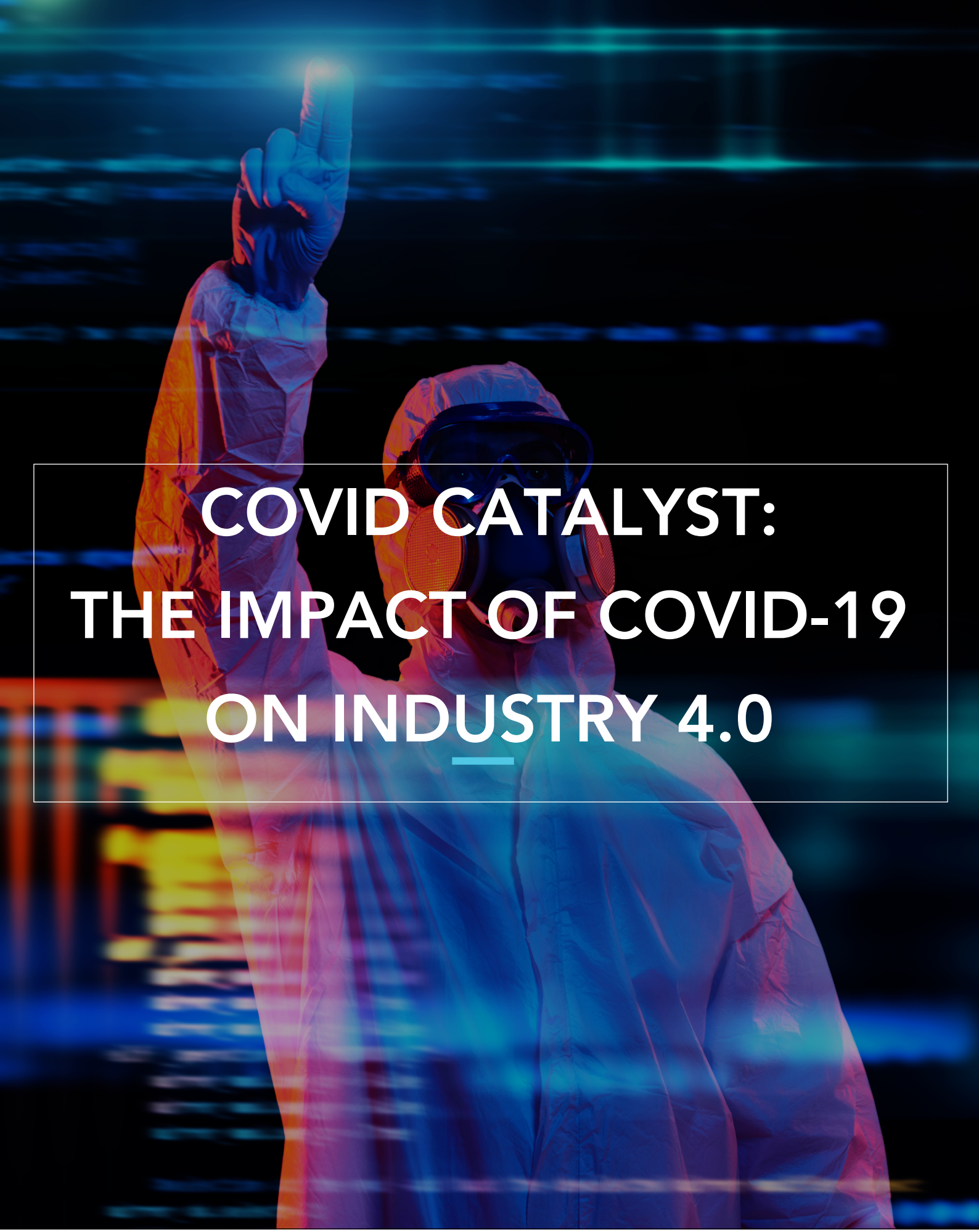

COVID CATALYST: THE IMPACT OF COVID-19 ON INDUSTRY 4.0

Special Briefing Report

McKayResearch™

About the author

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As principal and founder of McKayResearch, he has 12 years' experience providing strategic research services both to the world's leading market intelligence firms and a growing portfolio of private clients that include legal consultancies and investment firms. His research instruments and analyses have been widely published by a variety of technology and business publications, including the Financial Times.

