eit Manufacturing

Future European Manufacturing System

eitmanufacturing.eu

Co-funded by the European Union

Foreword

It has been only one year since we published our vision for 2030, called 'Fixing Our Future.' An optimistic forward look to the post-COVID-19 period, the reshaping of value chains and the re-globalisation, instead of de-globalisation, caused by the rise of nationalist politics and prevention measures that governments put in place in response to the pandemic. But with the war in Ukraine and its implications on the economic sector - mainly on energy supply for Europe - the situation has become even more complex. The manufacturing industry, as a global base for prosperity, a key to Europe's economic, social and environmental sustainability and the main driver of industrial innovation, job creation and growth, is heavily impacted by all these developments.

Despite all these short-term impacts and challenges, we must be careful not to neglect the main long-term challenge, that is the future of our planet as also reflected in the Green Deal of the European Commission. Sustainability cannot be an "innovative" add-on, it must be a mandatory priority. Therefore, we have to re-think manufacturing, we have re-think WHAT we manufacture and HOW we manufacture. The key elements of deploying process innovation, including people, processes and technologies, are also central to a successful transformation of industry towards the circular economy, decarbonisation and reduction of energy consumption. Like in most industries, the transformation of manufacturing is affected by the skills, well-being and innovative capacity of the workforce. People, with their experiences and knowledge, are the most valuable assets of the European industry, which is why leveraging a human-centered approach to Industry 5.0, as proposed by the European Commission, is critical." As one powerful ecosystem, EIT Manufacturing connects diverse networks and expertise that are essential for the transformation of the industry on its open innovation platform AGORA to build the pan-European manufacturing community. Through its focus on education, EIT Manufacturing seeks to empower the European economy with people that are capable and inspired to shape the future of manufacturing. EIT Manufacturing Innovation team supports the European manufacturing - companies and tech organizations and helps them to industrialize innovative projects, while the Business Creation team empowers high-growth, profitable companies with a positive social impact.

Based on this unique ecosystem, EIT Manufacturing, in cooperation with its partners and network of contributors, has taken the initiative to postulate the 'European Manufacturing System' as a strategic objective for the European manufacturing industry, with universal implications. The 'European Manufacturing System' aims to make the 'Fixing our Future' vision tangible to overcome traditional barriers, especially between enterprises, through an ecosystem approach. The transition features sustainability as a decisive factor and provides a roadmap to the vision of autonomous, self-organised production and logistics. Supported by the European data infrastructure Gaia-X, it is a foundation for a future-oriented business philosophy that becomes reality in the traditional manufacturing industry, affecting the workforce and society at large.

Klaus Beetz, CEO EIT Manufacturing
April 2023

Introduction

Starting out with an optimistic vision

When talking about the future, there are expectations of working towards reducing uncertainty and volatility in the world. However, for many sectors, manufacturing included, greater uncertainty and challenges have become prevalent over the past years. Questions around how to ensure that a fair human-centred transformation is also a green transformation, what we will be producing in a future where resources are limited, and how to future-proof factories in 2030, considering people, planet and profit, just scratch the surface of areas that urgently need addressing.

Therefore, in 2021, EIT Manufacturing developed a vision for the future of Manufacturing in Europe in 2030, called 'Fixing Our Future'. It presents an optimistic view of what manufacturing in Europe could become, a shared vision of hope for the present and a desired future, to meet the needs of current generations without compromising the needs of generations to come. Within this vision, ethics, circularity, and collaboration emerged as important themes for EIT Manufacturing in the future.

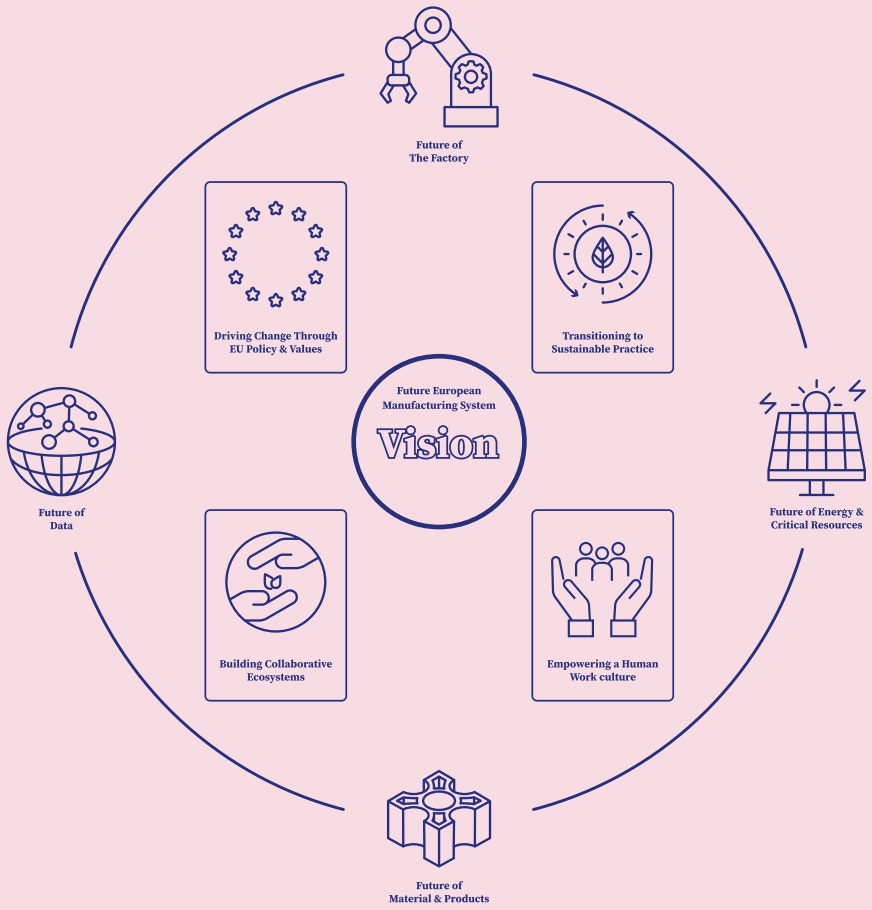
With this vision and the stories of change, EIT Manufacturing created a guiding star for new and better future for the European Manufacturing System.

This compelling vision and future-oriented storytelling aims to inspire thought leadership and help us consider how the decision-making of today will impact the generations of tomorrow. However, to achieve change and truly 'fix' our future, we need ideas, products, technologies, services, and processes that build towards the realisation of these imaginations. This is where 'The Future of European Manufacturing System' project comes into play.

Future Design: Co-creating insights & solutions

Using a collaborative, future design approach as a guiding structure, an intensive and extensive desktop research and horizon scanning was carried out, alongside conducting 16 industry expert interviews from inside and outside EIT Manufacturing to explore the future of the industry. On top of this, workshops were facilitated with various groups of stakeholders to build upon research findings towards co-creating a vision for desired and preferable future for manufacturing. All of this resulted in insights, learnings, and an overview of shared perspectives for change and action within the manufacturing system in Europe. Ultimately to transform stories of change and hopeful visions into realities and solutions.

The Future of European Manufacturing System is an inspiring overview for EIT Manufacturing that serves as an invitation for all stakeholders within its community to not only explore the future, but to also use this as a tangible backbone and proofing tool for future funding, strategy, and communications. This paper not only gives an overview of shared themes and learnings for the Future of the European Manufacturing System, but the process of participatory collective futuring to reach these insights also gave stakeholders the opportunity to better understand or imagine future competencies needed, while opening a dialogue around how to work together in the future.



