way.

The context of ConnectedFactories2 and the Day can be found in the effective use of digital twins that is a dedicated technology in the digital transformation of manufacturing processes.

4.12.3 Introduction

The Industrial Digitalization Technical Day called "INDIGO" was organized 4th time by the EPIC InnoLabs Ltd, subsidiary of SZTAKI and the Fraunhofer - Gesellschaft. The main topic of the Technical Day the industrial digitalization and the "efficiency" is the keyword this year. The digitalization of companies has speed up during the COVID-19 as the productivity level could be maintain by involving new IT technologies and tools into production.

The goal of the Technical Day was to call together the potential industry partners and to introduce them emerging technologies (digital twin, machine learning, big data, and simulation) applicable in industry. The capabilities of EPIC InnoLabs Ltd. in these fields have been introduced as well, demonstrating the raising efficiency by different case studies from manufacturing and logistic. These realized digitalization examples came from different countries, from the US, Asia and from Hungary.

The increasing use of emerging technologies to simplify complex tasks has proved rewarding across every industry in diverse ways. This includes increased operational efficiency, automating manual tasks, training and validation, as well as data analysis. The integration of emerging technologies has brought the fourth industrial revolution, in which data analytics and automation are important components. The digital transformation of traditional processes is also another aspect of Industry 4.0 and, here, simulation and the digital twin play outstanding roles.

4.12.3.1 Digital Twin technology

Digital Twin is a technology that involves e.g. cloud, AI, data modelling, AR, VR, and other emerging technologies to build a virtual model of a system, process, product, or other physical objects. This virtual copy of the physical world continuously can be updated based on real-time input data and environmental parameters.

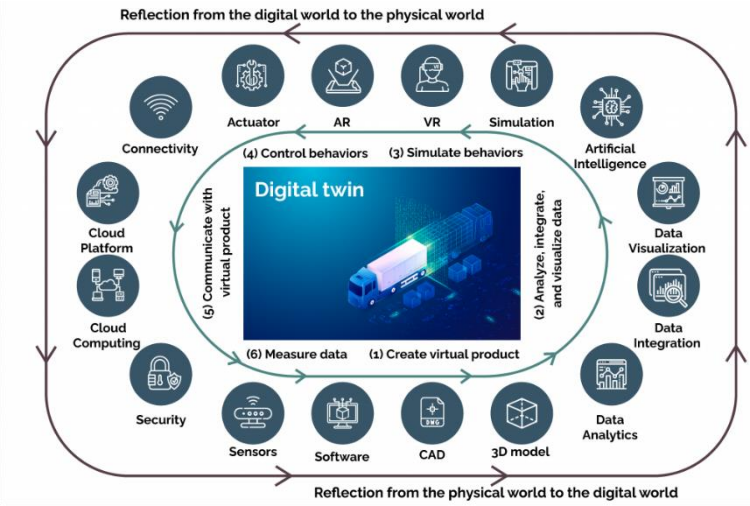


Figure 69. The Digital Twin and its environment

Digital Twins can be applied to model processes and objects at different levels; Component level, Asset level, System-level Product Level and Process level.

Digital Twins allow engineers to test a physical product through virtual modelling and monitor which aspects may need to be improved, replaced, or augmented. It also helps evaluate the risks and issues that might occur in the future without ever using the product.

Converging virtual and physical worlds helps manufacturers head off problems before they occur, prevent downtime, improve the scope of their products/services and even plan for the future by using simulations. A contemporary Digital Twin combines multiple interacting systems to account for different facets of the physical system.

4.12.3.2 Simulation technology

Simulation refers to digital models that mirror the operations or processes within a system. Such simulations are used for analysing the performances of systems and the testing and implementation of new ideas. Engineers make use of simulations across a variety of industries to test products, systems, processes, and concepts.

Simulations include discrete event simulations, stochastic simulations, and deterministic simulations. In these types, the variables used in running the simulation are either known or random. To run simulations, some level of digitization is needed. This process may involve only mathematical concepts or the design of 2D or 3D models representing assets within a process or a product.

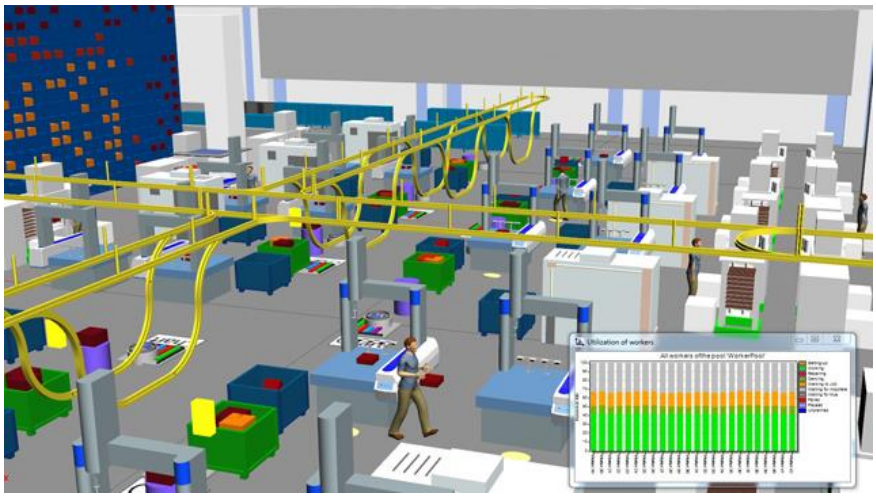


Figure 70. Analyse Production Systems with 2D and 3D Statistical Simulation

4.12.3.3 Connecting Digital Twin and Simulation Modelling

Digital Twins are confused sometimes with simulation. This mistake can originate that DT integrates business logic, IIoT data, modelling and simulation, and Data Analytics to predict a physical system's behaviour. Digital twin needs data, algorithms, sensors, and a data access framework. This communication line can be realised by the IIoT and this network provides that all the process components can access the latest sensor data in a product lifecycle.

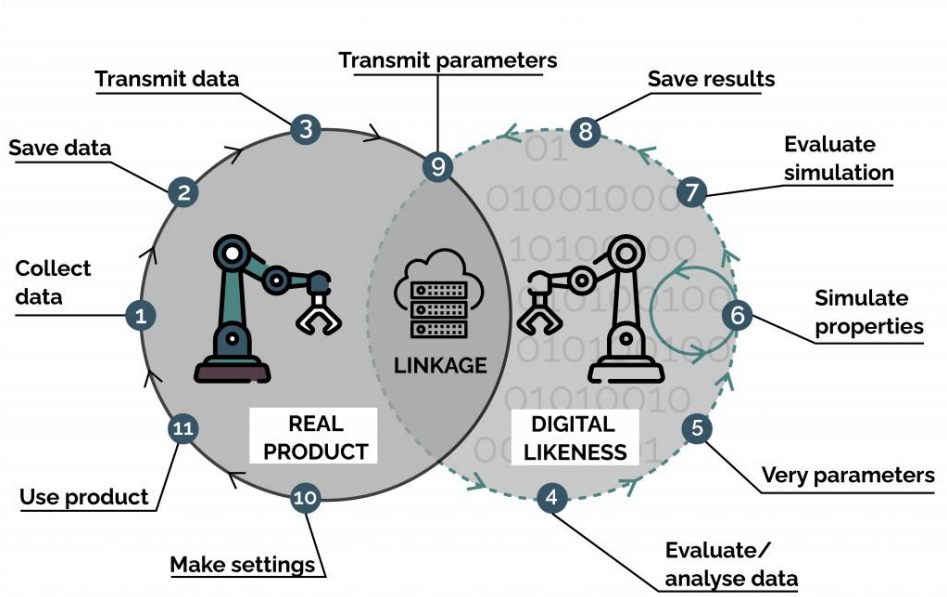


Figure 71. Digital twin components and operation scheme

Table 13. Differences between Digital Twin and Simulation Modelling

Criteria	Digital Twin	Simulation modelling
Goal	Direct control or influence, form real physical processes, objects based on real data.	Estimate the behaviour of a process by using theoretical data sets.
Application in life cycle	Used in every phase of the lifecycle.	Used on an early phase of the lifecycle (Designing and constructing).
Connection to reality	Tracing what is going on in the exact moment (real-time) in the physical world.	Constructing experiments on models what may happen, a theoretical possibility described by the model.
Communication	Interactions between digital twins.	Only analyse the processes representing by the model.

Applications of digital twins are most widely used in the manufacturing industry. Manufacturing relies on high-cost equipment that generates a high volume of data which facilitates creating digital twins. Some examples of digital twin applications in manufacturing are listed below:

- Manufacturing - Digital Twin helps meet the changing demands for better efficiency, yield, and quality. It adds clarity to how a projected change might impact costs or schedules in a manufacturing project.

- Operations and Service - Digital Twin helps minimize unexpected downtime, worker safety incidents, and operational glitches. It provides the current operational status and statistics on system alerts, maintenance issues, KPIs, etc.
- Modelling and Simulation: A Digital Twin model interface may include fields like property, telemetry, component, and relationship.
- Output data analytics: Real-time sensor data collected from the physical system can be analysed and visualized to interpret and communicate data patterns. These data patterns can help make effective decisions, predictions, and business performance improvements. Historical and current data comparisons help forecast future trends and improve high-level decision-making

At the INDIGO Industrial Digitalization Technical Day digital twin applications were introduced in manufacturing, healthcare, and supply chain.

4.12.4 Technical Day Organization and Preparation

The organization of the workshop partially was processed through a blog on the internet besides the direct email invitations. As the workshop was partially international, the foreign speakers communication and their presentations, case studies were processed in English.

The administration activities, the organization were going on in Hungarian as the very bigger part of the participants arrived from Hungarian companies. So the call, the introduction and the presentations and use cases introduction as well as the official WEB site were all in Hungarian. All materials have been written in Hungarian as well. In the report only the key points of the presentations are introduced/translated into English.

4.12.4.1 The WEB site of the Technical Day

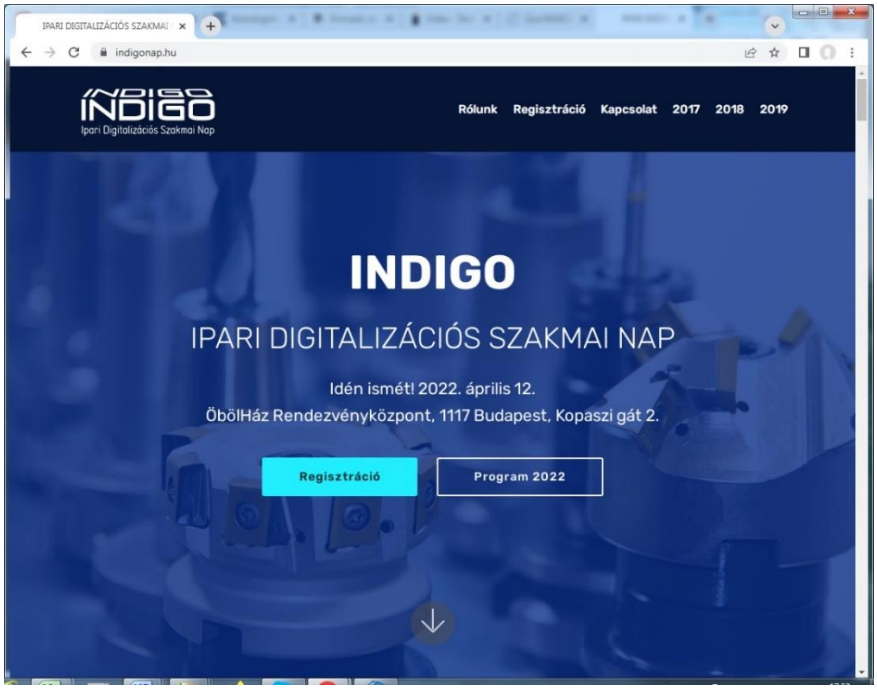


Figure 72. The start page of the Organisation of national/regional sessions and associated reports - First iteration

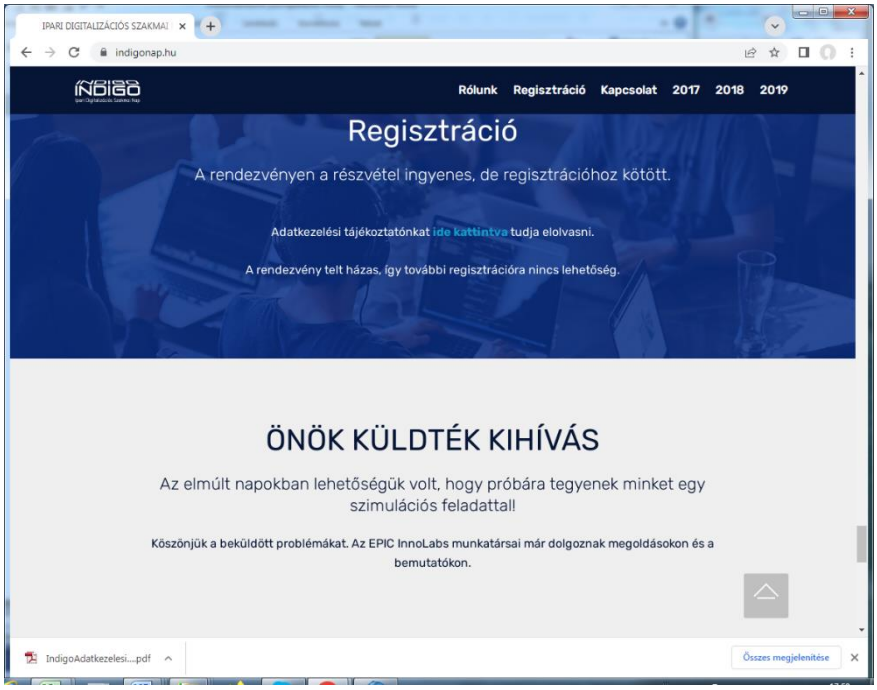


Figure 73. The registration page of Organisation of national/regional sessions and associated reports - First iteration

There was a possibility to send in problems to the organisers preliminary that could be solved at the workshop for the participants demonstrating the real possibilities of the software and the experts.

Download URL: https://blog.eplm.hu/wp-content/uploads/2021/05/PlantSim_SzakmaiNap_Feladat.pdf



Figure 74. Contact page of the Organisation of national/regional sessions and associated reports - First iteration

4.12.4.2 Organisers of the INDIGO Industrial Digitalization Technical Day

The organisation works have been done based on the human and technical resources of EPIC InnoLabs Ltd. The staff is introduced in Figure 75.



Figure 75. Organisers of the INDIGO Industrial Digitalization Technical Day EPIC InnoLabs Ltd staff

4.12.4.3 Main supporting partners

4.12.4.4 Agenda of the INDIGO Industrial Digitalization Technical Day

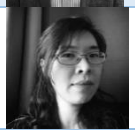
Table 14. Agenda of the INDIGO Industrial Digitalization Technical Day

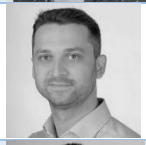
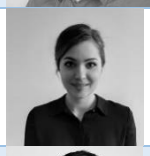
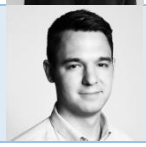
Time	Title	Speaker
8:30 - 9:00	Arrival, registration	
9:00 - 9:15	Greeting the Visitors/Participants of the Industrial Day	László Monostori, Director of SZTAKI, NTP President and Botond Kádár, EPIC InnoLabs Managing Director
9:15 - 10:50	Case studies from partner ’s view	
9:15 - 9:35	Future Vision of Simulation and Digital Twinning in Supply Chain	Crystal Zhu (Senior Logistics Manager at Western Digital) #supplychain #logistics #optimization
9:35 - 10:00.	Using Digital Twinning to bring oversight to manufacturing processes and decision making	Nitin Kaushik (Apollo Tyres- Head Application Operations - Digital Manufacturing) #digitaltwin #simulation #optmization
10:00 - 10:25	Reasoning instead Rupture – Data science in Industry	Tamás Járvás (Robert Bosch Power Tools), Júlia Bergmann

		#regression #machinelearning #datascience
10:25 - 10:50	Patient does not simulate – Specific Digitalisation examples	Dr. Imre László, Semmelweis University Botond Kádár #servicesystem #simulation
10:50 – 11:20	Coffe break	
11:20 - 12:30	EDGE tools for digitalisation and solutions	Gabor Nick
	Data-Based decision support in industrial environment – AI/ML in a closer view-	Klaudia Zeleny és László Zahorán
	Within and beyond manufacturing – Simulation of Warehouse and supply chain	Dávid Czirkó és Ádám Szaller
	Tailoring of Production scheduling solutions – the base of a successful implementation	Ádám Farkas és János Beluzsár
12:30 - 13:30	Lunch break	
13:30 - 15:30	Partnerships	
13:30 - 13: 50	Fraunhofer background in the forfront	Gallina Viola (Fraunhofer Austria)
13:50 - 14:10	When 1+1 is more then 2 - DigiLean Competence Hub	László Tömpe (DigiLean)
14:10 - 14:40	You have submitted – we have solved. Live demonstration of problems sent by the participants	Dávid Czirkó
14:40 - 14: 50	Summary, Conclusions	
14:50 - 16:00	Coffe, networking, consultation with the experts	

4.12.4.5 List of speakers

Table 15. List and photos of speakers.

Name	Title	Company	Photo
Prof. Dr. László Monostori	Director	SZTAKI, NTP President	
Dr. Botond Kádár	Managing Director	EPIC InnoLabs	
Dr. Gábor Nick	Deputy Managing Director	EPIC InnoLabs	
Crystal Zhu	Global Logistics Center of Excellence Project Manager	Western Digital	

Nitin Kaushik	Head Application Operations - Digital Manufacturing	Apollo Tyres	
Tamás Járvás	Director of Technology and Operation	Bosch Power Tools,	
Viola Gallina	Research coordinator	Fraunhofer Austria	
László Tömpe	founder, senior consultant	DigiLean Competence Hub,	
Júlia Bergmann	industrial data analyst	EPIC InnoLabs,	
Dávid Czirkó	digital manufacturting – group leader	EPIC InnoLabs,	
Ádám Szaller	System Engineer	EPIC InnoLabs,	
Ádám Farkas	Production Planning group leader	EPIC InnoLabs,	
Beluzsár János	developer	EPIC InnoLabs	
Klaudia Zeleny	data analyst	EPIC InnoLabs	
László Zahorán	SW developer	EPIC InnoLabs,	

4.12.5 Case studies from partner 's view

The slideshows of the presentations are not public; they are not downloadable as they contain actual operative sensitive information in some cases. The speakers apologised for this but the presentations were more actual, more informative in this way introducing real industrial problems with their real solutions.

In the followings in most cases only the title and content slides will be included into the report with a short summary of the presentation.

4.12.5.1 Future Vision of Simulation and Digital Twinning in Supply Chain – Crystal Zhu (Senior Logistics Manager at Western Digital)

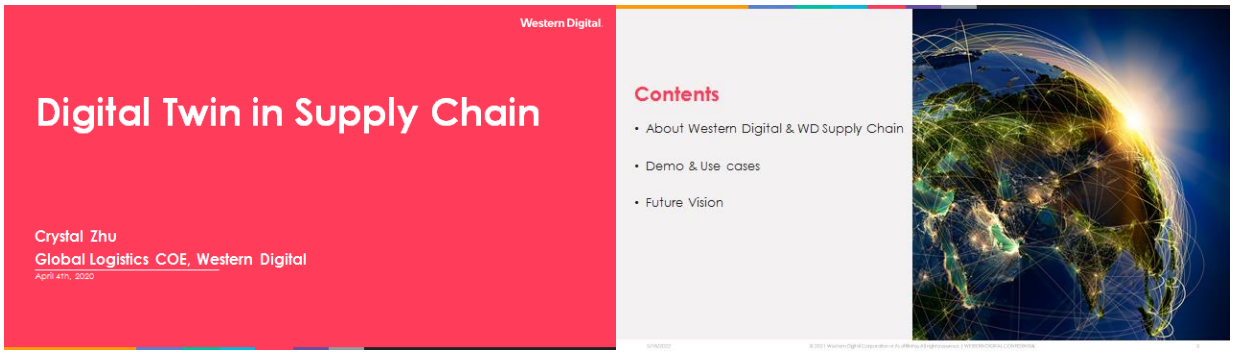


Figure 76. Introductory slides to the session by Crystal Zhu

This presentation was plenned face-to-face but because of the pandemic regulations in Hong Kong the speaker can not travel to this event. The presentation was on line.

Western Digital Supply Chain Network covers the globe, so it was important to optimose the trasportation routes. Digital Twin and simulation tools are apply to transportation , warehouse and end-to-end simulation. Digital twins are used e.g. for shipment tracking, monitoring and warehouse layout optimization. Several use cases were presented as e.g. DT for Logistics Center Location Optimization (result = carbon emission reduction – 1.5 %), Network Optimization.

4.12.5.2 Using Digital Twins to bring oversight to manufacturing processes and decision making – Nitin Kaushik (Apollo Tyres- Head Application Operations - Digital Manufacturing)

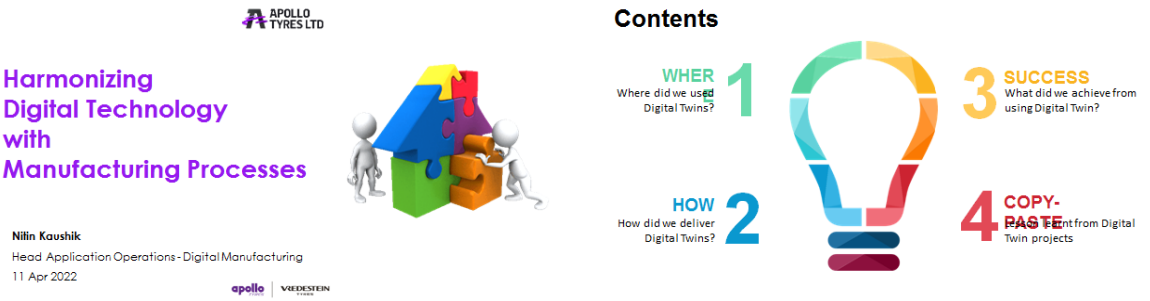


Figure 77. Introductory slides to the session by Nitin Kaushik

Apollo sales to more than 100 countries worldwide, so it is very important for the company to apply new technologies in planning different processes.

In the first part of the presentation an overview was given where, why and how Digital Twins can be applied in manufacturing. Apollo continuesly uses Digital Twin technologies to analyze & simulate its manufacturing processes in detail, and to forecast future investments. Several use cases have been presented. The success characteristics in DT applications are;

- Efficiency Improvements
- New operational insights
- Revised KPI
- Reduced cost for capacity expansion

4.12.5.3 Reasoning instead Rupture – Data science in Industry – Tamás Járvás (Robert Bosch Power Tools), Júlia Bergmann



Figure 78. Introductory slides to the session by Tamás Járvás and Júlia Bergmann

After a short overview of Bosch products, the problem of welding in accumulators has been introduced. Bosh produces a very broad pallet of hand tools operating with storage batteries/accumlators, so the high quality of accumlator welding has of vital importance. Testing the quality of weldings could be done by braking/rupture strain, but this approach is slow and very expensive. Several parameters of welding can be measured, and other key characteristics can be calculated but huge amount of data is generated in this way.

A new method has been developed containing data analysis and integration and machine learning technologies. Based on the tests done so far, this approach offers a satisfactory solution for identification of welding quality of accumlators.

4.12.5.4 *When not the Patient simulates – Specific Digitalisation examples - Dr. Imre László, Semmelweis University, and Dr. Botond Kádár*

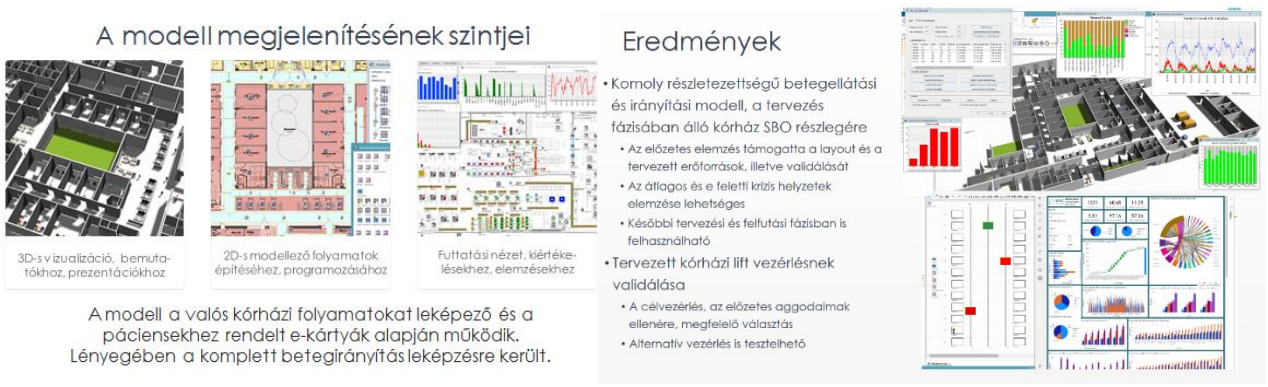


Figure 79. Slides of the session by Dr. Imre László and Dr. Botond Kádár

In this case the efforts were not to focuse on filtering the „simulating patients" but to develop the proper hospital building by using simulation experiments. A proper and exact model set of the hospital building has been developed decribing the different rooms, corridors and elavator operation as well.

Complex simulation experiments have been done to define the size of operating rooms, hospital rooms and elavator capacities with differet input data (arrival frequency and quantity of patients). The hospital building is under design but it is proven that the simulation tool can help in this process in a great extend to optimise the logistics of curative processes (e.g. elevator place, size and capacity).

The results are visualized in different forms, that the different experts can interpret them correctly.

4.12.5.5 *EDGE tools for digitalisation and solutions - Gábor Nick*

In the introductory presentation of this section, we talked about how to find a way to the factories of the futures. How can science and community contribute to this? What initiatives are in place at EU level in this area. What is the topic Connected Factories 2 deals with and what results it has achieved so far.



Figure 80. Slides and speakers of the session Edge tools for digitalization and solutions

4.12.5.6 *Data-Based decision support in industrial environment – AI/ML in a closer view – Klaudia Zeleny és László Zahorán*

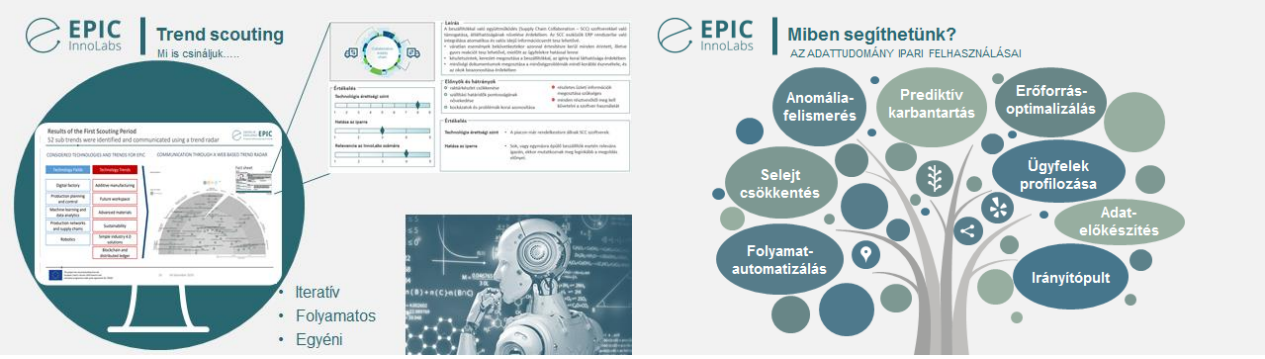


Figure 81. Slides of the Data-Based session.

The presentation introduced the application possibilities of machine learning in industry. Gave a short theoretical background, the risks and pros/contras of this technology. Finally the capabilities of InnoLabs Ltd. were presented that the company can offer for potential industrial partners.

4.12.5.7 *Within and beyond manufacturing – Simulation of Warehouse and supply chain – Dávid Czirkó és Ádám Szaller*

The simulation technic became an essential tool for analysing different processes in industry. The speakres introduced by examples the application possibilities of simulation in logistics. The short demonstrations were very impressive, especially the graphical, visual interpretation of the results. The importance of the visualisation is that non –experts also easily can understand the outputs of the simulation experiments.

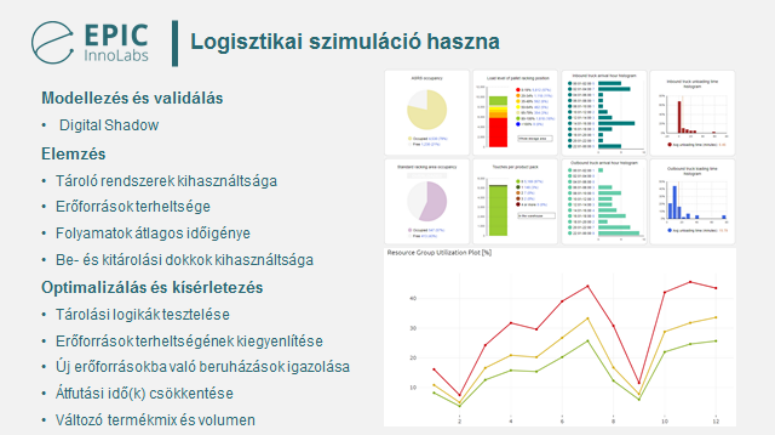


Figure 82. Slides of the simulation of warehouse session

4.12.5.8 Tailoring of Production scheduling solutions – the base of a successful implementation – Ádám Farkas és János Beluzsár



Figure 83. Slides of the session Tailoring production scheduling

The speakers summarised the advantages of a complex scheduling tool that integrates the material planning with manufacturing process and machine scheduling. A key point is in this case the user interface, that provides the users a well structured, transparent overview of the results.

4.12.6 Partnerships

In this section the cooperating partners of EPIC Innolabs Ltd introduced their profile and capabilities parallel gave short summaries of the projects done together so far. Future cooperating possibilities were outlined as well, including new industrial partners.

4.12.6.1 Fraunhofer background in the forfront – Gallina Viola (Fraunhofer Austria)

The presentation introduced the structure and operation of Fraunhofer R+D+I network and how this network is connected to the InnoLabs and the EPIC project. The results of cooperations and the fields of new future possibilties were listed as well.

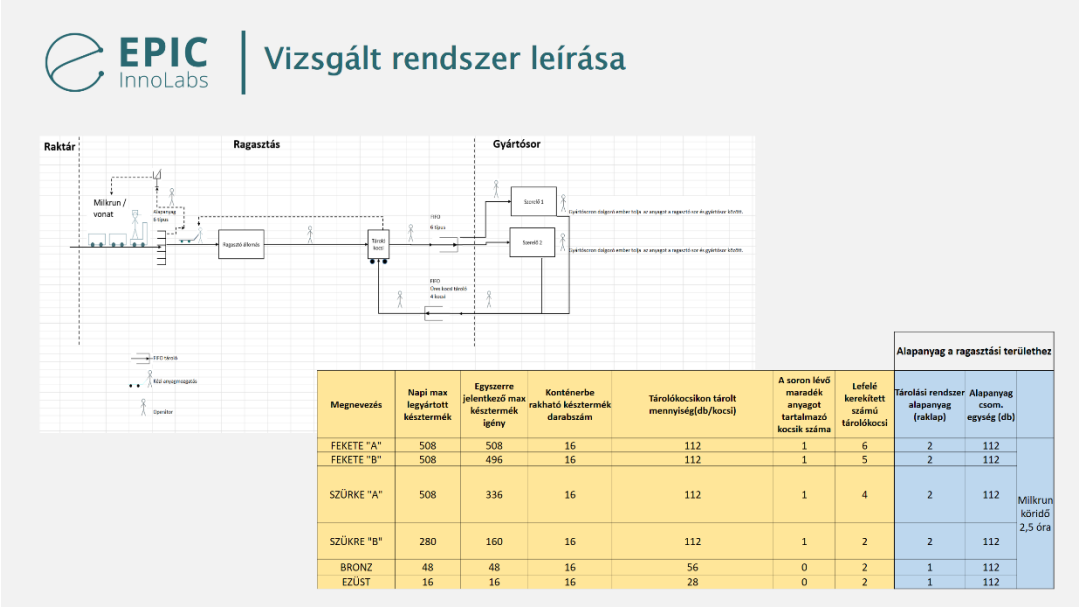
4.12.6.2 When 1+1 is more then 2 - DigiLean Competence Hub – László Tömpe (DigiLean Hub)

As a start the differences between lean digitalization and digitalised lean were defined. The connection of Lean digitalization and I 4.0 was presented in details focusing on the advantages of lean philosophy in case of intelligent manufacturing environment. The DigiLean Hub organises different courses, training on the topic and also cooperates on industrial realisations.

4.12.7 You have submitted – we have solved. Live demonstration of problems sent by the participants

Three case studies were introduced that was submitted by different participating companies a few days before the Technical Day. With these solutions it was demonstrated how an expert can help solving real industrial problems within a short time. These solutions were „first round” but showed well the directions to the effective modifications in production parameters.