On a personal level, James's experience in varied but interconnected sectors makes him at home with the inherent complexities and challenges of industry 4.0 adoption, and he is passionate about contributing to a deeper understanding of the ongoing digital transformation of industry.

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Executive Summary

The Fourth Industrial Revolution, or Industry 4.0, has been under way for the better part of a decade, with many manufacturers compelled to explore the disruptive potential of its constituent technologies across a range of sectors.

However, the ongoing COVID-19 pandemic raises several questions as to how this technological transformation will play out under its influence; will circumstances such as mass unemployment, global supply chain shifts, and repeated government lockdowns further accelerate its development? Or will the economic crisis take its toll on the industry, as it has many others?

In this report, we provide an overview of the impact of COVID-19 on the three core Industry 4.0 technologies of 3D printing, robotics, Industrial Internet of Things, and chart how the pandemic has impacted existing trends and developments for each.

Contents

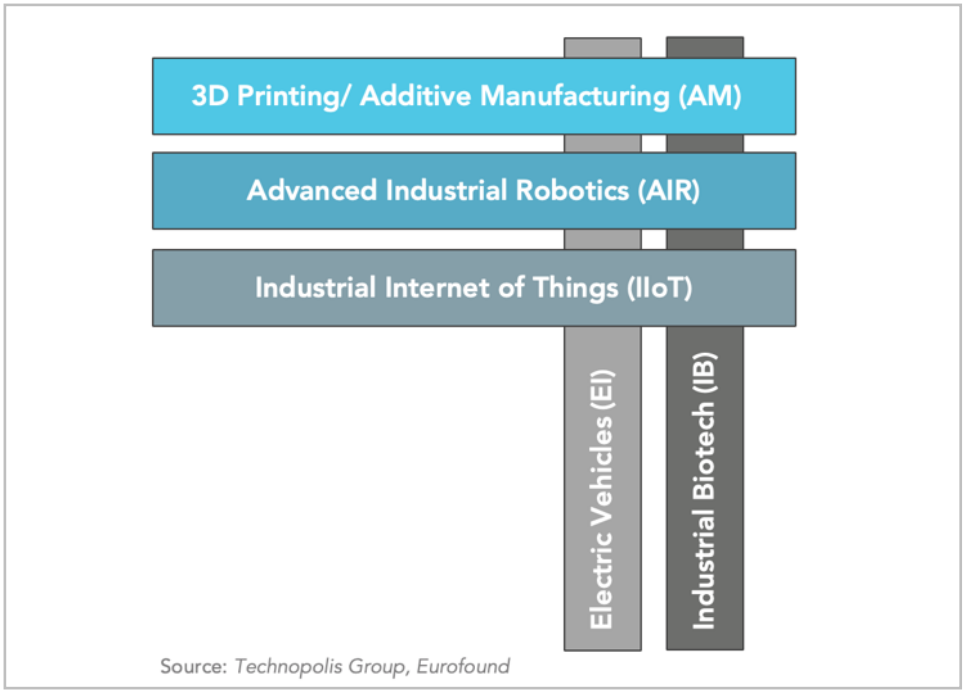
INTRODUCTION: The Covid-19 Impetus

Industry 4.0 refers to the automation of traditional manufacturing and industrial practices through the adoption of smart equipment. These technologies not only enable improvements in the efficiency, speed, and cost of manufacturing, but also make it possible to gather and analyse micro-level data across machinery, thereby allowing for improvements in production processes. Industry 4.0 is shifting the face of global economics by rebalancing human intervention in manufacturing, bringing about a paradigm shift in the nature of competitive advantage.

The outbreak of COVID-19 has brought with it a whole new set of challenges for companies and manufacturers. The pandemic has forced firms to think creatively to overcome the challenges of a limited workforce, global supply chain dependencies, as well as new health and safety restrictions that are being imposed by governments worldwide.