Overview of the european manufacturing system concept

Contents

Enablers

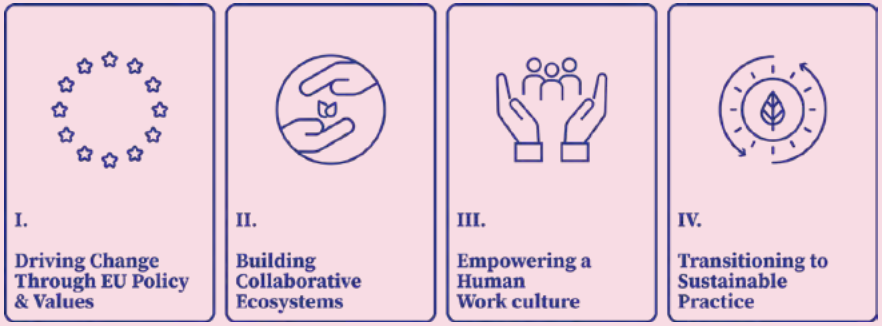
The Future of European Manufacturing is a paper that aims to make the vision, as described in Fixing Our Future, tangible. It gives an overview of shared themes and learnings for the Future of the European Manufacturing System and unpacks perspectives on key concepts and technologies that will shape the future of circular, digital, and sustainable manufacturing in Europe.

Enablers for future change and actions help make the vision a reality. While the Future Pillars of Change can be seen as foundational enablers, the Spheres of Action can be viewed as applied enablers for change, both offering opportunities and tools to make the vision, as described in Fixing Our Future, a reality. In complex, uncertain, and tumultuous times like these, it is important that the European manufacturing sector can imagine new systems. To see new opportunities, one should have the capacity to be open to other possibilities and to do things differently.

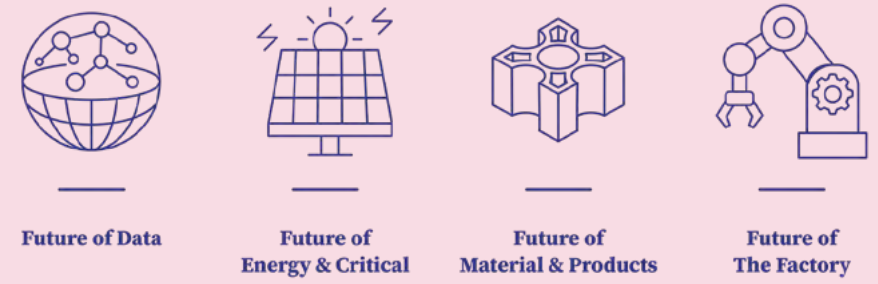
Future Pillars of Change
- Enablers for moving towards a preferred future, each of them including specific areas of action, followed by key supporting signals of change and interview quotes.

Future Spheres of Action
- Highlighting future areas of action applied to the context of the manufacturing sector.

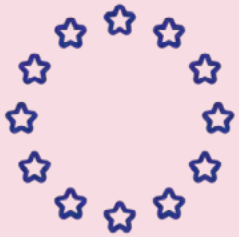
Future Pillars of Change



Future Spheres of Action



Future Pillars of Change



I.

Driving Change Through EU Policy & Values

II.

Building Collaborative Ecosystems

III.

Empowering a Human Work culture

IV.

Transitioning to Sustainable Practice

1. Driving Change Through EU Policy & Values

> "In a resource-constrained, polluted world with time constraints, you are going to need policy intervention to decide what is manufactured, how it is supplied, what materials are used, what energy is used. Policymakers can step in and say it's an emergency situation, we have to do something."
>
> **David Peck, TU Delft**

AREAS FOR ACTION

- Building Strategic Autonomy in a Global Economy
- Leading the Way in a Competitive AI Landscape
- Designing for a Greener Future

AREA FOR ACTION

Building Strategic Autonomy in a Global Economy

As supply chain resilience gains importance, the EU will need to advance policy initiatives to help European manufacturers build competitive capacity and continuity, protect the region's interests and promote its values worldwide.

The turbulent events of recent years, including the COVID-19 crisis and Russia's invasion of Ukraine, have challenged the vision of a globalised economy. This is forcing European politicians and companies to consider relocating manufacturing operations to trusted trade partners, as a way to guard against supply chain disruptions.

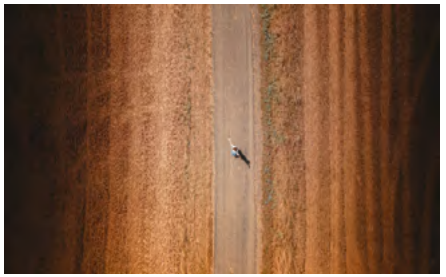
Such a shift will demand EU policymakers to work closely together with the private sector, think collaboratively and implement rules and standards that can help manufacturers pursue this strategy of strategic autonomy, and to do so in a way that allows them to sustain their global competitiveness.

AREA FOR ACTION KEY SIGNALS

INTERVIEW

European industry know-how is a strong competitive advantage

"You can't turn a not-so-good product into a super competitive-advantage product using digital technologies."



INTERVIEW

Autonomy vs Sovereignty

"We don't have to stop being open. This is something we have to continue to work on."

INTERVIEW

Cutting through red tape in Europe

There are a couple of challenges that we need to deal with at some point: labour costs and regulations.

Read the Signals of Change in full on futuremanufacturingsystem.eu/signals

AREA FOR ACTION

Leading the Way in a Competitive AI Landscape

Europe will need to take a sensible approach to data privacy and protection to ensure it leads the way in AI and becomes competitive while remaining in accordance with its EU values and principles.

With the rise of AI, the need for good data is greater than ever — and so is the need to establish adequate legal and ethical frameworks that can guarantee responsible implementation in the EU.

Policymakers will be faced with the challenge of balancing the risks and threats posed by AI applications, while also enabling European manufacturers to leverage the region's wealth of data, technical knowledge and industry know-how to develop and scale innovative solutions that are sustainable, secure, trustworthy and competitive. It will be essential for policymakers to be AI-literate as well as demand actionable data, to be able to make the right decisions.

KEY SIGNALS

INTERVIEW

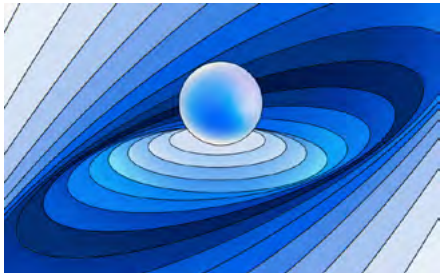
Artificial Intelligence demands access to data

"European industry is a little bit lagging behind and regulation does not help."

INTERVIEW

Mobilising private capital for industry innovation

"We must be able to mobilise these huge amounts of money, which are sitting uninvested, and bringing it to European companies."



CASE

EU Artificial Intelligence Act

What will be the international repercussions of the AIA and to what extent will it unilaterally impact international rule-making?

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AREA FOR ACTION

Designing for a Greener Future

EU policy will shape the next generation of products and equipment that will drive the 'twin transition' that Europe needs to make.

Policies, rules and principles laid down at EU level will guide, support and trigger innovation that will ensure that European manufacturers deliver on their commitment to address the climate emergency.

