FUTURES PLATFORM

Future of Industry & Manufacturing

Futurist Analyses on 3 Key Trends

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Methodology

In the interconnected digital age, what happens in one industry impacts another. While disruption once came primarily from within one's industry and by established players alone, today's most disruptive shifts often first emerge outside of one's own industry.

At Futures Platform, our academically-trained futurists continuously monitor industries from a holistic vantage point to identify early signals of such disruptive changes. Through our collaborative foresight platform, we help organisations look beyond their industries and anticipate the most impactful shifts reshaping the businesses, societies and values of tomorrow.

The phenomena featured in this report have been identified through Futures Platform's robust process centred on **continuous foresight** and **cross-industry horizon scanning** practices.

Phenomena are identified based on the following criteria:

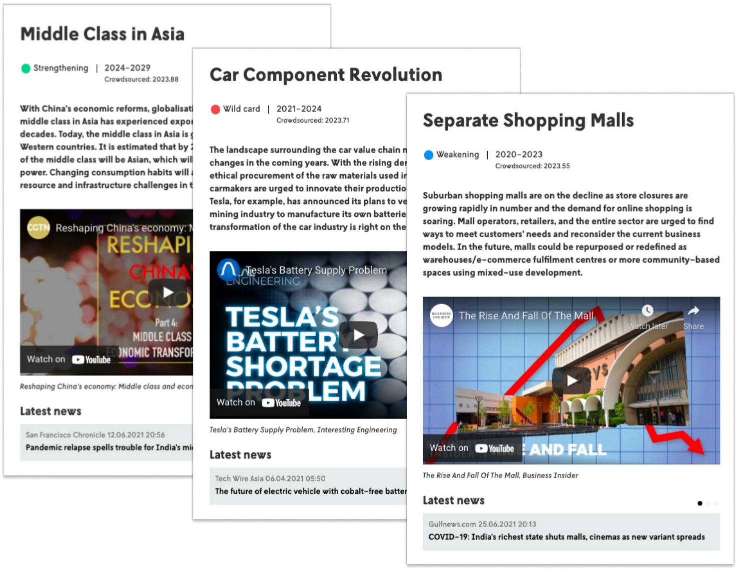
- **The phenomenon must have a significant future impact on several industries.**
  The estimation of the potential impact is based on the team's analysis, which compares the phenomenon with available data and industry outlooks.

- **The topic must appear several times in well-respected media.**
  Extensive coverage of a subject indicates its potential for greater, niche-market-exceeding impact. However, there may be exceptions to this criterion in the cases of wild cards and weak signals.

- **The phenomenon must have a developmental direction.**
  The identified phenomenon is either getting more influential, or it is becoming weaker, ending, changing directions, or merging with another phenomenon.

- **The phenomenon must have a sufficiently independent and robust core.**
  Even if we spot a change signal with novelty value, we do not necessarily identify it as an independent phenomenon if it is directly linked to an existing trend.

Phenomena Cards



Phenomena Types

STRENGTHENING

The phenomenon is becoming more common or acute during the given timeframe. Most of its change potential is still ahead.

WEAKENING

The phenomenon is becoming more unusual. During the given timeframe, most of its change potential or value has already occurred.