In this context, digital adoption has become more widespread than ever, providing an unparalleled opportunity for the broader adoption of Industry 4.0 technologies. 3D printing, robotics, and the Industrial Internet of Things (IIoT), lie at the heart of this drive towards automation and are both shaping and hastening the transition to the 'new normal'.

Figure 1: Five core Industry 4.0 technologies



An acceleration towards digital transformation

Having already been expected to exceed $200 billion in the next five years, digital transformation facilitated by the suite of Industry 4.0 technologies had already gathered plenty of momentum prior to the COVID-19 outbreak. Now, under the present circumstances, it has become even more critical for business managers to develop rapid cost optimisation to the dynamic market conditions.

A survey of European business managers indicated that 70% expect the COVID-19 outbreak to further accelerate the pace of digital transformation, with wider acceptance of remote working, increased channels for remote communication, and improved technological infrastructure driving the change[i].

The increased impetus towards digital transformation will also come from external stakeholders, governments, and broader society.

Countries such as the US, China, and Singapore among others have already proposed tax breaks and grants for organisations that implement flexible working arrangements for their employees. Additionally, digital consumer demand is fast reaching its highest levels ever. For example, data from payment systems company, ACI Worldwide, points to a sharp 74% growth in average transaction volumes in online retail sales during March 2020, compared with the same period last year[ii].

Experts predict that this changing behaviour will outlast the current crisis, paving the way to a future in which digital channels are central to every upstream and downstream interaction, from suppliers to end consumers.