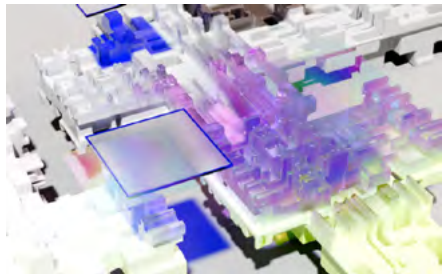
As new industry regulations are set, companies in Europe will be expected to rethink how their products are designed, manufactured, transported and used; find ways to reduce their resource and energy footprint; adopt circularity principles, and more generally, help improve the living conditions of citizens in Europe and beyond.

KEY SIGNALS

CASE

iPhones Will Switch Over To USB-C Chargers With New EU Law

The move comes after EU lawmakers voted to enforce a common charging standard for all portable devices.



CASE

Right to re-print: What role could 3D printing have in right to repair?

How might 3D printing have the potential to redefine how spare parts are controlled and supplied?

INTERVIEW

Manufacturing from Home

"The manufacturing industry will have to face the challenge of producing the items that are relevant for the new energy approach that Europe will need to take."

Read the Signals of Change in full on futuremanufacturingsystem.eu/signals

II.

Building Collaborative Ecosystems

2. Building collaborative ecosystems

> "I think something we kind of forgot or we were pressed into another direction is the topic of way more collaboration. Sustainability means to understand the issue, and to tackle it jointly (and prevent everyone from withdrawing at a time of crisis or danger). One of the reasons why we joined EIT Manufacturing was because we see a big benefit in having at least your value chain with a moderated set up to discuss certain issues Where do you have such platforms? Usually you don't have them"
>
> **EIT Manufacturing community member**

AREAS FOR ACTION

- Connecting Industry with Academia
- Collaboration with the Public Sector
- Collaboration within the Industry

AREA FOR ACTION

Connecting Industry with Academia

Stronger partnerships are needed to foster talent, capabilities and perspectives that can allow the region to position itself at the forefront of the manufacturing industry.

European universities and RTOs (Research and Technology Program Organisations) are leading the way in many areas of research, but when it comes to working with businesses, and especially small companies, the continent seems to be lagging behind.

Global competition will demand European universities and industry to create stronger incentives for collaboration, cooperation, and establish intermediary bodies that can link SMEs to academia. Furthermore, by designing guiding principles for collaboration, developing mechanisms and initiatives that can foster trust between academic institutions and their industrial partners, the understanding of the interests and needs of the parties involved can be deepened. Ultimately, collaboration and innovation will be essential to address sector-wide challenges.

KEY SIGNALS

INTERVIEW

Manufacturing must embrace a framework of collaboration

"I don't know if there are any mechanisms to make it happen."

CASE

Intel's University Shuttle Program

Intel Is Opening up Its Chip Factories to Academia.

INTERVIEW

Industry-Academia collaboration

"It's very important to keep a communication channel open between the industry and academia."

Read the Signals of Change in full on futuremanufacturingsystem.eu/signals

AREA FOR ACTION

Collaboration With the Public Sector

SMEs are facing a myriad of challenges and European governments, at all levels, can provide support and help them thrive well into the future.

The demands of the new world reality will require governments at all levels to reinforce existing mechanisms and create new ecosystems to cooperate with the companies that make up the backbone of the manufacturing industry.

The focus should be on providing resources and assistance that can help SMEs deliver on their sustainability commitments, keep up with digitalisation and acquire the talent needed to adopt new technologies. There is an untapped potential to bring new technologies and SMEs together, but most of the SMEs lack the time and resources to make this happen. By building strategic management capabilities, high levels of resilience can be achieved. As a result, SMEs can exploit their potential to become a major force for sustainable economic growth, innovation and positive societal impact in Europe.

KEY SIGNALS

CASE

Open Know-Where that enable anyone, everywhere, to participate in production

What if we could build a sustainable system that was globally networked, but locally executed?

INTERVIEW

The gap between large and small companies is growing

“There’s a huge difference between really innovative companies and the bulk of the European manufacturing industry”

CASE

MADE (Manufacturing Academy of Denmark)

MADE helps manufacturing companies digitalize and establish sustainable production.

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AREA FOR ACTION

Collaboration Within the Industry

Addressing issues of sustainability and the potential of circularity demands closer collaboration between and within organisations

An increasing number of European SMEs are embarking on the green transition, but despite their valuable progress, many barriers still remain.

How we innovate and create value is shifting, from a competitive to a more collaborative mindset. The creation and promotion of open, transparent and secure collaborative ecosystems in Europe can provide support for SMEs. It can facilitate the access to knowledge, expertise, skills and data from different departments within a company and from external companies, based on agreed upon criteria and standards. These ecosystems can remove collaboration barriers related to data incompatibility and risk of IP loss or theft, while ensuring manufacturers can more effectively draw upon valuable resources and information provided by key stakeholders all along the supply chain to help them reach their environmental goals while building a competitive advantage.

KEY SIGNALS

INTERVIEW

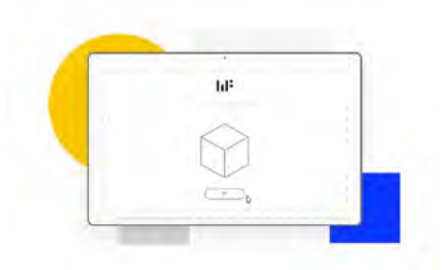
Open data key for supply chain resilience & a circular economy

Secure and open data exchange must be available to all players in the value chain.

INTERVIEW

Circularity depends on local partnerships

"We have to have better partnership and standards that are more manageable".



CASE

Wikifactory: the Collaborative Manufacturing Platform

With a community of over 90,000 designers, engineers, SMEs and hardware startups.

Read the Signals of Change in full on futuremanufacturingsystem.eu/signals

III.

Empowering a Human Work culture

3. Empowering a human work culture

> " What is going to be the role of humans in the future of manufacturing? We have to take that into account because in the end, if we have a very nice industry that is highly technological, but humans are of no use... we have not succeeded."
>
> **Ramon Antelo, CTO Capgemini**

AREAS FOR ACTION

- Rebranding Manufacturing as Human-Centred
- New Workforce Trends for New Ecosystems
- Developing Future-Ready Learning

AREA FOR ACTION

Rebranding Manufacturing as Human-Centred

Rebranding manufacturing has the potential to attract and grow a new and more diverse workforce

How might we look at the importance of manufacturing's reputation from the perspective of society and bring the sector up to date with a modern work culture? Currently, manufacturing needs a rebranding response to a diminishing workforce. This would be an opportunity to address the under-representation of women and people of colour, people with disabilities, as well as the industry's failure to meet the needs of younger generations and thereby attract new talent.

There is no manufacturing without people. Machines will never entirely replace humans in the workforce, but make jobs that are repetitive or labour- intensive redundant. There is an opportunity for the industry to build a human-centred manufacturing system, improving daily tasks and work environments to create more meaningful experiences for workers. The ultimate goal of a rebrand should be to showcase accessible, flexible and sustainable ways of building a career in manufacturing open to all - especially inclusive of those whose roles are directly affected by automation.

KEY SIGNALS

CASE

Made in Holland by Refugees

Comfortable face masks for healthcare professionals. Produced in the Netherlands by people with refugee backgrounds.