4.12.7.1 Case study I. – Analysis of an assembly line – Dávid Czirkó



Megnevezés	Napi max legyártott késztermék	Egyszerre jelentkező max késztermék igény	Konténerbe rakható késztermék darabszám	Tárolókocsikon tárolt mennyiség(db/kocsi)	A soron lévő maradék anyagot tartalmazó kocsik száma	Lefelé kerekített számú tárolókocsi	Alapanyag a ragasztási területhez: Tárolási rendszer alapanyag (raklap)	Alapanyag csom. egység (db)	
FEKETE "A"	508	508	16	112	1	6	2	112	
FEKETE "B"	508	496	16	112	1	5	2	112	
SZÜRKE "A"	508	336	16	112	1	4	2	112	Millkrun köridő 2,5 óra
SZÜKRE "B"	280	160	16	112	1	2	2	112	
BRONZ	48	48	16	56	0	2	1	112	
EZÜST	16	16	16	28	0	2	1	112	

Figure 84. Analysis of production volume in order to define number of needed AGVs and buffer capacity

4.12.7.2 Case study II. - Analysis of a painting line

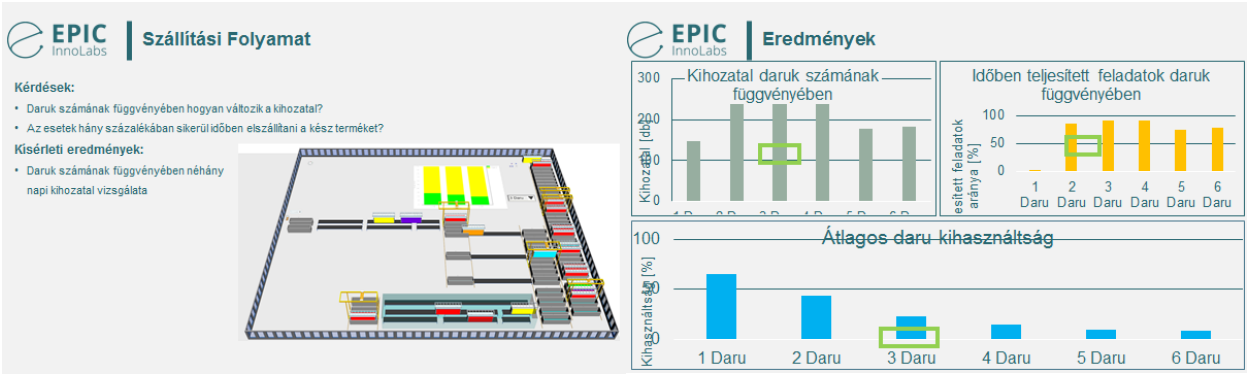


Figure 85. Analysis of a material handling system – definition of crane number, testing the rate of completed tasks in time

4.12.7.3 Case study III. – Analysis of an SMT line

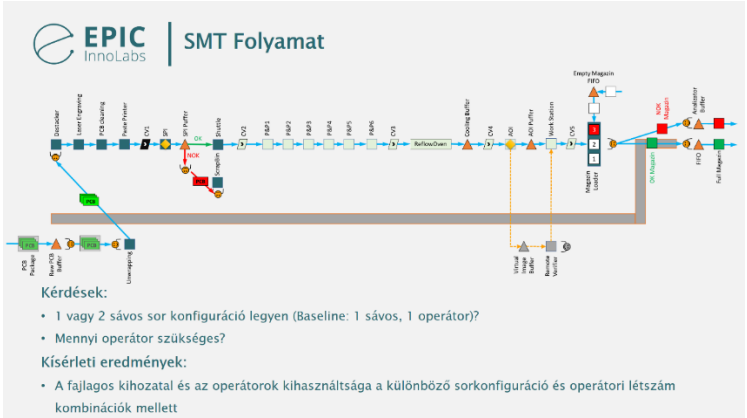
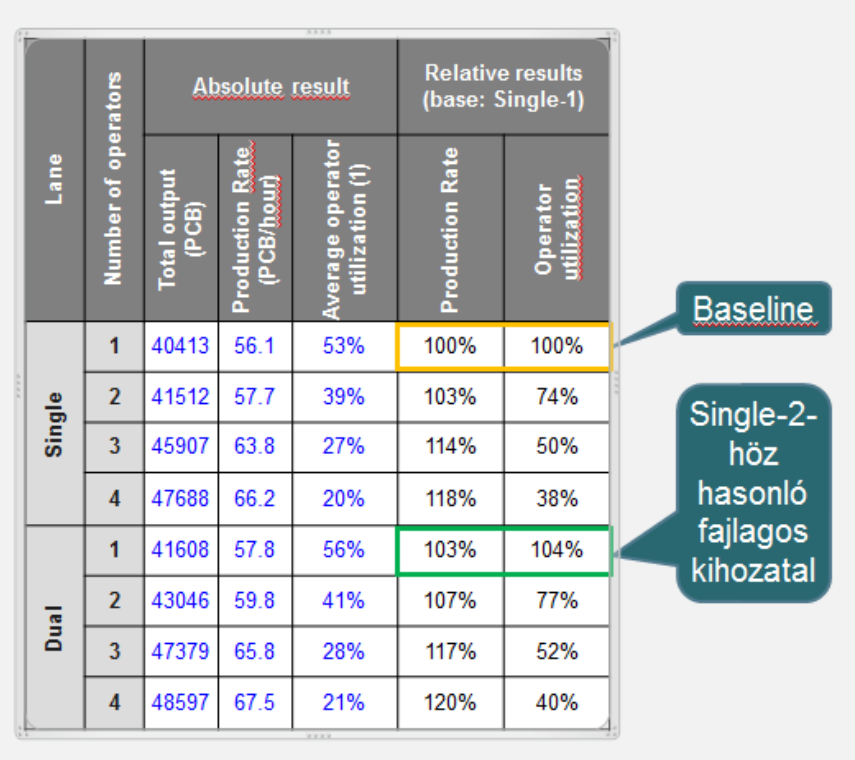


Figure 86. Diagram of an SMT line

The goal of the analysis was to define the number of lines (single or dual) and the needed number of operators.



Lane	Number of operators	Absolute result			Relative results (base: Single-1)	
		Total output (PCB)	Production Rate (PCB/hour)	Average operator utilization (1)	Production Rate	Operator utilization
Single	1	40413	56.1	53%	100%	100%
	2	41512	57.7	39%	103%	74%
	3	45907	63.8	27%	114%	50%
	4	47688	66.2	20%	118%	38%
Dual	1	41608	57.8	56%	103%	104%
	2	43046	59.8	41%	107%	77%
	3	47379	65.8	28%	117%	52%
	4	48597	67.5	21%	120%	40%

Figure 87. Performance indicators of an SMT line

4.12.8 Summary of the Day

Dr. Botond Kádár, the Managing director of EPIC Innolabs made a short overview and summary of the presentations. The applications of digital twins need high level expertise and theoretical background as there are several critical points (e.g. selection of parameters; data collection-, cleaning) in the development phases. So, the cooperation of theoretical experts and industrial partners is essintial to get good results, to reach the planned increase of process effectiveness or product quality.

The industrial case studies were convincing to increase the efficiency of industrial networks and processes by application of digital twins. As it was demonstrated in all cases the engineers from Innolabs and industry were working hand in hand and this was the right way to get good solutions, results.

He requested the participants to send reactions on the programme by completeing the questionnairs, so based on these opinions the next INDIGO Industrial Digitalisation Technical Day could be as successful as the actual one was.

4.12.8.1 Networking, consultation with the experts

4.12.8.1.1 Free discussions, consultations

The place of the INDIGO22 event was very appropriate to have discussions, as here were big spaces inside and outside of the conference building.

There were several live demonstrations installed in the hall that showed the application of cobots with intelligent control. The participants can test the face drawing robot (it was operating continuously – big success) and can have a look how an intelligent robot completes assembly tasks.

These demonstrations were inspiriting for useful discussions, consultations with the developer experts, how other specific tasks can be solved by robots. Other groups of visitors were discussing the application possibilities of digital twins in their companies for different problems. The simulation presentations were very attractive and gripped the phantasy of numerous visitors, immediately generating ideas on applications in their companies.



Figure 88. Demonstrator of cobots[27]

4.12.8.1.2 Reactions of the participants

4.12.8.1.2.1 Comments

A questionnaire has been circulated in the final phase of the Technical Day among the participants. Some practical remarks are shown in the followings:

- I shall come next year too.
- Sending a calendar file (*.ics) would be useful for the registrants to put the date directly into their calendar.
- Excellent event! Professional young speakers. The processing of the submitted case studies was too detailed.
- This was a high-level event from all aspects. The room was too cool for me the temperature was too low.
- Thank you for the excellent organization, and the friendly atmosphere. I especially liked the many young speakers.
- According to my opinion the 1. and 2. sections should be changed. First we heard intense solutions from two global firms and in the next section the capabilities of Innolabs were demonstrated through a ball pan manufacturing company. In case of a reverse order we could start from the basics and building from

[27] A short summary video of the Technical Day can be seen on: https://www.youtube.com/watch?v=lB5r1dJaGR0

this point we could get to the highest level step by step. The same is with the “You have submitted – we have solved” section, as the audience can learn the basic knowledge in this part, as well.

- Good place, good programme. The final block was a bit long.

4.12.8.1.2.2 Graphical summaries of some questions

The satisfaction degree of the following parameters:

Qualification categories: Very good- Good –Acceptable – Weak

- The topic of the presentations
- Structure of the program
- Rate of theory/practice
- Location/catering

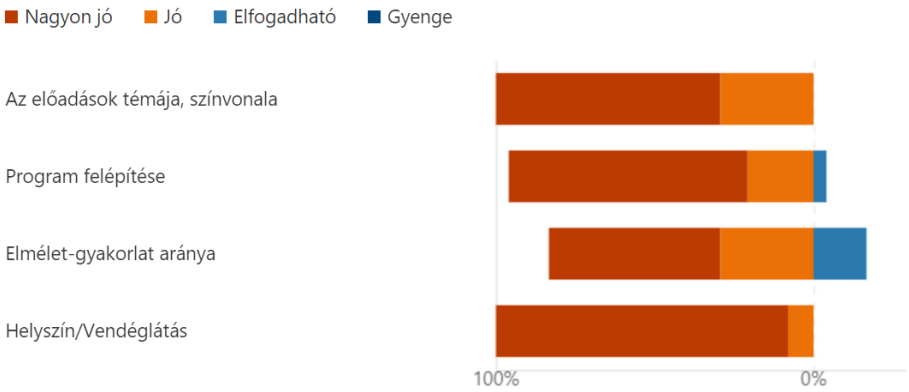


Figure 89. Results and feedback from participant (1)

Opinions on the usefulness of the presentations:

Qualification categories: Very useful – Useful – Partially useful – No useful

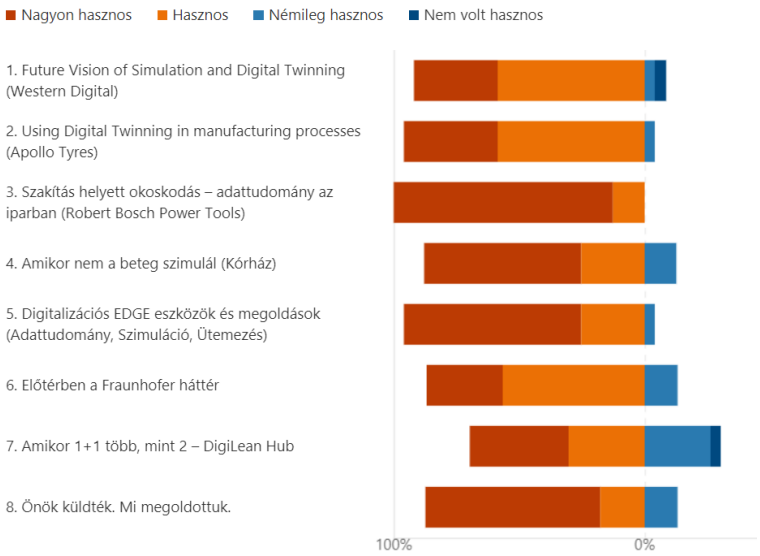


Figure 90. Results and feedback from participant (2)

4.12.9 Conclusion

The objectives of the Industrial Digitalization Technical Day have been achieved. The main characteristics and the importance of digital twins and simulation have been introduced and their ability for raising effectiveness was demonstrated.

Substantial industrial examples have been presented by foreign and Hungarian industrial experts as well as by the EPIC InnoLabs staff. As the speakers were professional users/developers of the technologies all ad hoc questions were answered; the solutions of the submitted industrial cases were also presented well.

The Technical Day was successful considering the number of participants as well; 158 persons have been registered and 98 participated.

The Technical Day results serve the experts of Innolabs as a very good starting point to extend their activities in introducing digital twin technology in new sectors of industry. DT can be applied in all industrial sectors and can become an important element of realizing circular economy.

First and last the Technical Day has reached its objectives and the immediate verbal feedback was definitely positive. A clear indication of the interest and high-quality content is that great number of the participants stayed at the networking and consultation part of the Technical Day having useful discussions with the speakers and each other. The installed robot demonstrations were interesting for the participants and generated questions on possible further robot applications.

Key outcomes include:

- Digital Twin is important new technology, but the industry needs help to introduce it in analysing their processes improving the production efficiency on different levels.
- DT applications need strong theoretical background, so having expert knowledge is basic need.
- Input data and data cleaning are important for the DT– false input data result specious results.
- The participants were convinced that with DT the effectiveness of manufacturing lines or transportation network can be significantly raised.
- The key benefit from implementing digital tools, techniques and technology seemed to be timesaving, followed by improved productivity and quality.
- Personal training and courses are the most efficient ways of up-skilling employees. Learning and training is the base for correctly use emerging technologies.
- The Technical Day was a good opportunity to reach out to large numbers of companies and spread the DT technology.

The participants were encouraged to continue the discussion in different channels.

4.12.9.1 Transferable results

The transferable results can be classified into two main groups:

- Skills: basic knowledge transfer of digital twin technology.
- Use cases: demonstration of different industrial use cases.

Transferable results in skills:

- In case of digital twin applications theoretical background and skills are crucial; skills came out as being one of the biggest enablers, but also one of the biggest barriers. This emphasises that

manufacturers have to be educated on the skills they need, where to find them, or even how to create them – from training etc…
- As a first step the cooperation between DT experts, consultants and engineers from industry have to be realised. The joint work gives additional capabilities for both partners and result good solutions.
- Theoretical and practical training courses (in person training and online courses) came out on top during the networking discussions. As manufacturers are constrained in time, they would prefer less time-consuming means, as opposed to long training days/courses.
- Barriers to employing skilled people and specific training aligned to digital manufacturing.

Transferable results in case of Use Cases:

- Most participants realized that digital twin technology can become a strategic driver giving competitive advantage by increasing efficiency of production and networking processes.
- The participants realised based on the case studies that the cooperation between DT experts, consultants and engineers from industry has of basic importance.
- The broad application fields/possibilities of DT demonstrated by the use cases generated new ideas in the participants – according to the discussions in the networking session.
- The importance of data handling, the preparation of reliable data sets for DT usage (e.g. collection, cleaning, integration, and grouping) was very well demonstrated in the use cases. These activities need professional data experts/analysers who are the key to reach good result.
- The attendants were very impressed by the very rich input/output tools of the simulation SWs, the graphical summary of results (that makes easy understandable the result also for not professionals).

4.12.9.2 Relevant Experiences

EPIC Innolabs has already experience in organizing technical days and workshops. At the Industrial Digitalization Technical Day the number of participant was higher as calculated (the registration has to be closed earlier as planned) that was a positive surprise.

- A registration webpage was simple but effective – only essential data needed from registrants.
- Marketing campaigns should begin earlier before the event and a calendar file should be attached to the registration confirmation mail.
- The closing section „Coffe, networking, consultation with the experts" was successful as the participants can have direct, free discussions with the speakers, experts and can exchange their ideas with each other as well.
- The questioner on the program structure and presentation quality brought useful results that can involve into the organisation of future/next Innolabs events.

4.12.9.3 Lessons Learnt

Attendees were interested in use-cases, which demonstrate real industrial applications of digital twin and simulation technology. These use-cases (or case studies) make the technology tangible to a broad spectrum of companies not only for manufacturers. Based on the participant opinions (section 8.2.2) a real industrial manufacturing case has the highest interesting rate.

It was positive that the use case presentations were shared by the DT experts and the engineers from the industrial partners. The participants could see the complexity of the problems, the role of experts and the need for substantial cooperation of the partners.

Use-cases demonstrated that SME's can apply effective the new technologies as well. In these cases the field of cooperation should be wider, but good results can be achieved.

Collecting participant's feedback is important. This feedback would allow the project partners to identify where they could make improvements to their respective events.

Further improvements can include:

- Inclusion of more theoretical part of digital twins besides example uses cases.
- Inviting industry speakers who apply already digital twin technology.
- Extending opportunity for discussion and brainstorming between speakers and participants.

4.13 Plant Simulation – Technical Workshop – 20/05/2022, EIL (HU)

4.13.1 Topics Addressed in the Workshop

	Topics adressed (X)
Trends, needs, challenges and barriers	
Successful use-cases	X
Cross-cutting Factors	X
Added Value and Business Models	
Interoperability and Standardisation	
Cybersecurity	
Industrial Agreement and Legal Aspects	
Humans in Manufacturing	X
Pathways	
Circular Economy	
Human Factors	X
Autonomous Smart Factories	
Hyperconnected Factories	
Collaborative Product-Service Factories	
Data Spaces	
Skills	

4.13.2 Executive Summary

The workshop was organized by the Enterprise Group Budapest and the EPIC InnoLabs, subsidiary of SZTAKI and the Fraunhofer - Gesellschaft. The goal of the technical workshop was the introduction of the Siemens process simulation software and its application possibilities through industrial examples and case studies.

Because of the timely fulfilment of the continuously changing demands and short deadlines the effective organisation of manufacturing and logistic processes became a key element. The simulation trials using the Plant Simulation software support the decisions for wide range solutions of digital manufacturing, to increase productivity, to reduce costs, and to achieve quality goals. The digital models of production systems (manufacturing lines, supporting- and storage systems) can be developed by the Plant Simulation software that can help the recognition, the analysis, and the optimization of processes.

Most of the participants came from different sectors of industry, from SMEs but from large companies as well. The main results of the workshop are the lessons learned from the industry-based demonstrations. These demos gave the participants good examples how they can operate more effective their own processes analysed with simulation applications.

The context of ConnectedFactories 2 and the workshop can be found in the effective use of simulation that is a dedicated technology in the digital transformation of manufacturing processes.

4.13.3 Introduction

The goal of the technical workshop was the introduction of the Siemens process simulation software and its application possibilities through industrial examples and case studies. The need for such a workshop originated from the industrial sector, different SMEs were interested in the possible application of simulation technology in production processes. The date of the workshop was on 20. May 2021 and was organized as an online workshop in MS Teams.

Because of the timely fulfilment of the continuously changing demands and short deadlines the effective organisation of manufacturing and logistic processes became a key element. The simulation trials using the Plant Simulation software support the decisions for wide range solutions of digital manufacturing, to increase productivity, to reduce costs, and to achieve quality goals. The digital models of production systems (manufacturing lines, supporting- and storage systems) can be developed by the Plant Simulation software that can help the recognition, the analysis, and the optimization of processes.

The increasing use of emerging technologies to simplify complex tasks has proved rewarding across every industry in diverse ways. This includes increased operational efficiency, automating manual tasks, training and validation, as well as data analysis. The integration of emerging technologies has brought the fourth industrial revolution, in which data analytics and automation are important components. The digital transformation of traditional processes is also another aspect of Industry 4.0 and, here, simulation and the digital twin play outstanding roles.

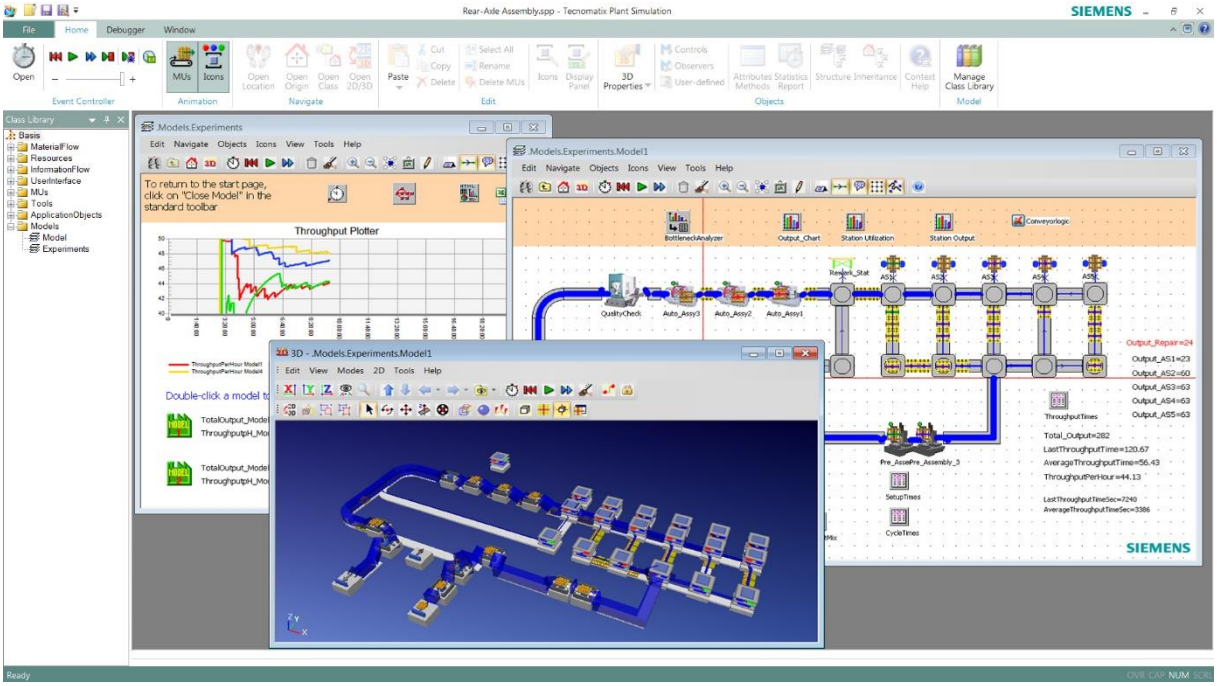


Figure 91. Plant Simulation & Throughput Optimization

Simulation refers to digital models that mirror the operations or processes within a system. Such simulations are used for analysing the performances of systems and the testing and implementation of new ideas. Engineers make use of simulations across a variety of industries to test products, systems, processes, and concepts.

Simulations include discrete event simulations, stochastic simulations, and deterministic simulations. In these types, the variables used in running the simulation are either known or random. To run simulations, some level of digitization is needed. This process may involve only mathematical concepts or the design of 2D or 3D models representing assets within a process or a product.

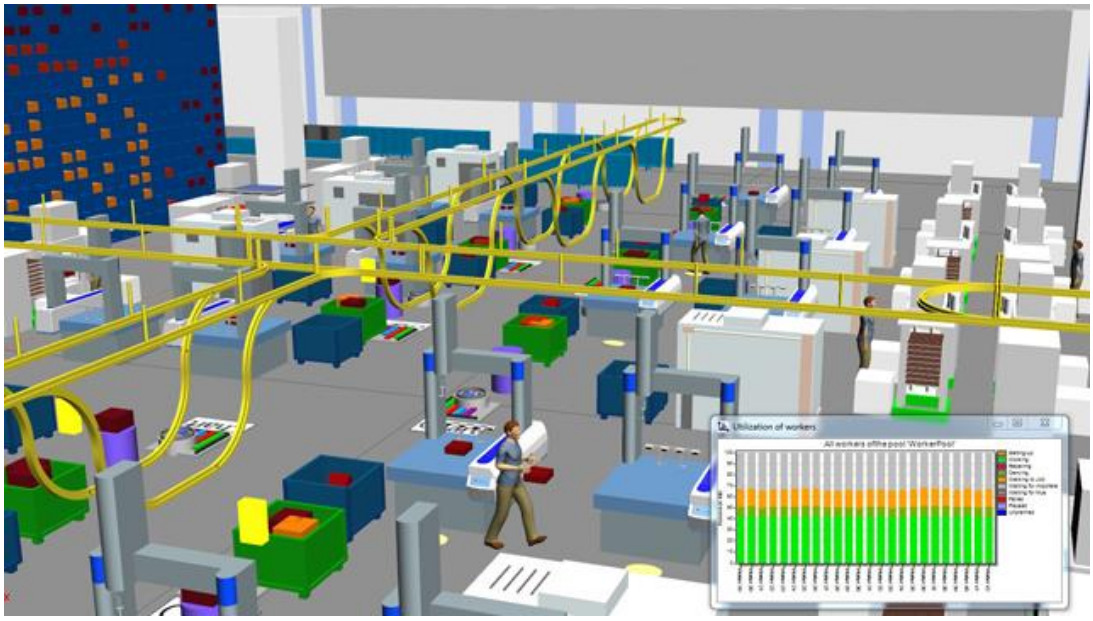


Figure 92. Analyze Production Systems with 2D and 3D Statistical Simulation

The Tecnomatix Plant Simulation application allows comparing complex production alternatives, including the immanent process logic, by means of computer simulations. Plant Simulation is used by individual production planners as well as by multi-national enterprises, primarily to strategically plan layout, control logic and dimensions of large, complex production investments

With the application of Plant Simulation companies can get effective help e.g. to

- Detect and show problems which might otherwise cause costs and time-intensive correction measures during the ramp-up phase.
- Reduce investment costs for production lines without endangering the required output quantities.
- Optimize the performance of existing production lines.

Using stochastic tools with object-oriented and 3D modelling capabilities, users can increase their manufacturing accuracy and efficiency while improving throughput and overall system performance. Powerful graphical visualization, charting and reporting features, genetic algorithms and experimentation tools enable the user to evaluate the behaviour of production systems in order to make fast, reliable manufacturing decisions. Plant Simulation models are used to streamline throughput, relieve bottlenecks and minimize work-in-process. Graphical outputs for automatic bottleneck detection, analysis of throughput, utilization of machines, resources and buffers

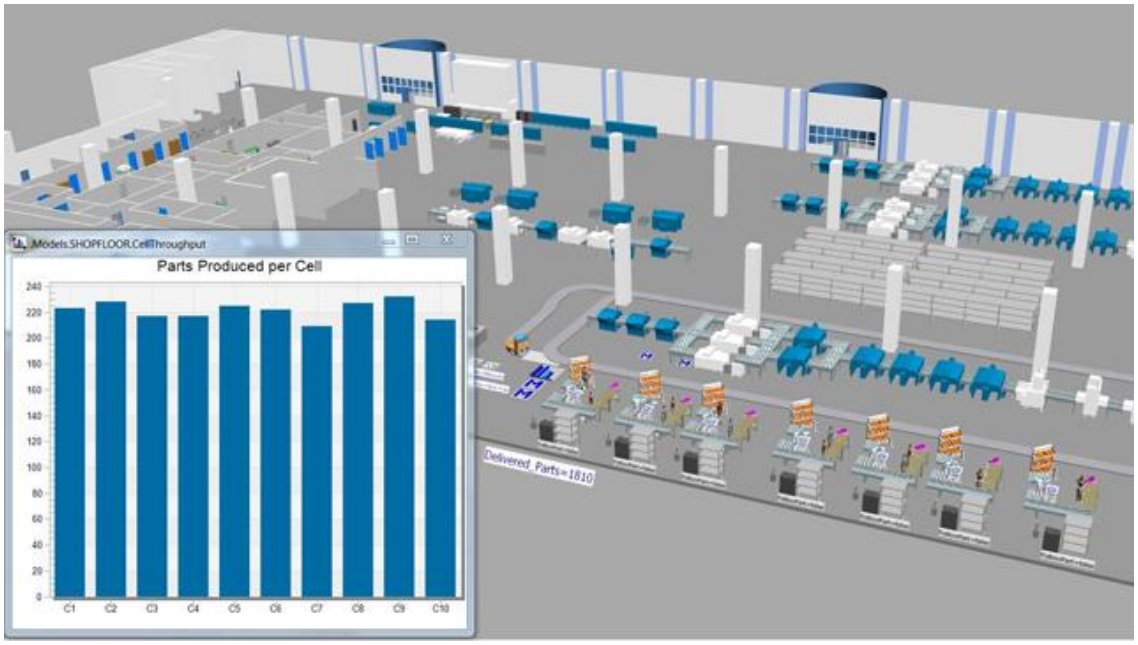


Figure 93. Eliminate Bottlenecks and Streamline Throughput

Most of the participants came from different sectors of industry, from SMEs but from large companies as well. The main results of the workshop are the lessons learned from the industry-based demonstrations. These demos gave the participants good examples how they can operate more effective their own processes analysed with simulation applications. The PS can be applied for the simulation of different types of systems as this have been demonstrated in the technical workshop.

4.13.4 Workshop Organization and Preparation

The organization of the workshop partially was processed through a blog on the internet. As the workshop was a national one, all communication and the presentations, case studies were processed in Hungarian.

So the call, the introduction and the presentations and use cases introduction were all in Hungarian. All materials are written in Hungarian as well. In the report only the key points of some presentations are introduced/translated into English.

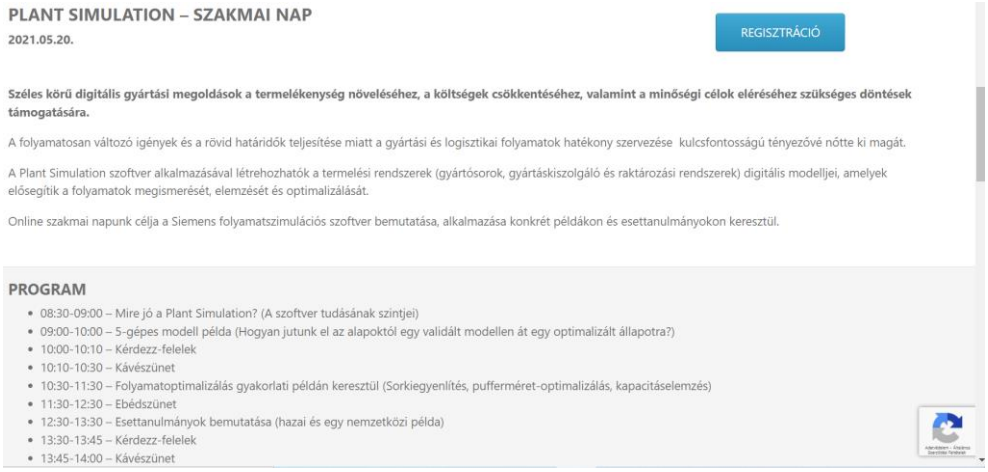
Table 3. Agenda of the simulation workshop

Hour	Topics
08:00	**Registration and Access to Workshop**
08:30	**Problems that can be solved by the Plant Simulation software (the levels of the SW)**
09:00	**Example of a 5 - machine model (How can we get from the basics through a validated model to an optimized status?)**
10:00	**Questions/answers**
10:10	**Coffee break**
10:30	**Process optimization based on a practical example (optimization of buffer size, capacity analysis)**
11:30	**Lunch break**
12:30	**Introduction of case studies (a Hungarian and an international example)**
13:30	**Questions/answers**

13:45	Coffee break
14:00	**You have submitted, we solve (Introduction of three examples submitted by the participants)**
14:45	**The EU Connected Factories cooperation – Applications and behind.**
15:00	**Feedbacks and closing remarks**



Figure 94. The entering screen of the call page of the simulation workshop



PLANT SIMULATION – SZAKMAI NAP

2021.05.20.

REGISZTRÁCIÓ

Széles körű digitális gyártási megoldások a termelékenység növeléséhez, a költségek csökkentéséhez, valamint a minőségi célok eléréséhez szükséges döntések támogatására.

A folyamatosan változó igények és a rövid határidők teljesítése miatt a gyártási és logisztikai folyamatok hatékony szervezése kulcsfontosságú tényezővé nőtte ki magát.

A Plant Simulation szoftver alkalmazásával létrehozhatók a termelési rendszerek (gyártósorok, gyártáskiszolgáló és raktározási rendszerek) digitális modelljei, amelyek elősegítik a folyamatok megismerését, elemzését és optimalizálását.

Online szakmai napunk célja a Siemens folyamatszimulációs szoftver bemutatása, alkalmazása konkrét példákon és esettanulmányokon keresztül.

PROGRAM

- 08:30-09:00 – Mire jó a Plant Simulation? (A szoftver tudásának szintjei)
- 09:00-10:00 – 5-gépes modell példa (Hogyan jutunk el az alapoktól egy validált modellen át egy optimalizált állapotra?)
- 10:00-10:10 – Kérdezz-felelek
- 10:10-10:30 – Kávészünet
- 10:30-11:30 – Folyamatoptimalizálás gyakorlati példán keresztül (Sorkiegyenlítés, pufferméret-optimalizálás, kapacitáselemzés)
- 11:30-12:30 – Ebédszünet
- 12:30-13:30 – Esettanulmányok bemutatása (hazai és egy nemzetközi példa)
- 13:30-13:45 – Kérdezz-felelek
- 13:45-14:00 – Kávészünet

Figure 95. The Call – giving the topic and the planned program



Figure 96. The registration form and the proposal for participation aspects

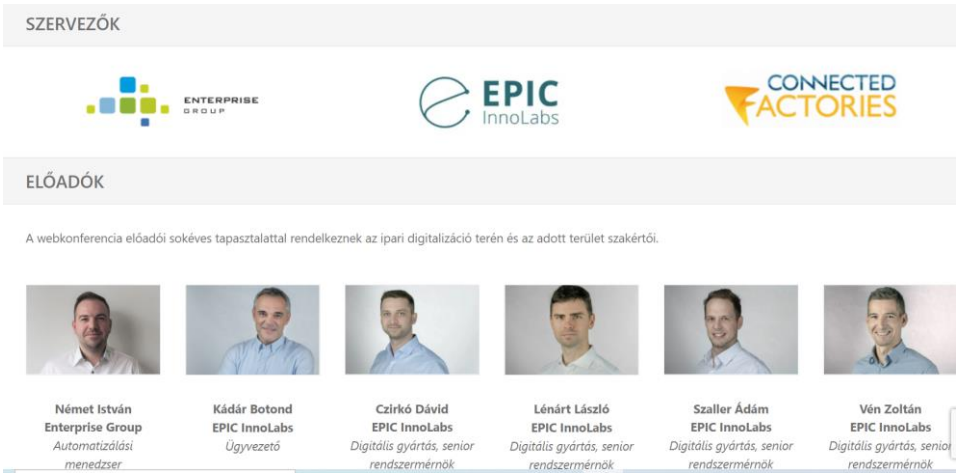


Figure 97. The list and photos of organizations and speakers

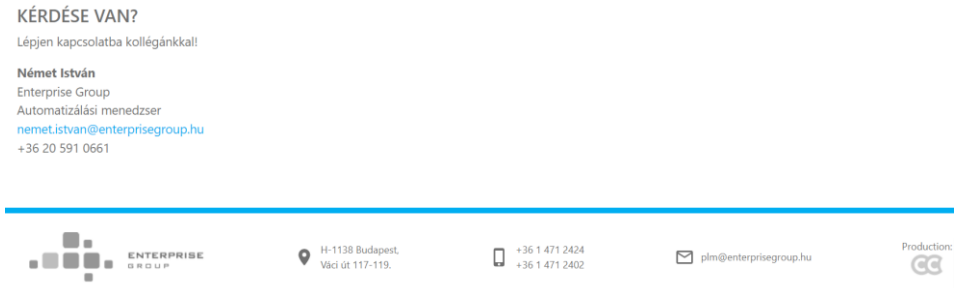


Figure 98. Contact person of the workshop

There was a possibility to send in problems to the organisers preliminary that could be solved at the workshop for the participants demonstrating the real possibilities of the software and the experts[28].

[28] https://blog.eplm.hu/wp-content/uploads/2021/05/PlantSim_SzakmaiNap_Feladat.pdf

ENTERPRISE GROUP

EPIC InnoLabs

Plant Simulation Szakmai Nap – Feladatkiírás

A szakmai nap fő célja, hogy megismertesse a résztvevőkkel a Plant Simulation szoftver széleskörű használati lehetőségeit. Véleményünk szerint ennek az egyik legjobb módja az, ha több, személyre szabott gyártási- és/vagy logisztikai folyamatokkal kapcsolatos probléma megoldását mutatjuk be.

Ezért kérnénk Önöket arra, hogy amennyiben van olyan múltbéli, aktuális vagy jövőbeli probléma, amelyet a jelenlegi folyamatelemzési és optimalizálási eszközeikkel, eljárásaikkal nehezen tudtak/tudnak megoldani annak komplexitása miatt, osszák meg velünk, mi pedig teszünk egy próbát erre szimulációval!

A beküldött feladatok közül 3-at választunk majd ki, és mutatjuk be röviden az elkészítés és megoldás menetét.

A feladat definiálásához kérjük használják a lentebb található irányelveket és adatigényeket. Az idő rövidsége miatt egyes feladatok esetében az egyszerűsítésére lehet szükség, de ezt igyekszünk minden esetben a fő célokat, elvárásokat figyelembe véve megtenni, fontos elemeket nem elhagyni.

