SMART INDUSTRIAL INNOVATION AS ENABLER TO DRIVE NEW VALUE CHAINS FOR TEXTILES AND AEROSPACE

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1. INTRODUCTION

The manufacturing industry is a strong asset of the European economy, accounting for 2 million enterprises and 28,5 million jobs. Europe's competitiveness is highly dependent on the ability of this sector to deliver high-quality innovative products using the latest advances, particularly in Information and Communication Technologies (ICT). Industrial production remains a key driver for innovation, economic growth and job creation in Europe. However, European leadership in many important sectors is constantly challenged by global competitors. European factories of the future need to deal with competitive pressures and incorporate new technologies, applications and services in order to remain competitive and regain European leadership[1].

While some sectors have made significant progress in the industry 4.0 (particularly automotive and electronics production sector), some other industrial sector are still lagging behind. Textile and aerospace sectors face similar challenges in the incorporation of advanced manufacturing technologies as cornerstone for digitalization and bringing in industrial intelligent system into productive environment. With this study, within the framework of the GALACTICA project, we aim at developing knowledge on the European manufacturing sector and the strategic technologies necessary to reach the factory of the future, especially for the textile and aerospace sectors. Furthermore, we will exploit the results of a survey ran in each sector to identifies barriers, drivers and topics of interest for the development of collaboration and new value chains between companies and organizations of the three involved sectors.

2. THE MANUFACTURING SECTOR IN EUROPE

2.1 GENERAL OVERVIEW

Eurostat definition of Manufacturing:

Manufacturing includes the physical or chemical transformation of materials, substances, or components into new products. The raw materials are products of agriculture, forestry, fishing, mining or quarrying as well as products of other manufacturing activities. Substantial alteration, renovation or reconstruction of goods is generally considered to be manufacturing. Selling to the general public products that have been made on the same premises from which they are sold, such as bakeries and custom tailors, is also included in manufacturing rather than retailing.

Manufacturing units may process their own materials, subcontract a part of the processing of their own materials, own legal rights and concepts of the product but subcontract the whole processing, or carry out the aforementioned subcontracted processes. Assembly of the component parts (whether self-produced or purchased) of manufactured products is also considered manufacturing. The output of a manufacturing process may be finished in the sense that it is ready for use or

[1] https://ec.europa.eu/digital-single-market/en/smart-manufacturing

consumption, or it may be semi-finished in the sense that it is to become an input for further manufacturing.

Europe is home to a competitive, wealth-generating manufacturing industry and of extremely comprehensive manufacturing ecosystems which accommodate complete manufacturing supply chains. Europe's manufacturing industry is the backbone of the European economy, bringing prosperity and employment to citizens in all regions of Europe[2].

The EU is a global market leader for high-quality products, and European Industry is the world's biggest exporter of manufactured goods. EU exports consist mainly of manufactured products: their share has annually been more than 80 % of total EU exports. In 2019, manufactured goods made up 83 % of all EU exports. Between 2002 and 2019, exports of manufactured goods increased by EUR 900 billion, from EUR 865 billion to EUR 1 765 billion. This was equivalent to an average annual growth rate of 4.3 %[3].

The manufacturing sector employed more than 28.5 million people and almost 2 million enterprises were classified as manufacturing in the EU in 2017.

Around 1 in 10 (8.8 %) of all enterprises in the EU-27's non-financial business economy were classified to manufacturing in 2017, a total of almost 2.0 million enterprises. The manufacturing sector employed 28.5 million persons in 2017 and generated EUR 1 820 billion of value added. By these two measures, manufacturing was **the second largest sector in terms of its contribution to employment** (22.8 %) and the **largest contributor to non-financial business economy value added**, accounting for more than one quarter of the total (29.3 %).

The gross operating rate (the relation between the gross operating surplus and turnover) was 9.8 % for the EU's manufacturing sector in 2017, below the 10.1 % average for the non-financial business economy, and as such this sector had the **second lowest level of profitability** (using this measure) among any of the NACE[4] sections within the non-financial business economy.

At the NACE division level the manufacturing sector is composed of 24 different subsectors. The largest subsectors in 2017 in terms of value added were the manufacture of machinery and equipment and manufacture of motor vehicles, trailers and semi-trailers, while in terms of employment manufacture of food products and the manufacture of fabricated metal products, except machinery and equipment were the largest.

[2] MADE IN EUROPE, The manufacturing partnership in Horizon Europe, 2020.
[3] Eurostat
[4] Statistical Classification of Economic Activities in the European Community