CASE

A growing number of women are entering the manufacturing industry

The nature of these jobs has changed, too - less manual labor, more tech and automation.

CASE

Gen Z Warms to Manufacturing Jobs

But the belief that manufacturing companies don't pay as much as other fields is potentially preventing them from taking the next step.

Read the Signals of Change in full on futuremanufacturingsystem.eu/signals

AREA FOR ACTION

New Workforce Trends for New Ecosystems

A transforming industry must lead with positive changes to working culture and job roles

How can manufacturing positively influence emerging workforce trends and job roles in response to the digital transformation of the industry? The shift from factory floor work to roles focused on monitoring, supervision and optimisation already demonstrates the benefits of providing better flexibility and work-life balance for employees and future generations. However, the risk of precarious working terms and increasing inequality in the labour market remains and may become more prevalent in the future.

New jobs created by Industry 4.0 (I4.0) are likely to be part-time, temporary, on-call work and so on, which can lack worker protection and security. Also, the requirements of a highly skilled workforce can result in more arduous conditions for middle- or low-skilled roles. Therefore, manufacturing must take responsibility within this changing environment by developing decent, resilient roles across all skill levels to co-exist with automation - for positions that embrace strong data-science skills, digital literacy, and ethical capabilities when dealing with AI alongside human skills, such as creativity, empathy and systems thinking.

KEY SIGNALS

CASE

Re and Upskilling for Industry 4.0 & Beyond

By 2025, half of all employees worldwide would need reskilling due to adopting new technology.

CASE

Aspire to lead in Industry 4.0? Hone your soft skills

Industry 4.0 may require organisations not just to adopt advanced technologies, but also to develop ethical, inclusive leaders.

INTERVIEW

Ethical manufacturing

Connecting conscious brands and sustainable manufacturers from all over Europe.

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AREA FOR ACTION

Developing Future-Ready Learning Models

Innovative approaches to re- & upskilling are integral to reaching the potential of I4.0.

The success of I4.0 depends not only on technological development, but also on efforts to prepare a future-ready workforce. And while commitment is needed to the essential phases of reskilling and up-skilling, (lifelong) learning opportunities must also adapt and keep up with how rapidly demands of the workforce arise and change.

To initiate action, business leaders, educators, and governments must co-create traditional and non-traditional routes for learning that are accessible, affordable and keep a competitive pace. This will involve innovation around how skills should be learnt, for example through a performance first approach that is context-specific and embeds learning in the everyday. Being proactive with I4.0 skills alignment is urgent and necessary for the endurance of an inclusive, human and sustainable industry and society.

KEY SIGNALS

CASE

A Collaborative Re & Upskilling Ecosystem in the Era of Industry 4.0

Digital transformation has initiated an instructional paradigm shift for learning and teaching.

CASE

The MassBridge project

Bridging the Gap in Manufacturing Technician Training in Emerging Technologies.

CASE

The Augmented Worker

New technologies will provide richer information to support operators in their jobs.

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IV.

Transitioning to Sustainable Practice

4. Transitioning to sustainable practice

> "At a European level, I have the feeling policymakers want to do a lot in the area of circular economy. We want to have more sustainable businesses in Europe. But with the existing (growth) mindset, even if we do it in a green way, manufacturing is not sustainable."
>
> **EIT Manufacturing community member**

AREAS FOR ACTION

- Sustainability as the Goal and not the By-Product
- Systemic Development of Circular Economy Operations
- Sustainability Metrics = Business Development

AREA FOR ACTION

Sustainability as the Goal and not the By-Product

Better sustainability performance is the key to reaching a more conscious, Triple Bottom Line outcome of I4.0

I4.0 and sustainability has gained momentum in academic, managerial and policy debate however, most action stops here. While I4.0 has the potential to support sustainability performance - this is not a given, with the risk of increased waste production and higher energy demand also a very possible reality if a conscious and holistic approach is not taken.

Now it is necessary to build direct links between I4.0 and its impact on the Sustainable Development Goals. At the same time, manufacturers should act critically upon unintended consequences and tensions that may arise within this transfo mation. These actions are important to ensure equal efforts across all three areas of the Triple Bottom Line are taken, rather than seeing the common example of people and the planet as only secondary to profit.

KEY SIGNALS

INTERVIEW

"Sustainability means to understand the issue and to tackle it jointly"

Cooperation is key but there are both legal and mental barriers to overcome.

INTERVIEW

New generational approach

Younger generation demands different standards, will industries take it seriously?

INTERVIEW

Manufacturing needs to shift to a degrowth mindset

"With the existing mindset, even if we do it in a green way, manufacturing will not be sustainable."

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AREA FOR ACTION

Systemic Development of Circular Operations

The systemic integration of I4.0 technologies is essential for developing a sustainable circular economy

The circular economy (CE) is building momentum, as research shows strong potential for I4.0 technologies in supporting the complexity of circular business models. I4.0 approaches can support CE aspects such as better transparency and decision-making, improved cost and flexibility, eco-design, added business value, reverse logistics and extended product/ material life-times. However, further research and more action is needed to achieve such sustainable operations in practice.

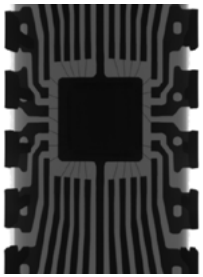
Most essential to success is understanding how to integrate I4.0 technology for the systemic and sustainable implementation of CE operations. This is required for monitoring and limiting the occurrence of circular rebound effects - where the circular economy results in an overall increase of production to partially or fully offset any sustainable developments.

KEY SIGNALS

CASE

Waste as a Resource

C-VoUCHER combines design and technology to support SMEs on their way towards circular economy.



CASE

EU plans ‘digital product passport’ to boost circular economy

The passport will address issues of recyclability by harnessing the data for public good.

CASE

Accelerating robotic development

Foxglove Studio is an open source visualization & debugging tool for robotics.

Read the Signals of Change in full on futuremanufacturingsystem.eu/signals

AREA FOR ACTION

Sustainability Metrics = Business Development

A positive correlation is growing directly between sustainability metrics facilitated by I4.0

I4.0 technologies can have a positive impact on sustainable business performance. The industrial IoT, in particular is helping to make smart factories sustainable through an approach that reduces energy consumption, optimises costs and encourages cleaner environments.

How might manufacturing further support positive development through sustainability evaluation tools for business performance? By utilising large and robust data-based (facility) layouts, it could be possible to advance businesses while clearly mapping all three sustainability aspects. For example - energy consumption for the environment, material handling for economics, and maintenance and hazard management for social sustainability.

KEY SIGNALS

CASE

Reducing manufacturing's carbon footprint through data sharing

C-VoUCHER combines design and technology to support SMEs on their way towards circular economy.

INTERVIEW

Sustainable Digital Twins

How might we utilise data and create environmental & economic simulations for sustainable outcomes?

INTERVIEW

End-to-end traceability across the supply chain

Data makes it clear where you have succeeded with the sustainability work and where improvements are needed.

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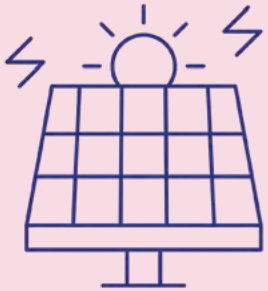
Future Spheres of Action

Future of Data



Future of Energy & Critical Resources

Future of Material & Products

Future of The Factory

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Future of Data

We live in a data-intensive age, thanks in particular to artificial intelligence and machine learning. While the amount of data grows, the European manufacturing system is using, sharing and collaborating on data across geographical boundaries, sectors, and value chains.