Figure 99. The criteria of the invited task description

4.13.5 Case Studies Session

Table 16. List of Case Study Speakers

Name	Company	Position
Német István	Enterprise Group	Automation manager
Kádár Botond	EPIC InnoLabs	Managing Director
Czirkó Dávid	EPIC InnoLabs	senior system engineer
Lénárt László	EPIC InnoLabs	senior system engineer
Szaller Ádám	EPIC InnoLabs	senior system engineer
Vén Zoltán	EPIC InnoLabs	senior system engineer

4.13.5.1 Case Study 1. – Process optimisation

Process optimisation example: the goal was to analyse the given system, and then using these results to define the optimization possibilities. Simulation experiments were run with different input parameters to define the local optimum.



Figure 100. Process optimisation title slide

4.13.5.1.1 Introduction

- Product: Programmable Circuit Board (PCB)
- Automated and operator handled workstations
- Transportation of products by Work Piece Carriers (WPC)



Figure 101. The products on the production line

4.13.5.1.2 Additional information

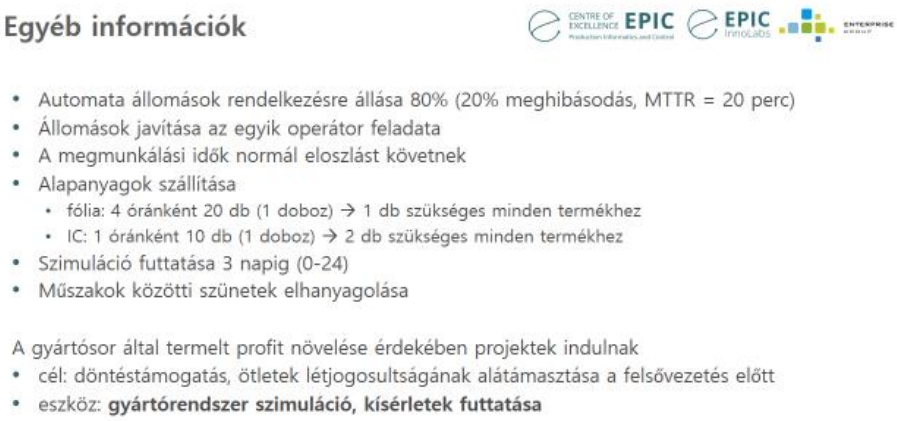


Figure 102. Additional information on production line

4.13.5.1.3 Definition of buffer capacities

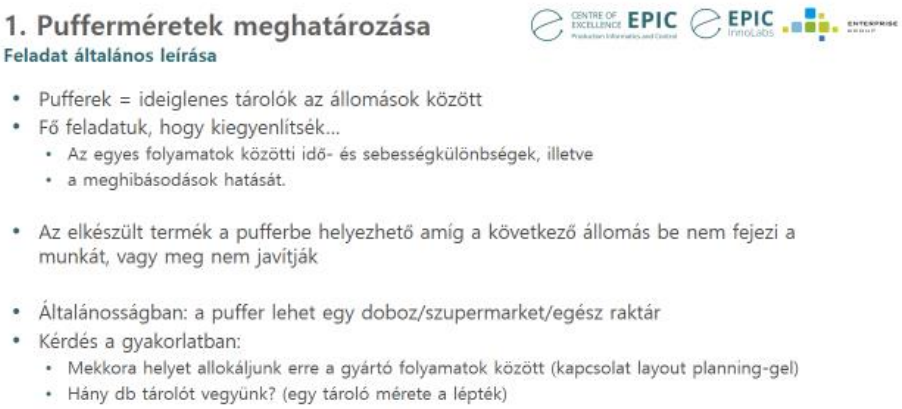


Figure 103. Definition of buffer capacities

4.13.5.1.4 Line balancing

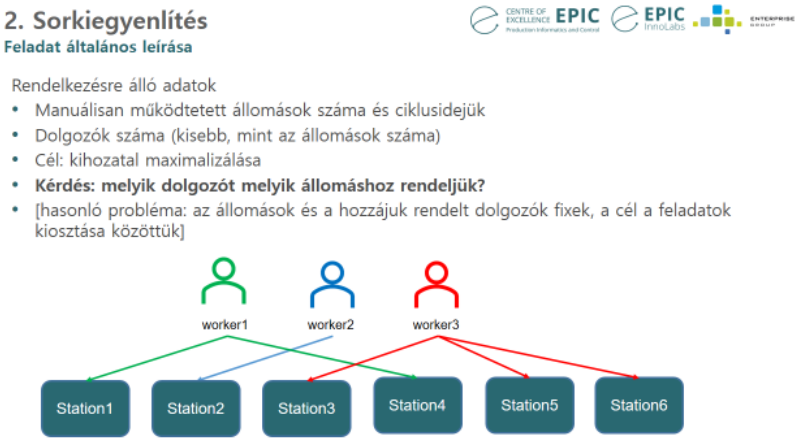


Figure 104. Line balancing

4.13.5.1.5 The simulation model

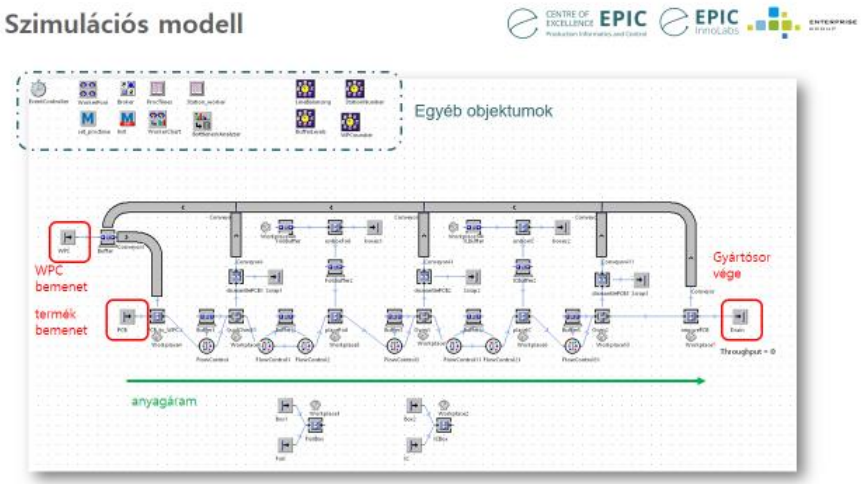


Figure 105. The simulation model

4.13.5.1.6 Stations

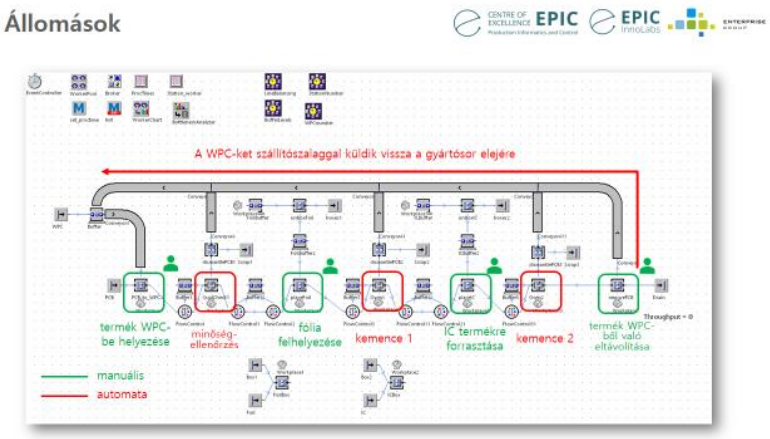


Figure 106. Stations of the simulation model

4.13.5.1.7 Quality check

Automated (red lines) and manual (green lines) tasks

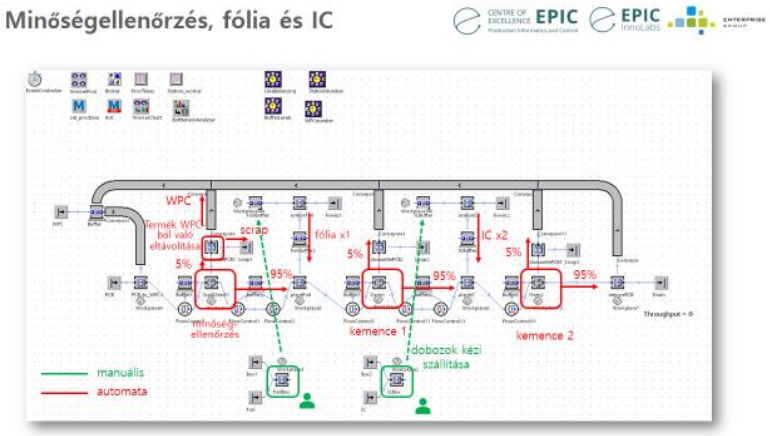


Figure 107. Quality check

4.13.5.1.8 Buffer analysis

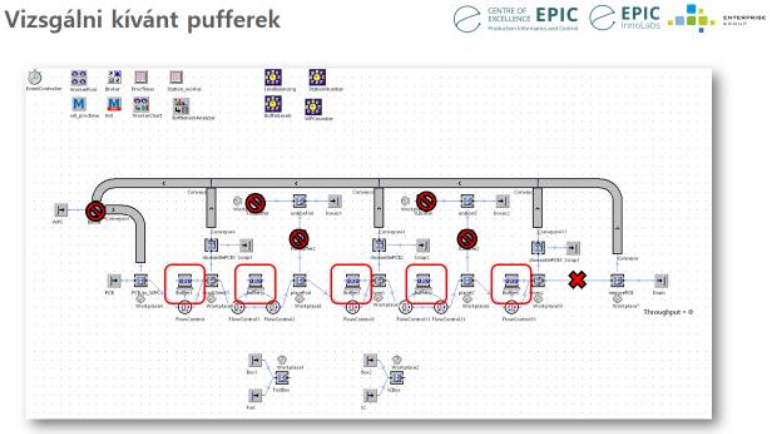


Figure 108. Buffer analysis

4.13.5.2 Case Study 2. – ARV fleet optimisation

4.13.5.2.1 Case studies by introducing real industrial projects – Material handling with ARV (Automated Robotic Vehicle = AGV + robot)

ARV fleet optimisation: with the modification of task distribution logic capacity increase, higher machine utilization and automation level have been achieved.



Figure 109. ARV fleet optimisation – title slide

4.13.5.2.2 Introduction

Goals of the simulation – analysis and optimisation of the system

- Raising capacity utilisation of machines
- Balancing the loading of ARVs
- Reducing the manual tasks

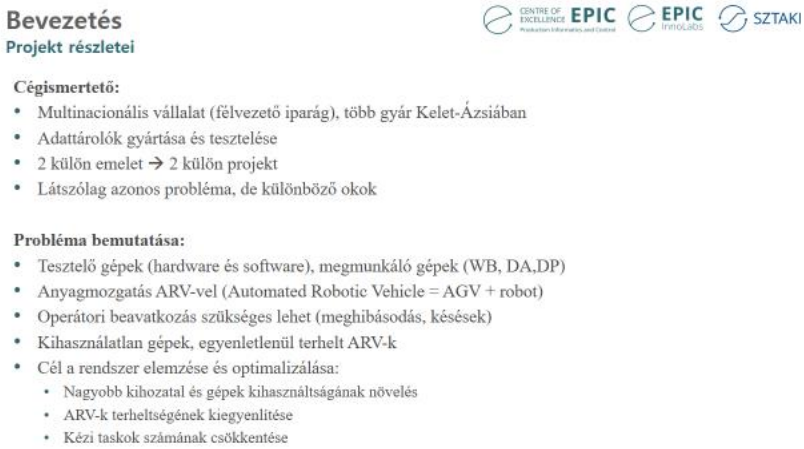


Figure 110. Project1 - Basic data of the system and introduction of the problem

4.13.5.2.3 Project 1. ARV routing simulation – Basic data

The components of the system and their layout

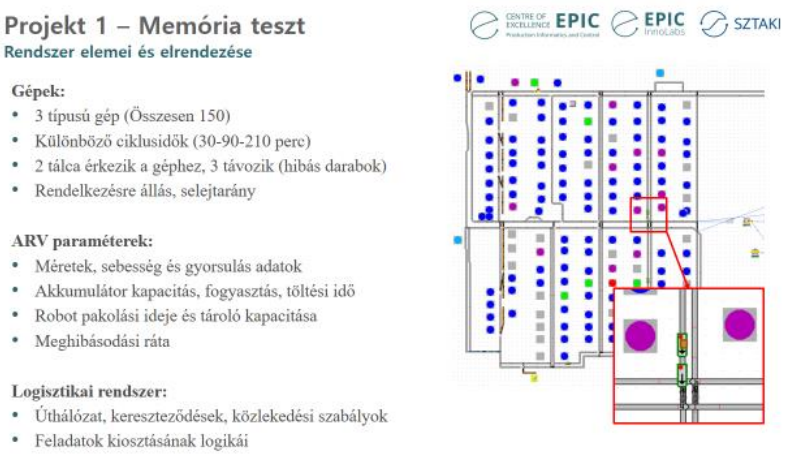


Figure 111. Project1 - System parameters

4.13.5.2.4 Project 1. – Results

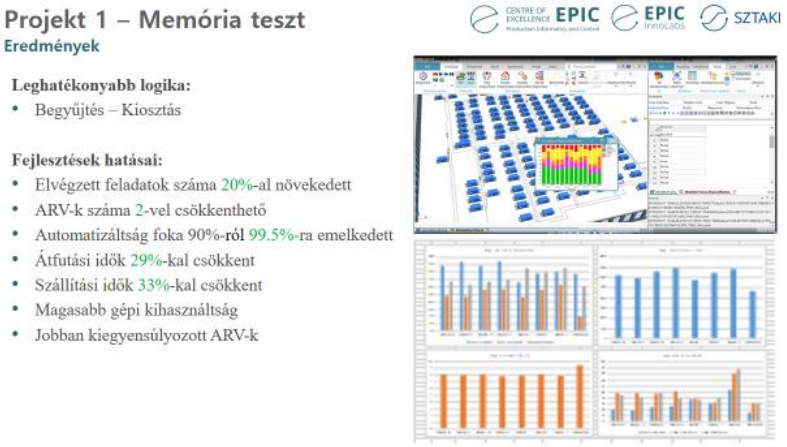


Figure 112. Project1 - Analysis of results

4.13.5.2.5 Project 2. – Layout analysis - Basic data

The components of system and their layout

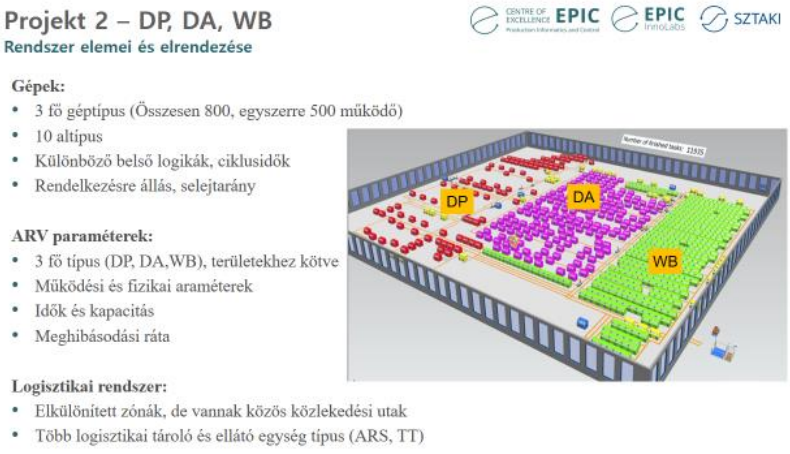


Figure 113. Project2 - Basic data of the system and introduction of the problem

4.13.5.2.6 Project 2. – Results 1

Proposals for layout modifications and the results

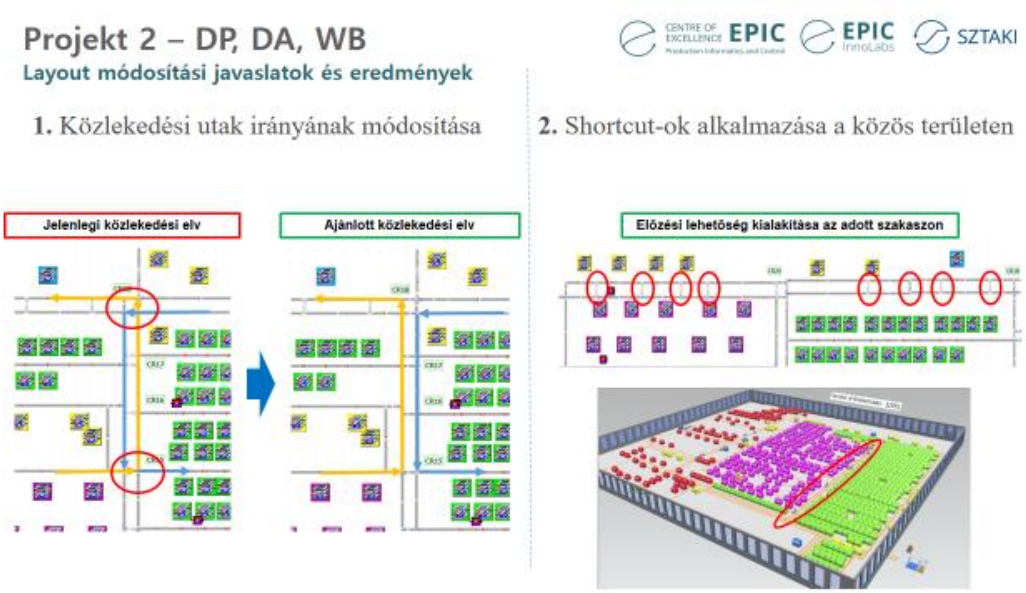


Figure 114. Project2 – Results 1

4.13.5.2.7 Project 2. – Results 2

- The completed tasks can grow with 20 %.
- The blocking of ARVs can decrease with an average of 20%.

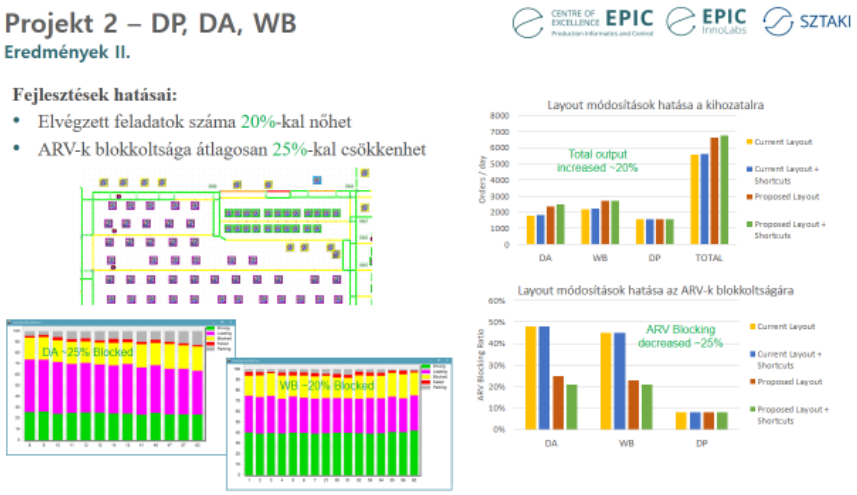


Figure 115. Project2 – Results 2

4.13.5.3 Case Study 3. – Hospital - Emergency Department Simulation

Accident Emergency Department Simulation

Hospital simulation: the modelling of emergency department has been done, then the bottlenecks (number of operating room, number of specialist per shift) have been analysed with different input parameters (big accident, high/low number of serious patients).



Figure 116. Accident Emergency Department Simulation – title slide

4.13.5.3.1 Goals of the analysis

Definition of the following parameters

- Architectural
  - Number of rooms
  - Capacities
  - Distances
- Organizational
  - Staff resources
  - Handling of extreme emergencies
- Services
  - Waiting times in check in
  - Rate of Service- and waiting times
  - Bottle necks, stops in diagnostic modularity

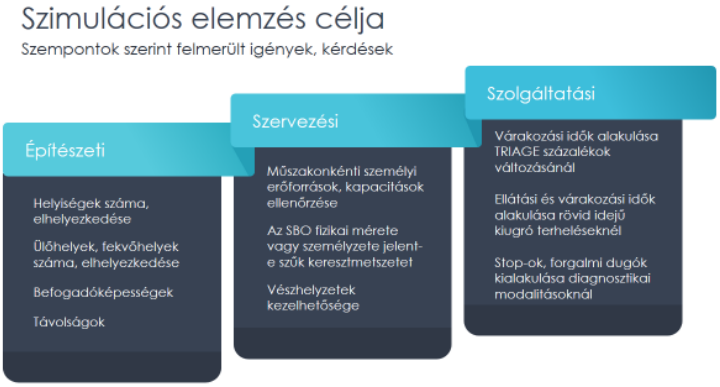


Figure 117. Goals of the simulation analysis

4.13.5.3.2 Arrival of patients

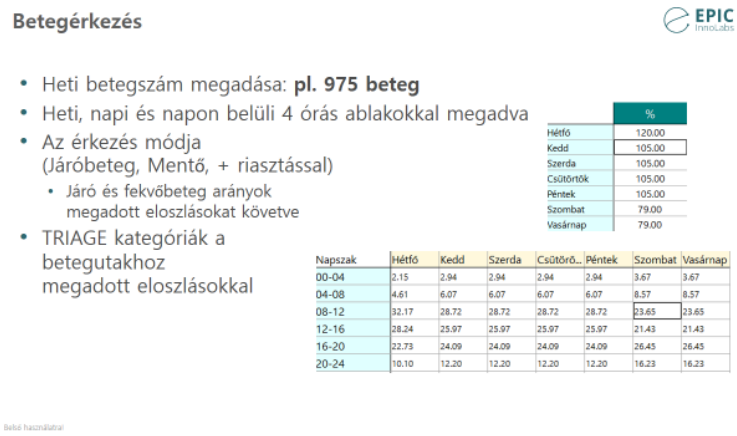


Figure 118. Arrival of patients

4.13.5.3.3 Patient routing and start frequencies

24 different routing and frequencies



Figure 119. Patient routing and start frequencies

4.13.5.3.4 Priorities

An electronic case sheet belongs to each patient containing all data and is updated continuously. The priority is defined at check in based on triage level and does not change in time.



Figure 120. Priorities

4.13.5.3.5 Example of a patient routing



scenario: újkeletű tadatzavar, féloldali gyengeség vérzéses stroke Gyakoriság:a neurológia tünetek 5- %-a				
ellátási művelet	helyszín	idő	személyzeti igény	eredmény
regisztráció	recepció	5		
triage	triage vizsgáló	5	Triage szakápoló	2-kategória
várakozás	"ágyas váróban" fekve			
VIZSGÁLAT	shocktalanító	15	orvos	fizikális vizsgálat , a panaszai nem szünnek gócjele van , laborvizsgálat
BLOOD SAMPLE	shocktalanító	5	ápoló	
LABORATORIUMI VIZSGÁLAT	shocktalanító	15-90	sürgősségi szakápoló	függ a labor típusától a szállítás módjától...a POCT preferált
CT angio VIZSGÁLAT	CT vizsgáló	30	radiológus	parallel leltezés ,CT-n vérzés
eredmény értékelése	adminisztratív helyiség	10	orvos	CT-n ischémia nagyér elzáródás látszik ,tünetei nem szünnek időablakon túl vagyunk
Neurológus konzilium	shocktalanító	10	neurológus	lízis nem jön szóba idegsebész bevonása
Idegsebész konzilium	shocktalanító	10	idegsebész	döntés műtétről,parallel szervezés indul
műtét szervezése előkészítés	shocktalanító	25	orvos ,aneszteziológus sürgősségi szakápolóparelel aneszteziológus bevonása	
eredmények kiértékelése	adminisztratív helyiség	10	sürgősségi orvos	áthelyezés műtőbe
MŰTÉT	Idegsebészeti műtőben	60-180	aneszteziológus idegsebész	ezután, kontoll labor,folyamatos monitorozás ,EKG,orvosi felügyelet
dokumentáció véglegesítése	adminisztratív helyiség	10	adminisztrátor, orvos	
Áthelyezés ITO-ra		10	orvos, ápoló	beteg ITOosztályra

Figure 121. Example of a patient routing

4.13.5.3.6 Description of staff

Basic types of staff – doctor, nurse, administrator.



Figure 122. Description of staff

4.13.5.3.7 Tracing of patients

The electronic case sheet of each patient are traced continuously and reported in the model.

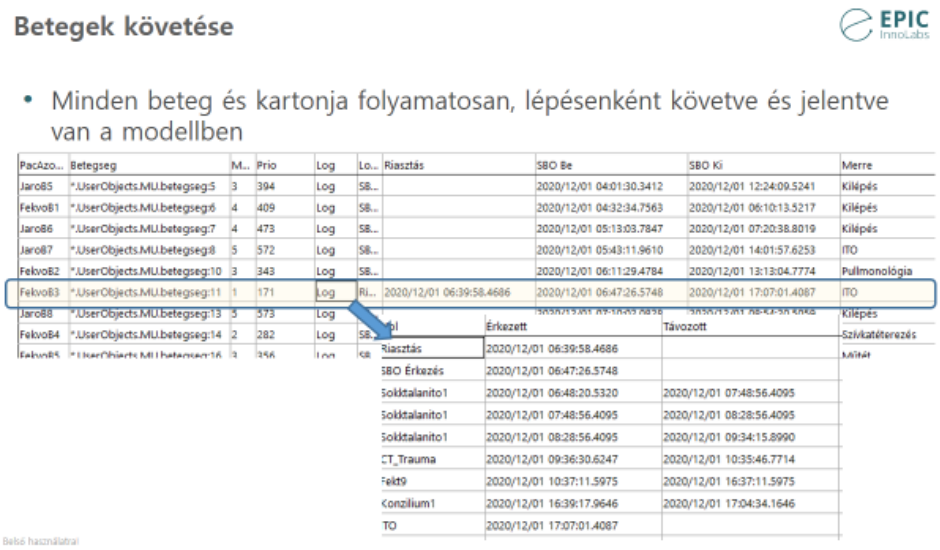


Figure 123. Simulation data sets - Tracing of patients

The simulation demonstration has been processed based on the above data sets.

4.13.6 Interactive Sessions

Example send by a participant: the participants have the possibility to submit a simple own problem, that has been solved and presented by Innolabs. The first, draft solution of such an example has been demonstrated and discussed at the workshop by all participants and also has forwarded for the management of the company. Based on the results a negotiation started on licence contract and a project is planned as well.

The workshop was very successful, many questions have been arrived in connection with the simulation solutions, e.g. from the following companies:

- Hirtenberger Hungary Kft.
- NAGÉV Rács Kft.
- ZF Hungária Kft.
- Delta-Tech Kft.
- BOS Automotive Product Bt.

The detailed answers will be sent to these firms including the materials of the presentations and case studies. The case studies introduced in the afternoon cannot be forwarded because of their sensitive data (as mentioned already during the presentation).

Some examples:

Questions

Q1: Only manufacturing processes can be modelled (question before hospital demo)

A1:-No, all types of processes can be modelled as logistical processes, hospital simulation,etc.

Q2:- How long is the lead time in case of a simulation project?

A2:- The lead time depends on the complexity of the project. An average project needs 1-3 months, in case of a more difficult case this time increases.

Q3: - What is the rate of international and national projects? How are motivated national companies in this field?

A3: -The rate is 50-50 % but this is increasing in Hungary, mainly in case of larger companies. In case of SMEs there is less resources and data availability that make more difficult launching projects.

Q4: - Is there possibility for trainings?

A4: - Yes, trainings can be organized according to the special needs of a company/SME.

4.13.7 Conclusion

The objectives of the technical workshop have been achieved. The main characteristics and the importance of simulation has been introduced in detail in the introductory presentation, which was followed by the EFFRA and Connected Factories 2 introduction.

Substantial industrial examples have been demonstrated and solved by the PLENT simulation application presented by the EPIC InnoLabs staff. As the speakers were professional users/developers of the SW package all ad hoc questions were answered; the solutions of the more complicated problems will be posted for the participants. The workshop was successful considering the number of participants as well; 44 persons have been registered, 32 participated and 30 from them continuously were connected to the presentations.

The workshop results served the experts of Innolabs as a very good starting point to extend their activities in introducing simulation technology in new sectors of industry. Simulation can be applied in all industrial sectors and can became an important element of realizing circular economy.

First and last the technical workshop has reached its objectives and the immediate verbal feedback was definitely positive. A clear indication of the interest and high-quality content is that more than 90% of the participants remained connected in the demonstrations till the end – and in case of an online workshop it is an outstanding and convincing result.

Key outcomes include:

- Simulation is in place, but the industry needs help to introduce it in analysing daily operation improving the production efficiency on the shop/factory floor.
- Input data important for the simulation – false input data result specious results
- The participants were convinced that with simulation the bottlenecks can be easily detected, the reconfiguration of the system can be designed, so the effectiveness of manufacturing lines (or any “production-like” or organizational process) can be significantly raised.
- The key benefit from implementing digital tools, techniques and technology seemed to be timesaving, followed by improved productivity and quality.
- According to the audience, personal training and online courses are the most efficient ways of up-skilling employees. Learning and training is the base for correctly use the simulation SWs.

- The workshop was a good opportunity to reach out to large numbers of SMEs and spread the simulation technology and forward information about the CF2 project.

After the workshop, the registered participants were encouraged to continue the discussion in different channels. The presentations and summaries of the group works were shared with the participants, and the organizers will facilitate the discussion further. The summaries of discussions were made and delivered to participants one week after the workshop as well as some answers for the questions.

4.13.7.1 Transferable results

The transferable results can be classified into two main groups:

- Skills: basic knowledge transfer of simulation technology.
- Use cases: demonstration of four different industrial use cases.

Transferable results in skills:

- In case of simulation experiment skills are crucial; skills came out as being one of the biggest enablers, but also one of the biggest barriers. This emphasises why we need to focus on a skills framework to educate manufacturers on the skills they need, where to find them, or even how to create them – from training etc…
- Training courses, short in person training and online courses came out on top during the interactive session. This suggests, manufacturers are constrained in time. Therefore, would prefer to digest information, through less time-consuming means, as opposed to long training days/courses.
- Typical challenge faced with implementing digital tools, templates and techniques – buying a simulation SW, invest in learning it (time factor) or bring the problem to a consultancy company to solve the problem within a relative short time.
- Barriers to employing skilled people and specific training aligned to digital manufacturing.

Transferable results in case of Use Cases:

- Most participants realized that simulation can become a strategic driver giving competitive advantage by increasing numerous production parameters based on an appropriate simulation model and the deep analysis of the results.
- The participants were astonished the broad application field/possibilities of simulation – the hospital use case was especially interesting for them.
- The users realized that data collection for simulation input is the key point of the simulation experiments, and also realized the difficulties of this task.
- The attendants were very impressed by the very rich input/output tools of the Plant Simulation SW, the 3D animations, the graphical summary of results (that makes easy understandable the result also for not professionals).

4.13.7.2 Relevant Experiences

EPIC Innolabs has already experience in organizing workshops but the big number of on-line participant was higher as calculated that was a positive surprise.

- A registration webpage was simple but effective – only essential data needed from registrants.

- Marketing campaigns should begin at least two weeks before the events and the calls should be intensified to twice a week including a reminder one or two days before the event to already registered participants.
- In case of an online workshop the log-in URL has to be circulated among participants one day before, providing the participant to test their IT infrastructure.
- General recommendations for the execution of a demo-oriented online workshop:
  - The general objectives should be as concise and realistic as possible,
  - The structure of the demos has to gradually introduce the possibilities of the presented SW.
  - The demos have to match the possibilities of the online communication platform (sharing videos, animation, etc.) to make effective and attractive the presentation.
  - Organizers should have a clear idea of the expected results and design the interactive session, Q/A accordingly (e.g. licencing the demonstrated SW).

4.13.7.3 Lessons Learnt

Attendees were interested in use-cases, which demonstrate real industrial applications of simulation technology. These use-cases (or case studies) make the technology tangible to a broad spectrum of companies not only for manufacturers. Use-cases are more powerful if they involve SME's embedding the technology. A successful route to obtaining use-cases is through digital technology providers who can present specific projects where they have helped manufacturers.

The conclusion is around the importance of collecting participant's feedback. Collecting feedback would allow the project partner to identify where they could make improvements to their respective workshops.

Further improvements can include:

• Inclusion of more theoretical part of simulation besides example uses cases.

• Inviting industry speakers who apply already simulation technology.

• More opportunity for discussion and brainstorming.

• Greater emphasis on event promotion to reach more (relevant) attendees.

4.14 Cybersecurity, essential in your path to the digital factory – 25/05/2022, SIRRIS (BE)

4.14.1 Topics Addressed in the Workshop

	Topics adressed (X)
Trends, needs, challenges and barriers	**X**
Successful use-cases	**X**
Cross-cutting Factors	
Added Value and Business Models	
Interoperability and Standardisation	
Cybersecurity	**X**
Industrial Agreement and Legal Aspects	
Humans in Manufacturing	
Pathways	
Circular Economy	
Human Factors	
Autonomous Smart Factories	
Hyperconnected Factories	
Collaborative Product-Service Factories	
Data Spaces	
Skills	

4.14.2 Executive Summary

The workshop "Cybersecurity, essentieel in uw weg naar de digitale fabriek", was organised on 25th of May 2022 as an online workshop with a duration of 3 hours. The agenda included an introduction on Connected Factories, two keynote presentations and an interactive session. 13 participants from 10 different organisations/companies registered. They came from companies, the Belgian sector federation of manufacturing industry, the European association promoting innovative production technologies and research institutes.

The aims of the workshop were to:

- promote the ConnectedFactories project and its resources
- provide the participants a first guideline on how to secure manufacturing processes
- present lessons learned from a manufacturing company that recovered successfully from a cyber attack
- have a discussion among all participants on developing a Risk Based Cybersecurity strategy

4.14.3 Introduction

This report describes the execution of the workshop "Cybersecurity, essential on your path toward the digital factory", organised by Sirris on 25th May 2022. The topics addressed in the workshop were Cybersecurity as cross-cutting factor, successful use-case, and trends, needs, challenges and barriers in the implementation of cybersecurity. The workshop was conducted in Dutch and one keynote in English.
Compared to the number of invited people from companies the number of participants was rather small, but all participants were participating actively in the discussions and interested in topics.

The main objective of the workshop was to improve the awareness of the importance of setting up a cybersecure environment in a manufacturing company.
A seven-step plan towards cyber resilience was presented as a first aid for companies who still have to take the first steps but don't know exactly how to start. It was illustrated by a concrete use case at company that suffered from a cyber-attack and what measures they have taken to recover from it and to become more resilient to it in the future.
During an interactive session participants gained insights that a 100% secure environment is not possible but what are the axes that are usually not thought enough about when it comes to make your environment cyber secure. Several opportunities were presented at the end of the workshop on how to be getting started in practice and how to get a deeper knowledge on the topic. The agenda for the workshop is presented in the table below.