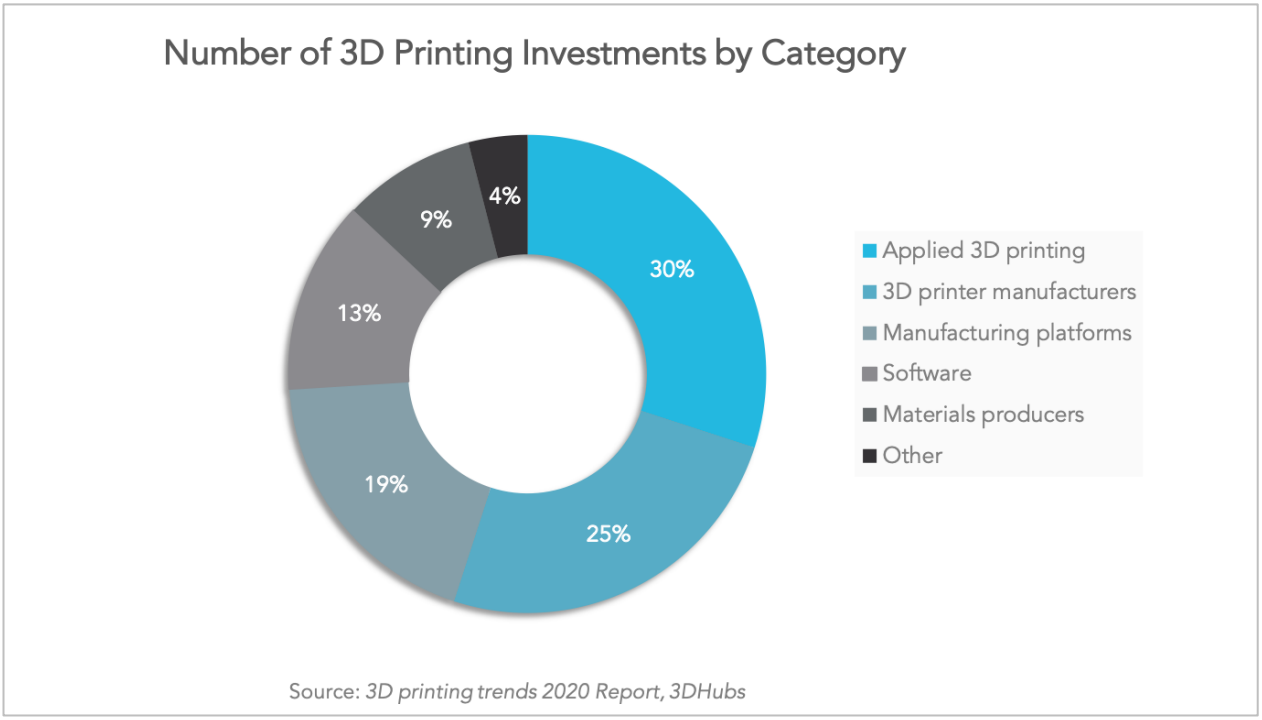
PART ONE: 3D Printing

3D Printing, also known as additive manufacturing (AM), offers a paradigm shift in manufacturing by increasing efficiency, decreasing waste, democratising design and production, and revolutionising industrial design through free complexity. Former CEO of 3D Systems, Avi Reichental, once told the Financial Times that 3D printing could potentially be "bigger than the internet."

The initial hype around 3D printing was centred on the belief that the technology would achieve mass penetration of the consumer market as desktop appliances for the home. This early universal optimism was a view shared and backed by many of the large market intelligence firms, resulting in a swell of media hype and unsustainably soaring stock valuations. However, this consumer-centric thesis of the technology's application was blindsided by R&D manufacturers ramping up R&D to unlock the technology's potential to cut costs and increase industry inefficiencies.

Even though consumer use has increased as 3D printers have become more widely available, it is the major businesses from a broad a range of sectors such as General Electric, Boeing, and Nike, which have become the dominant drivers of additive manufacturing. For example, of the $1.1 billion invested in 3D printing in 2019, 30% was dedicated to companies exploring the application of the technology industry.

Figure 2: Applied 3D printing leads investments by category



The unique advantage of 3D printing technology

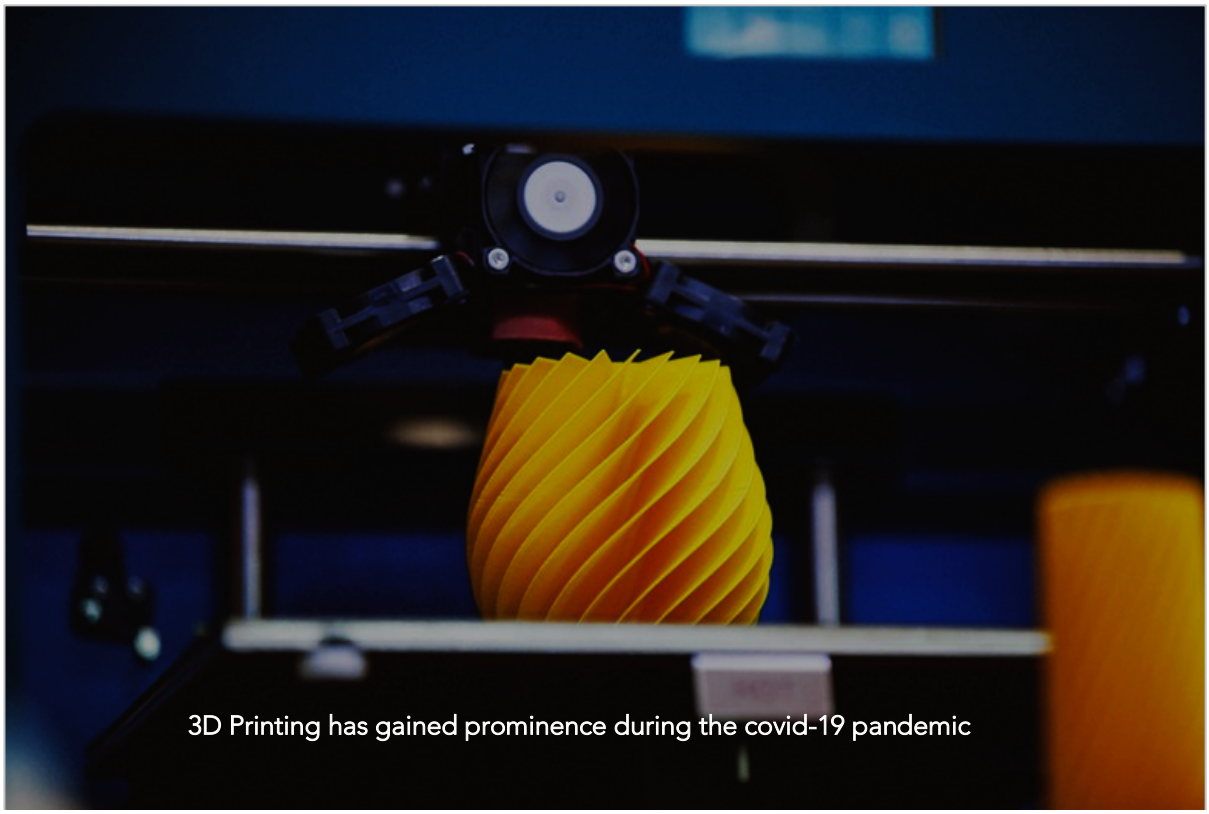
Its biggest advantage is that it overcomes the challenges associated with traditional manufacturing by offering a faster, more cost-efficient, and customisable alternative to production, while at the same time resolving several of the environmental sustainability and health and safety implications of the manufacturing process. As the 3D printing market matures and the technology becomes more affordable and widespread, the technology will allow for a far greater degree of personalisation and customisation of products, as well as allowing manufacturers to operate with fewer suppliers in the supply chain.

