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# BACK TO THE FUTURE

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## EMERGING TOPICS FOR LONG-TERM RESILIENCE IN MANUFACTURING

### TREND-DRIVEN INNOVATION IN MANUFACTURING

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Group Leader

**Fernando G. Alberti and Federica Belfanti**

Institute for Entrepreneurship and Competitiveness,  
Università LIUC – Carlo Cattaneo (Italy)

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# CONTRIBUTORS

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## **Mélanie Despeisse**

Research Associate and Assistant Professor,  
University of Cambridge and Chalmers University  
of Technology

## **Luiz Carlos Di Serio**

Full Professor, FGV - Fundação Getulio Vargas

## **Mark Esposito**

Professor, Harvard University

## **Jorge Forteza**

Professor and Strategy consultant, Universidad  
de San Andrés

## **Maria Mazzone**

Managing Director Innovation, Accenture

## **Astrid Ute Friderike Palmieri**

Senior Sustainability Manager Italy and Sustainability  
Coordinator EMEA, BASF

## **Rocio Prado Castillo**

CEO, Sintonia - Institute of Collaboration  
and Competitiveness

## **Alon Rozen**

Dean and Professor, École des Ponts Business School

## **Martin C. Sanne**

Managing Director, Expleo Group

## **Ivan Ureta**

Senior Lecturer and Head of the Executive Education,  
SUPSI - University of Applied Sciences of Southern  
Switzerland

## **Mario A. Varon**

Global Shaper, World Economic Forum

## **Bart Kamp**

Coordinator of Internationalization Affairs,  
Basque Institute of Competitiveness - ORKESTRA

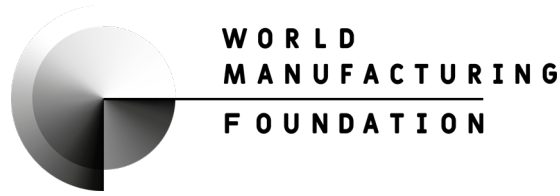
## **Jacopo Farina**

Strategic Partnerships Expert, Vodafone Business Italy  
Member, Young Manufacturing Leaders

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## **BACK TO THE FUTURE**

**EMERGING TOPICS FOR LONG-TERM  
RESILIENCE IN MANUFACTURING**



This whitepaper, published in October 2021, is part of the “Back to the Future: Emerging Topics for Long-Term Resilience in Manufacturing” initiative, promoted by the World Manufacturing Foundation, a non-profit organisation with a mission to spread industrial culture worldwide. The initiative involved global focus groups, each exploring a relevant theme for building a resilient manufacturing sector. Each focus group developed a whitepaper identifying key propositions to enable the manufacturing community to thrive in the long term.

The views and opinions expressed by whitepaper contributors are given in their personal capacity and do not necessarily reflect the views of the organisations for which they work or committees of which they are members.

For more information on the project and to read other topic-focused whitepapers that are part of the initiative, please visit <https://worldmanufacturing.org/report/back-to-the-future-emerging-topics-for-long-term-resilience-in-manufacturing/>

## INTRODUCTION

We are living in a time of unprecedented change. Breakthrough technologies are transforming the way we live and work; interconnectivity of people and businesses has never been so pervasive; profound shifts are impacting our societies, resulting in distress and political tensions; climate change is emerging as the most urgent and transformational challenge of the twenty-first century. And the global pandemic of COVID-19 has only sped up many changes that were already in motion.

In a post-pandemic world where the future is so uncertain and change comes so fast, the ability to spot opportunities and innovate – to evolve, adapt, and improve – is indispensable. Companies need to be “active resilient”, i.e. they need to develop the ability not only to reduce the impacts of shocks but to avoid them. It is “the capacity to change before the case for change becomes desperately obvious”<sup>1</sup>.

To this end, observing and understanding the key drivers of change impacting business and society is crucial, as it gives actionable insights into what is – or will be – relevant to a business or industry. Although future events are inherently unpredictable, firms can make curated observation of the present to spot the accelerating patterns that will lead them toward the future, eventually figuring out which trends are going to be the most relevant and impactful<sup>2</sup>.