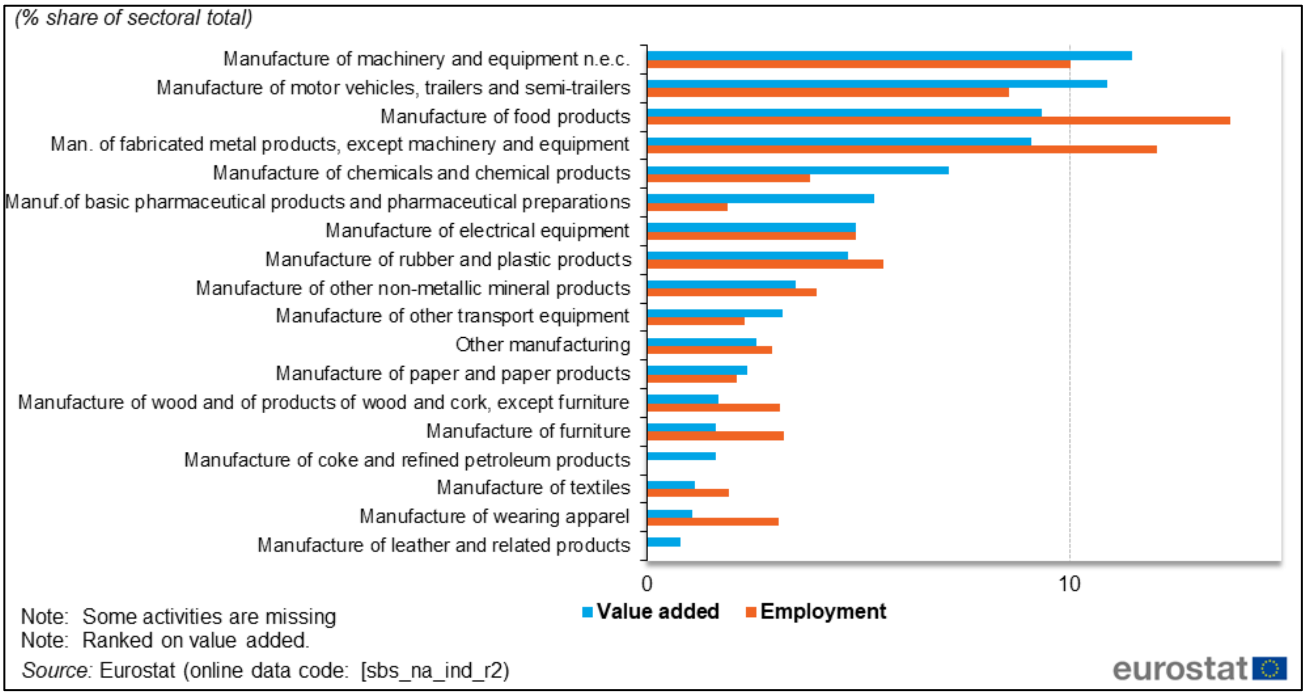


Figure 1: Sectoral analysis of Manufacturing (NACE Section C), EU-27, 2017, Eurostat.

We can see here that the textile sector has one of the lowest value-added of the European sectors, showing the need for new technologies and processes to increase competitiveness.

SMEs are the backbone of manufacturing industry in Europe. **Micro, small and medium enterprises provide around 40 % of the value added by manufacturing while they provide around 55 % of manufacturing employment in 2017**[5].

	Number of enterprises	Number of persons employed	Value added	Apparent labour productivity
	(thousands)		(EUR million)	EUR thousand per head
All enterprises	1 964.9	28 531.9	1 820 000.0	63.8
All SMEs	1 949.4	15 803.0	701 981.4	44.4
Micro	1 635.8	3 699.8	105 712.1	28.6
Small	248.4	5 196.3	226 004.3	43.5
Medium-sized	65.2	6 906.9	370 265.0	53.6
Large	15.4	12 700.0	1 120 000.0	88.2

Note: For confidentiality issues rounded or calculated figures have been used. The sum of all categories does not equal the total of all enterprises due to estimated values with lower reliability.

Source: Eurostat (online data code: sbs_sc_sca_r2)

Figure 2: Key size class indicators, Manufacturing (NACE Section C), EU-27, 2017, Eurostat.

[5] Manufacturing statistics - NACE Rev. 2

2.2 COVID IMPACT

In September 2020, industrial production in the EU-27 remained unchanged compared with the previous month. In August, July, June, and May, industrial production had increased by 0.9 %, 5.1 %, 9.6 % and by 11.7 % respectively, after severe decreases in April (-18.2 %) and March (-10.7 %). The total loss of industrial production between February and April amounted to 27.0 %. Since April, industrial production has increased by 29.9 %.

Figure 3 shows the 2020 development in industrial production for total industry and the various main industrial groupings, i.e. intermediate goods, capital goods, energy, durable and non-durable consumer goods.

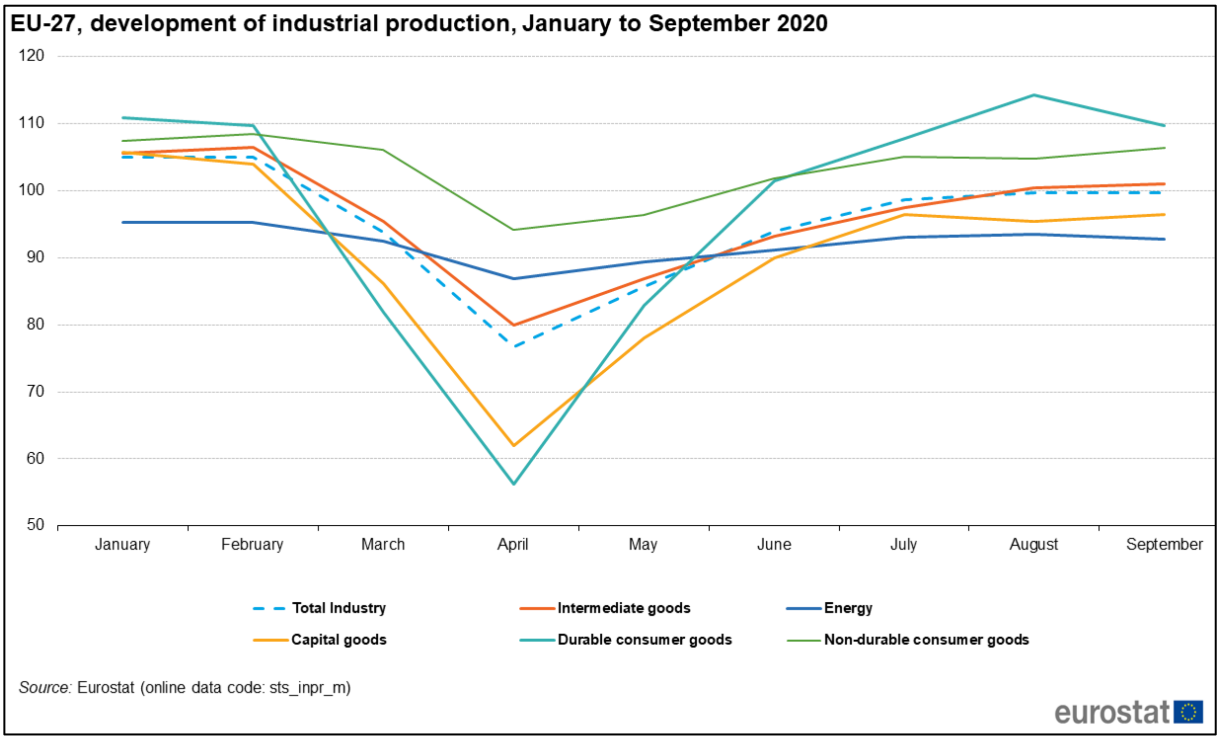


Figure 3: Industrial production in 2020, Eurostat.

Although industry have been more or less severely affected by the Covid-19 crisis, depending on their ability to transform their production and their dependence to one sector or one main clients (e.g. many industries and suppliers working for the aerospace sector were heavily affected); the pandemic had a global negative impact on production and sever economic consequences.