In the context of COVID-19, such advantages are invaluable, considering the limited capacity of a reduced workforce, and the global economic fallout as a result of global supply chain dependencies. The key drivers that will accelerate the adoption of 3D printing in a post-COVID world will be:

a) A shift towards decentralised manufacturing
b) The enablement of full-scale production via 3D printing
c) The increased need for sustainability

How COVID is accelerating the shift towards decentralised manufacturing

In response to COVID-19, a wide range of businesses have decided – or will soon decide – to transition to remote working, either temporarily or permanently. 3D printing will also become highly prized in this context due to the ability of makers to share their designs online, and for them to be reproduced worldwide. Advances in digital manufacturing have created a new ecosystem of partners, alliances, and networks consisting of OEMs, software development firms, and printing bureaux, allow for the remote design, production, and reproduction of any product anywhere in the world. This will enable a larger number of makers to partake in the 3D printing economy, democratising manufacturing to an unprecedented degree.



3D Printing has gained prominence during the covid-19 pandemic

At the same time, the pandemic has spotlighted firms' need to diversify their supply chains in order to remain operational, even under exceptionally challenging circumstances. Going forward, efficiency will be just one of the factors that determine key relationships in the supply chain, with risk mitigation becoming an increasingly strong consideration. A survey by the Institute for Supply Management[iii] reported that close to 75% of companies reported supply chain disruptions as a result of COVID-19, affecting both lead times and causing delays due to freight capacity shortages. Another report by Dun and Bradstreet[iv] identified some 51,000+ companies that had at least one key supplier in the Chinese provinces most heavily impacted by the outbreak of the virus. While trade intelligence can help businesses find alternative suppliers, the setup of such an

undertaking can take months, and in some cases even years to process. Here, 3D printing brings production closer to the end-user, eliminating both the dependency on supply chains and the downtime of finding suitable alternative suppliers. Furthermore, the shift away from conventional production and distribution models to more localised, demand-driven systems has the potential to reduce the imbalance between exporting and importing countries.

Full-scale production via 3D printing

The COVID-19 pandemic has underscored the degree to which additive manufacturing has moved beyond prototyping into first-run production, allowing large volume production in a relatively short period of time. As traditional supply chains in many jurisdictions struggled to maintain the supply of essential goods to combat the pandemic, 3D printing was shown to be an effective alternative, with additive manufacturers stepping in to produce everything from pharmaceuticals to personal protective equipment (PPE), and face masks.