WILD CARD

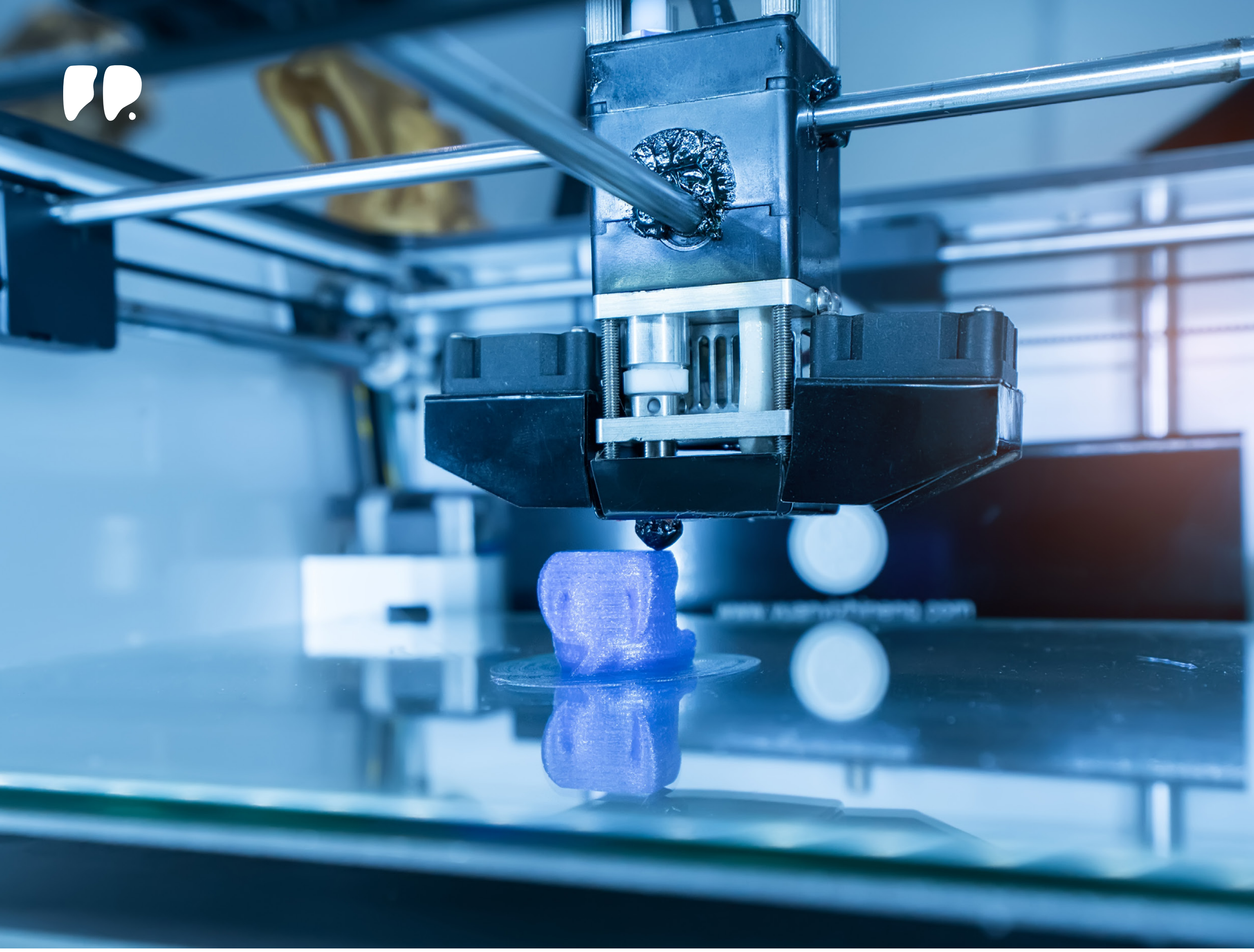
A possible but not probable event or change. The probability within the given timeframe is between 5% to 30%.

WEAK SIGNAL

A small emerging issue in the present. At the given timeframe, it is still hard to say whether it will become a trend.

Phenomena Timestamp

All Futures Platform phenomena have an expert-assessed timeframe within which the phenomenon is anticipated to either accelerate or decline. Our team uses S-Curve Analysis and Trend Impact Analysis to reason the probable time range. Each phenomenon also includes an additional **crowdsourced timestamp**, which is the median average based on the assessment of all Futures Platform users.



PHENOMENON 1

3D-Printing Metal

STRENGTHENING | 2024-2029
Crowdsourced: 2028

Thanks to recent advances in materials and printer technology, the 3D-printing metal market is about to enter a boom, with the global market size expected to reach as much as 5.51 billion dollars by 2027. The increasing use of 3D-printing metal in the automotive, aviation, and medical industries is a key factor driving the growth of the 3D-printing metal market. The ability to produce highly customisable parts and print cheaper equipment with a reduced lead time will increase demand in several industries.