It is now more important than ever to reinforce industry resilience and competiveness, though new technologies. "In the last century, we often thought about technology as enablement, as the back office, as something that we use to support our businesses. In this century—and certainly, post COVID-19—technology's going to be very much in the front. It will be the competitive differentiator for how all businesses and ecosystems work."[6]

The COVID-19 crisis has shown how important it is for the EU to reinforce its industrial capacity and its sovereignty while developing more flexible and resilient industry, able to absorb the market shocks.

2.3 R&D ACTIVITIES IN MANUFACTURING

Manufacturing is an indispensable element of the innovation chain: manufacturing enables technological innovations to be applied in goods and services, which are marketable in the marketplace and is key to making new products affordable and accessible so as to multiply their societal and economic benefits and achieve the desired impacts. Manufacturing is an RD & I-intensive activity[7].

The manufacturing sector is greatly important because of its major role in driving productivity and innovation. An hour of work in manufacturing generates nearly € 32 EUR of added value. With a share of approximately 16% of total value added, manufacturing is responsible for 64% of private-sector R&D expenditure and for 49% of innovation expenditure[8].

3. FACTORY OF THE FUTURE AND KEY TECHNOLOGIES

3.1 FACTORY OF THE FUTURE ROADMAP

We cannot talk about manufacturing in Europe, without mentioning the 4th industrial revolution and the advanced manufacturing technologies that are allowing this revolution. Advanced manufacturing technologies are the tools able to transform an industry into an industry 4.0, or so called "factory of the future" by the European Commission.

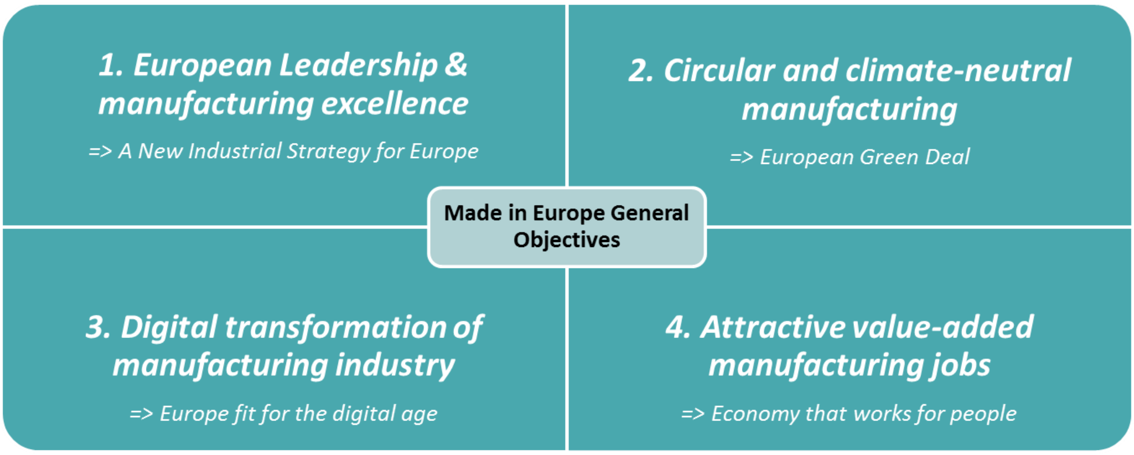
Fourth Industrial Revolution technologies, such as the internet of things, artificial intelligence, wearables, robotics and additive manufacturing, are spurring new production techniques and business models that will fundamentally transform global production systems.

[6] Lareina Yee, McKinsey senior partner, the technology industry in 2020 and beyond, video transcript, 2020.
[7] Factory of the Future, Multi-annual roadmap for the contractual PPP under Horizon 2020
[8] Dröll, Peter, and Luca Polizzi. 2018. "Re-Finding Industry: Report from the High-Level Strategy Group on Industrial Technologies." In Brussels, Belgium: European Commission. https://ec.europa.eu/research/industrial_technologies/pdf/re_finding_industry_022018.pdf

Advanced manufacturing technologies will generate growth and bring benefits beyond the factory itself. It has been estimated that they will potentially deliver up to $3.7 trillion[9] in value for the global economy, offering new products and services to society.

European manufacturing is at the centre of a twin ecological and digital transition, being both driver and subject to these changes. European industry is also facing increasing competition and manufacturing companies must maintain technological leadership and stay competitive. The size and the complexity of the associated challenges[10] -such as the integration of Artificial Intelligence, the use of industrial data, the transformation into a circular economy and the need for agility and responsiveness requires companies' support and trans-national cooperation.

To support the transition toward factory of the futures, 4 main objectives have been defined by the European Factory of the Future Research Association (EFFRA) in the future European public private partnership for manufacturing, Made in Europe. These 4 General Objectives are aligned with the EU's political priorities addressing manufacturing industries:



1. **International Industrial performance**

The challenge is to control cost, quality and timing in production, allowing European industries to stay competitive. This global objective aims to reach excellence in manufacturing though innovation for production and industrialization.

Excellent and responsive production combines speed, precision, quality and reliability with flexibility and agility. Manufacturing companies need to produce from very small lot-sizes to big volumes and there is a growing need for the ability to quickly scale up from small to big lot-sizes whilst retaining the required quality in zero-defect and first-time-right production. The manufacturing industry needs to respond quickly to market disruptions, changing customer demands, fluctuating characteristics of raw materials and components, and advanced emerging technologies that can be potential

[9] McKinsey, "How to achieve and sustain the impact of digital manufacturing at scale", June 2017. Available at ht tps://www.mckinsey.com/business-functions/operations/our-insights/how-to-achieve-and-sustain-the-impact-of-digital-manufacturing-at-scale.

[10] Made In Europe, consultation version, June 2020

differentiators. Simultaneously, the manufacturing industry needs to increase quality and efficiency and reduce Total Cost of Ownership. Hence, upgradable and robust manufacturing systems and plants are necessary for flexible, responsive and resilient manufacturing. Here, Artificial Intelligence, advanced Robotics and other digital technologies will help[11].

2. **Sustainable manufacturing**

The challenge is to take into account environmental and societal constraint in the manufacturing process. The major ambition is to reduce environmental footprint, in particular through optimizing processes and equipment energy efficiency, reinforcing and developing the recycling and waste treatment sector and develop circular economy approaches.