The challenge is for companies to be able to put trends to work by extracting powerful innovation opportunities for their target markets to meet new customers’ needs and increasing expectations, while differentiating themselves from their competitors.

Today, there are many different professionals and organisations dealing with trend studies, in a wide range of fields; some more related to scientific and academic institutions, some others to business strategy and consulting, while others to design and art disciplines. As a result, firms are constantly overwhelmed by a

number of reports aimed at scouting and analysing trends, monitoring their development and impact on business and society. However, companies need support not just in identifying trends that may shape their future, but also in understanding how to test, adapt and implement these trends in their organisations to easily experiment with new business models and value propositions, while also mastering the existing business<sup>3</sup>.

This chapter aims at supporting manufacturing firms in understanding how to leverage and use trends as a key driver for innovation – i.e. how to do “trend-driven innovation” – to foster their competitive advantage and stay competitive in the years ahead.

To fulfil this aim, we first created a curated list of the sixty most relevant technological, business and cultural trends that will guide manufacturing innovation in the coming years according to some of the most renowned trend firms and organisations (e.g. TrendWatching, TrendHunter, The Future Laboratory, Fjord, etc.) We then collected ideas and insights on the topic during two workshops we designed and organised with a distinguished group of 13 international academics and practitioners, world experts of trend analysis and forecasting thinking in manufacturing, and Faculty Members of the Microeconomics of Competitiveness Network of Prof. Michael E. Porter at Harvard Business School.

More specifically, the first workshop aimed to pick out and prioritise the Top 10 Trends that will drive innovation in manufacturing in the next ten years, out of the initial sixty we identified (Section 1); while the second workshop took a step further and aimed to uncover the specific innovation opportunities that these trends present for organisations by relying on the “Ten Types of Innovation” framework introduced by Larry Keeley and colleagues at Doblin (Section 2). According to this framework, innovation can be categorised within a range of ten distinct dimensions, i.e. profit model, network, structure, process, product performance, product system, service, channel, brand,

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and customer engagement; (for more information on the ten types of innovation, see Annex 1). Collecting and analysing contributions from all over the world allowed us to formulate a set of key learned lessons and recommendations for managers, policymakers and industrial leaders to help them be 'active resilient' and stay ahead of the competition in the next years (Section 3).

## CONTEXT – THE TOP 10 MANUFACTURING TRENDS FOR 2030

Here after, the most relevant technological, social and business manufacturing trends for 2030 are presented. Four main areas are covered: the future of supply chains, sustainability challenge, data and connectivity, consumer behaviour.

**Trend #1 Carbon negative:** As concerns around the future of our planet continue to rise, companies and organisations are pivoting to solve our carbon problem. The planet's temperature is rising and it is now clear that offsetting emissions to become carbon neutral is not enough – 'negative' has to be the new 'neutral' and brands must endeavour to actually remove more carbon emissions than they emit.

**Trend #2 Data-driven manufacturing:** In the near future, manufacturing companies will operate in digital and hyperconnected value networks. Value creation will be unlocked by data-and-analytics applications – such as predictive maintenance, advanced robotics, and tracking and tracing in supply networks – to increase productivity, enhance customer experience and have a positive impact on society and the environment.

**Trend #3 Phygital ecosystems:** Breakthrough technologies, including new sensors, smart connected products and artificial intelligence, generate a conver-

sion of the physical and digital worlds, transforming traditional, linear supply chains into connected, intelligent, scalable, customisable, phygital ecosystems. Alongside with retail shops and smart city initiatives, an increasing number of manufacturing industries will experiment with phygital solutions to create new value for their customers and users.

**Trend #4 Purpose-driven models:** Organisations that know why they exist and who they're built to serve will be uniquely positioned to ride out unprecedented and extraordinary change. According to recent studies, consumers are a third more likely to buy products from purpose-driven companies<sup>4</sup>, and employees, especially among millennials, are looking for greater 'meaning' from work. i.e. a company's commitment to the community and social impact initiatives<sup>5</sup>. Furthermore, people increasingly see businesses as the most competent actors to solve global issues – even more than nonprofits and governments.