Table 17: Agenda

Hour	Topics
09:00	**Welcome and introduction Connected Factories 2** Filiep Vincent, Sirris Chris Decubber, EFFRA
09:30	**Keynote 1: 5 steps to secure connected manufacturing** Tatiana Galibus, Sirris
10:05	**Keynote 2: Securing an ICS-network, lessons learned from a 'cyber-attack'** Bart Lagast, Picanol
10:40	**Break**
10:50	**Interactive session: 'How much do you have to invest in cybersecurity?'** Patrick Coomans, Agoria
11:50	**Wrap-up and next-steps** Filiep Vincent, Sirris
12:00	**End**

4.14.4 Workshop Preparation and CF2 presentation

4.14.4.1 Workshop preparation and promotion

The workshop was promoted to Belgian manufacturing industry through several communication channels:
Via Sirris website:
All events are published in three languages (Dutch, French and English) on the Sirris website.

- https://www.sirris.be/nl/agenda/webinar-cyberveiligheid-essentieel-uw-weg-naar-de-digitale-fabriek
- https://www.sirris.be/fr/agenda/webinaire-cybersecurite-essentielle-pour-votre-progression-vers-lusine-numerique
- https://www.sirris.be/agenda/webinar-cybersecurity-essential-your-path-toward-digital-factory

Via EFFRA website:
https://www.effra.eu/events/webinar-cybersecurity-essential-your-path-toward-digital-factory
Via LinkedIn:

- https://www.linkedin.com/posts/sirris_cybermonday-sirris-cybersecurity-activity-6931937068583419905-fQo0?utm_source=linkedin_share&utm_medium=member_desktop_web

- https://www.linkedin.com/events/webinar-cybersecurity-essential6931937065949380609/

Via two Sirris direct mailings:

- On 13/05/2022
- On 19/05/2022

Hereafter follow the screenshots of the different communication channels.
The workshop was organised with the online Zoom platform. The speakers shared their screen to show the presentation slides and to write down answers during the interactive session.

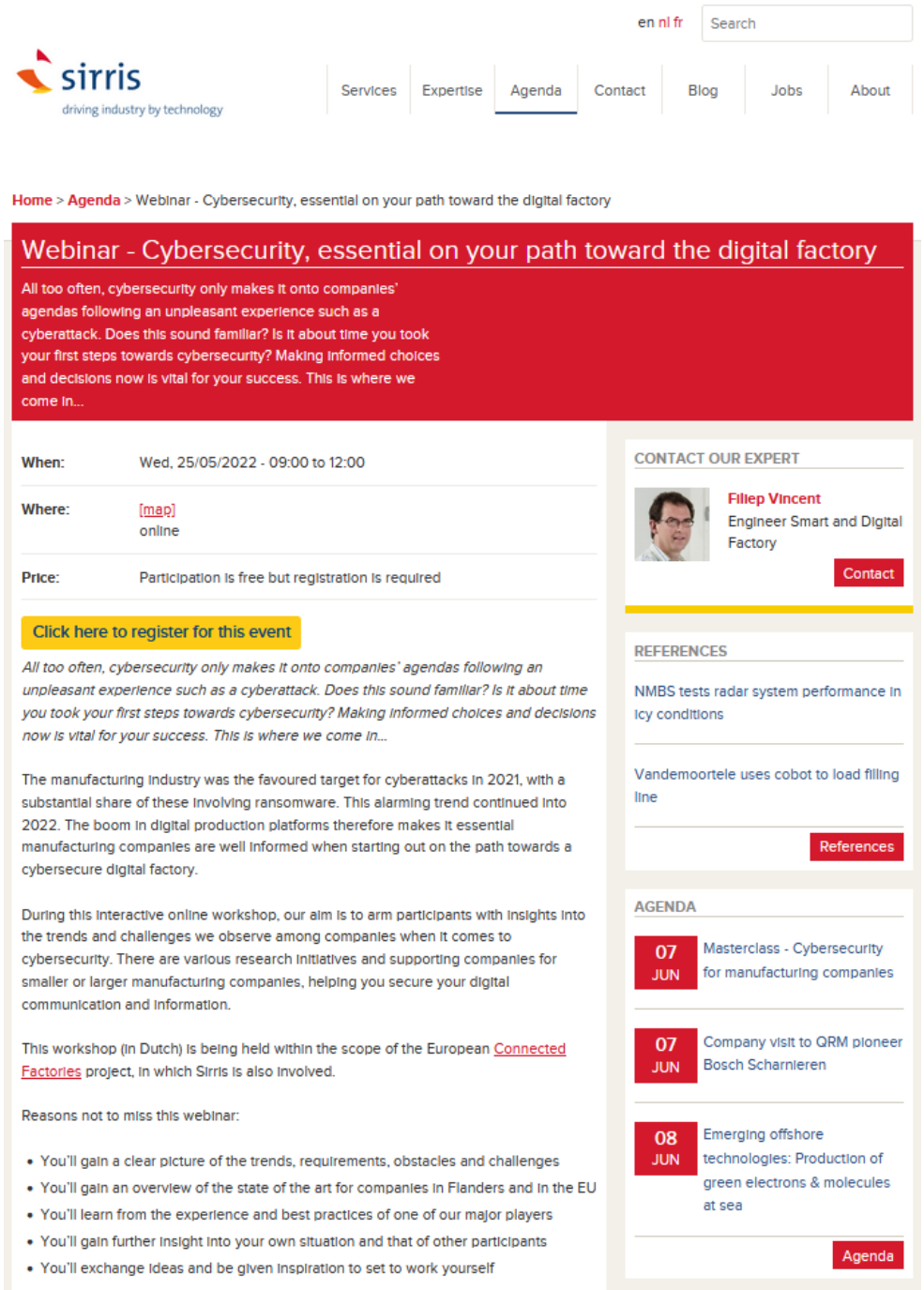


Figure 124. Invitation to workshop

Programme

09:00 Welcome and introduction Connected Factories 2, Filiep Vincent - Sirris and Chris Decubber - EFFRA

09:30 Keynote speeches

5 steps to secure connected manufacturing (Sirris, Tatiana Galibus)

Securing an ICS-network, lessons learned from a 'cyber-attack' (Picanol, Bart Lagast)

10:40 Break

10:50 Interactive session:

How much do you have to invest in cybersecurity? (Patrick Coomans, Agoria)

11:50 Wrap-up and next steps, Sirris and Agoria

11:55 End

For whom?

This webinar is intended for anyone from the manufacturing industry who wants to find out why embracing cybersecurity is important, and who wants to learn how best to approach cybersecurity.

The Connected Factories project is supported by the European Horizon 2020 European research and innovation programme.

CONNECTED FACTORIES

About ConnectedFactories

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreements No 723777 (ConnectedFactories1) and 873086 (ConnectedFactories2) under the Factories of the Future PPP.

Partners:

.AGORIA

Figure 125. Sirris website workshop announcement

EFFRA
EUROPEAN FACTORIES OF THE FUTURE RESEARCH ASSOCIATION

HOME ABOUT MADE IN EUROPE PORTAL STIMULATING INNOVATION

Home › Events › Webinar - Cybersecurity, essential on your path toward the digital factory

EFFRA

25.05.2022 0

Share



Webinar - Cybersecurity, essential on your path toward the digital factory

REGISTER HERE

25 May 2022 - 9 am until 12 pm

The manufacturing industry was the favoured target for cyberattacks in 2021, with a substantial share of these involving ransomware. This alarming trend continued into 2022. The boom in digital production platforms, therefore, makes it essential manufacturing companies are well informed when starting out on the path towards a cyber secure digital factory.

During this interactive online workshop, our aim is to arm participants with insights into the trends and challenges we observe among companies when it comes to cybersecurity. There are various research initiatives and supporting companies for smaller or larger manufacturing companies, helping you secure your digital communication and information.

This workshop **(in Dutch)** is being held within the scope of the European Connected Factories project, in which Sirris is also involved.

Figure 126. invitation through the EFFRA portal

Programme

09:00 Welcome and introduction Connected Factories 2, Filiep Vincent - Sirris and Chris Decubber - EFFRA

09:30 Keynote speeches

5 steps to secure connected manufacturing (Sirris, Tatiana Galibus)

Securing an ICS-network, lessons learned from a 'cyber-attack' (Picanol, Bart Lagast)

10:40 Break

10:50 Interactive session:

How much do you have to invest in cybersecurity? (Patrick Coomans, Agoria)

11:50 Wrap-up and next steps, Sirris and Agoria

11:55 End

Figure 127. EFFRA website workshop announcement

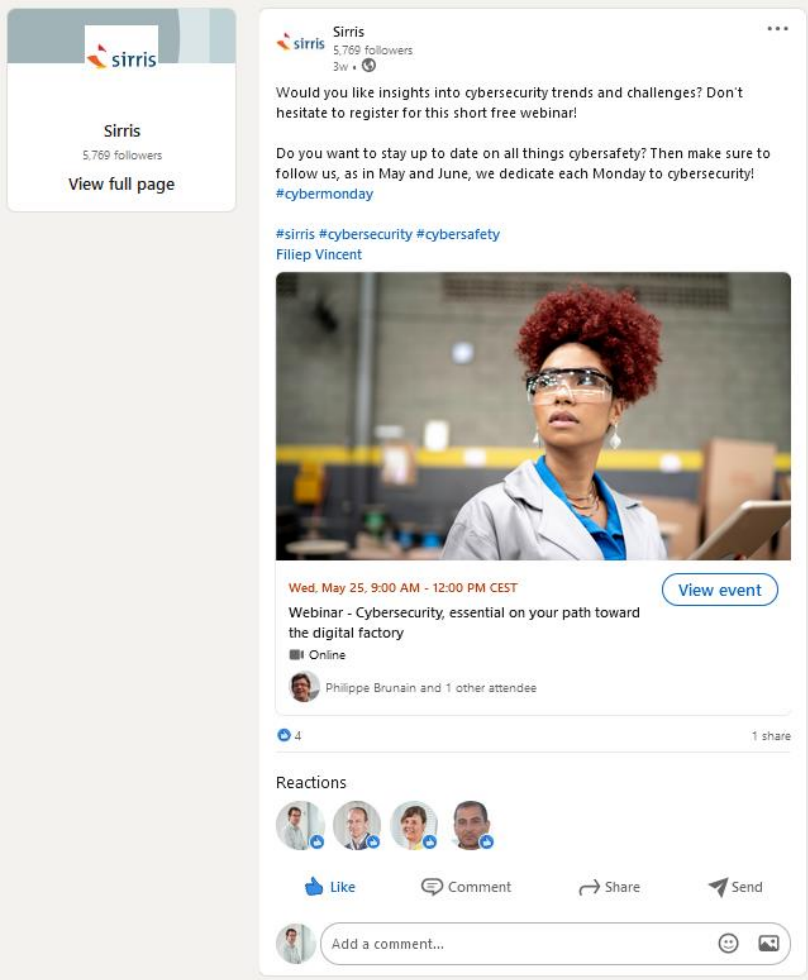


Figure 128. LinkedIn workshop announcement

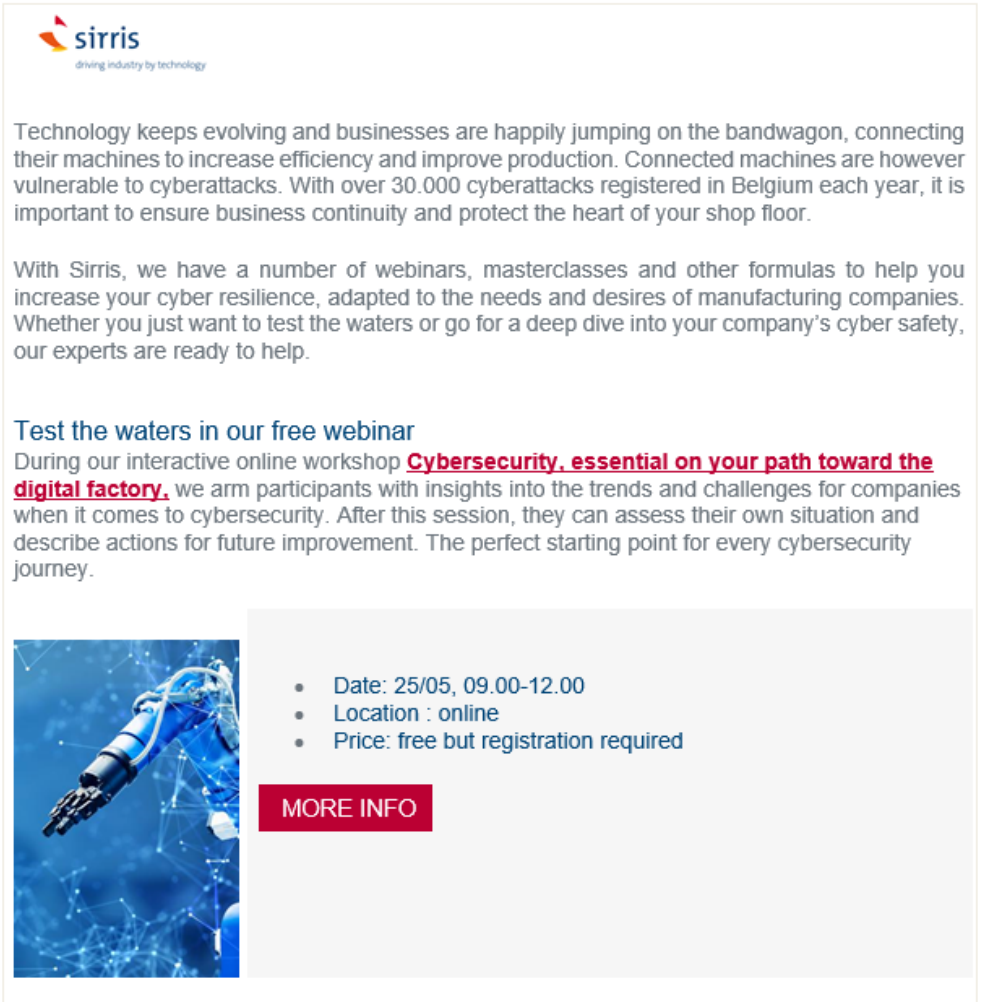


Figure 129. Sirris direct mailing

4.14.5 CF2 presentation and workshop introduction

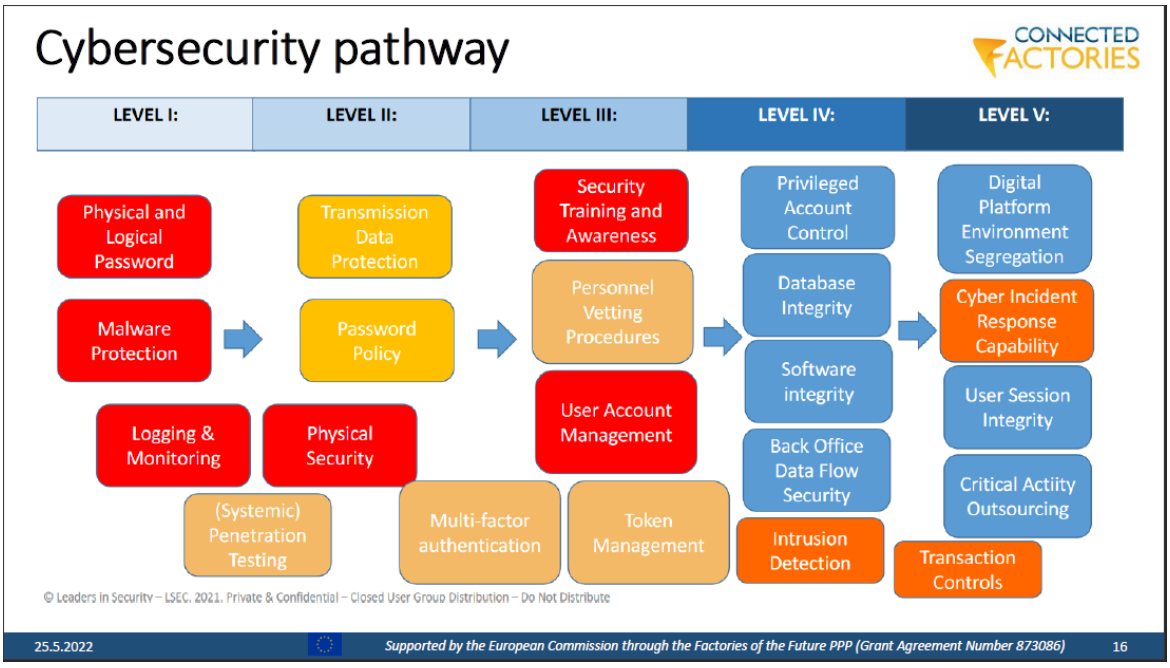
The workshop started with a brief introduction of Sirris and the goal of the workshop. As most of the audience was new to Connected Factories it was important to introduce the project and its aims, to set the scene for the rest of the workshop. Chris Decubber from EFFRA was the presenter. Available results from previous workshops and some published use cases were presented.



(1) Case catalogue



(2) Consortium Introduction



(3) Description of the Cybersecurity pathway

Figure 130: Introductory presentation to the workshop and CF2

4.14.6 Keynote Speakers Session

4.14.6.1 Keynote Speaker 1: 5 steps to secure connected manufacturing

The first keynote was delivered by Tatiana Galibus, Cybersecurity ambassador at Sirris. She presented seven topics to consider in the road to cyber secure manufacturing. (Although the title mentions 5 steps). NIS 2.0 was briefly mentioned and a number of ways how companies can get support and possibly financial aids from Flemish government (www.vlaio.be/cybersecurity) were presented at the end.

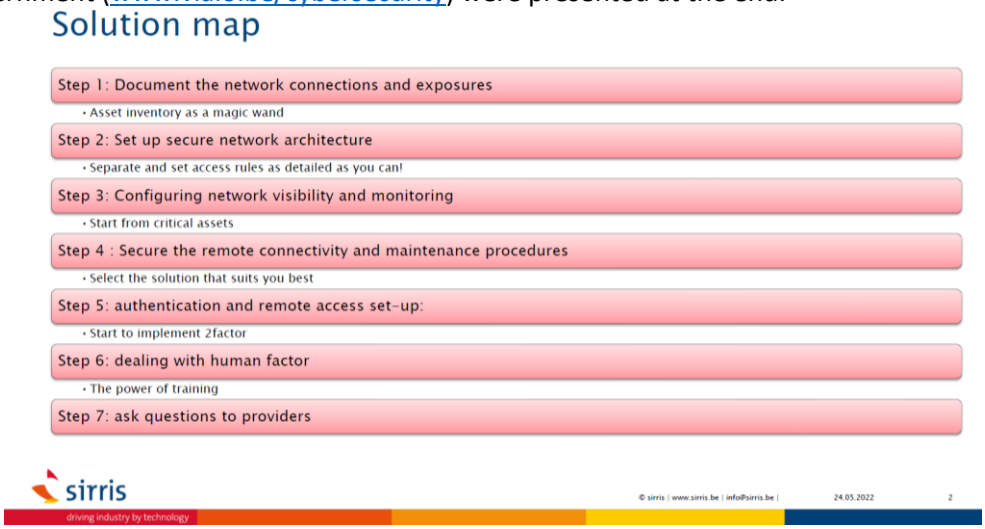


Figure 131: Keynote 1 7 steps towards cyber security



Figure 132: Keynote 1 Available support at Sirris/Agoria for companies

4.14.6.2 Keynote Speaker 2: Securing an ICS-network, lessons learned from a 'cyber-attack'

The second keynote was given by Bart Lagast, Senior system engineer at the Picanol Group. He presented the timeline (kill chain) of the events that happened before and during the crypto locking was active in January 2020. Afterwards he presented the new design principles for the IT network structure.

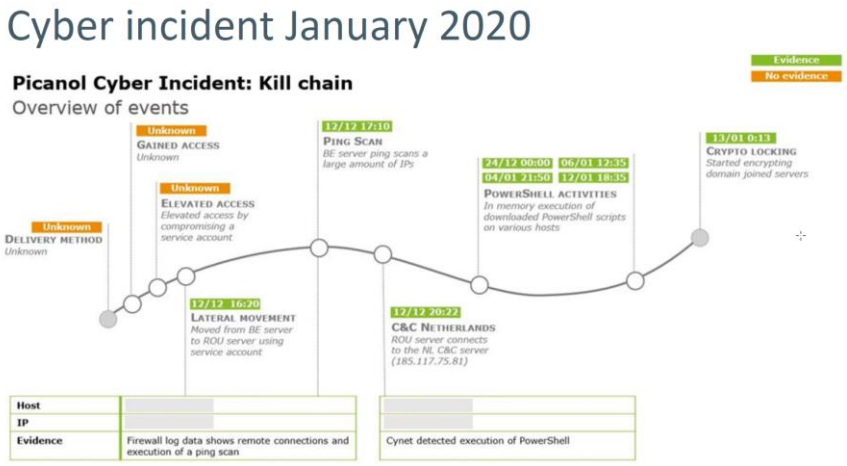


Figure 133: Keynote 2 Kill chain from cyber incident

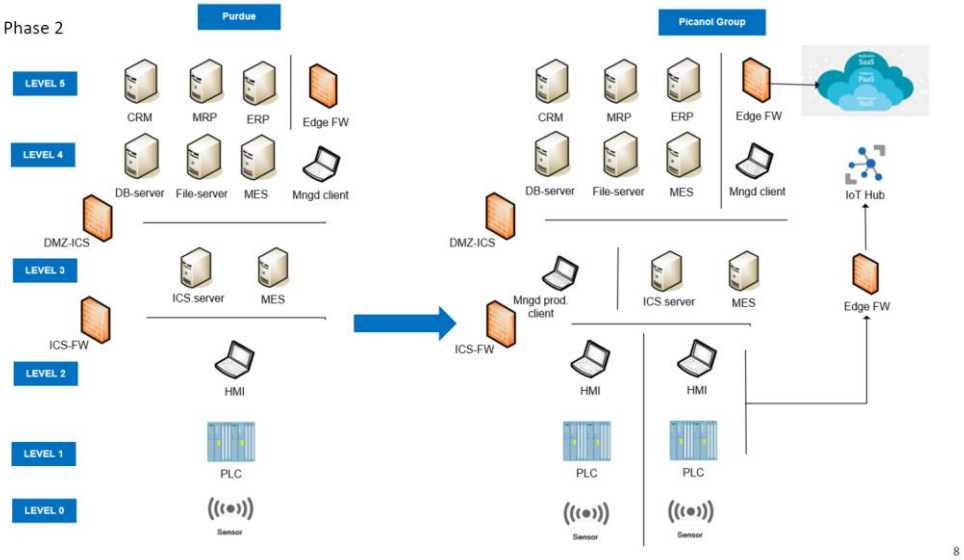


Figure 134: Keynote 2 new IT network structure

4.14.7 Interactive Session: How much do you have to invest in cybersecurity?

The second part of the workshop was an interactive session facilitated by Patrick Coomans, expert Cybersecurity Innovation & Entrepreneurship at Agoria.

The base for this session was an often-heard question “How much should we spend on cybersecurity?” Starting from a picture to scope and use case a typical situation in manufacturing the question to each of the participants was to mention everything you can think of to warrant its cybersecurity. The answers were written down in an Excel list and then checked at the end of the session to see how they fit in the 3-dimensional cube of cybersecurity.

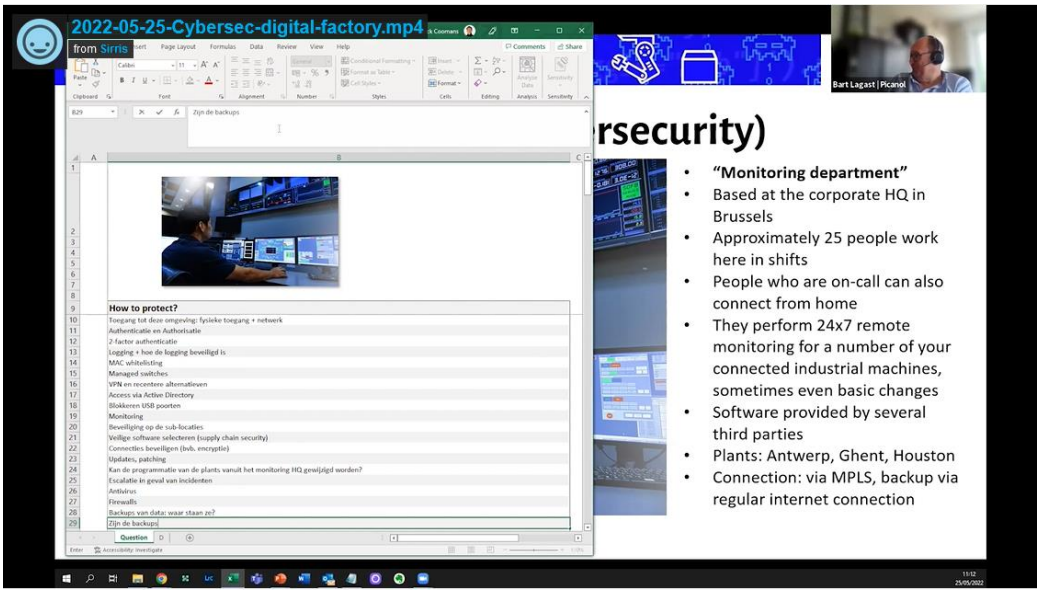


Figure 135: Interactive session building the list at the beginning of the session

Five basic questions were answered to build the foundation of cybersecurity:

1. What is (the scope of) "cybersecurity"?
2. What does cybersecurity (have to) warrant?
3. How are we being attacked? And what are corresponding functions of cybersecurity at the highest level of abstraction?
4. How are these functions of cybersecurity put into practice?
5. Can you do everything, can you be 100% cyber safe? How much should you spend?

The presenter busted two myths:

- Hacking is difficult → This is generally extremely easy, and the supply side ecosystem is working very well
- One single click can bring down the whole company → A successful attack is typically a demonstration that controls at every single layer failed.

To get an overall view it is good to define the 3 dimensions of cybersecurity:

Table 18. Three dimensions of cybersecurity

Dimension 1 (Z-axis): ***what to warrant?***	Dimension 2 (Y-axis): ***functions of CS***	Dimension 3 (X-axis): ***how to put in practice?***
• Confidentiality • Integrity • Availability	• Identify • Protect • Detect • Respond • Recover	• People • Process • Technology

When applying the answers from the participants in the beginning of the session (the same goes for results obtained in previous sessions) we observe that:

- most boxes stay empty.
- CS is till perceived as something purely technical
- Processes, procedures, governance, contracts, policies, training, culture,.. are seldomly mentioned
- Cybersecurity cannot be outsourced, only some of its functions can
- But: you can never tick ALL the boxes, so where to start?

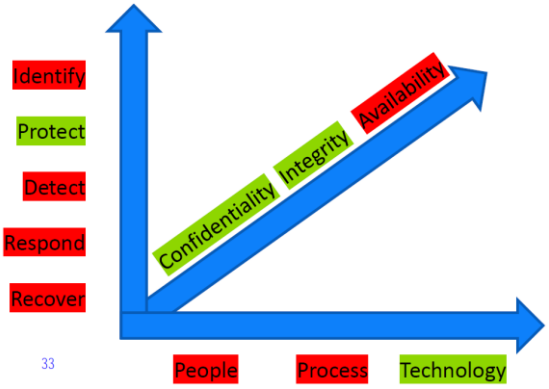


Figure 136: Three dimensions of CS

Since a company cannot do everything, it has to setup a ***"risk-based CS strategy"***.
Most important to start with is know what you have. Combine a top-down approach with a bottom-up approach and lateral exercises. The next step is to build a plan, step by step!

4.14.8 Conclusion

The following section includes an overview of the results and description of the engagement strategy after the workshop.

4.14.8.1 Transferable results

The workshop focussed on the pathway of cybersecurity.
The main focus was to increase the awareness of cybersecurity for the participants and to present them what are possible next steps for them to take and how they can be supported in that journey (via research institutes, commercial CS service providers, financial aids via government, etc.).
A challenge is that companies often do not have an idea on how to get started with a plan for cybersecurity. So it was good to present a structured way of working to set up such a plan with the different aspects to consider.
Also, big companies like the Picanol Group only started to elaborate such a plan after they had a cyber-attack and the implementation is still on-going. This successful use-case made it for the participants very concrete.
Cybersecurity is not only about technology.
Since not all risks can be addressed and budgets are limited, a risk-based cybersecurity strategy has to be set up and preferably before you experience some kind of cyber-attack. Better starting with this today then waiting till tomorrow.

4.14.8.2 Lessons learnt

Starting to promote the event six of more weeks would have been better to attract more participants. But it is a fact that after covid there are a lot of physical events that take place again and people from companies have to choose on what events they participate.

4.15 Digital twin: Expert panel on interoperability, standards, and challenges – 10/06/2022, F-IPA/S2i (DE)

4.15.1 Topics Addressed in the Workshop

	Topics addressed
Trends, needs, challenges and barriers	X
Successful use-cases	X
Cross-cutting Factors	
Added Value and Business Models	
Interoperability and Standardisation	X
Cybersecurity	
Industrial Agreement and Legal Aspects	
Humans in Manufacturing	
Pathways	
Circular Economy	
Human Factors	
Autonomous Smart Factories	
Hyperconnected Factories	
Collaborative Product-Service Factories	
Data Spaces	
Skills	

4.15.2 Executive Summary

The following report presents the development of the workshop *Expert panel on interoperability, standards, and challenges* organized by Fraunhofer IPA and Steinbeis 2i GmbH in the context of the ConnectedFactories 2 CSA.

The workshop aimed at (1) expanding and deepening the understanding of digital twins specially with regard interoperability and standardization; (2) exchanging ideas and concepts with experts in the field, and disseminate to SMEs first-hand learnings about the latest developments in these topics; (3) presenting technological solutions for interoperable models, e.g. Asset Administration Shell (AAS), and impacts and benefits for manufacturing companies; (4) specifying and discussing the current developments regarding standardization between the participating companies and transfer them into the current paths to digitalization of CF2.

The event achieved a consistent attendance of 40 people, which maintained throughout the duration of the event. Participants actively interact with the panellists and interest endured long after the planned running time of the workshop, i.e. the event lasted roughly 30 minutes longer than planned with 75% of the audience fully engaging.

Relevant outputs and results of the workshop discussions include:

- Current state:
  - Digital twins are fundamentally and operationally "accepted and arrived" in successful standardization processes, and thus in many settings ready for their industrial implementation.
  - The human remains in focus even within the digital twin.
  - Companies along their value chains can benefit tremendously from the digital twins' standards, which make the overall production processes much more efficient and reliable.
  - The AAS helps implementing digital twins for I4.0 and creating interoperability across the value chain participants.
  - The Industrial Digital Twin Association IDTA acts as a central point of contact for all interest groups. It provides the necessary specifications for interoperability and show how to integrate harmonised submodels into the big picture.
  - Currently IDTA initiated 27 successful projects for submodel development.
  - InterOpera is working closely with IDTA with the goal to implement 50 more submodels for digital interoperability in collaborative value networks.
  - Some concrete AAS submodels are being triggered by the newly promoted EU regulations and are now under development. For instance, the Digital Passport concept constitutes an opportunity for the AAS as an interoperability tool and paradigm.
  - There are several successive implementations of the AAS solutions. One of these is the Eclipse BaSyx, which is the open source Industry 4.0 middleware. The FabOS project is developing an open, distributed, real-time-capable and secure operating system for production that will be the IT backbone for the adaptable automation of the factory of the future and the foundation of an ecosystem for data-driven services and AI applications. Interoperability issues are also addressed by means of AAS.
  - The Reference Architecture Model Industry 4.0 (RAMI 4.0) and its innovative value proposition provides a considered a successful model case for the implementation of digital twins under a proper standardized platform and architecture. Such architectures are not only desirable, but also necessary for the industrial implementation of digital twins.
  - International convergence of IT/OT is key driver in standardization for the digital twin and is being currently addressed by two main players in standardisation: IEC TC 65 WG24 (application standards for AAS) and ISO/IEC JTC1/ SC41 WG6 and AG27 (basic standards for Industrial Internet of Thins and digital twin)
- Particular needs and future perspectives:
  - However, there is a global requirement of suitable and effective standards for the creation and operation of markets.
  - There is a need for integration of solo actors and stakeholders, such that the contribution to overall interoperability and standardisation efforts can be follow a coherent strategy.
  - It is fundamental to consider the scaling of the proposed measures and technologies. It is not enough to test digital twins in demonstrations that cannot clearly transfer into industrial settings, for neither technical nor financial reasons.
  - There is a current need to inform and show more concrete digital twin applications. Tools and trainings currently are available, and they are not abstract but practical, e.g. take a problem, take an example and change it to your case, try it out with an individual product.
  - This approach may galvanize the path to a wider and smoother adoption of digital twins through the foundations provided by standards and interoperability.

- An interesting future perspective might be given by the integration of blockchain, which may help identifying white spots, and complement interoperability particularly in the field of digital twins.
- Standardization of open source and committees operation and exchange should be accelerated but also become practice-oriented. Suitable SME-engagement with these types of structures should be carefully considered.

4.15.3 Introduction

This report describes the execution of the workshop on "*Digitaler Zwilling: Expertenpanel zu Interoperabilität, Standards und Herausforderungen*", organized by Fraunhofer-Institut für Produktionstechnik und Automatisierung IPA and Steinbeis 2i GmbH the 10th of June 2022. This workshop was jointly organized under the umbrella of two projects, CF2 and InterOpera[29]. The decision was made since both projects address the topic of **interoperability and standardisation** as cross-cutting factors, **successful use-cases**, **trends, needs, challenges and barriers**, and their impact in the implementation of **digital twins**. Moreover, InterOpera focuses on the German landscape, which was the target of CF2-parnters on this topic.

The workshop was conceived as a follow-up to the workshop, organized during the First Iteration of CF2-National/Regional workshops in October 2020. The setting had an informational and conversational character in which standardization challenges were faced by companies, particularly in the context of the implementation of digital twins in manufacturing settings, where addressed, discussed, and understood. The **main objective** was to establish a feedback loop between key digital twin standardization experts and companies to strengthen their development of their own digital twin solutions.

Other specific objectives of the workshop are:

- to expand and deepen the understanding of the digital twin including the knowledge regarding interoperability and standardization. Moreover, understanding the impact of these technologies on manufacturing companies and the digitization of production processes;
- to exchange ideas and concepts with experts on the field, and disseminate to SMEs first-hand learnings about the latest developments on these topics;
- to present technology solution with interoperable models, e.g. Asset Administration Shell (AAS)[30], and impacts and benefits for manufacturing companies;
- to specify and discuss the current and future developments regarding standardization between the participating companies and transfer them into the current paths to digitalization of CF2;
- to point out the key standardisation activities and respective standards for digital twin;
- to discuss the possible standardization gaps for digital twin.

To give context to the discussion and bring expertise on the subject, the panel discussion was constituted by four panellists:

- Detlef Tenhagen, Harting Technologiegruppe
- Jens Gayko, VDE Verband der Elektrotechnik Elektronik Informationstechnik e.V.
- Michael Hoffmeister, from Festo AG & Co. KG.
- Thomas Kuhn, Fraunhofer IESE und FabOS projekt

The interactive sessions were characterized by high engagement with the participants, including direct involvement of the keynote speakers.