Manufacturing industries should exploit the possibilities offered by advanced materials, digital technologies and manufacturing technologies to achieve a considerable reduction of the ecological impact and CO2-emissions. At an ecosystem level, recycling and re-use of materials and components will be increased while still raising the performance of the manufactured products[12].

3. **Digital manufacturing**

The challenge is to foster industry transformation through digital technologies. Digitization represent a major opportunity, in every part of the value chain, allowing production system to become agile, interconnected, smart, vertically integrated (with every internal services) as well as horizontally integrated (connecting the value chain actors, such as suppliers, clients,...). Digitization enables better traceability and speeds up the time to market while adapting to demands fluctuation (personalization and volume). The ambition with digitization is to progress in digital platform and new reliable architecture to foster exchange as well as real time data management on the overall value chain. Cybersecurity and data protection are also crucial issues when implementing new digital technologies. Smart and connected product, that communicate with users, and new business models based on data exploitation are expected to grow.

The increasing complexity of products, growing sustainability requirements, and the increasing innovation rate require that product design and engineering are carried out in parallel with manufacturing system engineering and configuration. In this context, the notion of Digital Twinning plays a role, where for each product design and each manufactured product a virtual/digital representation is maintained.

In the future, excellent and smart factories can fully offer and deploy their capabilities in dynamic and sustainable manufacturing ecosystems where digitalisation delivers new ways to interact with customers, consumers, and users. While products become more and more customised, the end-to-end integration of manufacturing networks is important, including logistics, which is a critical factor for unleashing the potential of very flexible distributed production[13].

[11] Ibid
[12] Ibid
[13] Ibid

4. A human factory

The challenge for industries is to consider at an early stage operators' acceptability for new technologies and accelerate their adoption in the factory. Operators are key in the development of a company, their innovation capacity, creativity and performances are a strong factor for industry to gain in competitiveness.

Humans are at the core of the innovation process, increasingly supported by data analytics and decision support systems. Innovation is a process where different processes and disciplines (technological and non-technological) converge into concrete solutions and implementations. Design and development of advanced technologies will consider the role of the workforce at the earliest stages and will consider the available or required additional skills of the people involved. The full benefit of new tools based on advanced technologies can only be achieved by designing new work practices and by involving employees in the co-design.

The implementation of innovative solutions is often subject to reluctance, either associated with potential failure or because decision-makers and/or the workforce are faced with the unknown. Change management approaches are required to provide clear insights into the risks and benefits that are associated with change while involving all stakeholders in the process. This should also be associated with anticipating the required skills[14].

It is therefore crucial to explore new technological solutions and management methodologies to:

- Facilitate access to knowledge and accelerate gain in experience,
- Exploit new technology to increase physical, sensory, communication and cognitive capacity,
- Foster implication, innovation and motivation.

The combination of these 4 major objectives for the factory of the future, lead to a vision for the European industry in 2030 that is a world technology leader, smart and flexible while ensuring environmental and social sustainability.

> *<u>Made In Europe PPP, vision for 2030:</u>*
>
> Europe's manufacturing industries vision for 2030 is to reinforce its global position in terms of competitiveness, productivity, and technology leadership. The goal is to increase the number and attractiveness of jobs, while at the same time securing the environmental, economic and social sustainability for future generations in Europe. While global competition is increasingly challenging, Europe will reinforce its position because of its technological leadership and capacity to handle complexity and to fully embrace digital technologies which in return provide the floor to increasing services around manufacturing and along the product life cycle.
>
> Europe will specialise in the engineering of complex and highly interconnected value creation processes and systems. Its experience, creativity and unique tradition and

[14] Ibid

identity will support the consolidation of European manufacturing. In 2030 the European manufacturing industry will be delivering excellent solutions, ensuring individual user-satisfaction (including customised products and services), high quality and environmental and social sustainability. Europe will be the leader in manufacturing engineering for highly personalised and complex products and services in a broad range of sectors, including aeronautics, automotive, production equipment, renewable energies, space and defence, and customer goods.

In 2030, Europe will be at the fore front of resource efficiency and circular economy implementation, which will contribute to its competitiveness at the global level and support its environmental sustainability. Manufacturing systems in Europe will be flexible and resilient, with optimal balance and integration between humans and machines. The European workforce will develop new skills to be prepared to address these challenges.

Europe will be the leading "solution provider" in production technology, digitalisation, resource efficiency and circular economy implementation, which can only be achieved through the continuous development and exploitation of new technologies. Research and innovation will promote industrial digital transformation and thus enhance the competitive strengths of European companies, products, production systems, and services.

This vision focuses on ensuring competitiveness and sustainability, and supporting resilient and adaptive manufacturing ecosystems able to cope with external disturbances and rising environmental and social requirements. The transformation to a circular economy will need innovative business models, which will furthermore rely on the data economy[15].

3.2 OPERATIONAL OBJECTIVES AND KEY TECHNOLOGIES

To reach this vision, in 2030, key objectives and advanced manufacturing technologies have been identified by the EFFRA as key for the sector:

[15] Made In Europe, consultation version, June 2020.