**Trend #5 Industrial Artificial Intelligence (AI) and Machine Learning (ML):** Industrial AI is "a systematic discipline, which focuses on developing, validating and deploying various ML algorithms for industrial applications with sustainable performance"<sup>6</sup>. Manufacturers are realising the need to move from artisanal AI to professional, customised and scalable models, to deploy AI and ML into production and operations. Three out of four executives believe that if they don't scale AI and ML in the next five years, they risk going out of business<sup>7</sup>.

**Trend #6 Next-generation cybersecurity:** As entire supply chains digitalise and connect – thanks to the rapid adoption of cloud infrastructure, applications and services, social media, the virtualisation of data centres, and IoT sensors – vulnerabilities must be shielded from the increasing likelihood of cyberattacks. According to the 2021 SonicWall Cyber Threat Report the world has seen a 62% increase in ransomware since 2019<sup>8</sup>. Companies are facing threats which are more sophisticated as well as harder to prevent, and while the level of risk is growing constantly,

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most of them still use outdated security solutions.

**Trend #7 Traceability:** Companies across industries will increasingly explore the adoption of new distributed ledger technologies enabling traceability of processes and products. Stricter regulations and highly conscious downstream consumers demanding details about products' quality, safety, and ethical and environmental impact, will drive a further acceleration of this trend, especially in some industries such as food production and engineering equipment.

**Trend #8 Human X:** As augmented reality, artificial intelligence, and other cognitive technologies enabled by the Internet of Things (IoT) gain traction, and take an active role in our daily lives, the line between humans and machines keeps blurring, realigning societal norms and challenging entrenched perceptions of ourselves. Beyond replication technology recreating human functions, tech is emerging to not just supplement but enhance our abilities.

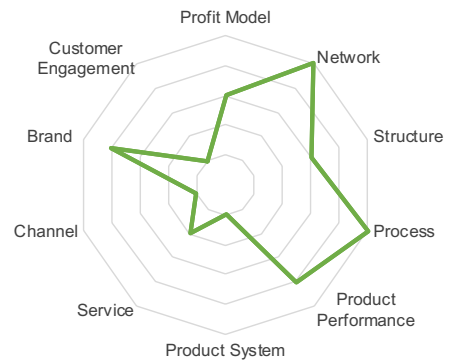
**Trend #9 Inclusiveness:** According to the World Health Organization, more than one billion people live with some form of disability, representing the largest underserved group worldwide. Global awareness of diversity and inclusion will rise, resulting in a societal push for change. Companies will need to make inclusion and diversity an integrated part of their strategy and business models, as well as of new product developments.

**Trend #10 Bespoke for everyone:** Hyper-customisation is entering a new phase in which it is not only driven by aesthetics but also by individual and personal taste and needs. New technologies are enabling manufacturers to push personalisation to its extreme. Some will help tailor and adapt the value created for each individual, such as social networking technologies and 3D scanning, while others will help make personalisation affordable for companies, balancing manufacturing costs and complexity.

## OPPORTUNITIES AND RECOMMENDATIONS

*"We never change as much as we think we will, and we never change as much as we should"*  
(Sandy Baruah, 2021)

**Trend #1 Carbon negative:**



To become carbon negative (or carbon free), i.e. to remove from the environment more carbon than that emitted, companies must profoundly and quickly reorient their strategic and operational priorities. They must take a collaborative approach with a systemic and transparent view over supply chains. Companies must calculate not just the carbon footprint of their operations, but also their indirect emissions, and the emissions from their value chain, that is, emissions from suppliers, customers and other partners. This will require collaboration and partnering between multiple players, as well as technology breakthroughs enabling new and efficient ways to collect, share and use data along supply chains. Circular economy initiatives and innovations reducing demand for primary resource extraction while introducing new sustainable materials will contribute greatly to carbon-negative goals.