With the volumes of data generated in all sectors of the economy exponentially increasing, it will be more important than ever to ensure data sovereignty and safeguard ethics and the quality of data throughout manufacturing processes. This results in a growing need for the future workforce to know how to handle the data with an increasing emphasis on cybersecurity.

Over the years, the manufacturing sector has increasingly started to collaborate across hyperconnected value networks to increase competitiveness and productivity, and to develop new products and processes that have a positive impact on society and the environment. Manufacturers of the future will not only need to understand and know their data, but should also be able to share it safely and securely beyond the walls of their factories. In an era where data collaboration between businesses will increase, trust is essential. Non-competing data spaces can offer this trusted exchange ecosystem where manufacturers can manage their data assets in a sovereign fashion, based on mutually agreed rules.

DIMENSIONS

- Resilient Data Spaces
- Data Quality & Ethics
- Sustainable Data

DIMENSION 1

Resilient Data Spaces

Sharing data is not a new thing, but the requirements of collaborating in data spaces go beyond the bare exchange of data.

Data spaces are part of the European manufacturing future, as they offer an innovative and powerful way to accelerate data sharing. However, it seems that a lot of the manufacturers, especially SMEs, are not jumping on the data space opportunity, as they mention 'the lack of data skilled workers in the company' or 'privacy concerns' as the biggest blockers for data collaboration. While the potential is endless, use cases are needed to show the business opportunity of data spaces and to develop relevant services.

With data sharing and collaboration becoming the norm, the question remains how European manufacturers can shift from being monopolies of knowledge to a safe and open, collaborative and sustainable network of data.

KEY SIGNALS

INTERVIEW

Open data key for supply chain resilience & a circular economy

Secure and open data exchange must be available to all players in the value chain.

CASE

Meet Gaia-X

Europe is pushing for independence from cloud giants in the US and China with Gaia-X.

CASE

The Resilience & Sustainability Dataspace

A federated ecosystem for resilience and sustainability.

Read the Signals of Change in full on futuremanufacturingsystem.eu/signals

DIMENSION 1

Resilient Data Spaces

"Data sharing, data spaces, is our future for the products or services that we want to have. We know that we want to have autonomous cars, but you need to share the data.

We couldn't make autonomous cars without sharing the data. So, this is a need already."

Martina le Gall Malakova, OECD

STRATEGIC DEPARTURES

What will it mean for future manufacturing businesses if a European trusted and non-competing data space would be working and providing free services to all manufacturing businesses?

What if EIT Manufacturing would be the 'one-stop shop' to find all needed information and data for smaller manufacturers to make trusted, fair and split-second decisions?

Will there be a growing need for a shared space for European manufacturers in the future, to manage increasing instability caused by the internet evolving into several fragmented pieces?

DIMENSION 2

Data Quality & Ethics

Manufacturers need to learn to use data while respecting current and future ethical standards.

Future organisations will require new skill sets to ensure they are able to talk and walk data ethics. Being able to create personalised products, services and experiences, while at the same time respecting users' need for privacy.

Transparency and responsible data handling will become a crucial differentiator for manufacturers in the future. With more data being needed and used within manufacturing, it will be increasingly important to ensure data sovereignty, and to be aware of ethics and the quality of data throughout the manufacturing process.

Furthermore, we see an interesting concept of data dignity emerging, proposed by Jaron Lanier and Glen Weyl, based on the premise that the user must be paid for using their data. It turns the data into a property that is owned by the user and is compensated by the company for monetising their property.

KEY SIGNALS

CASE

Muna.io - Get discounts with your data

Fair, ethical and transparent data exchange.

CASE

From Data as Asset to Data as Liability

Many problems can occur while working with data that must be addressed.

CASE

Zero-Trust model of cybersecurity

An effective approach to prevent data breaches and mitigate the risk of supply chain attacks.

Read the Signals of Change in full on futuremanufacturingsystem.eu/signals

DIMENSION 2

Data Quality & Ethics

"If you want to be better in sustainability, you have to use what you have. And we have data.
So, what we have to do now is really to start implementing and helping our companies in Europe to do it. And this data must be secure, but it should also be used with ethical values, for example, the democratic values we want to live by in Europe.
So the impact is not only technical and technological, using data to have sustainability in manufacturing also has an ethical impact on our society."

Martina le Gall Malakova, OECD

STRATEGIC DEPARTURES

What will be the impact for future manufacturers if consumers become data owners, what does this mean for future manufacturing business models?

What if technology makes it extremely easy for manufacturers and consumers to track and measure the 'ethical' footprint of products and services?

How can manufacturers develop a critical mindset between 'right' and 'wrong' data and spot the difference in ethical standards along the global value chain?

DIMENSION 3

Sustainable Data

An increasingly data-driven future for manufacturing should go hand in hand with environmental impact.

On one hand, data sharing will enable manufacturers to decrease their carbon footprint, using lifecycle data collection and analysis to improve sustainability. But on the other hand, an increasingly data-driven future for manufacturing is not necessarily a very sustainable one. Training AI and its large machine learning models requires a lot of power. In fact, according to a paper by researchers at the University of Massachusetts, Amherst, the use of AI technology across all sectors produces carbon dioxide emissions at a level comparable to the aviation industry.

Being aware of this environmental impact is crucial, as data processing and AI are increasing and heading in the direction of ever-more complex models and wider adoption across industries. These developments should be considered when working towards environmentally responsible manufacturing as it poses disruptive potential for the future of data-enabled manufacturing.

KEY SIGNALS

CASE

Reducing manufacturing's carbon footprint through data sharing

Determining a product's carbonfootprint is challenging due to a lack of data transparency.

INTERVIEW

Cloud Carbon Footprint

An open source tool to measure and analyse cloud carbon emissions.

INTERVIEW

Data Centers Are Facing a Climate Crisis

Companies are racing to cool down their servers as energy prices and temperatures soar.

Read the Signals of Change in full on futuremanufacturingsystem.eu/signals

DIMENSION 3

Sustainable Data

"We have a huge amount of data. But, if each company wanted to store and work with their data alone, I think the environmental impact of that of their data centre will not be very green.

That's the reason why data has to help us to decrease energy consumption, not to increase it. So we have to know

which kind of data we want, which kind of data that we could share will help me or will also help the value chain. This is the reason why the data space, data sharing and interoperability is very important, now and for the future."

Martina le Gall Malakova, OECD

STRATEGIC DEPARTURES

What if the development of data-driven business models would go hand in hand with manufacturers' net-zero ambitions?

What if, in the future, AI would learn itself to more efficiently reduce its own carbon footprint?

Could sustainable AI become a key performance indicator for future manufacturers?

Future of Energy & Critical Resources

Awareness in manufacturing of the need to be part of the green energy transition has accelerated due to the current energy crisis and geopolitical unrest. However, by breaking free of fossil fuels, Europe sets itself up for a new dependence — on rare metals.

The combination of today's crises (polycrisis*), from climate change, to a record-high inflation rate, the war in Ukraine and growing pressure on energy security, forces the European manufacturing sector to focus, now more than ever, on green and clean energy and zero carbon alternatives, as well as energy efficiency. In the future, it is crucial to reimagine infrastructure resilience and supply chain stability in an increasingly fractured world order.