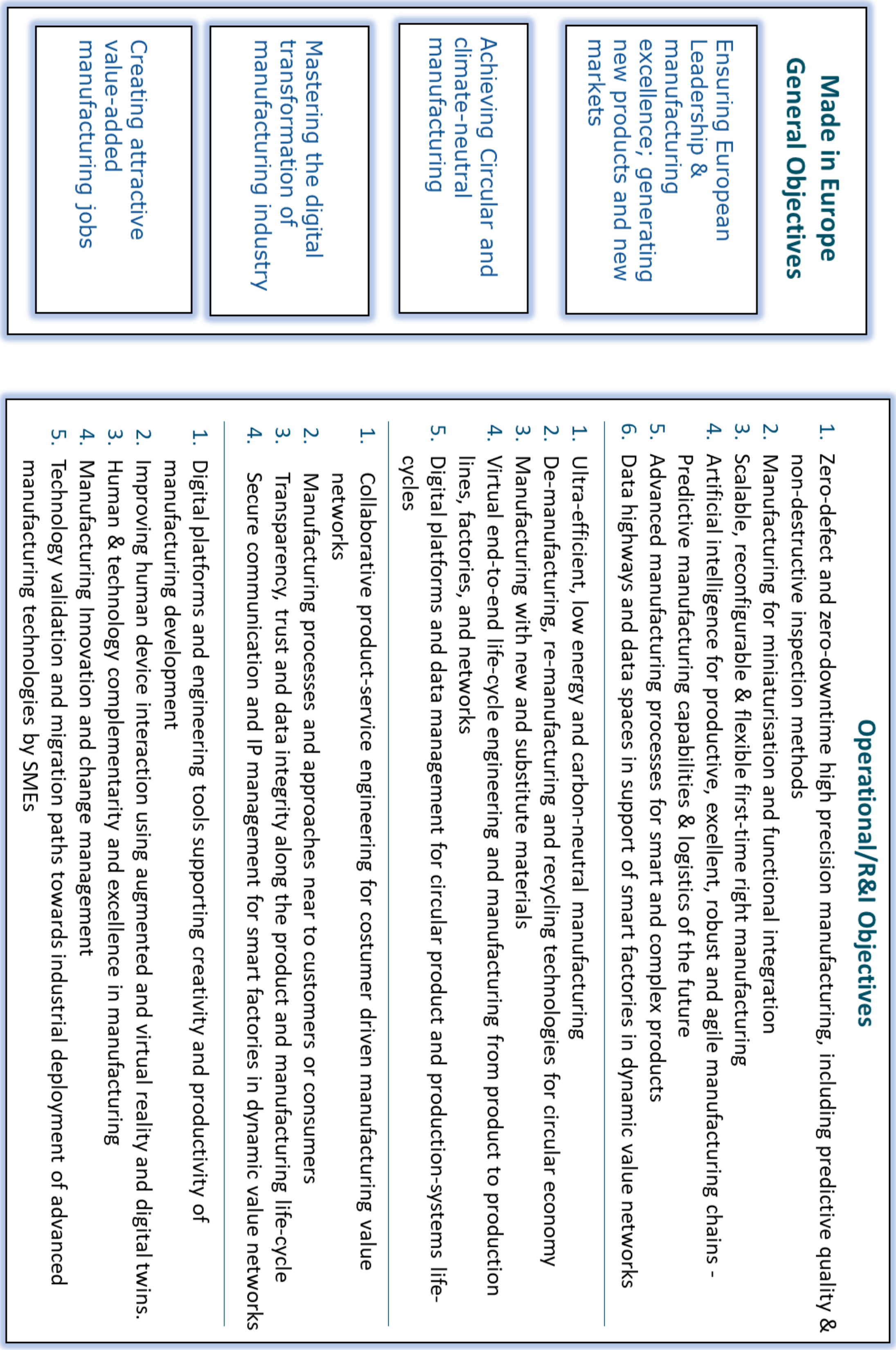


Figure 4 - Made In Europe Operational Objectives

The Advanced Technologies for Industry (ATI[16]) project, set up by the European Commission (a merge of the previous KETs Observatory and Digital Transformation Monitor initiatives) to monitor new technologies, has identified 16 groups of advanced technologies that encompass the numerous specific technologies:

1. Advanced Manufacturing Technology
2. Advanced Materials
3. Artificial Intelligence
4. Augmented and Virtual Reality
5. Big Data
6. Blockchain
7. Cloud Computing
8. Connectivity
9. Industrial Biotechnology
10. Internet of Things
11. Micro- and Nanoelectronics
12. Mobility
13. Nanotechnology
14. Photonics
15. Robotics
16. Security

You will find a definition for each technology in the annex 1 of this report. Among all those groups of technologies, several are specifically of interest for the GALACTICA project and the SME it plans to support: Advanced manufacturing technologies, advanced materials, artificial intelligence, augmented and virtual reality, big data, internet of things and robotics are the most relevant technologies for the aerospace and textile industries.

The EFFRA has also identified several technologies of importance to reach excellence in the 4 General objectives and selected the key ones for the 2030 vision to develop and reach a performing, sustainable, digital and inclusive factory of the future:

- Advanced smart material and product processing technologies, and process chains (additive manufacturing, joining, shaping, structuring, surface tailoring, etc.),
- Smart mechatronic systems, devices and components
- Intelligent and autonomous handling, robotics, assembly and logistic technologies
- De-manufacturing, recycling technologies, and life-cycle analysis approaches
- Simulation and modelling (digital twins) covering the material processing level up to manufacturing system, and factory and value network level from design until recycling.
- Robust and secure industrial real-time communication technologies, and distributed control architectures and standardized equipment protocols OPC-UA

[16] https://ati.ec.europa.eu/

- Data analytics, artificial intelligence, machine learning and deployment of digital platforms for data management and sharing
- New business and new organisational approaches, including links with regulatory aspects such as safety, data ownership, and liability

Each technology is defined in annex 2 of this report. What can be underline here, is that these technologies are trans-sectoral and therefor key to any industry and sector to develop their production process, and especially industrial sectors are lagging behind in terms of advanced technologies implementation such as aerospace and textile.

3.3 STATE OF IMPLEMENTATION

While several pioneering companies and early adopters praise technology's positive impact, adoption remains slow and limited across all industry sectors. More than 70% of industrial companies are still either at the start of the journey or unable to go beyond the pilot stage.

Only 66% of manufacturing firms in the European Union, compared to 78% in the United States, report having adopted at least one digital technology. Digital firms perform better and are more dynamic: they have higher labour productivity, grow faster and have better management practices. Size matters for digitalisation. Larger firms have higher rates of digital adoption than smaller firms, while old-small firms tend to be persistently non-digital[17].

To maximize the potential gains in productivity brought by technology, companies must move from pilots to adopting technology at scale, across multiple production facilities and through relevant value chains. They also must take their suppliers (often SMEs) and customers with them to be able to innovate and transform their businesses models[18].

Advanced manufacturing technologies implementation in the EU industry is a major challenge to ensure Europe competitiveness and support the vision of a strong and efficient industry that respect the environment and provide meaningful jobs.

4. SECTORAL SURVEY – MANUFACTURING

Within the GALACTICA Project we launched a survey within its clusters' members to identify the main needs of each sector in order to better design the project activities, support mechanisms that will be launched in early 2021 and to identify interested actors and their competences. In this chapter we describe the hot-topics, key issues and needs that have been detected. This serves as base to identify opportunities or challenges in

[17] Who is prepared for the new digital age? Evidence from the EIB Investment Survey© European Investment Bank, 2020.
[18] Ibid

collaboration. Shown are the answers with the highest agreement in percentage. The complete results/statistics of the survey can be found in the Annex.