[29] https://interopera.de/
[30] Verwaltungsschale, or VWS in German language

Given the conversational nature of the event, no online interaction tools were required. Conversely, the moderation managed live questions and interaction between the panellists and with the audience.

The agenda of the activity can be observed in Table *19*.

Table 19. Workshop Agenda

Uhrzeit	Thema
09:50	**Anmeldung und Zugang zum Workshop**
10:00	**Willkommengruß, Kontext und Ziele des Workshops** ***Olga Meyer**, Fraunhofer IPA*
10:05	**Einführung zu ConnectedFactories 2** ***Meike Reimann**, Steinbeis 2i GmbH*
10:10	**Einführung zu InterOpera** ***Alexandra Fezer**, Steinbeis Europa Zentrum*
10:15	**Einfürung zu Panelisten und Fragen** ***Carina Gliese**, Steinbeis Europa Zentrum and InterOpera*
10:20	**Kurzvorträge der Panelisten** ***Detlef Tenhagen**, Harting Technologiegruppe* ***Jens Gayko**, VDE Verband der Elektrotechnik Elektronik Informationstechnik e.V.* ***Michael Hoffmeister**, Festo AG & Co. KG* ***Thomas Kuhn**, Fraunhofer IESE und FabOS projekt*
10:50	**Dialog und Diskussion** *Moderiert von **Carina Gliese**, Steinbeis Europa Zentrum and InterOpera*
11:20	**Abschließende Fragerunde** ***Meike Reimann**, S2i GmbH*

The remaining of this document is organized as follows: Section 2 will describe the preparation process for the workshop, including the introductory presentations of CF2 and InterOpera. Section 3 will describe the development of the keynote speakers' and interactive sessions. Section 4 will conclude with the overall perspective on the outcomes of the workshop, including a detailed description of transferable results to the corresponding work packages.

4.15.4 Workshop preparation and CF2 presentation

4.15.4.1 Organization and reach out

The outreach and engagement were achieved by promoting the event through targeted e-mail invitations (Figure 137) to specific strategic stakeholders, especially those coming from the industrial area with experience in standardisation and manufacturing. Moreover, participants from the First Iteration workshop were also targeted, and the network of InterOpera was also utilized to further extend the reach of the event.



Sehr geehrte Frau Dr. Rios

Der Digitaler Zwilling ist die Schlüsseltechnologie der Industrie 4.0. Die Lösungskonzepte werden zu einem wichtigen Instrument, um die Herausforderungen im Produktionsbetrieb effektiv anzugehen, insbesondere mit Blick auf Interoperabilität zwischen beteiligten Akteuren und deren Ressourcen in den Wertschöpfungsketten.

Eine zentrale Herausforderung bei der Realisierung von Digitaler Zwillingen ist deren Integration untereinander. Dabei muss sichergestellt werden, dass die ausgetauschten Daten zueinander passen und auch von anderen Zwillingen in gleicher Weise verstanden werden.

Die Projekte ConnectedFactories 2 und InterOpera möchten Sie herzlich zu unserem virtuellen Workshop *Digitaler Zwilling: Expertenpanel zu Interoperabilität, Standards und Herausforderungen* am 10. Juni 2022 einladen, um ein tieferes Verständnis für die Herausforderungen der Interoperabilität und Standardisierung von Digitaler Zwillingen in industriellen Anwendungen und Umgebungen zu gewinnen.



Sie können sich auf der folgenden **Seite** für die Veranstaltung anmelden und die Agenda im Folgenden einsehen:

Uhrzeit	Thema
09:50	**Anmeldung und Zugang zum Workshop**
10:00	**Willkommengruß, Kontext und Ziele des Workshops** ***Olga Meyer**, Fraunhofer IPA*
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10:50	**Dialog und Diskussion** *Moderiert von **Olga Meyer**, Fraunhofer IPA*
11:20	**Abschließende Fragerunde** ***Meike Reimann**, S2i GmbH*

Wir freuen uns sehr, Sie auf unserem Workshop begrüßen zu dürfen!

Herzliche Grüße

Ihr Workshop-Team Digitaler Zwilling

(1) First page of invitation letter *(2) Second page of invitation letter*

Figure 137. E-mail invitation to potential participants

In addition to the targeted e-mail promotion campaign, the event was also promoted through social media channels, such as LinkedIn and twitter (Figure 138). Moreover, the registration website presented detailed information and description of the objectives, engagement strategy, and expected outcomes of the workshop (Figure 139). In preparation for the workshop itself, also regular reminders were sent to registered participants up to the day of the workshop itself.



Steinbeis Europa Zentrum
1.650 followers
2mo •

InterOpera Interoperabilität in Industrie 4.0
120 followers
2mo •
+ Follow

Am 10. Juni veranstalten die InterOpera-Partner Steinbeis Europa Zentrum & Fraunhofer IPA gemeinsam mit dem von der EU geförderten Projekt Connected Factories - Pathways to digitalisation of manufacturing ein Expertenpa ...see more

See translation

Maëva Pratlong and 3 others



Tweet

InterOpera_I4.0
@InterOpera_I40

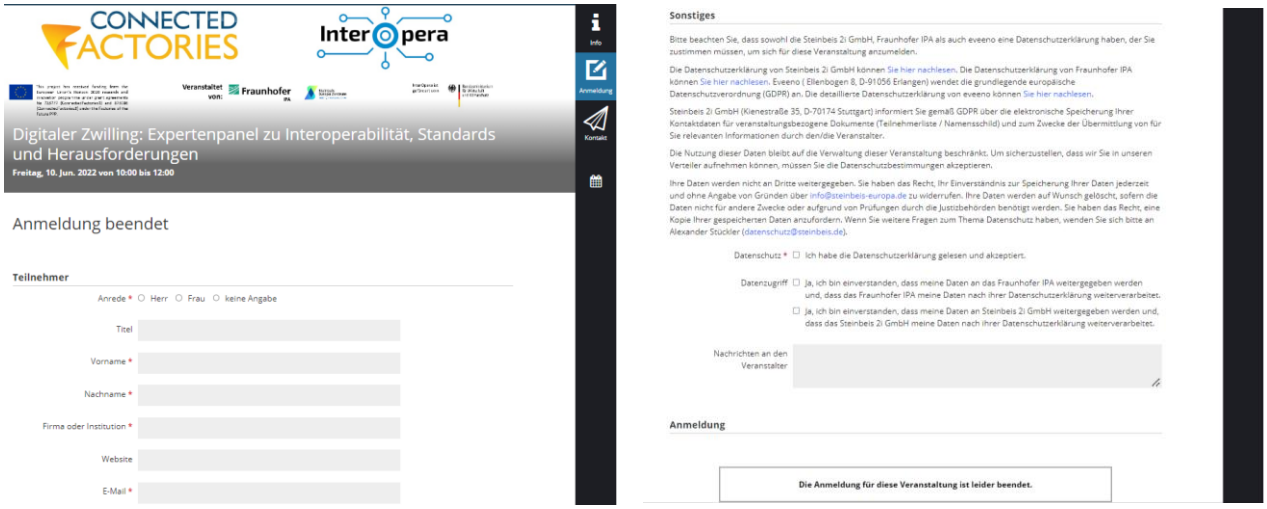
Möchten Sie Ihr Verständnis für #DigitalTwins & Ihr Wissen über #Interoperabilität erweitern & vertiefen? Am 10.6. laden InterOpera & @C_Factories zum Expertenpanel "Digitaler Zwilling: Expertenpanel zu Interoperabilität, Standards & Herausforderungen" ein bit.ly/3wCeqgd

10. Juni 2022 10:00 - 12:00 Uhr

Fraunhofer IPA und 2 weitere Personen

(1) First page of invitation letter *(2) Second page of invitation letter*

Figure 138. Social media promotion campaign



(1) First page of invitation letter *(2) Second page of invitation letter*

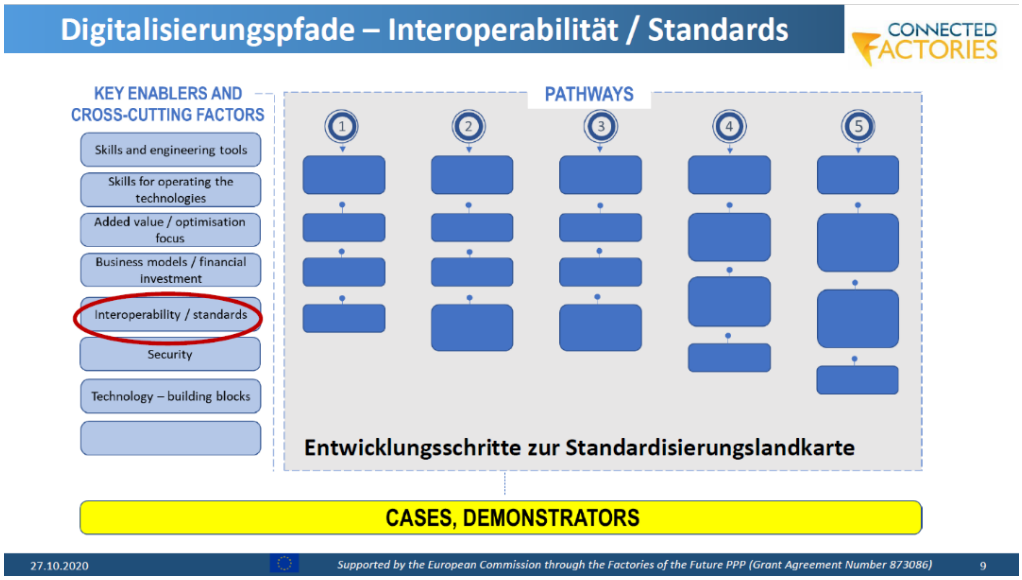
Figure 139. Registration website of the workshop

4.15.4.2 CF2 and InterOpera presentation and workshop introduction

The workshop initiated with a brief introduction to the activity and engagement approach with the panellists. Afterwards, CF2 was described, and the workshop was placed in the context of this project, particularly emphasizing the standardisation and interoperability digitalization pathway (Figure 140). For this, the standard CF2 presentation was adapted.



(1) Consortium introduction



(2) Description of the digitalization paths and placement of the standardisation cross-cutting factor

Figure 140. Introductory presentation to the workshop and CF2

In addition, an introductory presentation of InterOpera (Figure 141) was also provided. In the InterOpera research project funded by the German Federal Ministry for Economic Affairs and Climate Action, experts are working with industry and the Industrial Digital Twin Association IDTA, as well as other key Industrie 4.0 related associations and initiatives, to develop uniform methods for implementing the digital twin solutions driven by AAS in practice.

It is worth noting that some of the partners between both projects overlap. Hence, this creates a great opportunity for synergy, extending the impact and increase the overall reach of the CF2 outputs into other ecosystem focused on standardisation of manufacturing processes.



(1) Consortium introduction



(2) Description of the digitalization paths and placement of the standardisation cross-cutting factor
Figure 141. Introductory presentation to InterOpera

4.15.5 Keynote Speakers and Panel Discussion

All four panellists provided a brief presentation of the role of interoperability and standardisation in the implementation of digital twins in industrial settings, particularly, manufacturing. This included challenges and overviews on how to overcome them through the definition of standards. Afterwards, an open discussion between panellists and with the audience took place.

At the beginning, all panellists were given the task to answer a specific question in their presentation to answer, i.e. **"Why is the digital twin not an empty promise?"**. In doing so, they were to specifically address the different areas of their involvement in the standardization process for the digital twin, e.g. involvement in international standardization activities, involvement in national standardization activities, development of specific solutions for industry, etc.

4.15.5.1 Detlef Tenhagen, HARTING Technologiegruppe – Why is the Digital Twin not an empty promise

The first panellist introduced his participation addressing the existing challenges of the digital twin, while merging both the IT and OT worlds. He addressed the operational challenges associated with the implementation of digital twin as well as IT challenges and potential outcomes that could be obtained from the IT side (Figure 142).



Figure 142. Introductory slide of Mr. Tenhagen presentation of standardisation and digital twins

During his introduction, Mr. Tenhagen explained that the Reference Architecture Model Industry 4.0 (RAMI 4.0) and its innovative value proposition could be a considered and a successful model case for the implementation of digital twins under a proper standardized platform and architecture. Moreover, it was

elaborated that such architectures are not only desirable, but also necessary for the industrial implementation of digital twins, as they enable the connection with other (even external) data sets and processes (Figure 143).

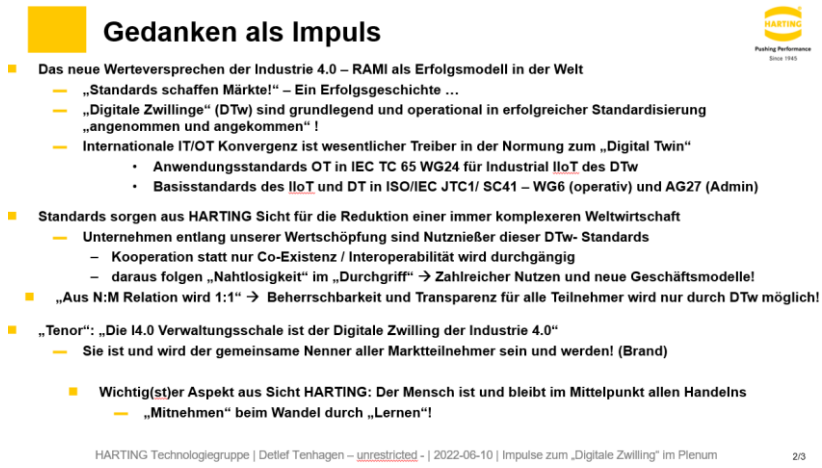


Figure 143. Discussion points proposed by Mr. Tenhagen during his introduction

The requirement of suitable and effective standards for the creation and operation of markets was also presented. Moreover, the notion that digital twins remain an experimental concept was also challenged. In fact, Mr. Tenhagen proposed that digital twins are fundamentally and operationally "*accepted and arrived*" in successful standardization processes, and thus in many settings ready for their industrial implementation. Nevertheless, the necessity of international IT/OT convergence in the definition and use of standards was recognized as a present challenge. In his speech, he also explained the roles of the key standardisation committees working to solve these challenges: IEC TC 65/ WG 24 developing industrial standards for AAS as basic standards to implement digital twin solutions; and ISO/IEC JTC1/ SC 41 WG 6 as operational and AG27 as administrative parts developing basic standards for Industrial Internet of Thins and digital twin.

Mr. Tenhagen also stated that, from HARTING's point of view, standards tend to reduce the complexity of the global economy. In their experience, companies along their value chains benefit tremendously from these digital twins' standards, which makes the overall production processes much more efficient and reliable. Furthermore, it was pointed out that these standards were able to foster cooperation between stakeholders in the value chain, instead of mere co-existence. This may result in "*seamlessness*" in "*access*", which facilitates operational processes associated with the utilization of digital twins as well as the exploration of new business models. This also transforms typically "*N:M relations in 1:1*" increasing the controllability and transparency for all participants through the successful implementation of digital twins, and thus, as an overarching result transforming interoperability into a universal asset for these companies, and end-customers.

Finally, Mr. Tenhagen pointed that for HARTING, the implementation of these standards to facilitate usage of digital twins, must put a human at the centre of all actions, thus concluding the important role of the human being still in the context of the digital twin in the future.

4.15.5.2 *Jens Gayko, VDE Verband der Elektrotechnik Elektronik Informationstechnik e.V., Standardization Council Industrie 4.0*

During his introductory presentation, Jens Gayko presented and discussed the proposed Triangle of Digital Transformation of the Standardization Council Industrie 4.0 (SCI 4.0, Figure 144).

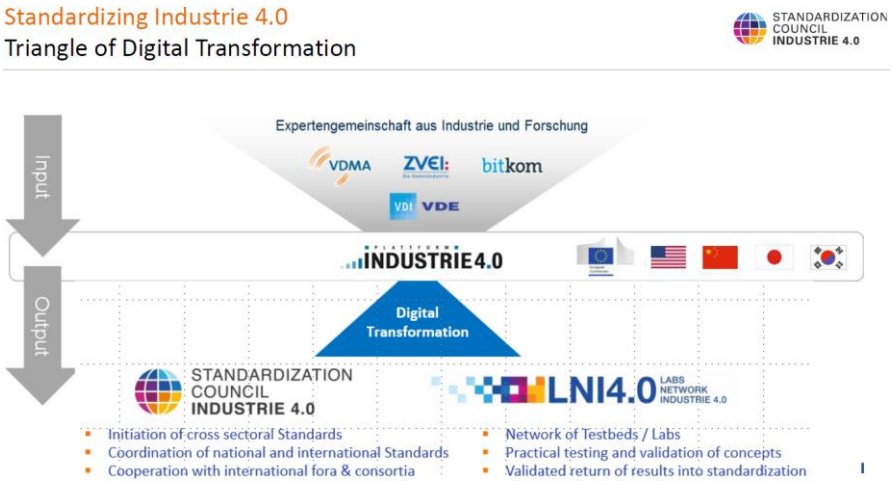


Figure 144. Description of the Triangle of Digital Transformation

In particular, strategic stakeholders were presented as well as the focal initiative of the German ecosystem on matter, i.e. Plattform Industrie 4.0[31]. The most relevant outputs of this initiative for the SCI 4.0 are the initiation of cross sectorial standards, coordination of national and international standards, and the cooperation with the international fora and consortia. To support and foster the testing, adoption, and implementation of these standards, the Labs Network Industrie 4.0[32] (LNI 4.0) also constitutes a component of this triangle. In particular, relevant outputs for the LNI 4.0 include the establishment and utilization of a network of testbeds, laboratories, and facilities in general, practical testing and validation of concepts, and transformation of validated results into concrete standards.

Activities considered by the SCI 4.0 include the definition of standards and enablement of solution through: (1) Orchestration: Initiate and develop standards for digital production; (2) Piloting & Agile Standardization: Close relationship between SCI 4.0 and LNI 4.0 to enable *Plan-Do-Check-Act* like approach;(3) Collaboration: Industrie 4.0 requires cross connected standards over domains and connection to all relevant organizations within the Industrie 4.0 Network; and (4) Internationalization: Discuss concepts from Germany in an early stage with international partners. These activities have culminated in a series of technical reports, which will be embodied in the latest version of Standardization Roadmap Industrie 4.0 V5.0 in 2023[33]. These reports actively consider and engage with requirements coming from the industry as well as from developers of policy, e.g. the development and implementation of a digital passport which provides information about the origin, composition, repair and disassembly options of a product, as well as its handling at the end of its service life.

[31] https://www.plattform-i40.de/IP/Navigation/EN/Home/home.html
[32] https://lni40.de/?lang=en
[33] Current V4.0 can be found in https://www.dke.de/en/areas-of-work/industry/standardization-roadmap-industry-40

With regard to the latest AAS developments, Jens Gayko presented the standardization activities of the Digital Product Passport, which attracted international interest following the publication of the recent EU legislative proposal for an Ecodesign Requirement for Sustainable Products (EU COM, Brussels, 30.03.2022).

4.15.5.3 Michael Hoffmeister, Festo GmbH & Co. KG – Impulses, Sub-models, and International Standardization

Mr. Hoffmeister introduction focused on describing the key players and the status of AAS submodel development (Figure 145), particularly by IDTA and InterOpera, linking these activities to international standardization and current needs with respect to the digital twin. In detail, the different levels of interoperability for the sub-models are technical, syntactic, semantic, behavioural, and organizational nature.

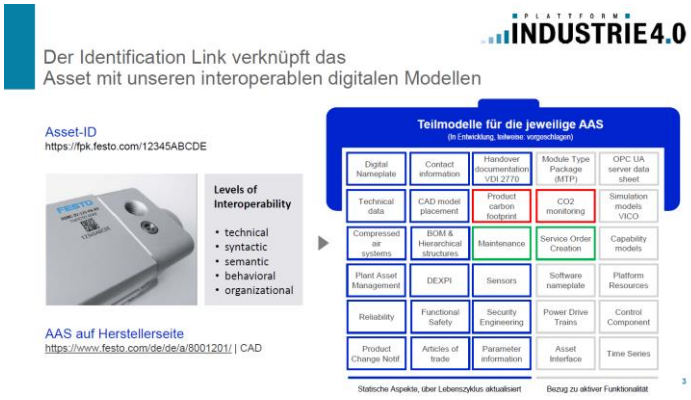


Figure 145. Identification Links that connect the AAS with Festo's interoperable digital sub-models

An important issue presented was the current level of progress regarding the running IDTA projects developing specific sub-models and their values for industry. In this context, it was also discussed which concrete functional tools may be utilized by SMEs, facilitating their digitalization transition (Figure 146). He also listed specific applications for a concrete utilization of AAS submodels, as e.g. Product Change Notification, 3D and Simulations, Product Carbon Footprint, Digital Nameplate, Bill of Materials (BoM), Service Orders, etc. Furthermore, also explained the utilization of AAS in production and logistics, particularly mentioning submodels for specific asset components, infrastructure and others.



Figure 146. Possible application of sub-models for the implementation of digital twins

Finally, it was emphasized that the definition of standards and interoperability open markets, create new business opportunities, and in general secure investments in innovative technological development, by virtue

of creating the means of communication and standardize interaction between organizations, and between their own technical systems. Thus, standards make value/supply chains much more resilient and adaptable to disruption (Figure 147).

The final slide of the presentation addressed international standardization activities and AAS standards.



Figure 147. Impacts of standards in investments

4.15.5.4 Thomas Kuhn, Fraunhofer IESE and FabOS project – Digital Twins: Implementation Project

The introduction of Mr. Kuhn focused on the main challenge in implementing digital supply chains, and industry 4.0 in general, is to enable fruitful communication between different stakeholders and technical systems, such that the flow of data and information may foster, and never hinder, productivity, resilience, and adaptability of such supply chains. This challenge also applies to the implementation of digital twins in production (Figure 148).

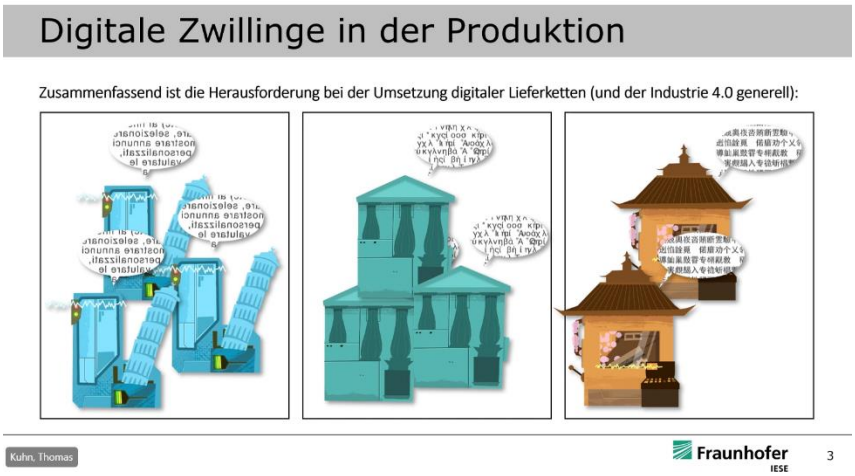


Figure 148. Challenges of digital supply chains, digital twins, and industry 4.0

An alternative to face these challenges was presented in the form of two projects (Figure 149) which showed the applied potential of digital twins in real industrial settings, i.e. BaSyx[34] and FabOS[35].

[34] https://www.eclipse.org/basyx/
[35] https://www.fab-os.org/en/

The former is a project supported by the Eclipse Foundation[36] and constitutes an open-source Industry 4.0 middleware. The middleware provides all necessary standards, infrastructure, and components for Industry 4.0 production environments. Moreover, it also provides the foundation for software platforms and ready-to-use components and extendable software development kits (SDK) for Java, C++ and C#, including also the AAS, which is the foundation of the digital twin with unified interfaces for all kinds of manufacturing assets.

The latter, i.e. FabOS, constitutes the IT backbone for the versatile automation of the *factory of the future* and the foundation of an ecosystem for data-driven services and AI applications. As such, both projects constitute ready-to-use instruments, a platform and a set of enabling IT tools, for the implementation of digital twins in manufacturing SMEs.

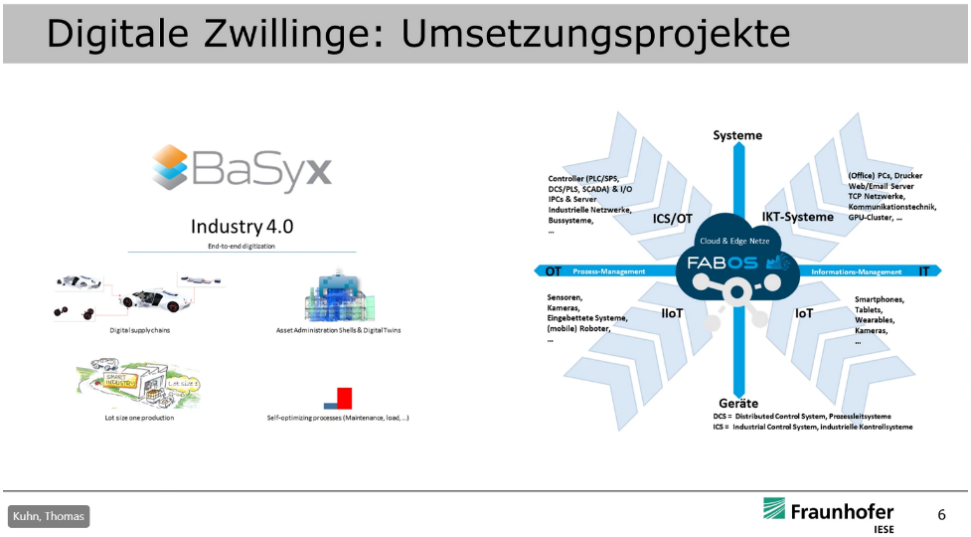


Figure 149. Description of BaSyx and FABOS projects

[36] https://www.eclipse.org/

4.15.6 Conclusion

The following section includes an overview of the results and transferable results.

4.15.6.1 Transferable results

The workshop focused on the cross-cutting factor of standardisation, which corresponds to WP1, and it was informative and conversational in nature, to the purpose of facilitating the access to a typically highly specialized topic, to a wider audience. The event achieved a consistent attendance of 40 people, which remained highly engaged throughout the duration of the event. Outstanding results include.

- The correct technical interpretation of standards is of vital importance for the success of the technologies that they norm and the standards themselves.
- AAS is a well-accepted international standard that is gradually becoming one of the branding solutions for digital twins, answering and guaranteeing different inquiries regarding interoperability, reliability, etc.
- National colouring, i.e. different countries utilizing different non-compatible standards, should be prevented. Global work is the major priority now.
- Standards and norms should facilitate the interaction between technologies and markets. Standards should aim at international acceptance and specify pathways to compatibility.
- It is essential to achieve common solutions (as e.g. AAS standard and its submodels) especially for sematic interoperability, even if specific technologies or standards change. This type of approach towards semantic definitions is also key to achieve cross-interoperability also on global level.

In terms of the applicability for SMEs:

- Tools and trainings are currently available as open source. Moreover, these are not abstract but practical, e.g. concrete problems that may be adapted to specific user-case, which may also be tried it out with individual product.
- Companies as a whole need to join and grow, self-assess, etc. A simple and interesting hands-on starting point may be the digitalization of products and services, in compliance with standards, e.g. article numbers to URL.
- The FabOS project provides interesting basis for the practical implementation of standards in a digital twins set up. In particular, FabOS middleware provides the necessary framework to establish interoperability between by different users and adopt AAS concepts including submodels, recipes, integration of devices, etc.. This should provide SMEs stock-up container in a low-threshold manner.
- Open source standards: Their operation of such global standards as digital twin should be fast but also practice oriented. Following challenges were discussed in this concern: e.g. paywall, user association, without royalty fee, as user time advantage, accessibility given, all standards freely accessible and accompanying software.

In terms of future steps, it was mentioned that:

- The Digital Product Passport constitutes an opportunity for the AAS as an interoperability tool and paradigm for the recently promoted European Green Deal.
- There is a need for integration of *solo* actors and stakeholders, such that the contribution to overall interoperability and standardisation efforts can be follow a coherent strategy.

- It is fundamental to consider the scaling of the proposed measures and technologies. It is not enough to test in demonstrations that cannot clearly transfer into industrial settings, neither for technical nor financial reasons.
- An interesting future perspective may be given by the integration of blockchain, which may help identifying white spots, and complement interoperability particularly in the field of digital twins.

4.16 5G and Industry 4.0 Applications – 28/06/2022, IMR (IR)

4.16.1 Topics Addressed in the Workshop

	Topics adressed (X)
Trends, needs, challenges and barriers	
Successful use-cases	✓
Cross-cutting Factors	
Added Value and Business Models	
Interoperability and Standardisation	
Cybersecurity	✓
Industrial Agreement and Legal Aspects	
Humans in Manufacturing	
Pathways	
Circular Economy	
Human Factors	
Autonomous Smart Factories	✓
Hyperconnected Factories	
Collaborative Product-Service Factories	
Data Spaces	
Skills	✓

4.16.2 Executive Summary

Irish Manufacturing Research (IMR) is Ireland's only independent research organisation. Its mandate is to de-mystify, de-risk and deliver high TRL technologies to its network of over 200 manufacturing companies on the island of Ireland. As part of this mandate IMR reaches out to companies who have an interest digitisation to participate in workshops and networking events to develop their understanding of specific technologies. IMR completed one of these events on June 28th 2022 on 'Digitisation and 5G'. The event was attended by over 80 individuals from over 30 companies.



Figure 150. Event logo with partnerships

The event had a number of objectives:

- Participants come away with a better understanding of 5G and related technologies
- To inform the participants about the eco-system around 5G and devices
- Enforcing IMR's support of both the Connected Factories and Digital Innovation Hub EU programs
- Enabling participants see IMR as a 'Go To' organization to engage with on 5G testing of research concepts and the development of applications for their needs
- Exposure to the types of skills needed to benefit from 5G
- To inform participants about IMR's 5G partners in Ireland who can help with future digital and 5G investments

The day consisted of a number of talks on how to create digital strategies, 5G technology and applications, practical hands on application demonstrations of 5G and a Question and Answer discussion with industry experts.

The day itself was successful in meeting these objectives with IMR now in the process of further engagements with participant organisations to define future digitisation programs.

4.16.3 Introduction

While there are many exciting and potentially impactful Industry 4.0 technologies emerging or recently in the marketplace, its been IMR's experience that there is a lot of confusion in companies in how to select the right technology to support application development within their businesses. IMR have observed confusion within its own company network and frustration with technology adoptions not delivering the impact anticipated. IMR prepared the workshop to start addressing these issues and to present IMR as an organisation which can help companies address these types of frustrations.

The day itself was designed to be both informative and interactive with the agenda tailored to these objectives as shown below in Figure 151.

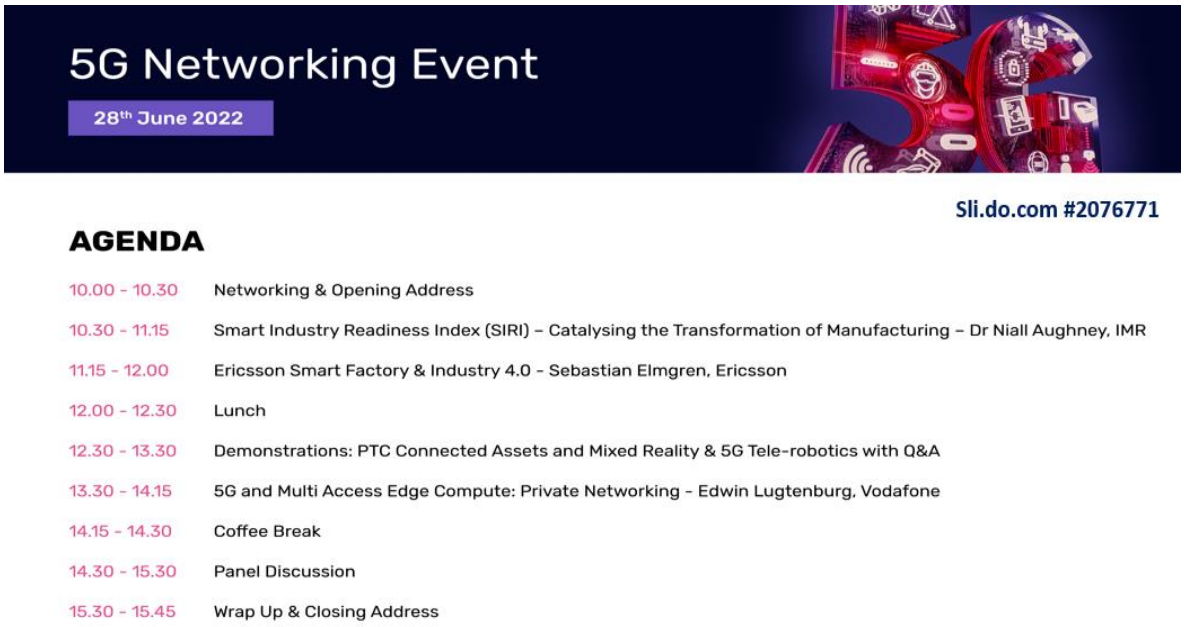


Figure 151. Agenda

The agenda was designed to move beyond the hype of 5G. IMR have observed that although there has been a significant push on 5G technology by both Telecom server providers and Original Equipment Manufacturers (O.E.M.'s), from a manufacturing perspective there are very few (if any) real world practical applications that companies can turn to in order to really understand how 5G and in particular Mobile Private Networks (M.P.N.'s) can impact manufacturing. This is particularly the case in Ireland.

The event had a number of objectives:

- Participants come away with a better understanding of 5G and related technologies
- To inform the participants about the eco-system around 5G and devices
- Enforcing IMR's support of both the Connected Factories and Digital Innovation Hub EU programs
- Enabling participants see IMR as a 'Go To' organization to engage with on 5G testing of research concepts and the development of applications for their needs
- Exposure to the types of skills needed to benefit from 5G
- To inform participants about IMR's 5G partners in Ireland who can help with future digital and 5G investments

In particular, IMR wanted to ensure all participants came away with a good understanding of the eco-system around 5G and in particular to help IMR's members understand where companies play within this eco-system, as shown below in Figure 152.



Figure 152. 5G Eco-system

4.16.4 Workshop Organization and Preparation

As part of the preparation for the event, IMR targeted participants who had responded positively to IMR's regular updates to its network on developments. From these responses a questionnaire was created and sent to these potential participants to gauge interest in a day focused on 5G. The following questionnaire was created and distributed.

With the introduction of the 5G mobile communications standard by the 3GPP body in 2016, cellular communication providers (mobile network carriers and equipment manufacturers) have been able to offer increasingly powerful communication capabilities. These capabilities extend beyond personal communication tools and include capabilities directly targeting Smart Factory / Industry 4.0 requirements.

- Do you have a data management compliance requirement that could be realized by automated monitoring, reporting and attestation?
- Do you have a need for lower latency wireless communication between machines and monitoring devices?
- Do you have concerns with the predictability of real time wireless communication?
- Do you want to better manage the wireless communication between devices and your IT network?
- Are you concerned about using wireless devices operating in un-licensed radio spectrum?
- Would you like to learn more about how 5G technologies can improve your operational efficiency?
- Would you like to learn more about 5G technologies in general?
- Would you like to investigate to suitability or application of 5G technology to a specific operational need?
- Would you be interested in joining a multi-organization workshop on exploring and elaborating potential use cases?