Replacing fossil fuels with new renewable forms of energy is necessary to further avoid the catastrophic effects of the climate emergency. That said, we need to make better use of what we have and in the end, the greenest energy is the energy we do not use. Looking ahead, energy efficiency must go hand in hand with this energy transition as a response to the climate crisis. Adding to this complexity is our dependency on rare metals and minerals used for the sustainable energy transition. This will require new plans, actions and thinking.

** The 'polycrisis' term was coined by European Commission President Jean-Claude Juncker (2016) to refer to the confluence of multiple, mutually reinforcing challenges facing the EU, from 'the worst economic, financial and social crisis since World War II' through 'the security threats in our neighbourhood and at home, to the refugee crisis, and to the UK referendum', that 'feed each other, creating a sense of doubt and uncertainty in the minds of our people.'*

DIMENSIONS

- Clean, Green & Efficient Energy
- Decentralised Energy Options
- Race for Critical Resources

DIMENSION 1

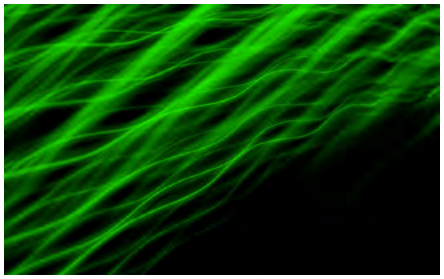
Clean, Green & Efficient Energy

Given the energy intensity of manufacturing, new and efficient sources of energy are needed.

Manufacturing, being responsible for a lot of the carbon emissions, can actually make an impact to reach climate goals. To ensure that Europe can meet the international commitments made in the Paris Agreement, fossil fuels used in manufacturing need to be replaced with renewable energy, but at the same time, we need to be more efficient and smart. Electrification of the manufacturing process could be an enabler for decarbonisation and ultimately support the transformation to fossil-free factories.

Green hydrogen can play a major role in reaching net-zero targets, particularly in sectors such as steel and chemical production. The demand for green hydrogen is expected to grow, but it needs to narrow the efficiency gap and address its cost-effectiveness to be competitive with direct electrification and really become an energy solution for a greener future.

KEY SIGNALS



CASE

Green & Affordable Hydrogen

Scalability of green and affordable hydrogen is necessary.

CASE

Decarbonisation in manufacturing

Focus on intensive industrial processes.

CASE

Green Steel

Investment in green manufacturing processes.

Read the Signals of Change in full on futuremanufacturingsystem.eu/signals

DIMENSION 1

Clean, Green & Efficient Energy

"We calculated that final energy demand could be reduced up to 40% by switching to renewable energy sources where it is feasible and using green hydrogen when direct electrification is not an option. We already see factories in Europe decarbonising by electrification of their manufacturing processes"

Nick Eyre, University of Oxford

STRATEGIC DEPARTURES

What if hydrogen reaches the scalability phase? How will that disrupt the manufacturing landscape?

What if, in the future, electric cars are not just considered green, but also labelled with energy efficiency labels?

What if the green transition will end up in a polarised landscape of people maintaining an energy lifestyle while others are forced to consume significantly.

DIMENSION 2

Decentralised Energy Options

With Web3 technologies such as blockchain, the physical world has the option to become more decentralised, including in energy.

Future manufacturers will need to prepare for more decentralisation. With the rise of renewable energy, there is a growing need for flexibility in the energy system, opening up for new opportunities of decentralised energy structures. Use cases with peer-to-peer energy trading and micro-grids are just two examples of how blockchain technology can fuel the decentralisation of the energy system.

Furthermore, as we continue down the road of electrification, security concerns will matter much more than they do today. To increase energy resilience, electricity is going to be best organised nationally or in blocks, like within the European Union, according to Professor Helen Thompson from the University of Cambridge.

KEY SIGNALS

CASE

Companies invest in their own renewable energy

Ikea to invest £3.4bn in renewable energy by 2030.

INTERVIEW

Europe will need to design products for the energy transition

"This is a challenge but also a great opportunity for European manufacturing."

CASE

Distro - A new microgrid electricity trading platform

Distro is accelerating the energy transition by providing better prices for renewable power.

Read the Signals of Change in full on futuremanufacturingsystem.eu/signals

DIMENSION 2

Decentralised Energy Options

> "Manufacturing basically cannot operate as it is trying to operate and cannot deal with producing stuff in the way it's trying to do it [now]. It can't be done.
>
> The system we're running now in manufacturing doesn't work. That market... take stuff, make stuff, waste stuff, use fossil fuel... that whole system is broken beyond repair."
>
> **David Peck, TU Delft**

STRATEGIC DEPARTURES

What would be needed from the manufacturing system to move towards a fully decentralised energy grid in Europe?

What if manufacturers would build capacities and skills for a world where decentralisation of energy is the default?

What would it mean for the manufacturing sector if decentralised online communities will create the standards for the future (of energy), instead of governments and states?

DIMENSION 3

Race for Critical Resources

While looking for a greener future for manufacturing, challenges arise when it comes to access to critical materials and resources.

The green-tech revolution will reduce our dependence on nuclear power, coal, and oil, heralding a new era free of pollution and fossil-fuel shortages. Yet the currently known global mineral reserves will not be sufficient to supply enough metals to manufacture the planned non-fossil fuel industrial system", suggests a 2021 GTK (Geological Survey of Finland) research report. That means that our transition from fossil fuels to a green future comes with a new dependence on rare metals with a risk of shortages. Therefore, critical material scarcity could threaten a renewable energy future.

Understanding this context can trigger new developments to be more efficient with the scarce resources we have and strengthen security with respect to rare earth materials. As a result of these described developments, Europe may increasingly focus on local and domestic production and sourcing. Another possibility could be that mines will be (re)- opened and metal extraction will start again on the continent. Ultimately, Europe needs to plan for actions to diversify sustainable material sourcing to not be dependent on only currently known mineral reserves.

KEY SIGNALS

CASE

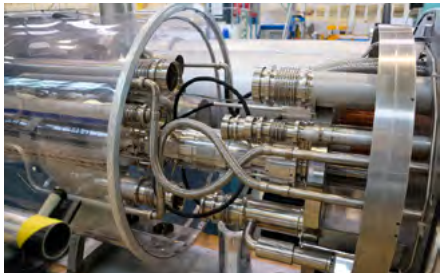
The Resource Race is On

Powering our digital lives and green technologies are some of the Earth's most precious metals — but they are running out.

CASE

P&G's New Strategy to Help Address Global Water Crisis

Including a first-of-its-kind goal to restore more water than is consumed in water-stressed areas.



CASE

Noveon

Permanent magnets. Sustainable power.

Read the Signals of Change in full on futuremanufacturingsystem.eu/signals

DIMENSION 3

Race for Critical Resources

> "We want to restore not only the water that we use, and not only a little bit more water than we use for production and product, but also the water that people are using."
>
> **Maja Borowska, Procter & Gamble**

STRATEGIC DEPARTURES

What will be strategies and policies in the future that are both environmentally sustainable and geopolitically sustainable?

Could moonshot missions be part of the ambition to secure rare metal scarcity in the future?

How can public opinion be influenced on initiatives that could bring sourcing back to Europe?

Future of Materials & Products

A sustainability mindset is challenging the norms for material and product innovation of the future. Manufacturers need to start addressing the root problems, not just solving symptoms.