4.1 GENERAL STATISTICS

The survey, designed for SME from the advanced manufacturing sector, collected 48 full responses, with 91% of SMEs and 2% of Start-Ups respondent. 95% of the respondents are engaged in R&D activities.

With the majority of participants being SMEs (under the terms of the EU definition) and with experience in funded R&D project collaboration, the answers of the survey build a reliable and useful base for the upcoming activities. The already existing experience in either international, national or cross-sectoral collaboration will be helpful for the successful realization of the GALACTICA activities.

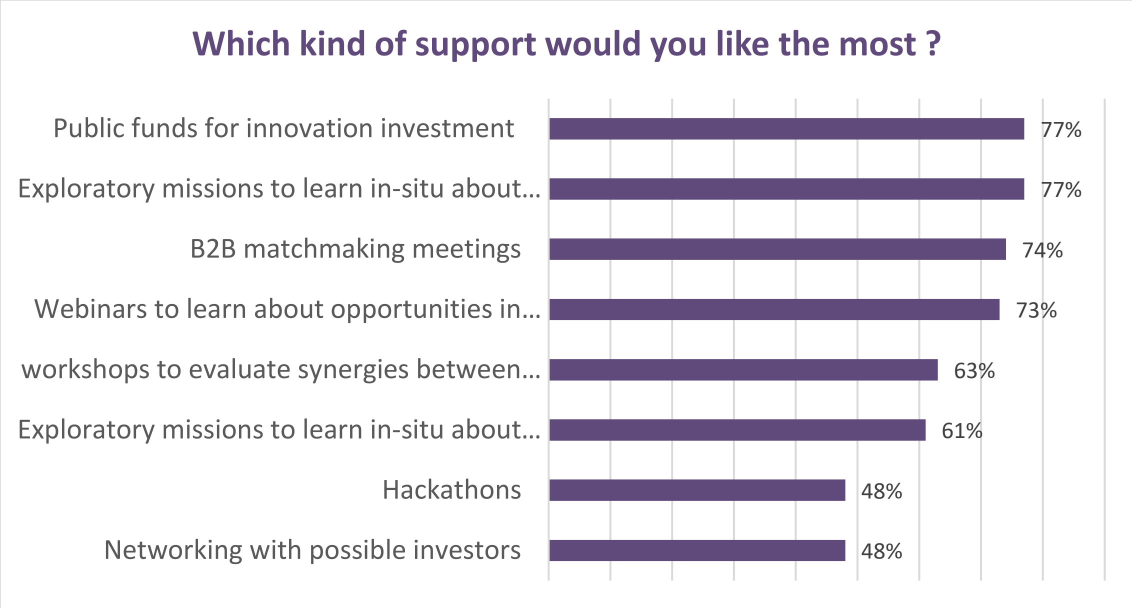
4.2 IMPORTANT QUESTIONS: HOT-TOPICS, KEY ISSUES, NEEDS

- As most sectors, the major current major pain point for most SMEs is the Covid-19 crisis impact on businesses:
    - Loss of business due to Covid-19: 79%
    - International competition: 60%
    - Dependence on only one industry sector: 55%

- According to the participant, the 2 major challenges that companies will face in the near future are:
    - Entering a new market sector (90%)
    - Enhanced Customer requirements (90%)
- And most companies consider tackling these challenges through R&D activities (87,5%), cross-sectoral collaborations (87,5%) and international collaborations (65%).

- 83% of the respondents would consider expanding their business into the aerospace sector, while 74% would consider expanding their business to the textile sector.
- However, their main challenge to do so would be the lack of contact/entry point in the market (73%) and the lack of knowledge of the market (63%).

- All 48 participants are interested in the GALACTICA activities and especially in:
    - Public funds for innovation investment (77%)
    - Exploratory missions to learn in-situ about aerospace (77%)
    - B2B matchmaking meetings
    - Webinars to learn about opportunities in the textile/aerospace/manufacturing sectors
    - Exploratory missions to learn in-situ about textiles industries



4.3 HOT TOPICS IDENTIFIED BY RESPONDENTS

35 respondents provided their input on what topics of interest could be common to all three sectors: aerospace, textile and advanced manufacturing. Their feedback can be divided into 4 general areas of the factory of the future:

- **Sustainable industry:**

Several advanced manufacturing key technologies could help the textile and aerospace industry reduce their environmental footprint such as circularity and industrial symbiosis concept (recyclable and re-use of materials), but also bio-sourced materials and weight savings.

- **Digital factory:**

Digital tools developed for industrial application can bring enormous competitive advantages, but can be complex to implement, especially in more traditional sector and for SMEs that lack skills and investment capacity to apprehend such tools. However, technologies such as robotics, Artificial Intelligence, process simulation, digital twin and big data are crucial to increase and improve production process efficiency and gain market share.

- **Industrial performance:**

Several topics directly linked to production process and materials have been identified as common topics to the three sector, such as lightweight materials, composites processing, additive manufacturing, non-destructive testing.

- **Human centered industry:**

Industries could not function without the working men and women involved in the production process. While it is a strategic objective of the 2030 ambition for European industries, the operator's involvement in new processes development, and the development of skills and know-how is also mentioned by the survey respondent as key topics for the three sectors.

5. CONCLUSION

It appears that **manufacturing is a trans-sectoral industry**, production technologies are used in various industries, accordingly with their characteristics and state of play regarding industry 4.0 implementation.

From the survey, we can see that there is a strong interest in both the aerospace sector as well as the textile industry. The most common manufacturing topics to the 2 markets are oriented toward the **digitalization of the factory (implementation of robotics solution, digital twin, Artificial Intelligence**), but also toward the **gain in industrial performances through new production process such as advanced materials (mostly composites), additive manufacturing, lightweight materials.**

Two other topics are the center of the three manufacturing, aerospace and textile industry, and they are linked to the **environmental performances of production processes (re-use and recycle, bio-sourced materials, industrial symbiosis, circularity and optimization of value chains)** and the **inclusion of the human in the innovation process and the development of new skills** (training, know-how transmission).

Advanced manufacturing represents a junction between aerospace and textile, with possible production technology transfer from one sector to another. But the manufacturing industry can also draw inspiration from those sectors to keep developing innovative production process. **Fiber and composites manufacturing, and technical textiles** are strong examples of advanced processes and technologies used in the textile sector that could be used more transversally in various industry, including the aerospace.