This informed the format and content of the day. The initial discussion was centered around an approach on how organizations can develop their own digitization strategies. IMR led this through presenting work they have completed in assisting organizations to develop their own strategies. The discussions focused on how transformation strategy should be about identifying in a structured way the application areas across a company's entire business. In particular where significant impact to the bottom line can be delivered through Industry 4.0. IMR highlighted that there is a lack of a standardized approach to using Industry 4.0 technologies. The World Economic Forum (WEF) has acknowledged this problem of impact delivery which has been influenced by the lack of a standardized approach, as a result the pace of Industry 4.0 adoption is uneven across different industries and companies. Companies both globally and locally are grappling with the concept of Industry 4.0 and the value it could bring. IMR presented the approach they use to help organizations in Ireland – the Smart Industry Readiness Index (SIRI), developed by INCIT - https://www.incit.org/ . The approach is both standardized and structured to assess an organizations digital maturity as shown in Figure 153 below.

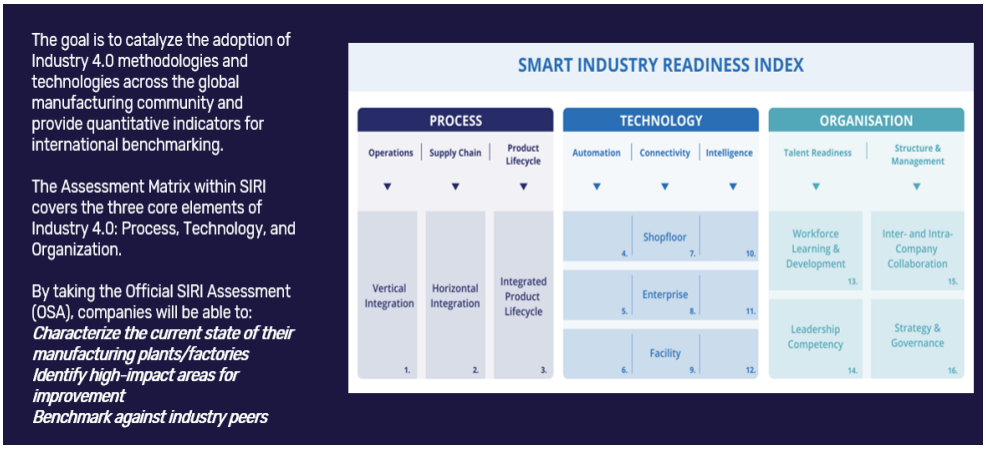


Figure 153. The Smart Industry Readiness Index.

Application and use case demonstration was also a key part of the event. This was to highlight the types of applications which 5G can enable. The experiences created were designed to allow participants to get hands on with the technology and show relevance to their own enterprises. 2 applications were developed with this intent.

The 1st application involved using IMR's 5G Stand Alone network to demonstrate how Augmented Reality (AR) can facilitate interaction with an industrial CNC system. The use cases which this digital technology could benefit were:

- Maintenance tasks by highlighting maintenance procedures and tasks and positioning
- How to remotely connect in experts to assist in troubleshooting
- How to obtain real time feedback

Figure 154 highlights the interactive aspect of the demonstration where an IMR staff member was demonstrated the capability to manage these applications remotely from the CNC system itself, which was in another area of the IMR building.

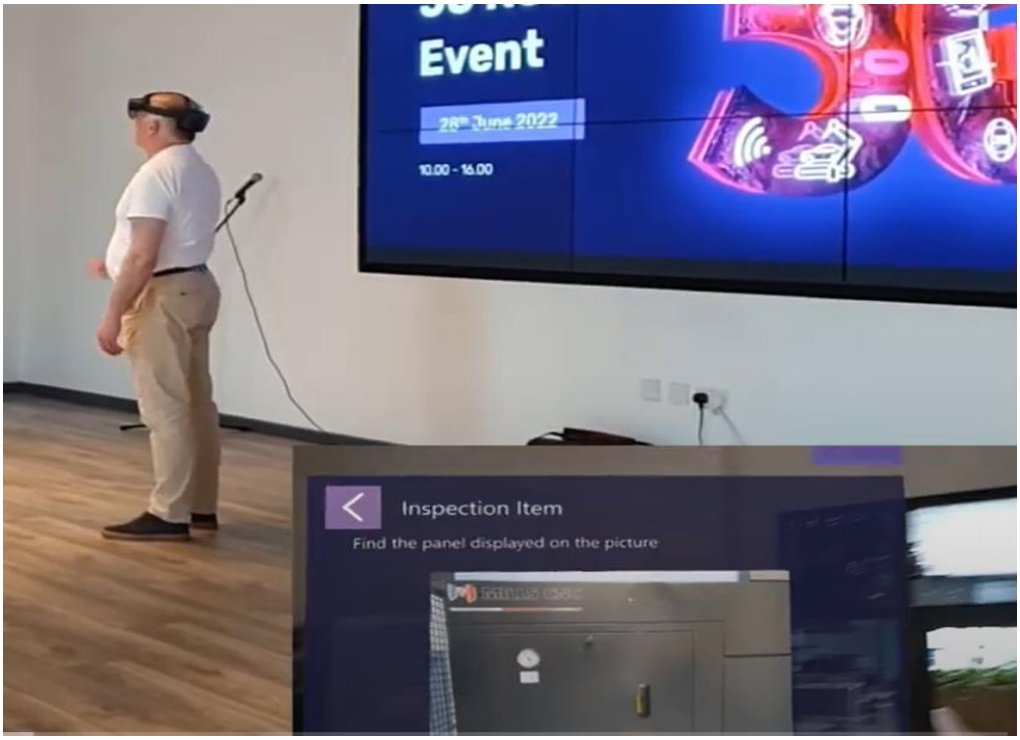


Figure 154. AR demonstration

The 2nd application involved the usage of the 5G network to demonstrate a telerobotic application to the participants. The demonstration highlighted to the audience the capability of 5G to manage and control real time mission critical systems in a safe and secure manner as shown in figure 5. In particular a number of applications were discussed**.**

Restricted access applications:

C*leanrooms* and highly controlled environments – where strict, time-consuming procedures must be followed when entering or leaving controlled areas, as well as *hazardous environments* - where chance of

health or injury risks is high, applications where cross contamination risk between areas is high and undesired.

- *In this case human operator presence can be avoided while still allowing necessary task to be completed*.

Remote access applications:

For example, maintenance - in this case the human operator presence is possible, but could be difficult due to *limited accessibility*, *expert availability* might be limited or economically non feasible for example remote locations.

- *In this case highly trained operators can be made available anywhere in the world.*

Micro-operation applications:

Applications where motion accuracy and precision are not achievable or very difficult to do by human hand.

- *In such applications operator might sit in the same room as robot, but his inputs at controller could be scaled down to micrometre scale.*

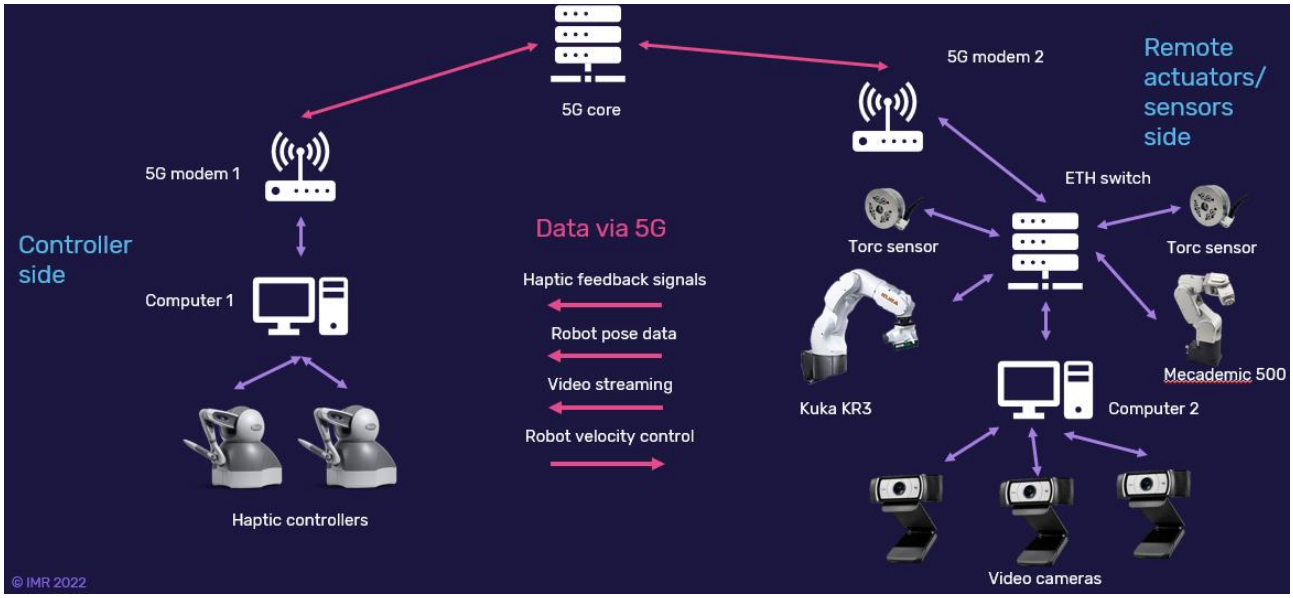


Figure 155. Tele-bot application.

4.16.5 Keynote Speakers Session

The speakers who presented during the day, all had extensive industrial experience in the adoption and deployment of new technologies and were identified as individuals who could give a diverse range of perspectives on 5G from a buyer, a builder and a user of 5G technologies. This approach was taken to ensure the participants got a broad range of perspectives on 5G.

Dr. Niall Aughney, IMR's director of IIoT and digitisation highlighted the need to ensure technology aligned with organisations overall digitisation strategies. He has been working in technology and product development for over 30 years within the ICT industry. Niall holds a M. Eng. Sc in microelectronics and Ph.D in engineering. Niall's most recent work has included 5 world-wide product launches in the IOT space

including cellular sensor solutions and point of sale system development. Niall's most recent roles have included being a senior world-wide SW director for Verifone payment systems and as a senior director within the IOT group in Intel responsible for product development.

Sebastian Elmgren as head of product management and business development in smart manufacturing, leads Ericsson's smart manufacturing vertical for dedicated 5G networks portfolio based in Sweden. Sebastian has worked many years in Ericsson product development and was previously the manager of the 5G innovation and incubation factory in Ericsson Stockholm. Sebastian now leads a global team that work on the edge of industrial digitalization with 5G, IoT and AI focused particularly on applications in factories, warehouses, and mining. Sebastian will share industry knowledge and insights from driving sustainable global

Edwin Lugtenburg is a Business Development lead for Mobile Private Networks in Vodafone Group. He has worked in Telecoms for over twenty years and has been involved with the development of Mobile Private Networks in Vodafone from the outset. In his current role, he is responsible for driving MPN growth in Ireland, MEA & APAC and works closely with Product Development to ensure Vodafone's products meet customer needs today- and in the future. He sees 5G, MPN and MEC as the key enablers that will completely change the way manufacturers operate. He states the importance of getting onto the digital transformation journey sooner rather than later to get ahead of the competition. Edwin joined Vodafone in 2014. In previous roles, he delivered Mobile Private Networks in the Middle East and led consulting engagements to help customers make the business decision for Mobile Private Network investments.

4.16.6 Interactive Sessions

The final session of the day was designed to allow the participants to reflect on the information they had received through the earlier talks and the interactive sessions with the applications. A questions and answers forum were facilitated with a panel of experts. It was an open session with a range of questions being tabled, which all were answered by the panel. The questions fielded were:

1. What is the typical footprint/size of MEC and MPN hardware? What we saw behind us appears quite large.
2. What is the benefit of MEC alongside 5G?
3. Could MPN/MEC be deployed in remote locations? I.e. ruggedized?
4. What's the business case for adopting mixed reality solutions?
5. What is the Dell strategy to underpin the telcos with edge infrastructure and innovation to support 5g MPN/MEC use cases?
6. Is a private network's performance - e.g. in terms of coverage, data speed etc. - be monitored in the traditional way? (QoS, N/W probes etc.)
7. How important is the latest 5G R16 standard for these robotics use cases within MPNs? or can 5G R15 be used. What 5G R16 modules/gateways are available?
8. For a greenfield development can a 5g deployment completely replace traditional wired and WiFi infrastructure. If so how does it compare on investment cost.
9. Do the panellists see better inter / intro company collaboration as equally strategically important to them, and if so, what are you doing to improve?
10. How does 5G align with Industry 4.0 and SIRI
11. How are the panellists addressing their own workforce learning needs for these new technologies?
12. What is Ericsson seeing in terms of the balance globally of MPNs deployed in partnership with a telco vs using industrial spectrum?

13. How are manufacturers establishing the business case for private networks in countries like China where labour costs are lower?
14. For Ericsson: in your factories, have you also deployed WiFi onsite and how do you differentiate between those applications that use 5G and those that use WiFi?
15. Sebastien mentioned Vodafone delivering drone detection as a service in addition to the private network connectivity. What other solutions are you developing?
16. Could a SIRI assessment help me devise a digital strategy for my organisation?
17. What are the typical timescales you see for companies to drive meaningful change in their SIRI scores?
18. How many companies have undertaken a SIRI assessment?



Figure 156. Panel Discussion

The panel discussion was moderated by Irish Manufacturing Resaearches Dr. Niall Aughney and guest experts, Elizabeth Rumsey, Senior Global Product Manager at Vodafone Global, Sebastian Elmgren, Head of Product Management and Business Development at Ericsson, Eric van Vliet, Director of Telecom Market Development, APJ & EMEA at Dell, and Mike Hibbett, Senior IIOT Technologist at Irish Manufacturing Research (IMR).

4.16.7 Conclusion

There was strong positive feedback from the participants on the information relayed on the day. In particular the practical use cases IMR had developed lent to a deeper understanding by the participants of the potential of 5G MPN's in an industrial setting. The event has encouraged IMR to undertake an additional event specific to 5G applications based on the feedback on the day. Since the event, several companies have reached out to IMR to engage to further understand how IMR can facilitate the development of 5G enabled applications for their specific organisations.

4.16.7.1 Transferable results

The primary result of the event was to deliver an interactive day where previously identified organisations who had expressed a strong interest in understanding the benefits of 5G was achieved.

- The day resulted in participants getting a hands-on experience with the 5G technology and engaged with Subject Matter Experts (S.M.E.'s) to develop a deeper understanding.
- The day resulted in participants getting a deeper understanding of the technology and what it takes to develop applications.
- The applications demonstrated on the day (AR and Telebot applications) resulted in participants receiving a hands-on experience which allowed them to see how 5G can facilitate digitisation.
- The broad eco-system of 5G was explained which resulted in participants understanding the role a range of companies play in this eco-system such as telecoms provision, OEM's, solution providers.
- The event resulted in participants understanding what 5G infrastructure and architecture looks like and how the infrastructure in IMR can facilitate companies in developing their digitisation applications (test before investing).
- The day resulted in empowering participants with what to consider in terms of scaling 5G deployment models and how the eco-system can facilitate this.

4.16.7.2 Relevant Experiences

There was a broad appreciation expressed by the participants that the event did support their learning and understanding of 5G in general. IMR is currently soliciting more formal feedback with several additional companies having requested further engagements with IMR with additional 5G events now planned. The event has facilitated the development of deeper relationships with telecoms and OEM partnerships which has resulted in additional 'in-kind' capabilities being contributed by Vodafone and Dell with the addition of a 'Multi-Access Edge Compute (M.E.C.) platform which will enable IMR's 200+ company network access to Ireland's only stand-alone 5G MPN to accelerate their digitisation strategies.

5 Annex

5.1 MTC Workshop

The whole conference can be viewed here: Digitalising Manufacturing Conference

5.1.1 Interactive Session 1:

1. ***What does "digital skills" mean to you?***



2. ***What Digital Skills do you think you need?***

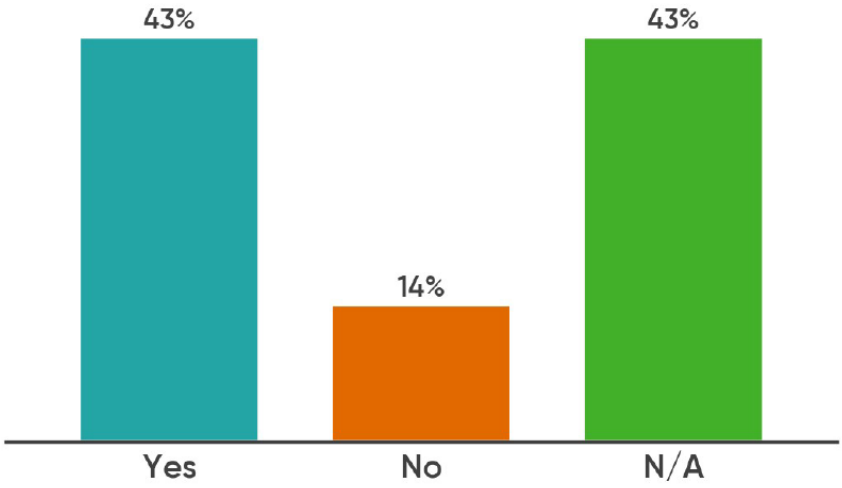


Interactive Session 2:

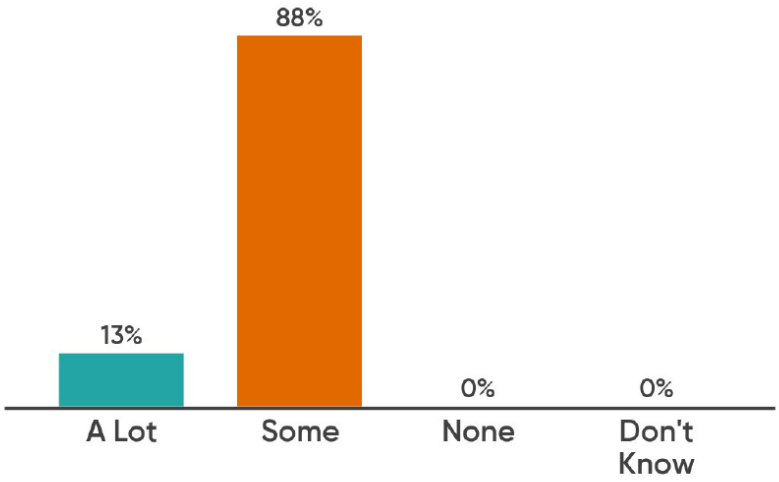
1. ***What barriers are stopping you from having the right skills?***



2. ***Have you been able to hire in your missing skills?***



3. ***What existing potential do you have in your work force?***

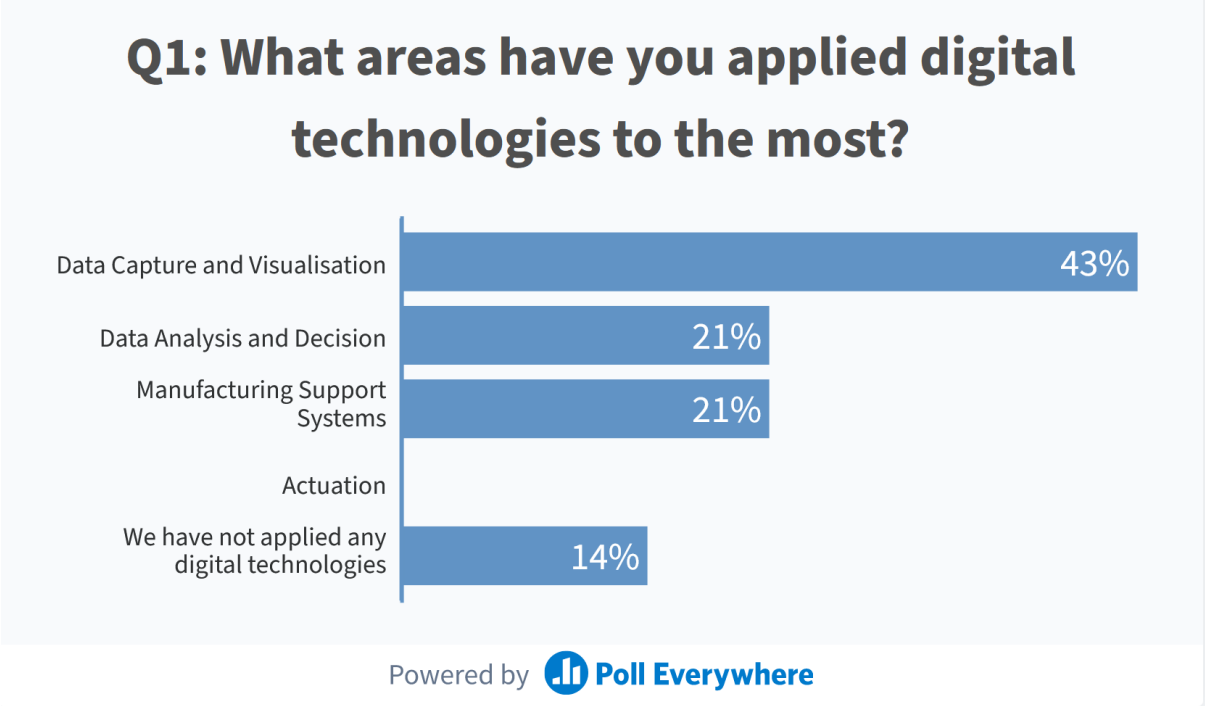


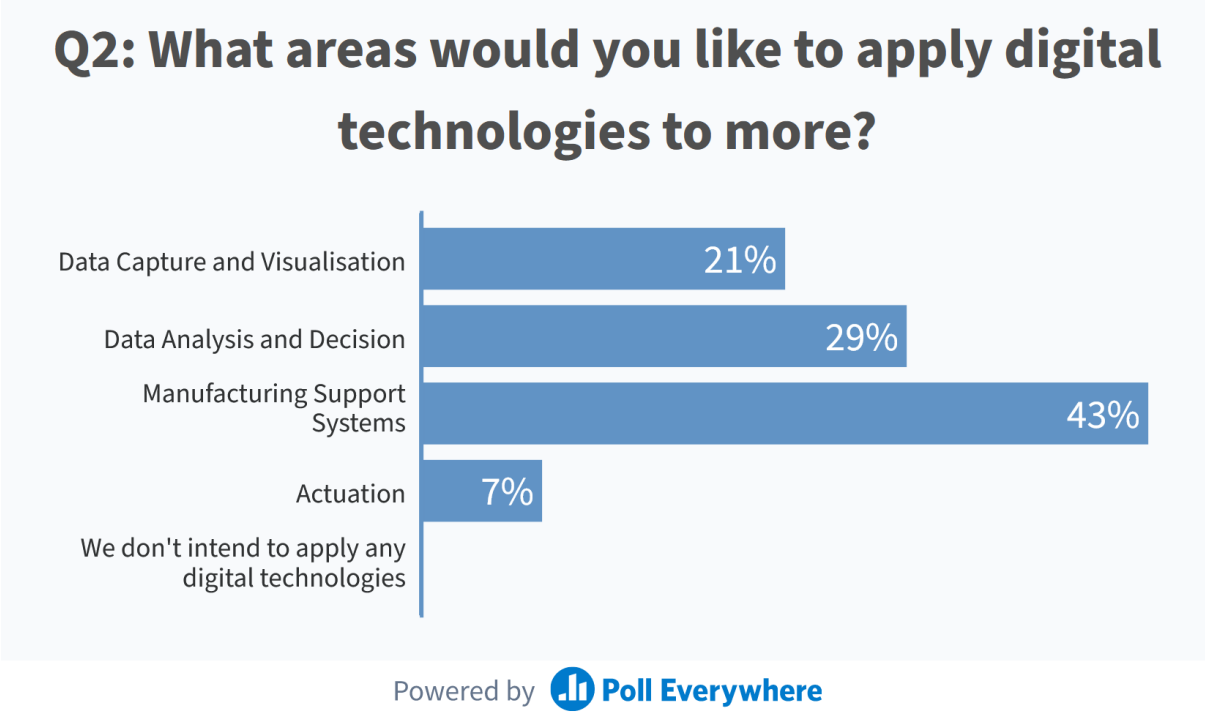
4. What one word sums up your next step?

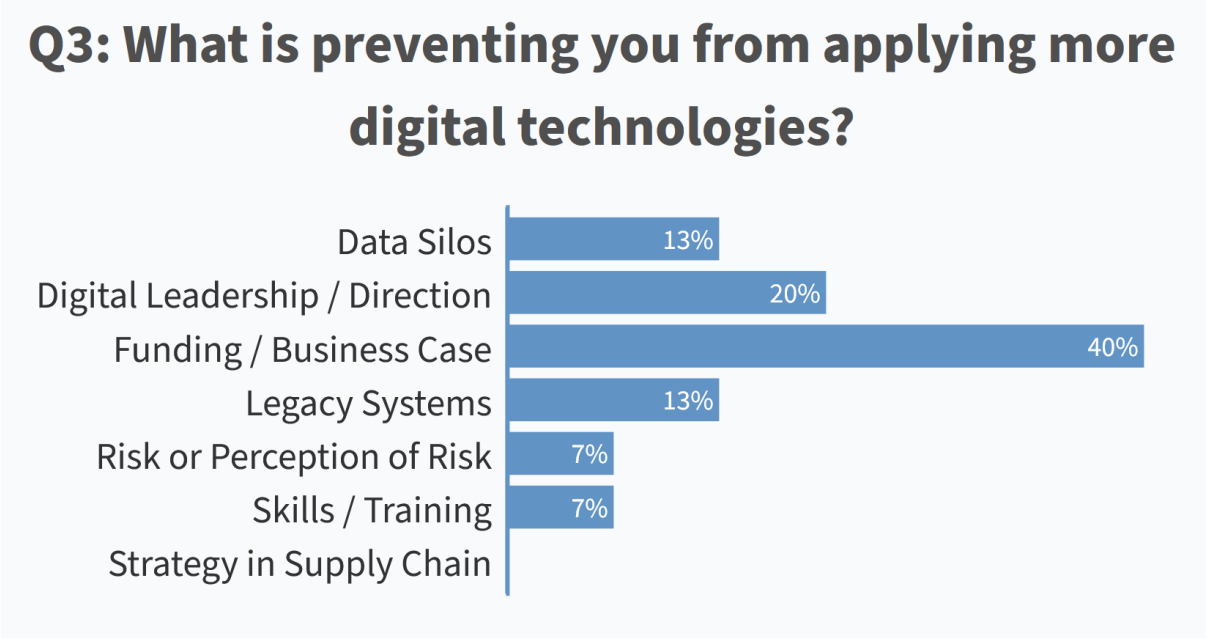


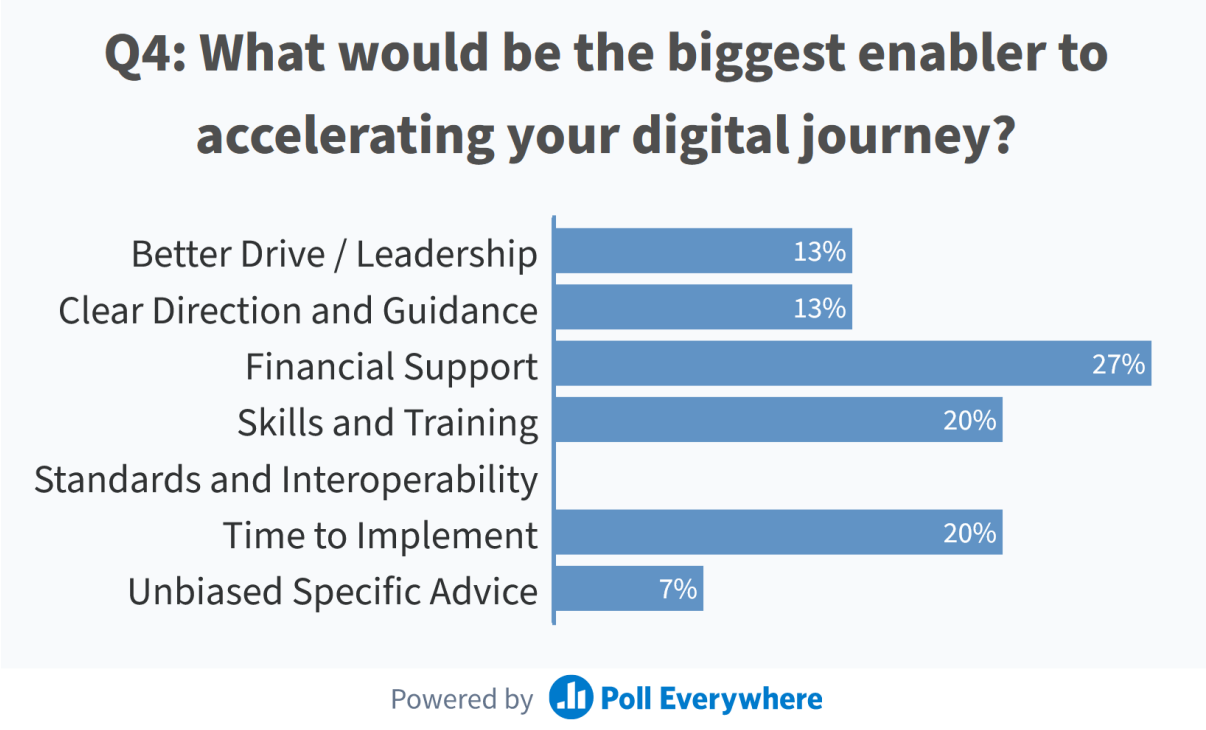
5.2 UNOTT Workshop

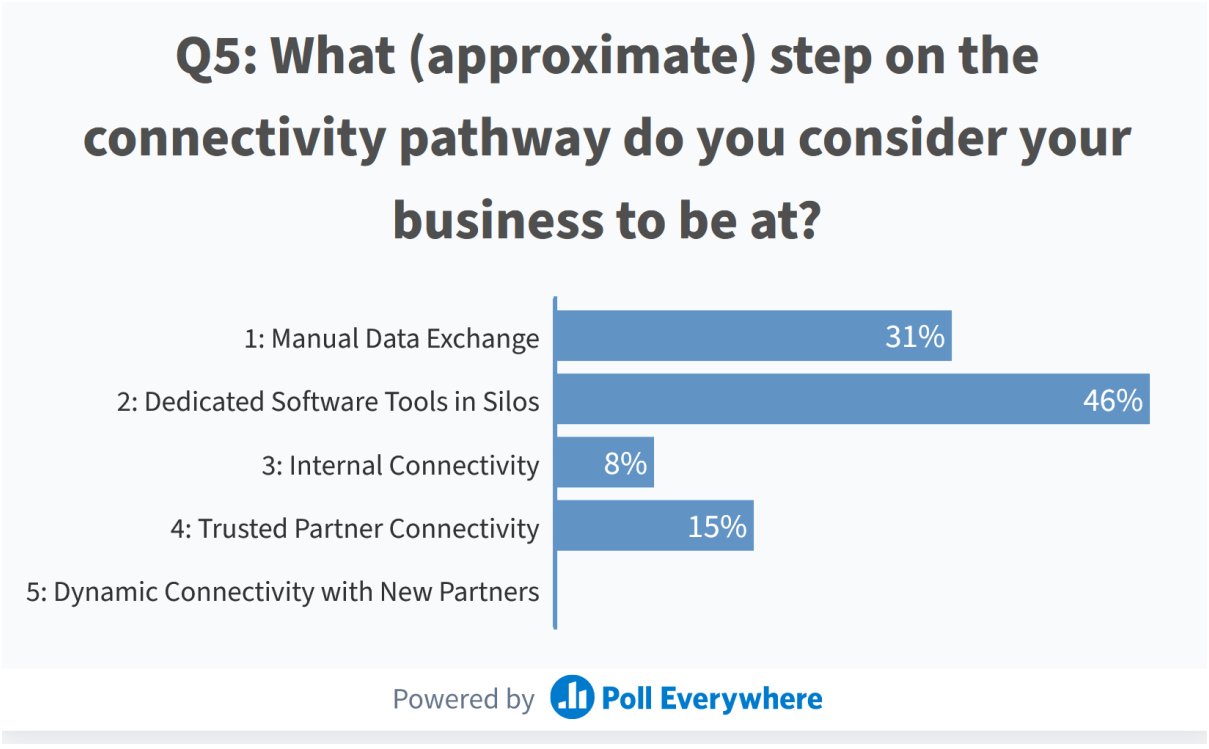
5.2.1 Poll Everywhere results

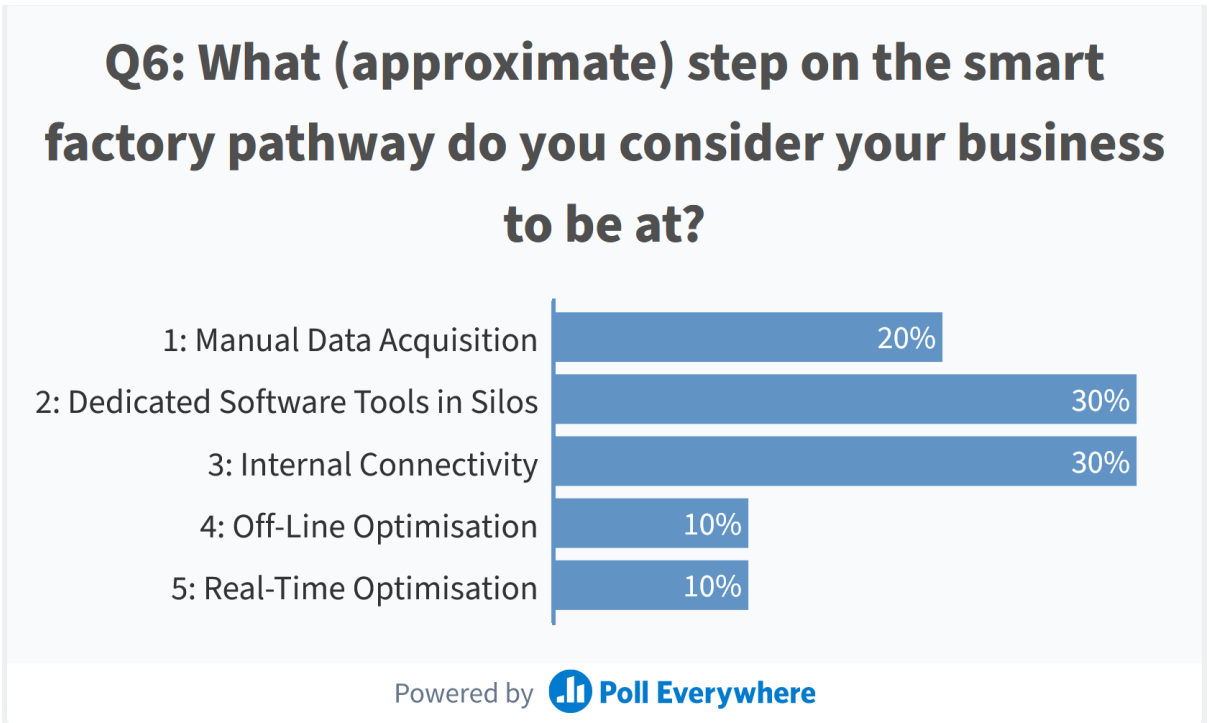





Q3: What is preventing you from applying more digital technologies?
Data Silos
13%
Digital Leadership / Direction
20%
Funding / Business Case
40%
Legacy Systems
13%
Risk or Perception of Risk
7%
Skills / Training
7%
Strategy in Supply Chain
Powered by Poll Everywhere


Q4: What would be the biggest enabler to accelerating your digital journey?
Better Drive / Leadership
13%
Clear Direction and Guidance
13%
Financial Support
27%
Skills and Training
20%
Standards and Interoperability
Time to Implement
20%
Unbiased Specific Advice
7%
Powered by Poll Everywhere


Q5: What (approximate) step on the connectivity pathway do you consider your business to be at?
1: Manual Data Exchange
31%
2: Dedicated Software Tools in Silos
46%
3: Internal Connectivity
8%
4: Trusted Partner Connectivity
15%
5: Dynamic Connectivity with New Partners
Powered by Poll Everywhere


Q6: What (approximate) step on the smart factory pathway do you consider your business to be at?
1: Manual Data Acquisition
20%
2: Dedicated Software Tools in Silos
30%
3: Internal Connectivity
30%
4: Off-Line Optimisation
10%
5: Real-Time Optimisation
10%
Powered by Poll Everywhere

5.2.2 Keynote Speaker Slides





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Our Industrial Digitisation Journey

Martin Rigley MBE

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Me

- Born in North Nottinghamshire
- Degree in Electrical & Electronic Engineering
- Chartered Engineer
- Advanced Apprentice
- 14 Years in Coal Mining
- Joined Lindhurst in 1994
- 2016 MBE, Services to Business & Innovation



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Quick Lindhurst History To Date

- Established in 1985
- Original Market Engineering Services: Coal Mining
- Currently Employ 36 Staff, Mixed Engineering Disciplines
- Fabrication Mechanical Components
- Bespoke Plant & Equipment
- Heavier, Dirtier End Of Industry
- Turn Over £3.75M….on a good day!