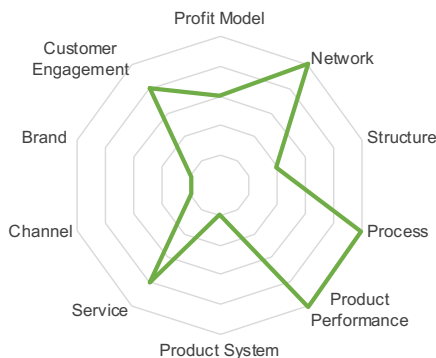
The turning point is the inclusion of carbon-negative goals as a factor in the determination of executive pay. Moreover, companies must keep all their stakeholders, especially customers, informed about progress on carbon-negative goals by releasing data in corporate sustainability reports and via public disclo-

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sure. In the future, it is highly probable that a company's carbon footprint must always be communicated with every product sold.

There is one major concern when it comes to the decarbonisation of firms: Who will pay for this? Institutional and public-private coordination can help by providing the right incentives and supportive regulation.

### Trend #2 Data-driven manufacturing



A data-driven approach will help companies focus on productivity-related issues, but also improve product quality and reliability, increase personalisation, optimise resource efficiency and improve environmental footprint transparency. Data will be the lifeblood of these innovation opportunities and will allow manufacturing firms to shift from delivering products to delivering solutions to customer needs, further accelerating servitisation processes.

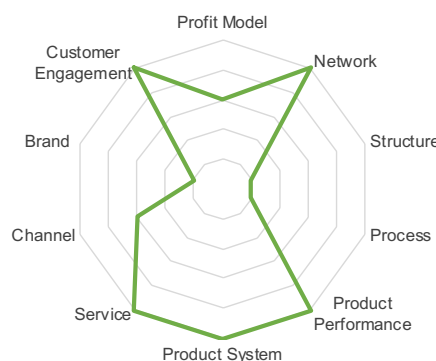
In this regard, there are a few questions that firms must consider before adopting this approach, such as, "What data is needed and what data should be shared with third parties? What will this data help accomplish? How can this data be used to enable efficiency and innovation?"

Major concerns about the willingness to share data are found, especially in B2B contexts where OEMs assembling or producing capital goods are typically hesitant to share their production or operational information with machines and designers of assembly lines. Rather, downstream of the supply chains, customers are more willing to share personal data, especially if

they know it is contributing to the customisation of products and services.

Although a data-driven approach represents a cost, particularly for well-established companies, it could also have a massive and positive impact on profit model innovation by enabling dynamic pricing strategies. Prices need to make sense within an increasingly competitive landscape, and a business' pricing model needs to be ready to adapt to future fluctuations in customer demand and purchasing behaviours.

### Trend #3 Phygital ecosystems



IoT sensors, mobile devices and smart connected products will generate the big data driving the emergence of phygital ecosystems. This trend will potentially bring about entire business model innovations, allowing manufacturers to better serve their customers, expand their markets, and drive profitable revenue growth.

Phygital ecosystems are characterised by a continuous flow of information from the physical to the digital world. They will allow manufacturers to have a direct and ongoing digital link to their end customers. Analytics technologies could, indeed, take the continuous stream of usage data, preferences and consumption – generated by products themselves – and turn it into usable information. These new "close-loop systems" will open up a vast frontier of customisation and servitisation opportunities for manufacturers who can better adapt their offerings to the dynamic needs of their customers. For instance, by leveraging a combination of physical asset management with digital

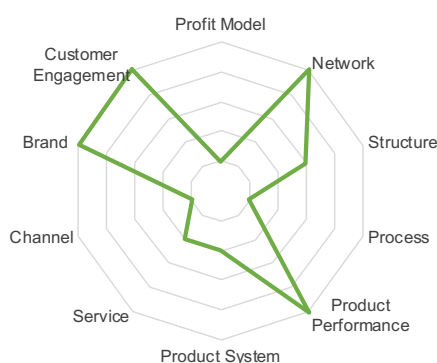
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solutions, Manobi Africa is able to help smallholders monitor their fields in real time, improve their intakes, and optimise logistics, thus de-risking investment in agriculture for banks and unlocking access to credit for farmers.