From the survey, we can establish that most manufacturing SMEs have interest in addressing new sectors, and that their main barrier is the **lack of contacts/entry points, and the lack of knowledge of the targeted sector**. The GALACTICA project will therefore play a central role in overcoming these barriers and develop new cooperation and new value chains between companies and organizations of the three involved sectors.

ANNEXES

ANNEX 1: ATI TECHNOLOGY DEFINITIONS

Advanced Manufacturing Technology

Advanced manufacturing technology encompasses the use of innovative technology to improve products or processes that drive innovation in manufacturing. It covers two types of technologies: process technology that is used to produce any of other advanced technologies, and process technology that is based on robotics, automation technology or computer-integrated manufacturing. For the former, such process technology typically relates to production apparatus, equipment and procedures for the manufacture of specific materials and components. For the latter, process technology includes measuring, control and testing devices for machines, machine tools and various areas of automated or IT-based manufacturing technology.

Advanced Materials

Advanced materials lead both to new reduced cost substitutes to existing materials and to new higher added-value products and services. Advanced materials offer major improvements in a wide variety of different fields, e.g. in aerospace, transport, building and health care. They facilitate recycling, lowering the carbon footprint and energy demand as well as limiting the need for raw materials that are scarce in Europe.

Artificial Intelligence

Artificial Intelligence is a term used to describe machines performing human-like cognitive functions

(e.g. learning, understanding, reasoning or interacting). It comprises different forms of cognition and meaning understanding (e.g. speech recognition, natural language processing) and human interaction (e.g. signal sensing, smart control, simulators). Artificial Intelligence is a heterogenous field in terms of its technology base. While some aspects like sensors, chips, robots as well as certain applications like autonomous driving, logistics or medical instruments refer to hardware components, a relevant part of AI is rooted in algorithms and software.

Augmented/Virtual Reality

Augmented reality devices look to overlay digital information or objects with a person's current view of reality. As such, the user is able to see his/her surroundings while also seeing the AR content -

Virtual reality devices place end users into a completely new reality, obscuring the view of their existing reality.

Big Data

Big Data is a term describing the continuous increase in data, and the technologies needed to collect, store, manage, and analyse them. It is a complex and multidimensional phenomenon, impacting people, processes and technology. From a technology point of view, Big Data encompasses hardware and software that integrate, organise, manage, analyse, and present data. It is characterised by "four Vs": volume, velocity, variety and value. Big Data technologies are new generation of technologies and architectures, designed to economically extract value from very large volumes of a wide variety of data, by enabling high-velocity capture, discovery, and/or analysis.

Blockchain

Blockchain is a digital, distributed ledger of transactions or records, in which the ledger stores the information or data and exists across multiple participants in a peer-to-peer network. Distributed ledgers technology allows new transactions to be added to an existing chain of transactions using a secure, digital or cryptographic signature. Blockchain protocols aggregate, validate, and relay transactions within the blockchain network. Blockchain technology allows the data to exist on a network of instances or "nodes," allowing for copies of the ledger to exist rather than being managed in one centralised instance.

Connectivity

Connectivity refers to all those technologies and services that allow end-users to connect to a communication network. It encompasses an increasing volume of data, wireless and wired protocols and standards, and combinations within a single use case or location. *Standard connectivity* includes Fixed Voice and Mobile Voice telecom services to allow fixed or mobile voice communications, but also Fixed Data and Mobile Data services to have access and transfer data via a network.

Advanced connectivity that is in the focus of the ATI project refers to the rise of Internet of Things scenarios, where connectivity technology boundaries expand beyond wired and cellular (e.g. 4G,
5G,…) services to Low Power Wide Area Network (LPWAN), Satellite, and Short Range Wireless technologies.

Cloud computing

Cloud computing includes the delivery of tools and applications like data storage, servers, databases and software based on a network of remote servers through the Internet. Cloud computing services enable users to store files and applications in a virtual place or the cloud and access all the data via the Internet.
Public Cloud services that have been explored specifically by the ATI survey are available on public networks and open to a largely unrestricted universe of potential users. Public clouds are designed for a market, not a single enterprise.

Industrial Biotechnology

Industrial Biotechnology is the application of biotechnology for the industrial processing and production of chemicals, materials and fuels. It includes the practice of using microorganisms or components of micro-organisms like enzymes to generate industrially useful products in a more efficient way (e.g. less energy use, or less by-products), or generate substances and chemical building blocks with specific capabilities that conventional petrochemical processes cannot provide.
There are many examples of such bio-based products already on the market. The most mature applications are related to enzymes used in the food, feed and detergents

sectors. More recent applications include the production of biochemicals and biopolymers from agricultural or forest wastes.

Internet of Things (IoT)

The Internet of Things (IoT) refers to the network of smart, interconnected devices and services that are capable of sensing or even listening to requests. IoT is an aggregation of endpoints that are uniquely identifiable and that communicate bi-directionally over a network using some form of automated connectivity. Objects become interconnected, make themselves recognisable, and acquire intelligence in the sense that they can communicate information about themselves and access information that has been provided by another source. The Internet of Things relies on networked sensors to remotely connect, track and manage products, systems and grids. The Industrial Internet of Things (IIoT) – a subset of the larger Internet of Things – focuses on the specialised requirements of industrial applications, such as manufacturing, oil and gas, and utilities. IIoT systems connect non-consumer devices, used by companies, governments and utility providers in their service delivery.

Micro- and Nanoelectronics

Micro- and nanoelectronics deal with semiconductor components and highly miniaturised electronic subsystems and their integration in larger products and systems. They include the fabrication, the design, the packaging and testing from nano-scale transistors to micro-scale systems integrating
multiple functions on a chip.

Mobility

IT for Mobility

Mobility covers a large number of different technology areas and markets, which does not only encompass vehicles that take people from point A to point B, but also includes all kinds of technologies that make people more mobile (like for example mobile phones etc.). These, however, consist of a large set of sub-technologies that are hard to capture at the same time. In this project, the patent, trade, prodcom, investment and skills analysis focus on a sub-section of mobility, which is related to vehicles only, e.g. satellite navigation and radio-location, which are also the core technologies that are necessary to make autonomous driving work.