Background

Until fairly recently, 3D-printing was only used in metal manufacturing to make plastic prototypes. Direct 3D-printing of metal has been too slow and challenging to have any real commercial value.

Now, as technology develops and new materials become available, 3D-printing metal has become one of the fastest-growing segments in the entire 3D-printing industry. The global 3D-printing metal market is estimated to reach 5.51 billion US dollars by 2027.

The main driver is the increasing use of metals such as nickel, titanium, steel, and aluminium for 3D-printing applications in end-user industries like automotive, aerospace & defence, and medical & dental.

Compared to traditional ways of metal manufacturing, the most significant advantage of 3D-printing, also called additive manufacturing, is that it allows cost-efficient creation of very complex shapes and even objects that are impossible to make by traditional means of production, such as parts within parts.

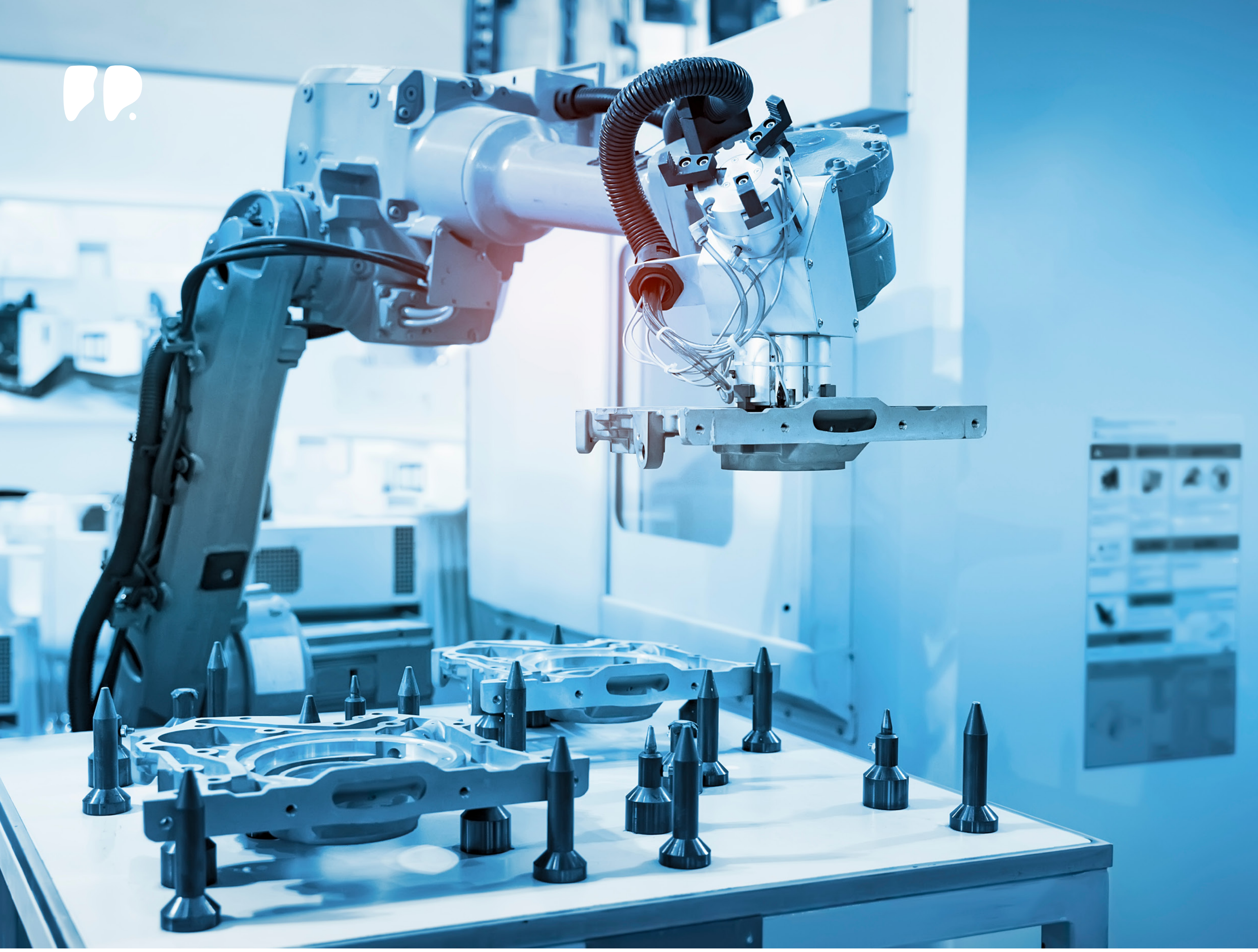
One interesting sub-segment of the industry is 3D-printing of titanium. Additive manufacturing of the light yet hard and non-toxic metal is increasingly used in the aerospace, dental and medical fields. For instance, a Norwegian company Norsk Titanium currently 3D-prints structural titanium components for the aeroplane manufacturer Boeing.