Phygital business models will also generate for companies new ways to interact and connect with customers along the entire customer journey, as well as with all the different actors operating in their ecosystems. Xiaomi, for instance, makes great use of systematic customer listening from a plurality of different sources to improve its products and customer engagement. A team of over 200 employees, including the founder, CEO Lei Jun himself, scan online content daily, searching for suggestions and feedback about possible product improvements. Once identified, changes are implemented, and the user is notified within a week about the future product. This helps create stronger engagement with Xiaomi’s users, who feel valued and part of the company’s community.

Moreover, phygital models also unlock further collaborative innovation opportunities for small and large manufacturers, just like BMW did with its “Co-Creation Lab”. The car manufacturer launched the lab to involve its passionate customers to co-design cars’ specifications, thus encouraging them to complete the purchase once the product was made.

#### Trend #4 Purpose-driven models



A purpose-driven company articulates why the organisation exists at all and puts its purpose at the centre of every strategic and business decision it takes.

This trend will unlock product innovation opportunities as it enables companies to identify and select new solutions linking unmet social needs and business value, through “shared value” practices<sup>9</sup>.

This first requires gathering and integrating new and greater input from the external stakeholder network, while ensuring regular conversation with end-consumers to understand their real needs and the purpose for which they are buying the products and services. From an internal perspective, a purpose-driven model also requires cross-functional collaboration, breaking silos and making sure that everyone is well-aligned with the company’s purpose.

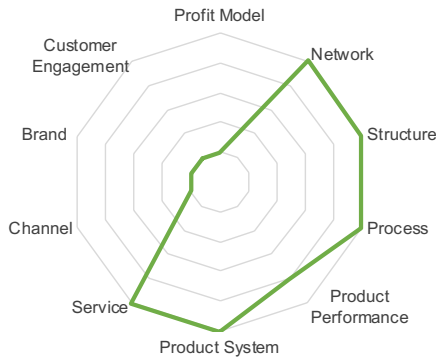
Companies should also hold themselves accountable to meeting their purpose-driven strategy’s goals, by measuring and communicating their progress in a transparent and reflective way, while engaging their employees.

At BASF, the leading global chemical company, corporate purpose drives “what they do and why they do it”. They want to “create chemistry for a sustainable future, and thus sustainability is a key driver of their strategy, innovation, production, and operations. They pledged their commitment to sustainability in 1994 and, since then, have systematically aligned their products and actions with its principles.

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## Trend #5 Industrial AI and ML



The industrialisation of AI platforms will enable reusability, scalability and safety, thus accelerating AI adoption and growth.

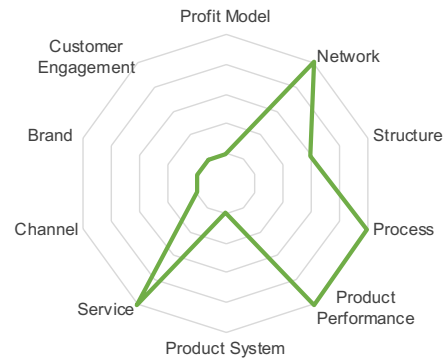
Industrialised AI and ML can help achieve the 3W's in smart manufacturing: Work Reduction, Waste Reduction, and Worry-Free Manufacturing<sup>10</sup>. By lowering barriers to adoption, industrialised AI will offer new opportunities for manufacturers to significantly reduce costs, improve efficiency, and transform their operations for the better. In this way, firms will be able to improve their product performance while successfully dealing with customer dissatisfaction or business decline. The implementation of adaptive AI modules will also allow manufacturers to address specific waste issues, resulting in an optimisation of time and resource management.

These innovation opportunities will potentially unlock many economic benefits for manufacturers. On one hand, the use of scalable AI and ML algorithms will have positive effects on productivity by augmenting and optimising the work of their existing labour force. On the other, they will allow companies to scale their personalisation efforts and offer AI-enhanced products and services, thus increasing consumer demand.