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The Journey Begins

- I have worked in industrial automation all my working life, both at British Coal & Lindhurst.
- The catalyst for the step I am going to talk about this morning was the IoT sessions run by Nottingham University in 2018 "**Industrial 4.0 for manufacturing**"

The University of Nottingham

UNITED KINGDOM · CHINA · MALAYSIA

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Lindhurst Challenges



- Like most SME's, as an MD you wear multiple hats.
- We all like to think we have a handle on how we manage the utility resources we us!
- We all have the draw of managing our health & safety and QA procedures, amongst many other things

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Next Step

- Had the good fortune to be paired up with Devtank as their business coach under the Scale Up Programme
- Started dialogue around using the Hilltop system as a low cost means of harvesting industrial data



Devtank; https://www.devtank.co.uk/

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First Steps

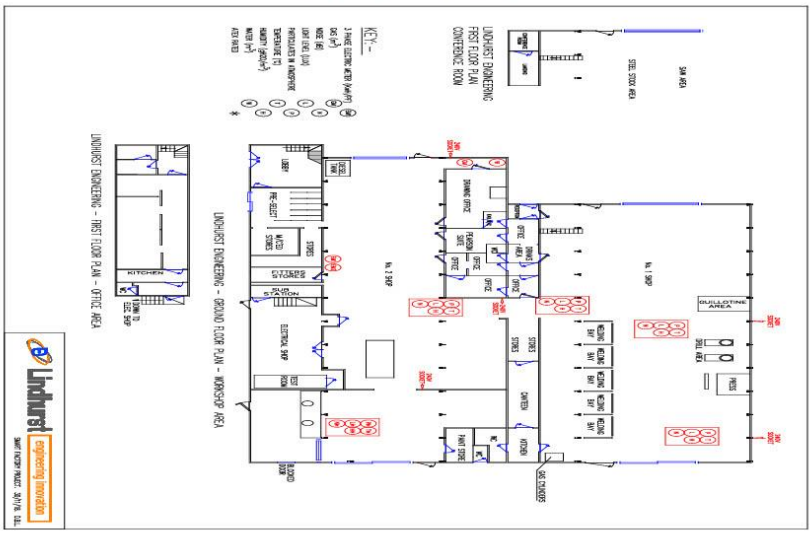
- We chose to monitor parameters that we believed were important to us.
  - Electricity (V, A, KWhr, KVAr, PF); Environmental & £
  - Water (m3); Environmental & £
  - Gas (m3); Environmental & £….coming soon!
  - Noise (dB); H&S
  - Light Levels (Lux); H&S & Productivity!
  - Particulates In The Atmosphere (ug/m3); H&S & Env
  - Humidity (%); QA
  - Temperature (C); H&S, QA, Productivity

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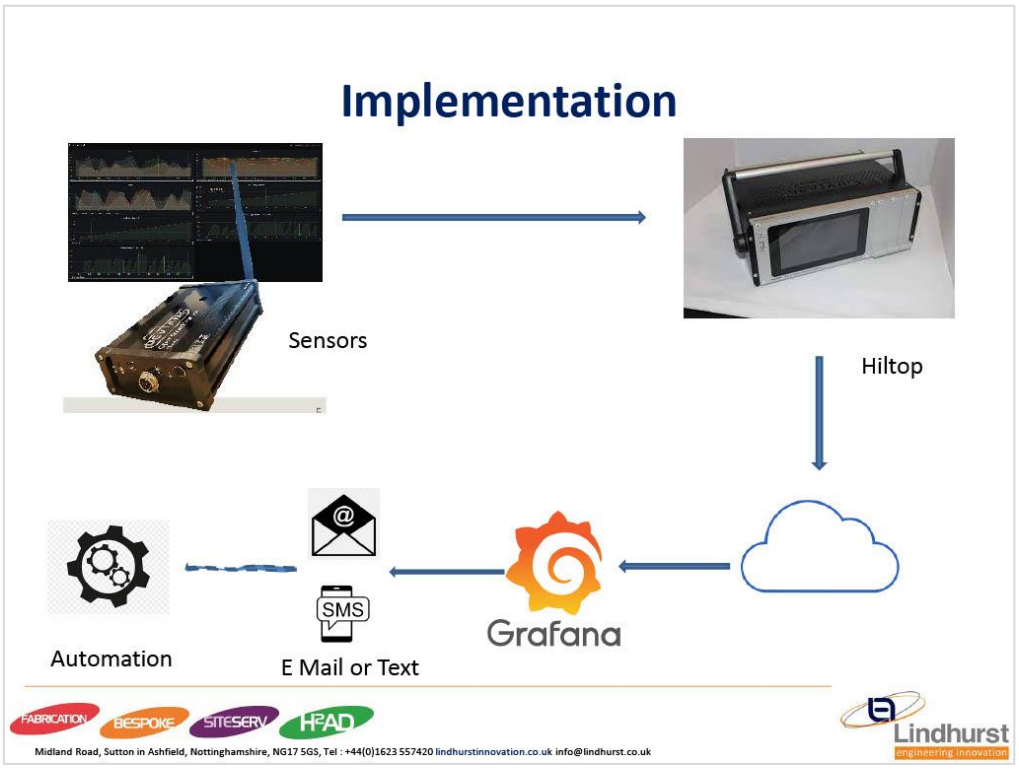
Schematic

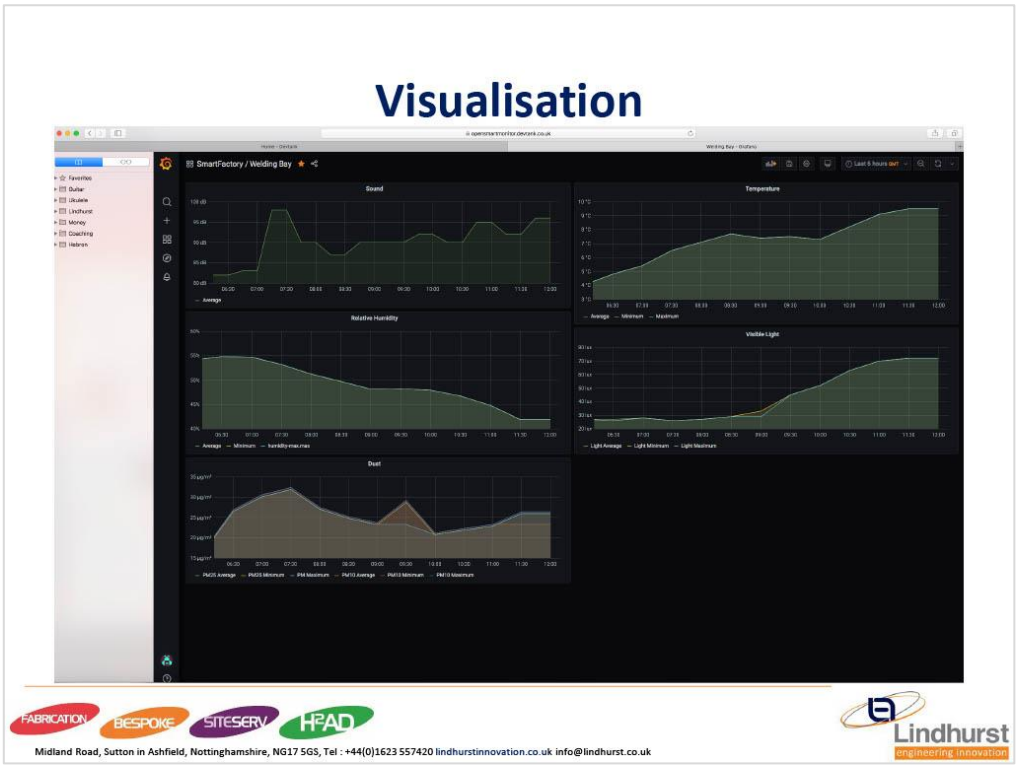


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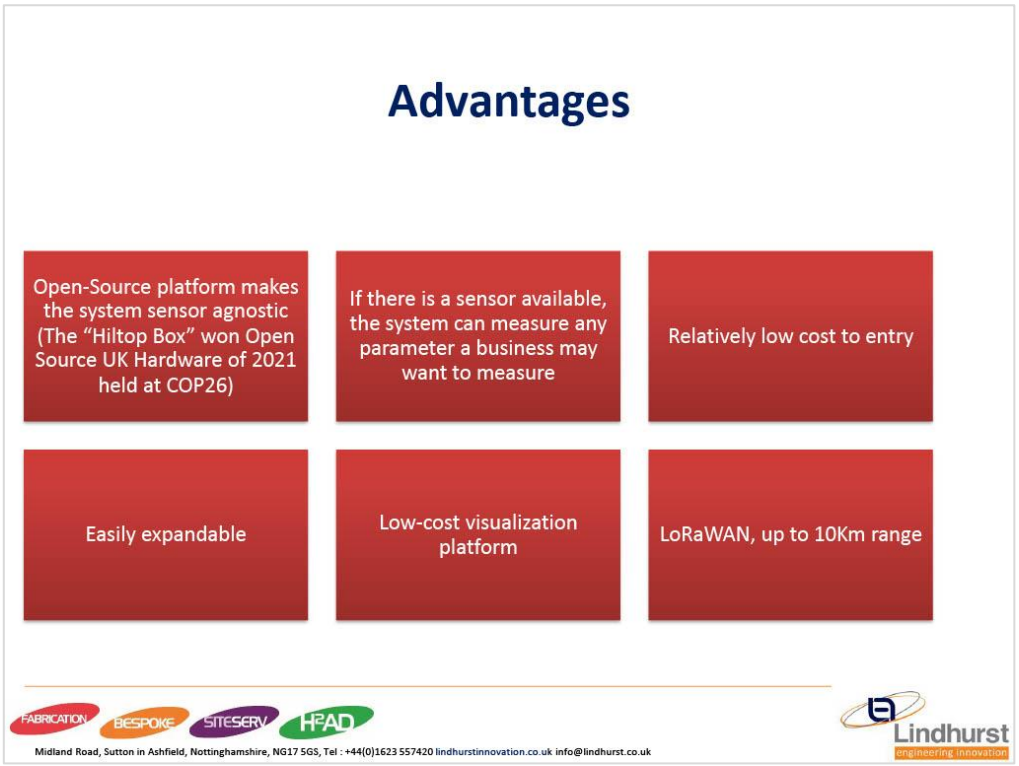
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Implementation
Sensors
Hiltop
Automation
E Mail or Text
SMS
Grafana
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Visualisation
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What Has It Told Us So Far
Profiling current demand showed us we were losing money with the working patterns we had
How we heated hot water for hand washing was very inefficient
Taps were not being switched off after hand washing
Drinks machine was still heating water during the night
We needed increased ventilation for certain activities we undertake
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Advantages
Open-Source platform makes the system sensor agnostic (The "Hiltop Box" won Open Source UK Hardware of 2021 held at COP26)
If there is a sensor available, the system can measure any parameter a business may want to measure
Relatively low cost to entry
Easily expandable
Low-cost visualization platform
LoRaWAN, up to 10Km range
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Next Steps For Lindhurst
Optomise automatic response to alarms and notifications; linking particulate sensing to existing ventilation system
Are there any other resource, environmental, health & safety or financial parameters we should be considering
Could we integrate our MRP & CRM system into the system, real time project QCD monitoring?
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On Going Work
DEVTANK
UNIVERSITY OF DERBY
DE-CARBONISE SMART FACTORY PROJECT
FABRICATION
BESPOKE
SITESERV
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What Could The Future Look Like

- AE Aerospace and its 'Glass Factory' – A window into the future of production: The Manufacturer 26th March 2021
- AE Aerospace will be the first UK SME to deploy a 5G private network, with the aim of dramatically improving your productivity.

aerospace

https://www.themanufacturer.com/articles/ae-aerospace-glass-factory-window-future-production/

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Thank You

Questions?

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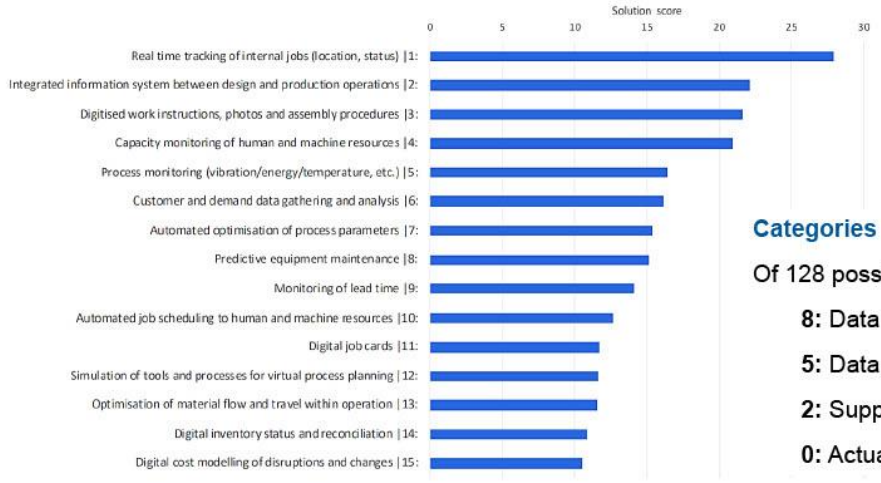

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5.2.3 Interactive Session Slides





SME Priorities



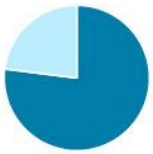
Categories

Of 128 possible solutions, in the top 15:

- **8:** Data Capture and Visualisation
- **5:** Data Analysis and Decision
- **2:** Support Systems
- **0:** Actuation

Digital Manufacturing on a Shoestring project
Low-Cost Digital Solutions for Manufacturing SMEs: Priority Solution Areas whitepaper
digitalshoestring.net

Challenges



77% of companies consider missing digital skills as the key hurdle to their Digital Transformation…

…59% of companies cite high investment and operating costs as a major obstacle.

- Saam et el 2016



Digitalisation is perceived as inaccessible to many companies, especially SMEs.

It is **complex**
It is **expensive**

How can we help with this?

"It's Expensive!"

Digitalisation may not be as expensive as you think.

- Start with small, low-risk solutions with simple business cases and build from there.
- Identify the enabling technologies you need – many solutions are free / open source.
- The Digital Shoestring project (soon to be foundation) has a wealth of information.
- digitalshoestring.net

Funding support is available.

- The UK government and the EU are pushing support for digitalisation.
- If you're looking to try out some digitalisation implementation, consider writing a proposal for support.
- Our business managers are always happy to advise.
- madesmarter.uk
- aerospaceup.com

"It's Complex!"



ConnectedFactories



EU Horizon2020 coordination and support action aiming to promote **easier take-up of digital technologies from research to real-world use cases** and **supporting the transfer of skills and know-how**.



Project Targets

- Supporting a **common understanding of key enablers and cross-cutting factors** influencing digital technologies and platforms for manufacturing.
- Identifying **pathways to the industrial take-up** of digital technologies and platforms.
- Situating **state-of-the-art cases**, key enablers and cross-cutting factors on pathways.
- Stimulating the matching of **skills** transfer offering with skills demand across Europe.
- **Engaging with research and industrial actors** in EU and local ecosystems of manufacturing.
- Generating a **broad awareness** about key enablers, cross-cutting factors, pathways and cases.



University of Nottingham

First, a few questions

PollEv.com/jackc003

Q1: What areas have you applied digital technologies to the most?

- Data Capture and Visualisation
- Data Analysis and Decision
- Manufacturing Support Systems
- Actuation
- We have not applied any digital technologies

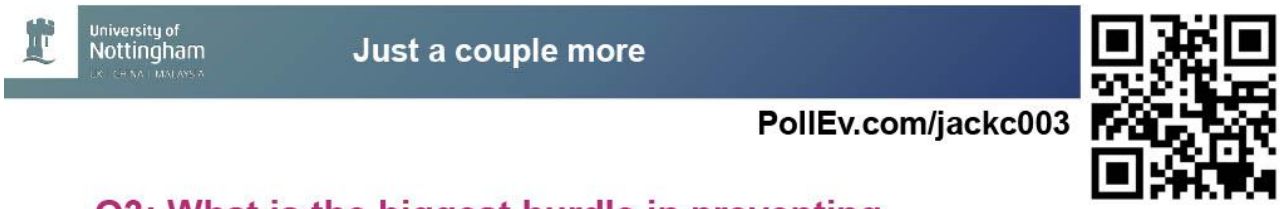
University of Nottingham

First, a few questions

PollEv.com/jackc003

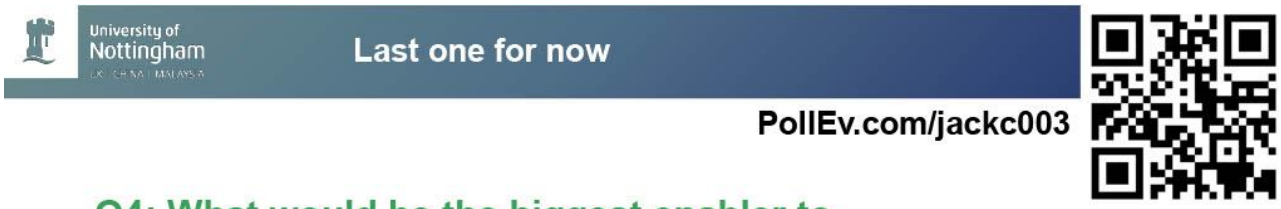
Q2: What areas would you like to apply digital technologies to more?

- Data Capture and Visualisation
- Data Analysis and Decision
- Manufacturing Support Systems
- Actuation
- We don't intend to apply any digital technologies



Q3: What is the biggest hurdle in preventing you from applying more digital technologies?

- Data Silos
- Digital Leadership / Direction
- Funding / Business Case
- Legacy Systems
- Risk or Perception of Risk
- Skills / Training
- Strategy in Supply Chain

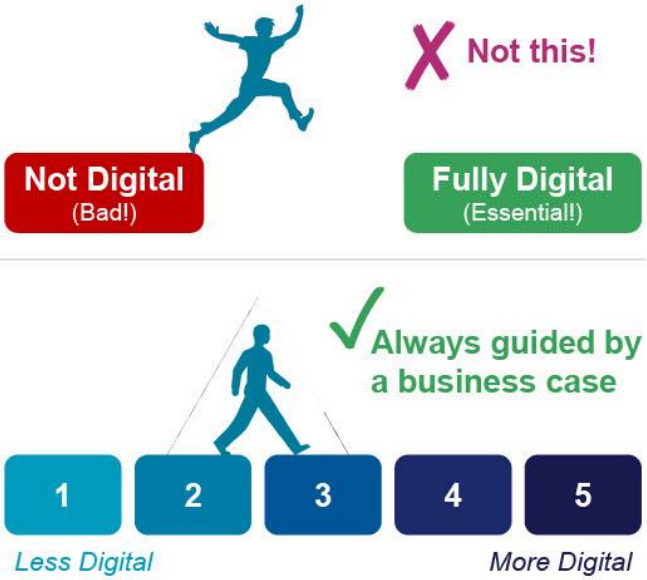


Q4: What would be the biggest enabler to accelerating your digital journey?

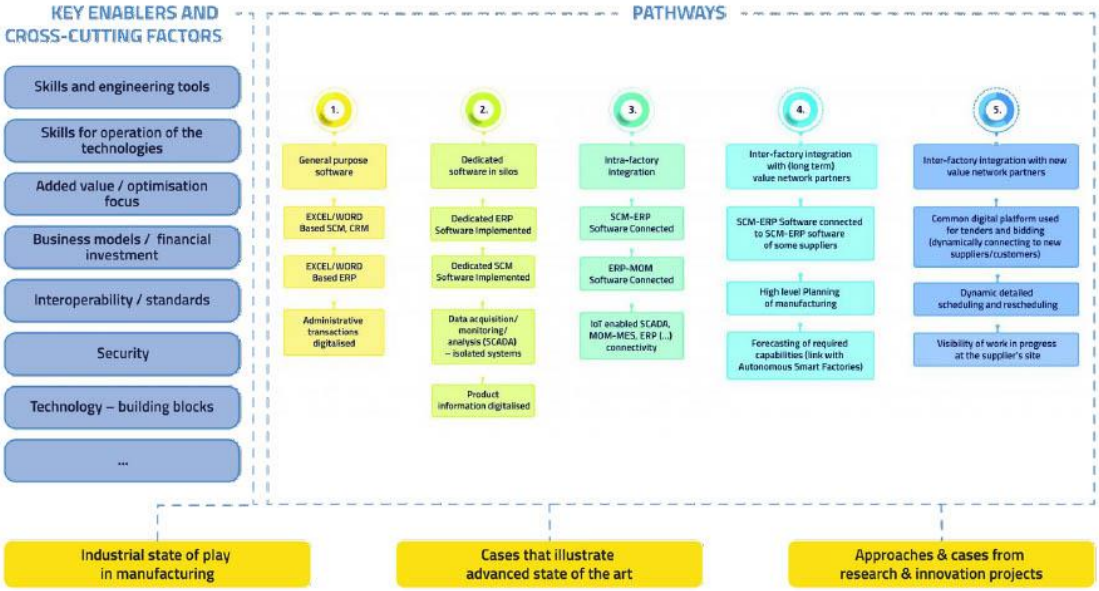
- Better Drive / Leadership
- Clear Direction and Guidance
- Financial Support
- Skills and Training
- Standards and Interoperability
- Time to Implement
- Unbiased Specific Advice

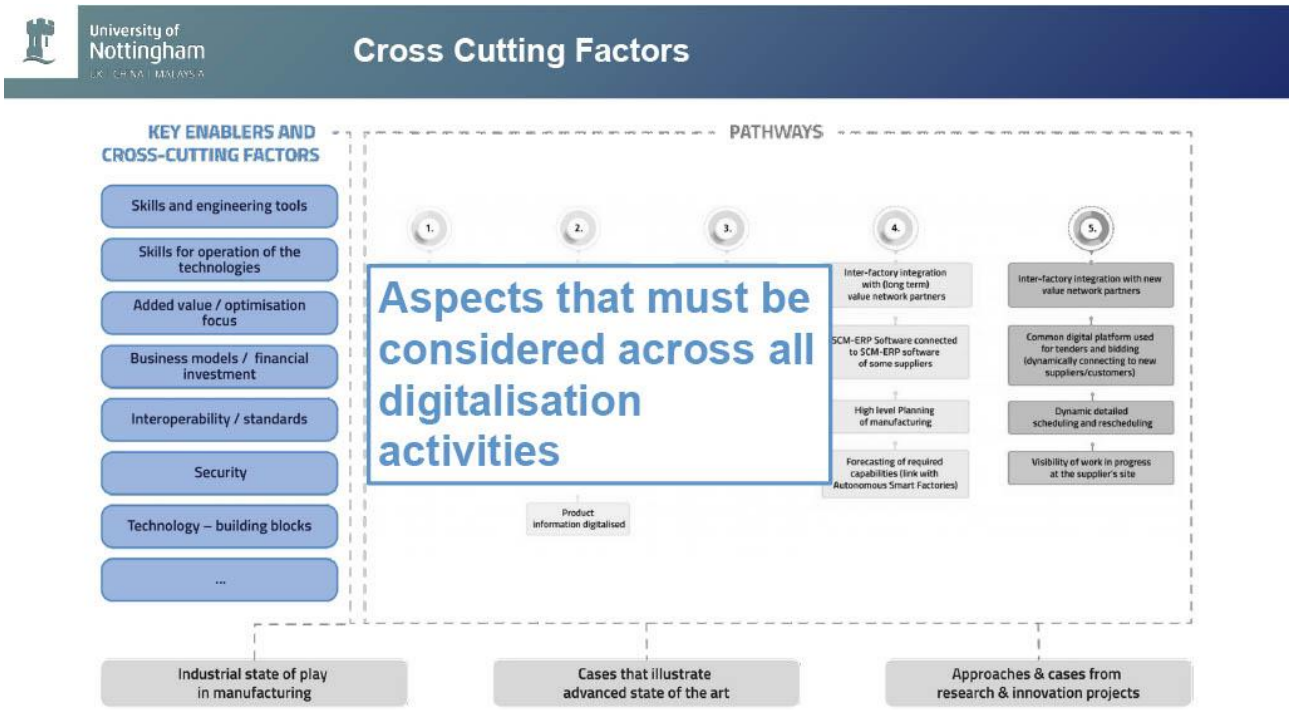
Digital Manufacturing Pathways

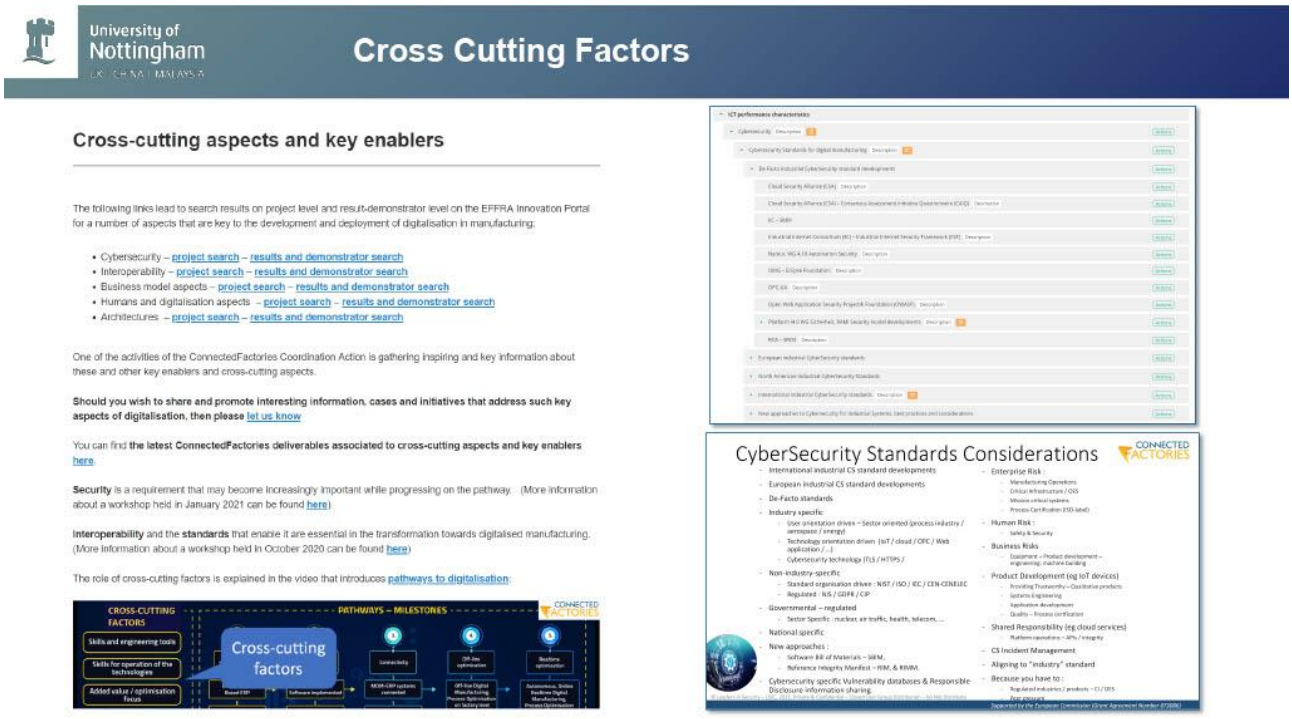
- **Pathways** are a key development in the ConnectedFactories project.
- Digitalising manufacturing is not a destination, **it is a journey**.
- The pathways aim to **show steps along this journey** so companies can identify their next steps.
- It's not about high levels being better and lower worse, it's about **identifying what is right for each company.**