Future Directions

The development of metal-printing technologies is likely to have a positive impact on all industries that use parts made by it. It also increases the potential for innovation: objects previously unimaginable may now be possible to make.

Meanwhile, 3D technology is likely to disrupt local machine-shop businesses because complex parts and small volumes are increasingly cheaper to make with it, and also because it requires less material than using a subtractive manufacturing method such as CNC machining. However, 3D-printing is unlikely to replace all traditional methods, as some parts are better to create by casting, forging, stamping, moulding, and similar techniques. Most likely, the main impact is that yet another technology becomes a permanent part of the metal manufacturing industry, which means it becomes more complex and more challenging to succeed in.

In addition, as with all 3D-printing technologies, the supply chain for consumer metal parts may also see a fundamental shift from centralised manufacturing to localised production and sourcing, meaning that consumer products such as car parts could be 3D-printed in local shops.



PHENOMENON 2

Self-Healing Robots

STRENGHTENING | 2028-2040
Crowdsourced: 2035

Self-healing robots are a new and emerging technology that has the potential to transform the field of robotics and manufacturing. These robots can detect and repair any damage or faults in their systems without any human intervention, leading to increased productivity and efficiency in industrial settings. Different methods used to develop the self-healing ability of robots include utilising materials that can self-heal, equipping robots with 3D-printers, and building robot swarms consisting of multiple parts.

Background

In industrial settings, repairing malfunctioning robots can be a time consuming and expensive process, often requiring replacement parts and the presence of repair workers on-site. This is particularly challenging in environments that are difficult or impossible for human workers to access, such as in space or underwater. Self-healing robots can solve these issues by detecting and repairing any damage or faults in their systems without human intervention.

Recent advancements in materials science and engineering have made it possible for robots to self-detect faults and repair themselves in various ways. For example, modular robots or swarms can adapt to their surrounding conditions and continue functioning even if one part fails. Robots can also be equipped with the necessary tools for repair, such as 3D-printers for manufacturing replacement parts. Additionally, self-healing materials can be used to build parts that can repair themselves over time, just like living organisms.