Of course, the organisations that make the most progress in digitising core business processes will also lead on AI and ML adoption. This evolution requires the setting up of a central AI team – involving data scientists, but also data engineers, UX designers and business analytics translators – collaborating with

the different manufacturing functions' teams to jointly develop and put into practice AI solutions for specific use cases.

## Trend #6 Next-generation cybersecurity



Manufacturing companies will increasingly need to manage the tension arising between the need to digitise and automate operations, and the responsibility to protect the organisation, its employees, and its customers.

By building cybersecurity into their production processes and (sensitive) data exchanges with suppliers and business partners, companies have the opportunity to improve their customer experience and value proposition, thus differentiating themselves from their competitors.

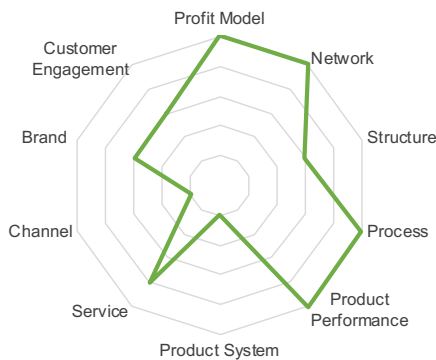
Cybersecurity will bring about product innovation design aimed at building safe and secure customer experiences, ensuring a higher level of privacy, and lowering data breach risks. For manufacturers, this will result in higher brand reputation and customer trust, lower liability risk, and easier regulatory approval and ease to market.

Moreover, cybersecurity will enable network innovations for companies providing new ways to interact with all their business partners. Indeed, security posture is highly dependent on every employee, supplier, cloud partner, and sometimes even competitors, operating in their ecosystems and in the wider global economy. By embedding security into every interconnection and operational process, manufacturers will

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be able to support and amplify the value of products through additional security-driven services provided around their core offering.

### Trend #7 Traceability



In an increasingly digital world, the way we regulate and trace contracts, transactions, and the records of these, will radically change. Enabling technologies for such transformation are now available off the shelf and will become increasingly affordable for both large and small companies. Particularly blockchain and non-fungible tokens will gain traction in an increasing number of industries, enabling a number of processes and business model innovations in which the logic of value creation, capture and storage, and the proof of ownership depart from existing approaches.

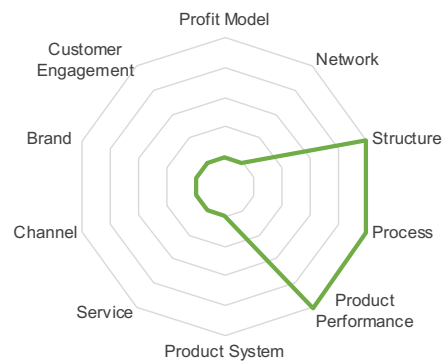
Blockchain will significantly improve supply chains by enabling the faster and more cost-efficient delivery of products, enhancing traceability, improving coordination between network actors, and unlocking access to financing. Moreover, it could help manufacturers to differentiate themselves from their competitors by enabling greater levels of verifiability of data across complex and global supply chain networks, thereby driving provenance and sustainability decisions. For instance, information about the carbon footprint of raw materials can help purchasing departments adhere to green procurement objectives.

Blockchain will also accelerate the servitisation trend of manufacturing firms by streamlining customers' decision-making processes by enabling "connected consensus" and thus transforming products into ad-

vanced services.

This trend will force a variety of corporate functions, including IT, finance, accounting, sales, and marketing, to invest in the creation of new capabilities, as well as making additional corporate efforts to attract highly specialised talents.