Enterprise mobility

The survey analysis captures mobility in terms of the workforce. The enterprise mobility market is made up of a conglomeration of mobile solutions and technologies, including hardware, software and services, empowering a borderless workforce to securely work anywhere, at any time and from any device. It does not include only the provision of smartphones or tablets to the workforce but also all the tools and applications for transforming key processes, from internal operations to operations with customers and suppliers, all the way from the shop floor to the top floor and from the back office to the end customers.

Nanotechnology

Nanotechnology is an umbrella term that covers the design, characterisation, production and application of structures, devices and systems by controlling shape and size at nanometer scale.

Nanotechnology holds the promise of leading to the development of smart nano and micro devices and systems and to radical breakthroughs in vital fields such as healthcare, energy, environment and manufacturing.

Photonics

Photonics is a multidisciplinary domain dealing with light, encompassing its generation, detection and management. Among other things it provides the technological basis for the economic conversion of sunlight to electricity which is important for the production of renewable energy, and a variety of electronic components and equipment such as photodiodes, LEDs and lasers.

Robotics

Robotics is technology that encompasses the design, building, implementation, and operation of robots. Robotics is often organised into three categories: 1) Application specific. This includes robotics designed to conduct a specific task or series of tasks for commercial purposes. These robots may be stationary or mobile but are limited in function as defined by the intended application. 2) Multipurpose. Multipurpose robots are capable of performing a variety of functions and movements determined by a user that programs the robot for tasks, movement, range, and other functions and that may change the effector based on the required task. These robots function autonomously within the parameters of their programming to conduct tasks for commercial applications and may be fixed, "moveable," or mobile. 3) Cognitive. Cognitive robots are capable of decision making and reason, which allows them to function within a complex environment. These robots can learn and make decisions to support optimal function and performance and are designed for commercial applications. When measuring production and uptake of robotics, industrial applications will be taken into account.

Security

Security products are tools designed using a wide variety of technologies to enhance the security of an organisation's networking infrastructure — including computers, information systems, internet communications, networks, transactions, personal devices, mainframe, and the cloud — as well as help provide advanced value-added services and capabilities. Cybersecurity products are utilised to provide confidentiality, integrity, privacy, and assurance. Through the use of security applications, organisations are able to provide security management, access control, authentication, malware protection, encryption, data loss prevention (DLP), intrusion detection and prevention (IDP), vulnerability assessment (VA), and perimeter defense, among other capabilities.

ANNEX 2: KEY TECHNOLOGIES AND ENABLERS OF THE MADE IN EUROPE PARTNERSHIP

The integration of technologies and multidisciplinary collaborative are a key characteristic of the Made In Europe Partnership. The following set of key technologies and enabling approaches will play a key role in achieving the main and the associated policy objectives of the Partnership.

Advanced smart material and product processing technologies, and process chains (additive manufacturing, joining, shaping, structuring, surface tailoring, etc.)

Advanced smart material and product processing technologies are at the centre of any manufacturing activity; they cover a broad range of manufacturing sectors and products. The combination of materials and process engineering (often supported by advanced simulation) with smart mechatronics (next enabler in the list below) is key. Bio-inspired or bio-integrated manufacturing is an example of new developments, while also, the so-called 'traditional material processing technologies', that have been incrementally but significantly improved towards 'high performance' material processing technologies over the past decades, play an important role in manufacturing innovation. 'Younger' technologies such as photonics or other physical or chemical processes must be integrated in hybrid, flexible, and robust process chains.

Smart mechatronic systems, devices and components

Smart mechatronic systems, devices and components are at the core of multi-technology approaches, where electronics and software (including (micro-)sensors and (micro-)actuators, local data processing or edge computing devices) are enhancing the accuracy, speed, energy-efficiency etc. of the manufacturing systems, and where these manufacturing systems are connected to ICT solutions and human decision makers in order to optimise the operation of the factories from a multitude of perspectives. Here open source solution and standards are gaining rapidly importance, as compared to vendor lock-in situations that happened sometimes in the past. Products offerings therefore become more data-driven value-added services as predictive maintenance, machine learning, all using data analytics.

Intelligent and autonomous handling, robotics, assembly and logistic technologies

Factory automation approaches – in synergy with the role of humans in the factory – are evolving rapidly, not least through advances in connectivity, data analytics and cognitive approaches. Advanced handling and logistic approaches within and around factories have a big impact on their performance.

De-manufacturing, recycling technologies, and life-cycle analysis approaches

These technologies, tools and knowledge-based methods should recover, re-use, and upgrade functions and materials from high-tech products (including capital goods). Product design and manufacturing engineering should anticipate end-of-life strategies.

Simulation and modelling (digital twins) covering the material processing level up to manufacturing system, and factory and value network level from design until recycling.

Advances in the physical understanding of the behaviour of materials and mechatronics systems and the associated models are enhanced by real time monitoring, data collection and artificial intelligence. Predictive model-based approaches will be deployed from machine level up to supply chain level.

Robust and secure industrial real-time communication technologies, and distributed control architectures and standardized equipment protocols as OPC-UA.

This includes peer-to-peer communication approaches, distributed ledger technologies for industrial applications, wireless communication technologies, including 5G, etc., considering specific application requirements such as latency, safety aspects, etc.

Data analytics, artificial intelligence, machine learning and deployment of digital platforms for data management and sharing.

Data analytics, artificial intelligence/machine learning and the deployment of digital manufacturing platforms are enabling the provision of services that support manufacturing in a broad sense. The Made In Europe Partnership will build on the actions that have been initiated at the end of Horizon 2020, aiming at a broad industrial application-oriented deployment of these technologies, taking account requirements of SMEs as well as the needs for sovereign European industrial data-ecosystems

New business and new organisational approaches, including links with regulatory aspects such as safety, data ownership, and liability.

The introduction of innovative systems, products and services, where the product can be a manufacturing asset or an innovative consumer good, essentially relies on all of the above -mentioned technologies but need to be complemented by non-technological innovation. Sharing of data among people or legal partners in the value chain should consider regulatory aspects and boundary condition. Also, the implementation of advanced solutions requires migration approaches or ‘pathways’ from as-is situation towards innovative solutions.

The described set of enabling technologies provides clear pointers to existing PPPs or initiatives that focus on particular enabling technologies, for example: photonics, electronic systems and components, 5G, Cybersecurity, Big Data and AI, Robotics, and HPC.

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