By manipulating materials or developing bio-based ones, and designing machines and products that support and enable new ways of producing, manufacturers can set new norms for collaborating and overall 'greener' thinking.

Driven by the circular economy, we see an ongoing push from consumers and regulators to move towards more repairability as part of the (product) experience and a possibility to put remanufacturing at the centre of the circular economy. This will change how manufacturers design and plan their production processes now and in the future.

To go even further, along with an altering consumer mindset and growing support from some economists, the degrowth debate is accelerating. Jason Hickel, author of the book ' Less is More, How Degrowth Will Save the World', clarifies that degrowth is not about reducing GDP, but rather about reducing [energy and resource] throughput. All of this is putting pressure on manufacturers to be more open to a radical paradigm shift. Or as mentioned by one of the interviewees: "Manufacturing needs to shift to a degrowth mindset. With the existing mindset, even if we do it in a green way, manufacturing will not be sustainable."

DIMENSIONS

- Remanufacturing Businesses are Relevant
- Manipulating Materials & Machines
- Bio Materials and Manufacturing

DIMENSION 1

Remanufacturing Businesses are Relevant

Remanufacturing is “the rebuilding of a product to specifications of the original manufactured product using a combination of reused, repaired and new parts.”

The concept of remanufacturing is not new, but is gaining momentum. The European Remanufacturing Network has estimated that the remanufacturing industry could grow to €90 billion by 2030 and employ 255,000 people. Along with changing consumer expectations, especially of younger generations that demand different standards, it is up to manufacturers to take the remanufacturing opportunity seriously.

Remanufacturing is opening up possibilities for cost-effective innovation while complying with sustainability mandates and addressing customer expectations. The manufacturers that are pioneering and finding out how to be proactive by researching flexible remanufacturing models, reverse planning, sharing and accessing accurate data and developing their own industry-specific solutions, will be the ones who will stay relevant and lead in the future.

KEY SIGNALS

CASE

AI Image Recognition for Vehicle Components

Turning old into new: A second life for vehicle components.

INTERVIEW

Remanufacturing and product life extension

“I manufacture it, I make a loss. I remanufacture it, I break even. Then I start making money. That’s completely different, isn’t it?”

INTERVIEW

Additive Manufacturing and product lifecycle extension

“Additive manufacturing can support this change and the market for repairing is very huge.”

Read the Signals of Change in full on futuremanufacturingsystem.eu/signals

DIMENSION 1

Remanufacturing Businesses are Relevant

"What is remanufacturing?

It's not repaired, it's not refurbished, it's not pimped, it's not resprayed. It's not on EBay. It's a product that has gone through a manufacturing process, a remanufacturing process.

I manufacture it, I make losses.I remanufacture it, I break even. Then I start making money. That's the business model."

David Peck, TU Delft

STRATEGIC DEPARTURES

What if European manufacturers would aim for localised remanufacturing, and at the same time contribute to neighbourhoods and social values?

How can European manufacturers design and adapt products for multiple users and cycles as well as normalise remanufactured products?

What is the opportunity for European manufacturers to expand the 'postpuchase' consumer experience and build long-lasting product experiences?

DIMENSION 2

Manipulating Materials & Machines

Successful material innovation goes hand in hand with developing the machines for it.

Technologies such as artificial intelligence are more frequently used in material research and in the creation and design of newer and better materials. It opens up opportunities for manufacturers to work with materials that contain the right characteristics and requirements from scratch.

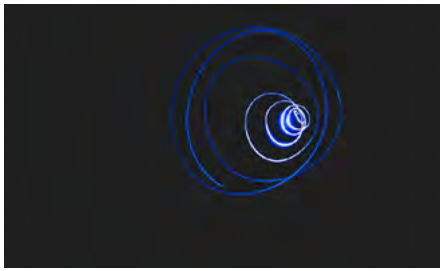
Researchers at MIT have even developed a machine learning algorithm that can help to detect defects in materials before they even occur, improving the reliability and efficiency of existing manufacturing processes. To ensure manufacturers also have the right machines to handle the new materials, recent developments are focused on the industrial compatibility of material and machine. In the end, it is all about creating and manipulating materials that bring a positive impact to the world.

KEY SIGNALS

INTERVIEW

Machine learning and AI for allow discovery

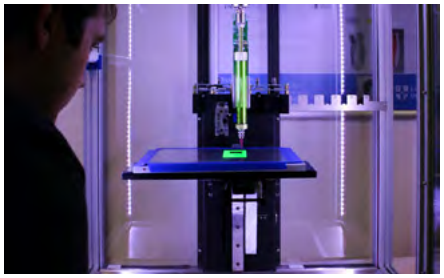
"There's basically an unlimited potential with alloys."



CASE

Science is on the brink of a materials revolution

Ability to control subatomic 'spin' crucial to designing advanced new materials set to change the world.



INTERVIEW

Developing AM capabilities for new materials

"We are working on how to implement the additive manufacturing in different sectors and applications."

Read the Signals of Change in full on futuremanufacturingsystem.eu/signals

DIMENSION 2

Manipulating Materials & Machines

"We can engineer the raw materials right now. And there are many startups that are working on it right now in Europe, but also in North America.

Using engineered materials, building them cell by cell. Building them from the molecular level.

So instead of using components that have to be either mined or harvested or whatever, we engineer those materials"

Ramon Antelo, Capgemini

STRATEGIC DEPARTURES

How do we encourage collaboration and innovation between the different departments of material innovation and machine innovation?

What if European manufacturers start collaborating and supporting new material entrepreneurs in the future and create a European Material Library accessible for everyone?

How do we support standardisation to enable widespread adoption, collaboration and sharing of discoveries?

DIMENSION 3

Bio Materials & Manufacturing

New materials and processes will be developed to make a positive contribution to the planet, instead of taking things aways from it.

Inspired by nature and a regenerative mindset, and enabled by science and technology, we see better bio-based materials being developed that are influencing the manufacturing sector. Bio-based materials offer alternatives to plastic and other well-known polluting materials that for too long now have been some of the main causes of the environmental crisis.

Most experimentation and innovation come from young start-ups, designers and entrepreneurs and they are setting new norms for material innovation. Furthermore, biomanufacturing is not only about new materials. Biomaterials using DNA are also used in chips, to address the challenge of data storage.

KEY SIGNALS

INTERVIEW

New plant-derived composite is tough as bone and hard as aluminium

The material could pave the way for a sustainable alternative to plastics.

CASE

Synbio Powerhouse

Synthetic Biology Ecosystem.

CASE

Materials for a better world

Bolt Threads invent cutting-edge materials on a path towards a more sustainable future.

Read the Signals of Change in full on futuremanufacturingsystem.eu/signals

DIMENSION 3

Bio Materials & Manufacturing

"We have lived in a manufacturing environment in which the manufacturing was tightly coupled to where the raw materials were sourced, either in the form of minerals or harvest or whatever.

If we can decouple that, then Europe, especially, might have a very good competitive edge because we will then have access to producing any type of products without the limitation of the raw material.

I think biomanufacturing is one of the key elements of the future."

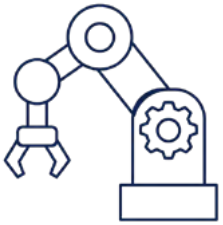
Ramon Antelo, Capgemini

STRATEGIC DEPARTURES

What if manufacturers start growing their own materials in the future?

What if we only use biomaterials and what does this mean for education and skills needed in manufacturing?