### Trend #8 Human X



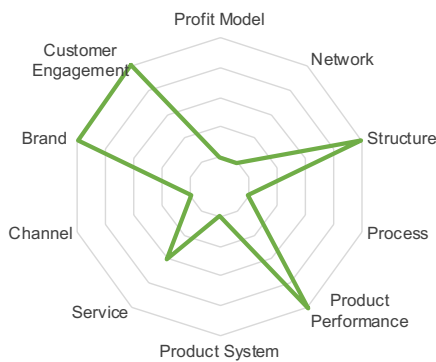
In the future digital era, "human augmentation" will take on whole new dimensions. Future advances in technology will result in a wide array of cognitive and physical enhancers, allowing humans to augment their characteristics and capabilities.

The next frontier for human augmentation will be wearable, ingestible and implantable products. Powerful physical enhancement technologies are already on the market. For instance, exoskeletons are wearable, mechanical devices attached to human bodies for either power augmentation or motion assistance. The Sarcos Guardian is an industrial exoskeleton allowing workers to lift up to 200 pounds. Implantable and ingestible devices will perform an expanding variety of medical diagnostic, therapeutic and monitoring functions. As for neurological human enhancements, research and development is accelerating greatly. Elon Musk's Neuralink aims to connect computers directly to human brains with one- and bi-directional interfaces. They are commonly used to enable motor control and communication tools for people with brain injuries, but the goal is to do cognitive enhancement also in healthy, able-bodied people to provide an extension of the human mind and capabilities.

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Human enhancement technologies will make significant contributions to innovation in terms of how people work and individuals' performances, thus influencing how companies organise talents and assets to create value. They could benefit both employees and employers, and the usefulness of their potential implications will vary with context and occupation. Organisations will see improvements in employee efficiency and coordination, and thus also in productivity. There could be economic benefits to organisations and society more widely as a result of a minor but widespread improvement in cognition. And, finally, technologies could enable the use of collective intelligence to solve problems that were beyond individuals' capabilities.

### Trend #9 Inclusiveness



Inclusiveness will gain increasing traction in the next decade, unlocking tremendous innovation opportunities, especially in the areas of product design, brand strategy and customer engagement.

Design processes will need to shift their paradigm so that diversity and inclusivity are baked in from the start, and products will target as many different types of people as possible. This means flipping the traditional "80-20 rules" upside-down to consider the smaller edge-case users before the core audience and ensure that everyone's needs are met.

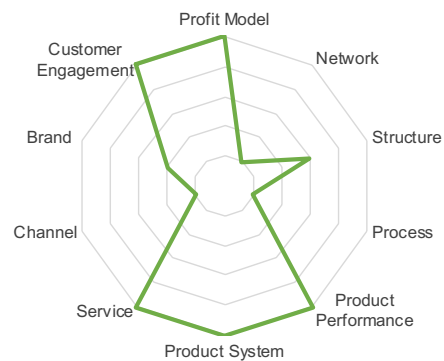
The key to inclusiveness will be to offer the user a variety of interactive experiences, from eye-tracking technology, machine-brain interfaces, natural language processing, to voice-enablement. Degree, Unilever's

antiperspirant and deodorant brand, has created the first adaptive deodorant, designed for one-handed use. Lego has created the first "Braille Bricks" devised as a solution to help get kids excited about learning the language.

Inclusive product design will also boldly enter the public space in more noticeable ways. A great example of this is NaviLens, which installed public transit guides featuring hyper-responsive pixelated QR codes for those who are visually impaired, in collaboration with the Transports Metropolitans de Barcelona.

Inclusiveness needs to be communicated in a 360-degree manner, through storytelling, advertising, social media channels, the company's website, and customer care. Finding a unique, innovative way to communicate a corporate's inclusiveness values, which haven't yet been conveyed by competitors, will be challenging but can differentiate brands while helping them stay relevant for consumers.

### Trend #10 Bespoke for everyone



In the near future, the value of personalisation will reside in creating experiences tailored to the needs, behaviour, preferences, values, beliefs, and even taste of single individuals.

Using big and small data, AI and ML, companies can develop a deeper understanding of what individual consumers want, to find new ways of segmenting them, and thus creating bespoke experiences based on understanding who the individual is, where they are, and which range of products and services they

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are likely to want. This will help companies evolve their offer into new types of bundles, including complementary products and services.