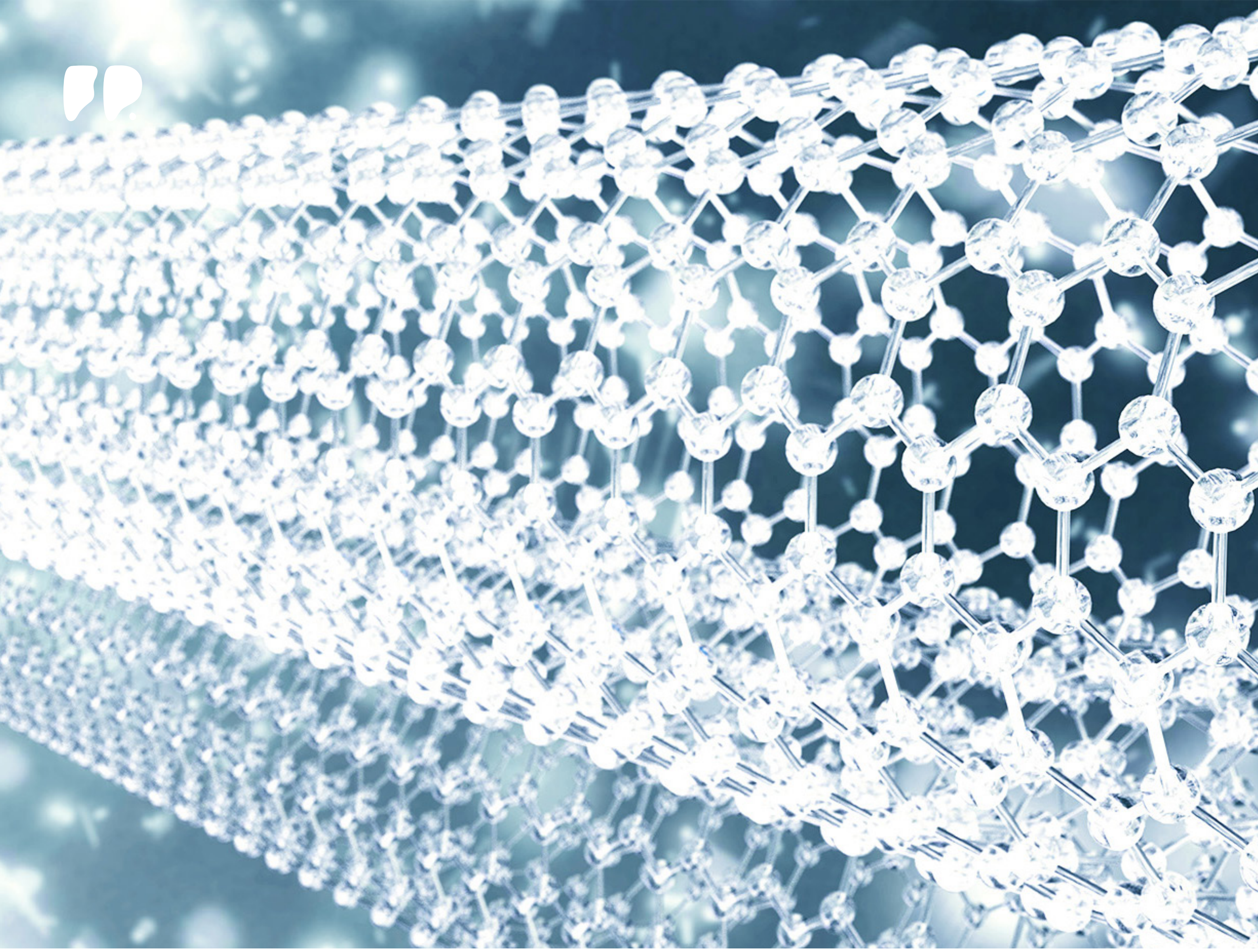
For instance, scientists at Northwestern University in Illinois have developed a simple soft robot with sensors that can detect when it is damaged and stop its movement, self-heal, and then start moving again in only a few minutes. The robot is equipped with soft, rubber-like materials that can reattach after being cut or punctured. Another example is a team of researchers from the National University of Singapore who developed a smart foam made of highly elastic polymers that can be used to coat robots. The polymer can heal itself when exposed to temperatures above 70°C.

Future Directions

The use of self-healing robots in industrial settings has the potential to revolutionise manufacturing. By reducing downtime, increasing efficiency and improving safety, they can significantly improve the productivity and profitability of manufacturing operations.

If the technology proves economically feasible and becomes available on a mass scale, it may transform existing manufacturing processes. Robots may replace human labour more widely or sooner than anticipated. Artificial intelligence combined with self-healing technology could potentially enable robots to adapt to changing situations in innovative ways. As a result, the role of humans in the development of robotics would change, with humans and robots working together in novel ways.

The development of self-healing robots will pave the way for a new era of manufacturing and robotics, and will be instrumental in the development of smart factories of the future. As research in this area continues to evolve, we can expect to see more innovative and advanced self-healing robots being utilised in various industrial settings.



PHENOMENON 3

Metamaterials

WILD CARD | 2050–2123

Metamaterials are artificial materials engineered to have properties not found in nature. They are manufactured by arranging materials in a specific pattern or structure that alters the way they interact with electromagnetic waves, acoustic waves, or other types of waves. They change the natural properties of materials and can be used to make materials extremely light, strong, or flexible. Metamaterials have many potential commercial applications, including manufacturing, EMI shielding, energy harvesting, and acoustic control.