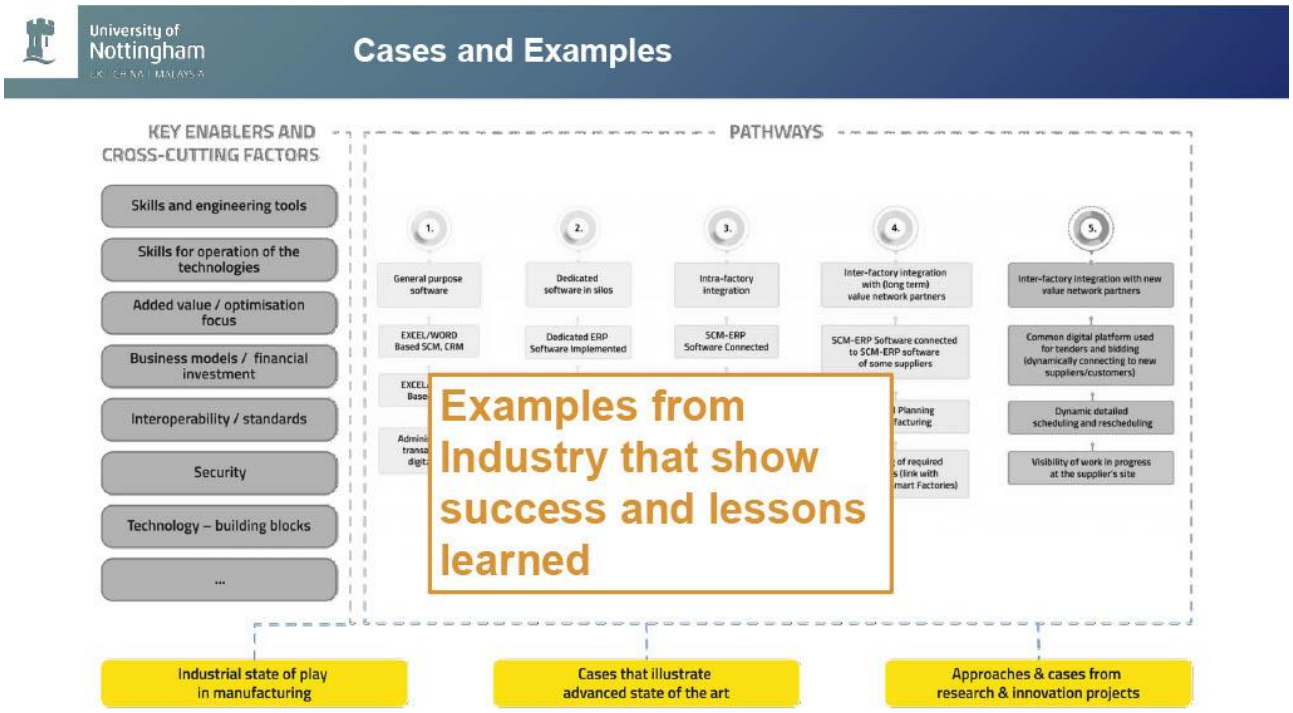


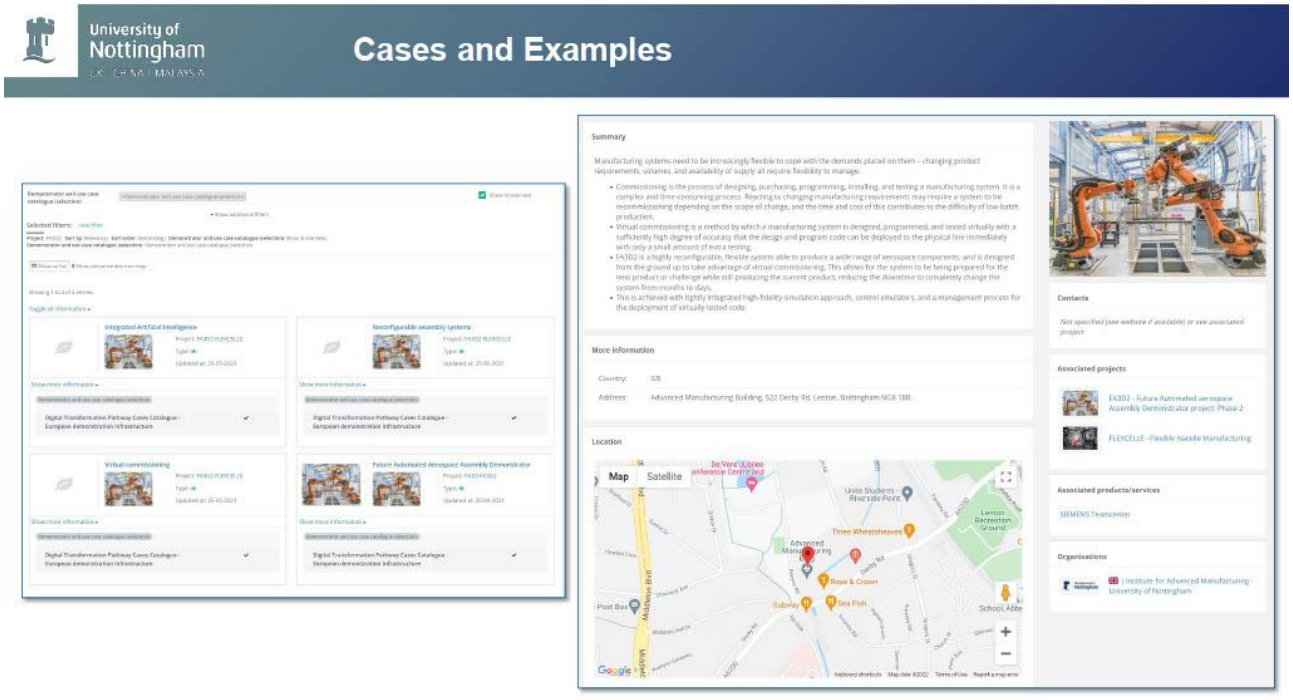
Hyperconnected Factories Pathway

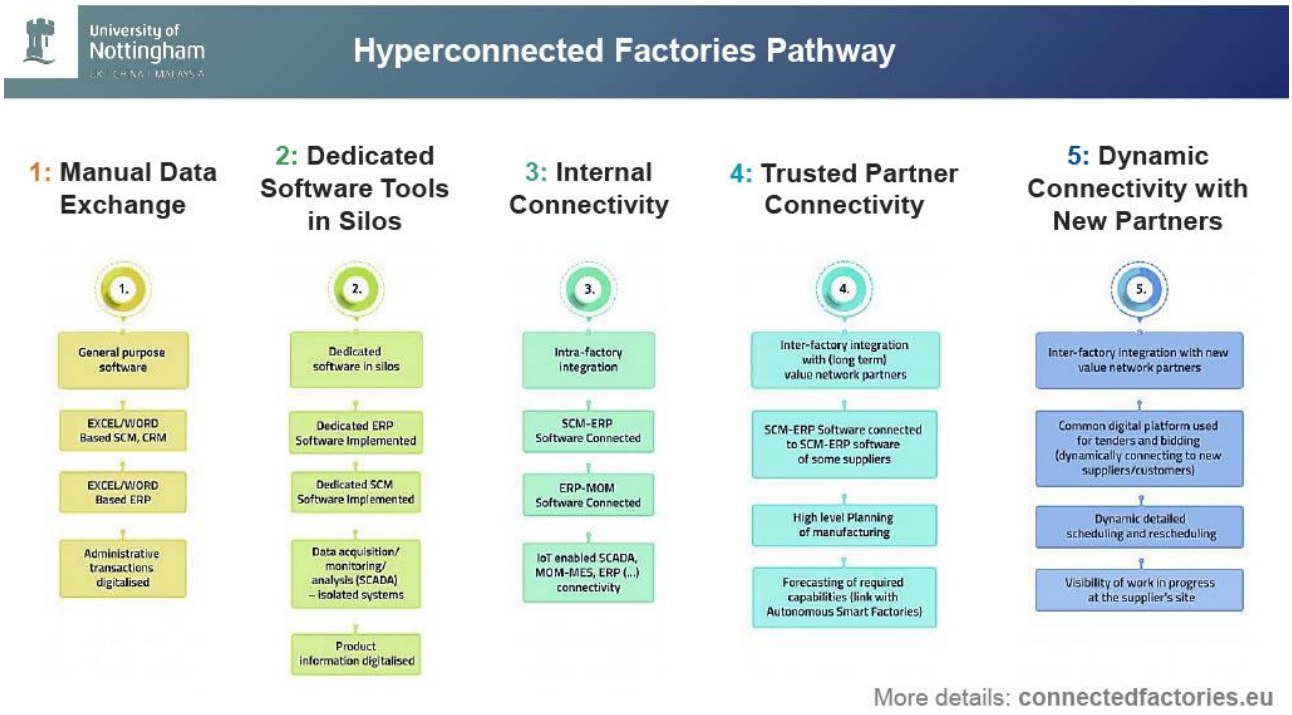


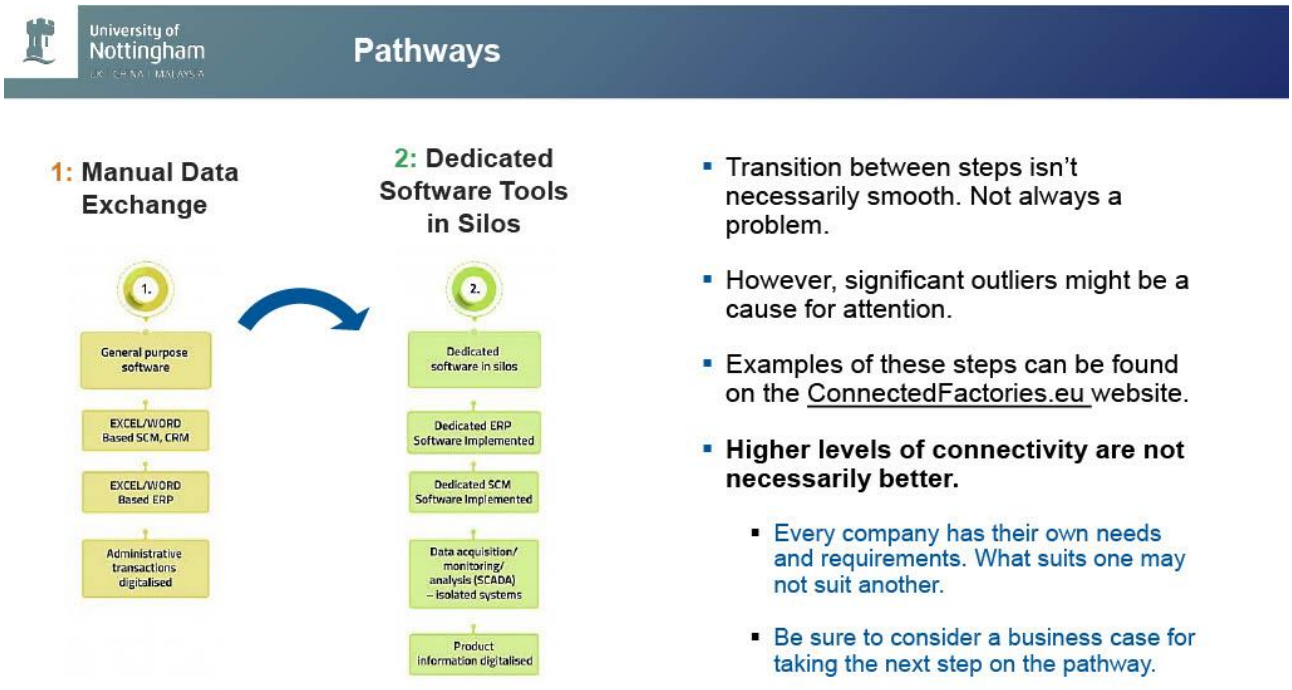

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Cross Cutting Factors
KEY ENABLERS AND CROSS-CUTTING FACTORS
Skills and engineering tools
Skills for operation of the technologies
Added value / optimisation focus
Business models / financial investment
Interoperability / standards
Security
Technology – building blocks
...
PATHWAYS
1.
2.
3.
4.
5.
Aspects that must be considered across all digitalisation activities
Inter-factory integration with (long term) value network partners
SCM-ERP Software connected to SCM-ERP software of some suppliers
High level Planning of manufacturing
Forecasting of required capabilities (link with Autonomous Smart Factories)
Inter-factory integration with new value network partners
Common digital platform used for tenders and bidding (dynamically connecting to new suppliers/customers)
Dynamic detailed scheduling and rescheduling
Visibility of work in progress at the supplier's site
Product information digitalised
Industrial state of play in manufacturing
Cases that illustrate advanced state of the art
Approaches & cases from research & innovation projects

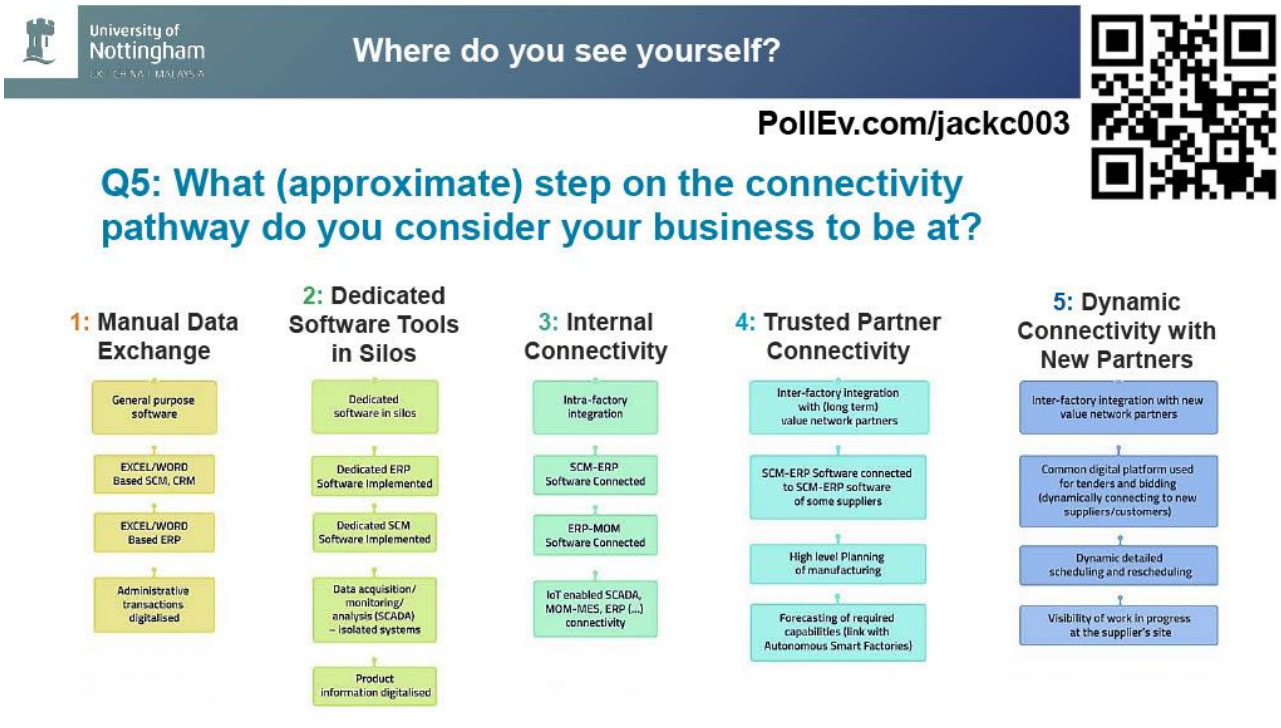

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Cross Cutting Factors
Cross-cutting aspects and key enablers
The following links lead to search results on project level and result-demonstrator level on the EFFRA Innovation Portal for a number of aspects that are key to the development and deployment of digitalisation in manufacturing:
Cybersecurity – project search – results and demonstrator search
Interoperability – project search – results and demonstrator search
Business model aspects – project search – results and demonstrator search
Humans and digitalisation aspects – project search – results and demonstrator search
Architectures – project search – results and demonstrator search
One of the activities of the ConnectedFactories Coordination Action is gathering inspiring and key information about these and other key enablers and cross-cutting aspects.
Should you wish to share and promote interesting information, cases and initiatives that address such key aspects of digitalisation, then please let us know
You can find the latest ConnectedFactories deliverables associated to cross-cutting aspects and key enablers here.
Security is a requirement that may become increasingly important while progressing on the pathway. (More information about a workshop held in January 2021 can be found here)
Interoperability and the standards that enable it are essential in the transformation towards digitalised manufacturing. (More information about a workshop held in October 2020 can be found here)
The role of cross-cutting factors is explained in the video that introduces pathways to digitalisation:
CROSS-CUTTING FACTORS
PATHWAYS – MILESTONES
Cross-cutting factors
CyberSecurity Standards Considerations

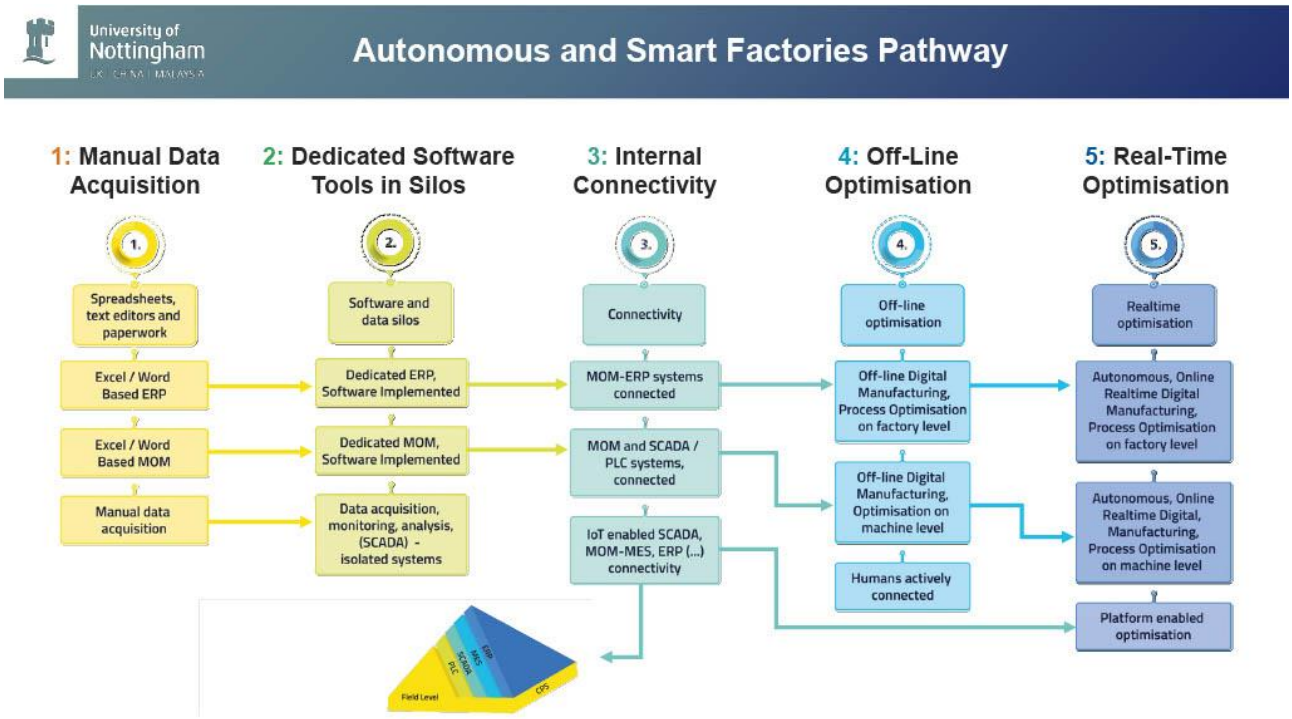

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Cases and Examples
KEY ENABLERS AND CROSS-CUTTING FACTORS
Skills and engineering tools
Skills for operation of the technologies
Added value / optimisation focus
Business models / financial investment
Interoperability / standards
Security
Technology – building blocks
...
PATHWAYS
1.
General purpose software
EXCEL/WORD Based SCM, CRM
2.
Dedicated software in silos
Dedicated ERP Software Implemented
3.
Intra-factory integration
SCM-ERP Software Connected
4.
Inter-factory integration with (long term) value network partners
SCM-ERP Software connected to SCM-ERP software of some suppliers
5.
Inter-factory integration with new value network partners
Common digital platform used for tenders and bidding (dynamically connecting to new suppliers/customers)
Dynamic detailed scheduling and rescheduling
Visibility of work in progress at the supplier's site
Examples from Industry that show success and lessons learned
Industrial state of play in manufacturing
Cases that illustrate advanced state of the art
Approaches & cases from research & innovation projects

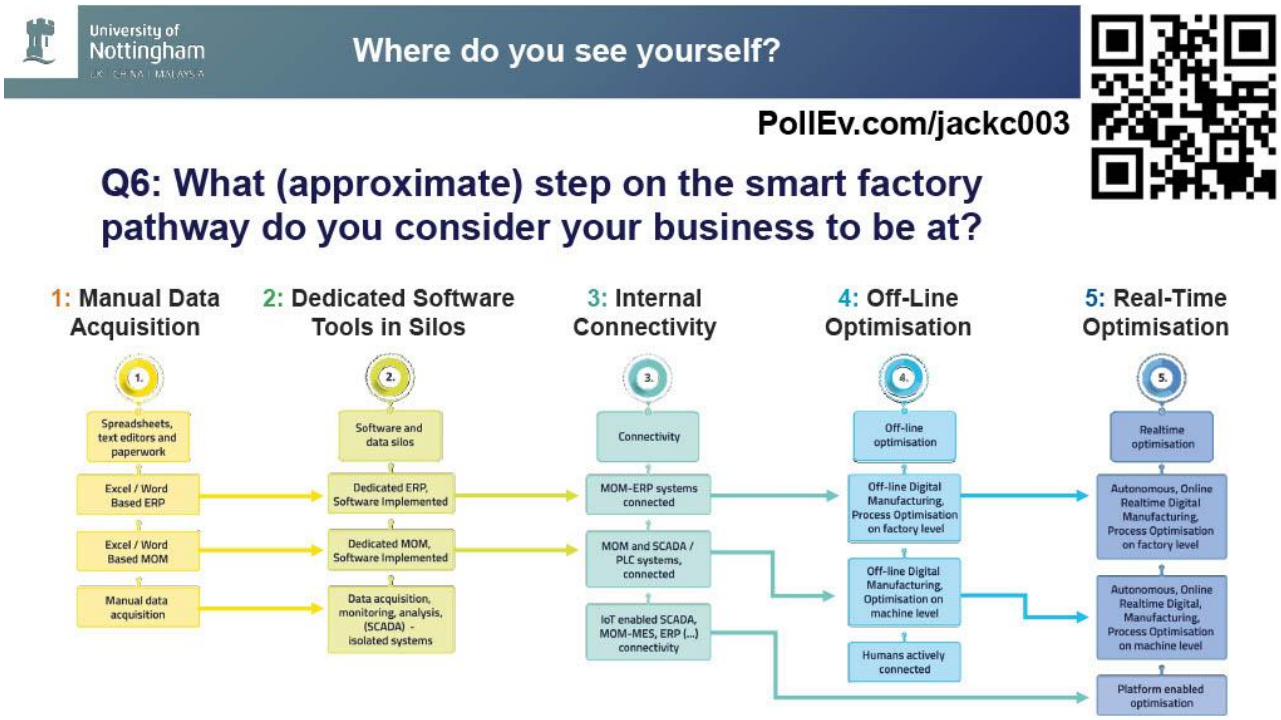

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Cases and Examples
Summary
More information
Location
Map
Satellite
Contacts
Associated projects
Associated products/services
Organisations


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Hyperconnected Factories Pathway
1: Manual Data Exchange
General purpose software
EXCEL/WORD Based SCM, CRM
EXCEL/WORD Based ERP
Administrative transactions digitalised
2: Dedicated Software Tools in Silos
Dedicated software in silos
Dedicated ERP Software Implemented
Dedicated SCM Software Implemented
Data acquisition/ monitoring/ analysis (SCADA) – isolated systems
Product information digitalised
3: Internal Connectivity
Intra-factory integration
SCM-ERP Software Connected
ERP-MOM Software Connected
IoT enabled SCADA, MOM-MES, ERP (...) connectivity
4: Trusted Partner Connectivity
Inter-factory integration with (long term) value network partners
SCM-ERP Software connected to SCM-ERP software of some suppliers
High level Planning of manufacturing
Forecasting of required capabilities (link with Autonomous Smart Factories)
5: Dynamic Connectivity with New Partners
Inter-factory integration with new value network partners
Common digital platform used for tenders and bidding (dynamically connecting to new suppliers/customers)
Dynamic detailed scheduling and rescheduling
Visibility of work in progress at the supplier's site
More details: connectedfactories.eu


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Pathways
1: Manual Data Exchange
General purpose software
EXCEL/WORD Based SCM, CRM
EXCEL/WORD Based ERP
Administrative transactions digitalised
2: Dedicated Software Tools in Silos
Dedicated software in silos
Dedicated ERP Software Implemented
Dedicated SCM Software Implemented
Data acquisition/ monitoring/ analysis (SCADA) – isolated systems
Product information digitalised
Transition between steps isn't necessarily smooth. Not always a problem.
However, significant outliers might be a cause for attention.
Examples of these steps can be found on the ConnectedFactories.eu website.
Higher levels of connectivity are not necessarily better.
Every company has their own needs and requirements. What suits one may not suit another.
Be sure to consider a business case for taking the next step on the pathway.

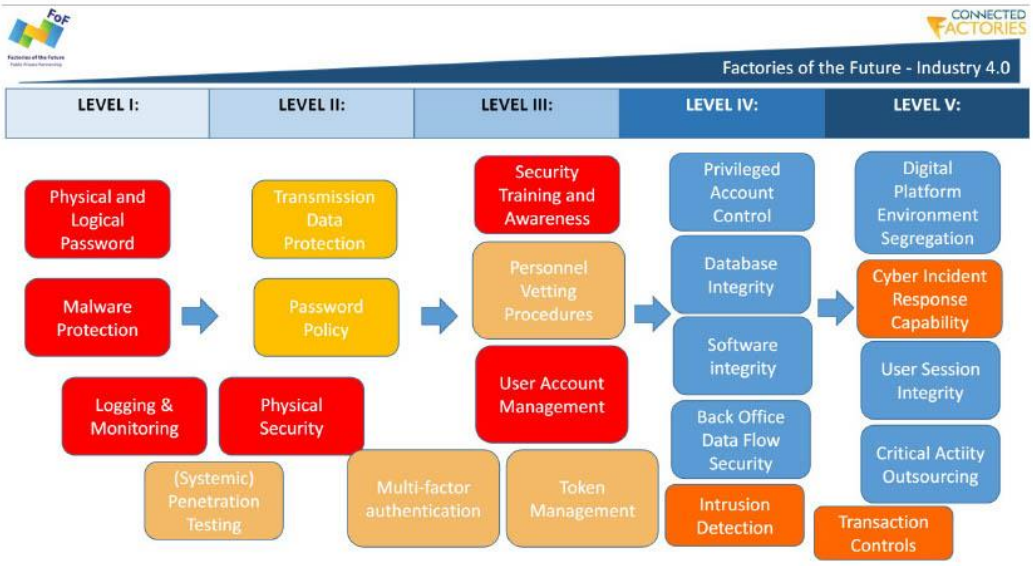

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Where do you see yourself?
PollEv.com/jackc003
Q5: What (approximate) step on the connectivity pathway do you consider your business to be at?
1: Manual Data Exchange
General purpose software
EXCEL/WORD Based SCM, CRM
EXCEL/WORD Based ERP
Administrative transactions digitalised
2: Dedicated Software Tools in Silos
Dedicated software in silos
Dedicated ERP Software Implemented
Dedicated SCM Software Implemented
Data acquisition/ monitoring/ analysis (SCADA) – isolated systems
Product information digitalised
3: Internal Connectivity
Intra-factory integration
SCM-ERP Software Connected
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IoT enabled SCADA, MOM-MES, ERP (...) connectivity
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High level Planning of manufacturing
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Inter-factory integration with new value network partners
Common digital platform used for tenders and bidding (dynamically connecting to new suppliers/customers)
Dynamic detailed scheduling and rescheduling
Visibility of work in progress at the supplier's site


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Autonomous and Smart Factories Pathway
1: Manual Data Acquisition
Spreadsheets, text editors and paperwork
Excel / Word Based ERP
Excel / Word Based MOM
Manual data acquisition
2: Dedicated Software Tools in Silos
Software and data silos
Dedicated ERP, Software Implemented
Dedicated MOM, Software Implemented
Data acquisition, monitoring, analysis, (SCADA) - isolated systems
3: Internal Connectivity
Connectivity
MOM-ERP systems connected
MOM and SCADA / PLC systems, connected
IoT enabled SCADA, MOM-MES, ERP (...) connectivity
4: Off-Line Optimisation
Off-line optimisation
Off-line Digital Manufacturing, Process Optimisation on factory level
Off-line Digital Manufacturing, Optimisation on machine level
Humans actively connected
5: Real-Time Optimisation
Realtime optimisation
Autonomous, Online Realtime Digital Manufacturing, Process Optimisation on factory level
Autonomous, Online Realtime Digital, Manufacturing, Process Optimisation on machine level
Platform enabled optimisation
ERP
MES
SCADA
PLC
Field Level
CPS


University of Nottingham
Where do you see yourself?
PollEv.com/jackc003
Q6: What (approximate) step on the smart factory pathway do you consider your business to be at?
1: Manual Data Acquisition
2: Dedicated Software Tools in Silos
3: Internal Connectivity
4: Off-Line Optimisation
5: Real-Time Optimisation
Spreadsheets, text editors and paperwork
Excel / Word Based ERP
Excel / Word Based MOM
Manual data acquisition
Software and data silos
Dedicated ERP, Software Implemented
Dedicated MOM, Software Implemented
Data acquisition, monitoring, analysis, (SCADA) - isolated systems
Connectivity
MOM-ERP systems connected
MOM and SCADA / PLC systems, connected
IoT enabled SCADA, MOM-MES, ERP (...) connectivity
Off-line optimisation
Off-line Digital Manufacturing, Process Optimisation on factory level
Off-line Digital Manufacturing, Optimisation on machine level
Humans actively connected
Realtime optimisation
Autonomous, Online Realtime Digital Manufacturing, Process Optimisation on factory level
Autonomous, Online Realtime Digital, Manufacturing, Process Optimisation on machine level
Platform enabled optimisation


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Other Pathways: Collaborative Product-Service Factories
Moving towards a service-orientated business model.
PATHWAY - COLLABORATIVE PRODUCT-SERVICE FACTORIES
Product, no Service
CAD Systems
PDM Systems
Product and disjoint Service
PLM Systems (integration of CAD and PDM)
CRM Systems
Service-enabled Product Design
Voice of Suppliers Customers / Users
Service orient. Product Design (integration of PLM and CRM)
Product Service Innovation
Closed loop PSS Design (Connected to user's data)
Service Innovation and new Business Models
Product Service Symbiotic Evolution
Digital Platforms for next generation PS Systems lifecycle management
Product-Oriented Organizations based on highly qualified professional knowledge for design-manufacturing
Products are considered along their own lifecycle. Complex Interactions between Lifecycles considered
PSS Design Engineering open to customers and final users. Advanced services integrated
Manufacturing companies integrate innovative services in their value proposition
PSSs induce Digital transformations at all levels: technical organizational and procedural. Collaborative PS Factories

Coming Soon! – Cybersecurity Pathway

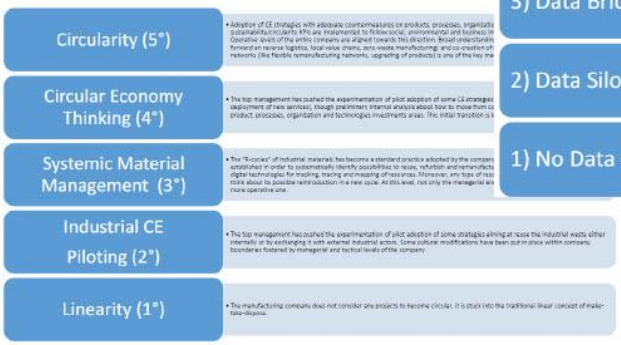


Coming Soon!

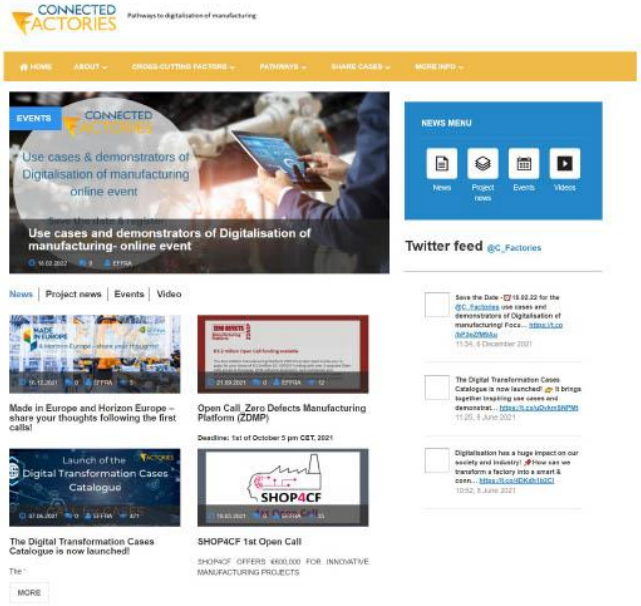
Data Spaces



Circular Economy

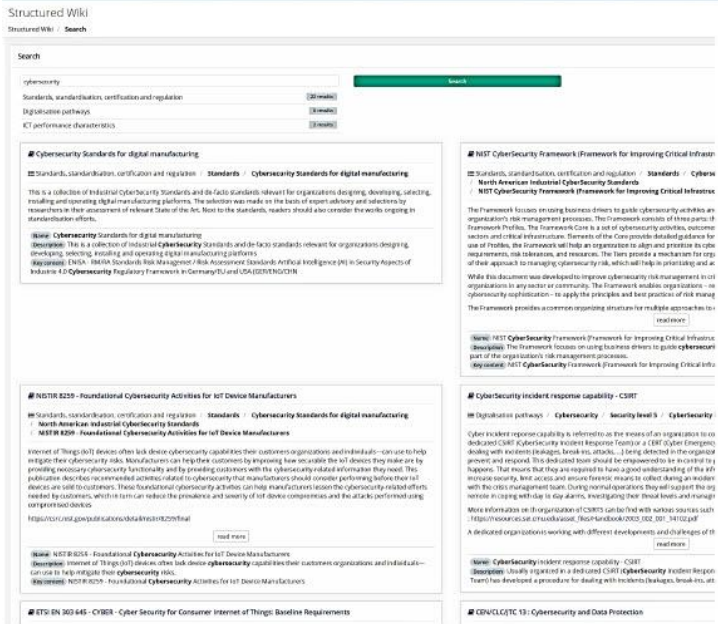


Connected Factories – connectedfactories.eu



- Home for the pathways, cases, and guidance on their use.
- Information on EU digital manufacturing events.
- Information on EU digital manufacturing projects and funding calls.

Structured Digital Manufacturing Wiki – portal.effra.eu



- Additional pathways and cross-cutting factors information.
- Taxonomy and key concepts for digital manufacturing.
- Research projects and their results.
- Use cases and demonstrations of digital manufacturing technologies.
- People and organisations dealing with digital manufacturing.
- Currently being overhauled!

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Digital Manufacturing on a Shoestring – digitalshoestring.net

Low-cost, low risk digitalisation solutions.

Designed to encourage people to use and develop their technical digital skills in manufacturing.

	Low Cost	Simple
Equipment and Technologies	Off-the-shelf technologies / openly available software.	Common interfaces.
Development	Reusable approaches.	Building block approach. Prioritised solutions.
Deployment	Stand-alone solutions.	Simple IT environment needed.



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Digit-T – digit-t.eu

Open-source digital manufacturing training for SMEs

High level overview of what's available and what's changing.

Management in Industry 4.0
- Fundamental Concepts of I4.0
- Towards an Intelligent and Connected Industry
- Human Resource Management in I4.0

Advanced Manufacturing Systems
- Manufacturing Systems Strategies
- Manufacturing Systems Modelling and Simulation
- Sensing and Data Collection
- Manufacturing Data Analysis and Decision Making

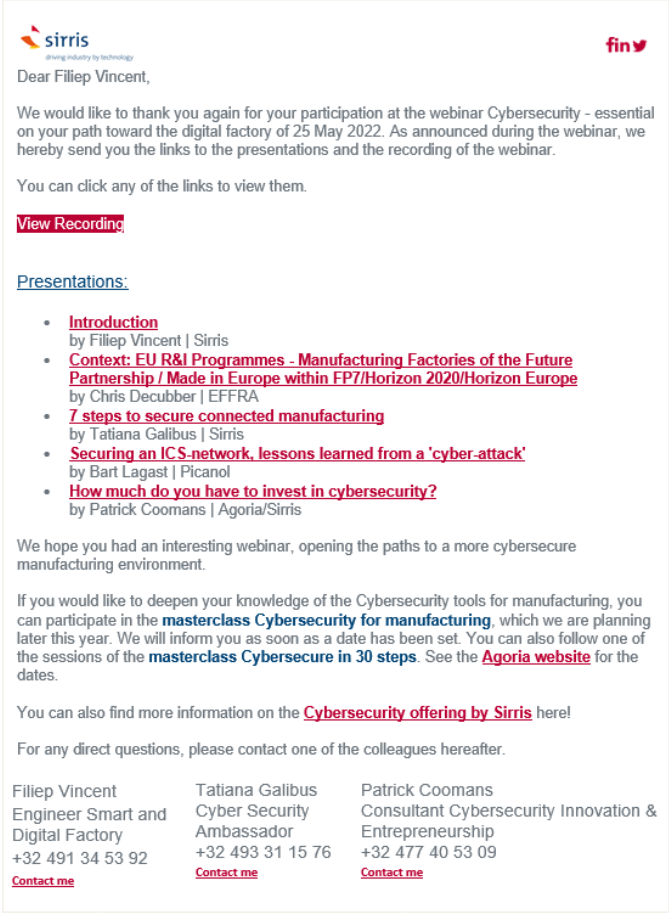
Intelligent Robotics
- Industrial and Collaborative Robots
- Sensors, Actuators, and Control Systems
- Advanced Robotics



5.3 Sirris Workshop

5.3.1 Thank you email

All participants received an email containing the links to the presentation handouts and the recording of the webinar:



sirris

Dear Filiep Vincent,

We would like to thank you again for your participation at the webinar Cybersecurity - essential on your path toward the digital factory of 25 May 2022. As announced during the webinar, we hereby send you the links to the presentations and the recording of the webinar.

You can click any of the links to view them.

View Recording

Presentations:

- Introduction
  by Filiep Vincent | Sirris
- Context: EU R&I Programmes - Manufacturing Factories of the Future Partnership / Made in Europe within FP7/Horizon 2020/Horizon Europe
  by Chris Decubber | EFFRA
- 7 steps to secure connected manufacturing
  by Tatiana Galibus | Sirris
- Securing an ICS-network, lessons learned from a 'cyber-attack'
  by Bart Lagast | Picanol
- How much do you have to invest in cybersecurity?
  by Patrick Coomans | Agoria/Sirris

We hope you had an interesting webinar, opening the paths to a more cybersecure manufacturing environment.

If you would like to deepen your knowledge of the Cybersecurity tools for manufacturing, you can participate in the **masterclass Cybersecurity for manufacturing**, which we are planning later this year. We will inform you as soon as a date has been set. You can also follow one of the sessions of the **masterclass Cybersecure in 30 steps**. See the **Agoria website** for the dates.

You can also find more information on the **Cybersecurity offering by Sirris** here!

For any direct questions, please contact one of the colleagues hereafter.

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Contact me

Tatiana Galibus
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Contact me

Patrick Coomans
Consultant Cybersecurity Innovation & Entrepreneurship
+32 477 40 53 09
Contact me

Figure 157: Thank you email with weblinks to presentation handouts and workshop recording

5.3.2 Weblinks to handouts and recording

Workshop recording: recording

Presentation handouts:

- Introduction
  by Filiep Vincent | Sirris
- Context: EU R&I Programmes - Manufacturing Factories of the Future Partnership / Made in Europe within FP7/Horizon 2020/Horizon Europe
  by Chris Decubber | EFFRA
- 7 steps to secure connected manufacturing
  by Tatiana Galibus | Sirris
- Securing an ICS-network, lessons learned from a 'cyber-attack'
  by Bart Lagast | Picanol
- How much do you have to invest in cybersecurity?
  by Patrick Coomans | Agoria/Sirris