To this end, customer engagement innovations should be unlocked to understand the deep-seated aspirations and needs of customers and users. For example, Euveka has developed the first adjustable and connected robot mannequins which can be customised for each individual trade according to its specificities. It is a new way of working for any textile manufacturer, in series production or on demand, with market data available in real time and remotely.

This trend will also bring about some profit model innovations, such as subscription-based models. Customers will increasingly recognise the value of having access to services and support from suppliers rather than owning a product that involves maintenance and operational expenses. The rise of IoT devices and technology will further encourage the widespread use of subscription models, for example, allowing manufacturers to sell after-market connectivity, tracking the condition and operations of a product in the field.

## CONCLUSION

This paper provides an overview of the Top 10 Trends that will drive innovation in manufacturing in the next ten years according to our panel of experts, and it aims to help firms unlock the related innovation opportunities, guiding them along the way as they design their future innovations.

The pandemic we have been through has taught us that being actively resilient, i.e. getting ready for change before change occurs, is crucial for business success. Despite most firms possibly calling themselves 'innovative', becoming actively resilient implies that innovations are 'trend-driven'.

The trends we have prioritised in this whitepaper are not meant to be the only ones on which to focus, and, in fact, we started our process from a list of about 60 relevant trends for the future of manufacturing, but they are meant to push firms towards being more trend-oriented, getting used to knowing trends, talking about them and exploring them. Similarly, we have suggested how these top-priority trends might have an impact on innovation, relying on the well-known framework called 'Ten Types of Innovation'. As a result, the future agenda for manufacturing firms comprises innovation trajectories that converge on a few broad areas. A first trajectory that manufacturing firms might consider is moving from 'predictions to preparedness', i.e., investigating how to incorporate trends in their innovations, as indicated here. This goes hand-in-hand with fighting business-as-usual approaches and embracing a purpose-driven approach, i.e., a trajectory that we might call 'from panic to purpose'. It means paying tangible attention to sustainability, carbon-negativity, inclusiveness, and individuals. From a different perspective, data-driven business models supported by cybersecurity, machine learning, artificial intelligence and the Internet of Things allow a shift in business models 'from assets to subscriptions', enabling extreme customisation, traceability and phygital ecosystems. The traditional client-supplier approach is evolving into a dense network of collaborations with a plurality of stakeholders for the sake of innovation, i.e., 'from transactions to interactions', that has been largely described as "servitisation". As a result, firms might read their industry boundaries 'from vertical to horizontal', overcoming the dichotomy between manufacturing and service, in line with a servitisation approach. Finally, trend-driven innovations call for a last trajectory: the continuous adaptation of organisational structures and processes, i.e. 'from organisation to organising', which calls for more general and transversal competences.

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## ANNEX 1

After years of examining business innovations, in 2013, Larry Keeley, Ryan Pikkell, Brian Quinn, and Helen Walters observed that innovations can be categorised within a range of ten distinct dimensions.

Table 1 shows the “Ten Types of Innovation” that firms can use to make innovation a systemic approach and that we have used to fulfil the aim of this paper.

<b>Innovation type</b>	<b>Description</b>
Profit Model	The way in which companies make money
Network	Connections with others to create value
Structure	Alignment of company's talent and assets
Process	Signature of superior methods for doing the work
Product Performance	Distinguishing features and functionality
Product System	Complementary products and services
Service	Support and enhancements that surround company's offerings
Channel	How offerings are delivered to customers and users
Brand	Representation of company's offerings and business
Customer Engagement	Distinctive interactions companies foster

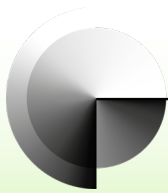
*Table 1 - Ten Types of Innovation (source: Keeley, L., Walters, H., Pikkell, R., and Quinn, B. (2013). Ten Types of Innovation: The Discipline of Building Breakthroughs. John Wiley & Sons)*

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**World Manufacturing Foundation**  
Via Pantano, 9 - 20122 Milano, Italy  
[worldmanufacturing.org](http://worldmanufacturing.org)