Background

Metamaterials are a class of artificially engineered materials that exhibit properties not found in natural materials. These properties are created by manipulating the structure of the material on a wavelength smaller than the phenomena they influence, usually arranging the materials in repeating patterns. Metamaterials can be made using ordinary materials such as metals and polymers that are readily available; but their extraordinary properties are achieved thanks to their innovative design.

The unique properties of metamaterials, such as negative refractive index, superlensing, and invisibility cloaking, make them highly versatile and suitable for a wide range of applications in industry and manufacturing. They have the potential to improve the performance of existing products, as well as enable the development of entirely new technologies.

Metamaterials can be used to create more durable and lightweight materials, which can reduce energy consumption and improve efficiency. They can also be utilised to enhance sensors and actuators, leading to increased accuracy and precision in manufacturing processes.

However, the technology is still in its early stages and faces many technical challenges, such as the difficulty of predicting metamaterial responses. Nonetheless, various new products based on smart metamaterials continue to emerge, and the potential benefits have led to continued investment in metamaterials research around the world.

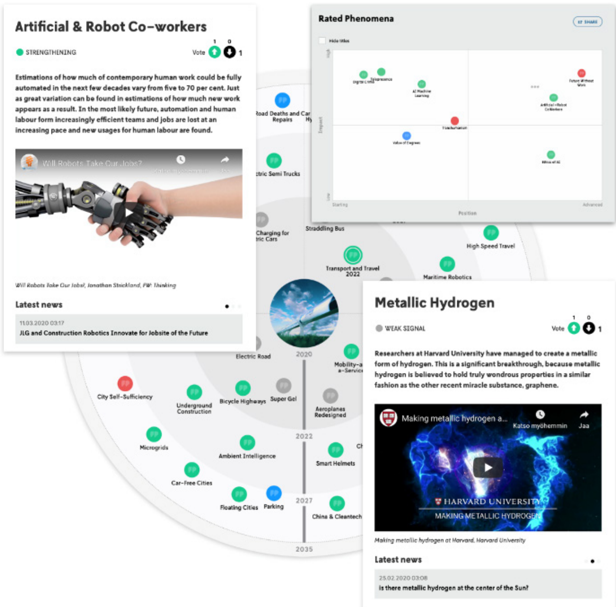
Future Directions

As the field of metamaterials continues to advance, they may become an essential component of many technologies and industries. The possibility of manipulating and creating new materials with exceptional properties may enable new advanced manufacturing techniques, leading to the creation of complex and precise metamaterials with unprecedented properties, levels of control, and customisation.

If the technology proves cost-effective and efficient, we can expect to see various new applications in multiple sectors, including construction, energy storage, transportation, and healthcare. Metamaterials can, for example, enable the development of fully immersive augmented reality systems, holographic displays, and advanced biometric sensors. They will also allow for thinner, lighter, and more flexible devices with enhanced performance and longer battery life, leading to new commercial applications in consumer electronics.

Metamaterials can also benefit the aerospace industry by creating lightweight and strong materials, leading to more efficient and cost-effective aircraft. The energy sector can use metamaterials to develop better energy storage systems, which can help address the increasing demand for renewable energy.

About Futures Platform



Futures Platform is the industry standard source for future trends, scenarios and long-term change. It's a full-functionality visual and collaborative toolbox for foresight and management teams, ensuring strategy, innovation and decision-making are future proof.

The solution brings together an AI-powered digital foresight platform and the expertise of professional futurists. At its core, the platform features more than 900 analyses of future phenomena – from technological and environmental to societal change, with a focus on the long term. These compact, easy-to-digest scenario descriptions are combined with auto-crawled additional information from validated sources.

The visually engaging, collaborative foresight radars map interconnections between phenomena and allow teams to understand alternative futures and co-shape future-proof strategies. On top of this, a team of professional futurists and foresight consultants are there to help and guide organisations on any related matter, from custom scenario analyses and horizon scans to building foresight capability onto the next level.

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