How do we demystify the narrative of biomaterials made of mushrooms and tea bags into an economically solid one?



Future of the Factory

The everyday experience of the factory is changing, as I4.0 technologies are transforming production, processes and working roles.

Digital transformation is revolutionising all aspects of manufacturing, and as a result, changing the factory as we know it. The Industrial Metaverse is taking shape - a new ecosystem currently represented by the Internet of Things, artificial intelligence, and digital twins - and is leading the development of new manufacturing and service systems across the entire value chain.

The impact is being seen in reducing resource use while increasing factory output; raising efficiency while cutting greenhouse gas emissions; raising quality while reducing cost; and increasing customer satisfaction as well as reimagining employee engagement. Within this space, the mainstreaming and scaling of novel manufacturing concepts will be critical to seeing tangible results, along with the need to align progress with key factors for success: productivity, sustainability and resilience.

DIMENSIONS

- Creative Freedom in the Industrial Metaverse
- Collaborative Technology for Radical Servitisation
- Resilience through Non-linear, Distributed production

DIMENSION 1

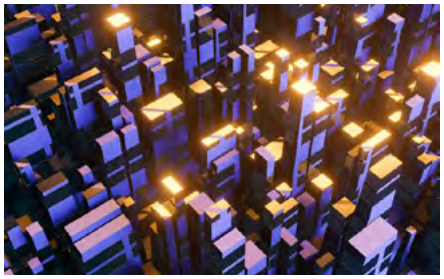
Creative Freedom in the Industrial Metaverse

The Industrial Metaverse unleashes a new era of creative freedom within manufacturing innovation.

The Industrial Metaverse has the potential to remove barriers around innovation such as costs, timelines and geography, alongside being fully integrated with the real economy and environment for accelerated implementation and impact.

Companies that put their best ideas forward to embrace experimentation in the virtual world, will excel in transferring these learnings to be pragmatic first movers in the 'real world'.

KEY SIGNALS



INTERVIEW

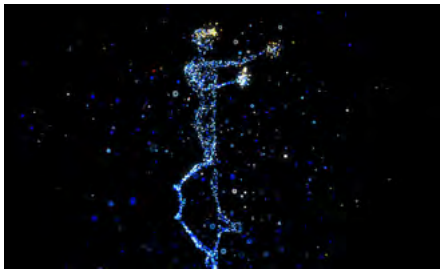
"Digital Twins is not a panacea"

"It's not always the case that building a digital twin will lead to a better performance."

CASE

Metaverse Manufacturing

Research institute opens virtual factory in metaverse environment.



CASE

Metaverse as Innovation, Sustainability Tool

Sustainability could be one of the biggest benefits presented by the industrial metaverse.

Read the Signals of Change in full on futuremanufacturingsystem.eu/signals

DIMENSION 1

Creative Freedom in the Industrial Metaverse

"I have had several discussions with big European companies in the past, and one of my questions would be "Do you try to use advanced digital manufacturing tools for modelling this specific process so that you can optimise the process, reduce the cycle time, and so on and so forth?"

[Currently] we just limit ourselves to modelling the most critical process and not everything."

Nikolaos Papakostas, University College Dublin

STRATEGIC DEPARTURES

What if digital twins could lead the way in design innovation while making this a zero-waste process?

What if collaborative metaverse platforms could completely remove geographical boundaries from the design process?

What if remote work becomes the norm in manufacturing through immersive metaverse environments?

DIMENSION 2

Collaborative Technology for Radical Servitisation

Manufacturing has been transformed, as companies are moving to service-centric business models and logic.

With no one-size-fits-all solution to servitisation, successful companies have followed an agile, incremental adoption of technologies aligned with their business strategy, while managing interconnections between implementation and organisational change.

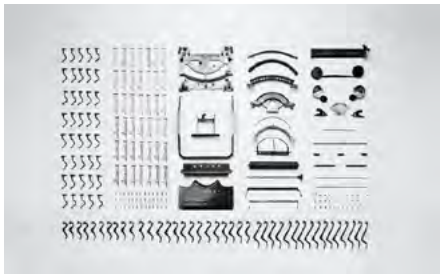
The higher the servitisation the better the performance, with use cases deeply connected to I4.0 technologies.

KEY SIGNALS

CASE

Formic: Robots by the Hour

'We Manage Automation, You Manage Your Business.'



CASE

A digital one-stop-shop for custom parts

KREATIZE is a full-service platform granting hardware companies access to all manufacturing capabilities.

CASE

Lights-Out Manufacturing Is a Game-Changer for Production

A relatively new methodology using automation to operate a facility without human intervention.

Read the Signals of Change in full on futuremanufacturingsystem.eu/signals

DIMENSION 2

Collaborative Technology for Radical Servitisation

"What is also a big trend is this equipment as a service trend, where machine manufacturing companies start to not only sell their products, or their machines that cost maybe 500,000 euros, but you can just kind of rent it or subscribe to it as you know from the private sector, like with your Spotify subscription.

If you don't want it anymore, you stop subscribing. Having the same kind of logic applied to production equipment or machines is a big trend. Lots of people are thinking about how to do that."

Martin Plutz, Oculaviz

STRATEGIC DEPARTURES

What if manufacturing infrastructure such as machinery was shared across different companies?

What if the startup environment flourishes in this new landscape bringing a younger audience and changing the 'branding' of manufacturing?

What new business opportunities will arise through I4.0 technologies as moderators of servitisation?

DIMENSION 3

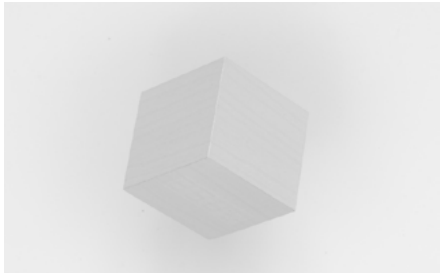
Resilience through Non-linear, Distributed production

The development of EU-level value chains has evolved into an expansive network of localised, specialist manufacturers.

A landscape of localised, specialist manufacturers develop in response to the geopolitical landscape and sustainability goals, with companies now able to deliver value and compete.

The model promotes designing globally while producing locally, leveraging digital manufacturing technologies, and highlights the opportunity for engaging directly with customers to shift from mass to personalised and on-demand production.

KEY SIGNALS



CASE

The 'Factory in a Box' Concept

At one end you supply the materials and at the other your product rolls off the assembly line.

INTERVIEW

Modular manufacturing systems

"Modularization instead of the huge monster production machines that we have today."

CASE

Pay-per part business model disrupts manufacturing industry

The "pay-per-part model" reduces risk, increases flexibility, and supports agile sustainability.

Read the Signals of Change in full on futuremanufacturingsystem.eu/signals

DIMENSION 3

Resilience through Non-linear, Distributed production

"You need to have parallel value chains, where basically you can have several suppliers that are based in different geographical areas.

So that if something is affecting an area, it's not affecting the other one. Probably a good deal of insourcing will also be required.

You want to be sure that if everything goes bad, at least you have the capability to ramp up production in-house, or in the country where there's some control."

Roberto Saracco, IEEE

STRATEGIC DEPARTURES

What if the pay-per-part model breeds a new era of highly specialised manufacturers?

How might product design and supply chain management processes become more transparent, agile and customisable?

What if production became mobilised, moving and leasing locations dependent on where manufacturing services are required?

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