For example, Avid, a specialist 3D printing product service provider recently acquired by Lubrizol, teamed up with other members of the additive manufacturing ecosystem to deliver essential protection equipment such as face shield frames and masks using HP's Multi Jet Fusion Technology (Figure 2). Technology multinational, Siemens, also tapped into its 3D printing capability, to reduce the impact of spreading the virus through 'contact prevention' door openers. The company teamed up with Russian Railways (RZD) to test door handles that can be opened with an elbow or lower arm rather than by hand, reducing the risk of spreading germs or a virus like COVID-19 (Figure 3).

Figure 3: 3D Printable Face Shield by Avid

Source: *avidpd.com*

Figure 4: 3D printed door handle for elbow/arm by Siemens

Source: *railjournal.com*

"Covid-19 has impacted our business in many ways. We have had projects slow down and new opportunities have been found. The key for our team at Avid was to "pivot". Avid has been fortunate to have a focus on engineering and 3D Printing and we have been designing and printing PPE since April."

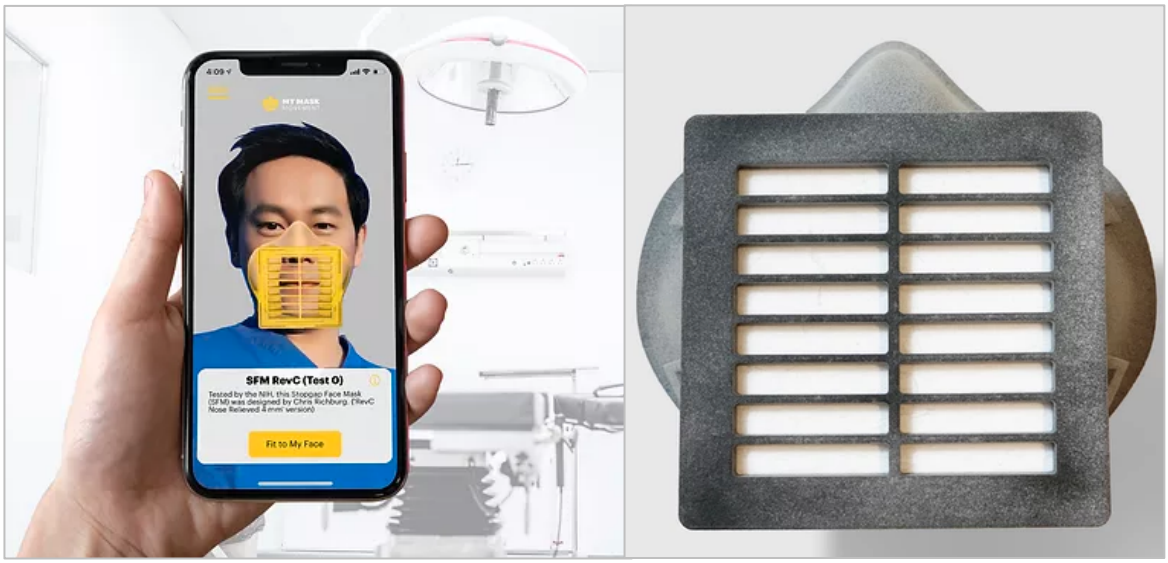
Doug Collins

Development Director at Avid Product Development

At the same, the speed of end-to-end concept to production and personalisation possible with additive manufacturing has seen a growing number of start-ups looking to plug the unmet equipment needs during the pandemic. For example, according to the Mayo Clinic, 40% of healthcare workers are unable to consistently find access to respirators that fit. Here, social enterprise, My Mask Movement, have created a digital supply chain to address the critical shortage of face masks and respirators, as well as the challenge of proper fit. Using light depth-sensing facial scanning technology through the My Mask app, individuals can obtain a custom-fitted mask through a simple process.

The speed with which 3D printing has been adopted to respond to COVID-19 underscores how rapidly the technology is maturing en route to mass production, and there is no shortage of examples of industrial use cases from outside the medical sphere. For example, aerospace giant Airbus is making extensive use of 3D-printed hydraulic flight components for the localised production of essential tooling equipment.

Figure 5: Light depth-sensing facial scanning technology with submillimetre precision to produce custom-fitted masks



Source: *mymaskmovement.org*

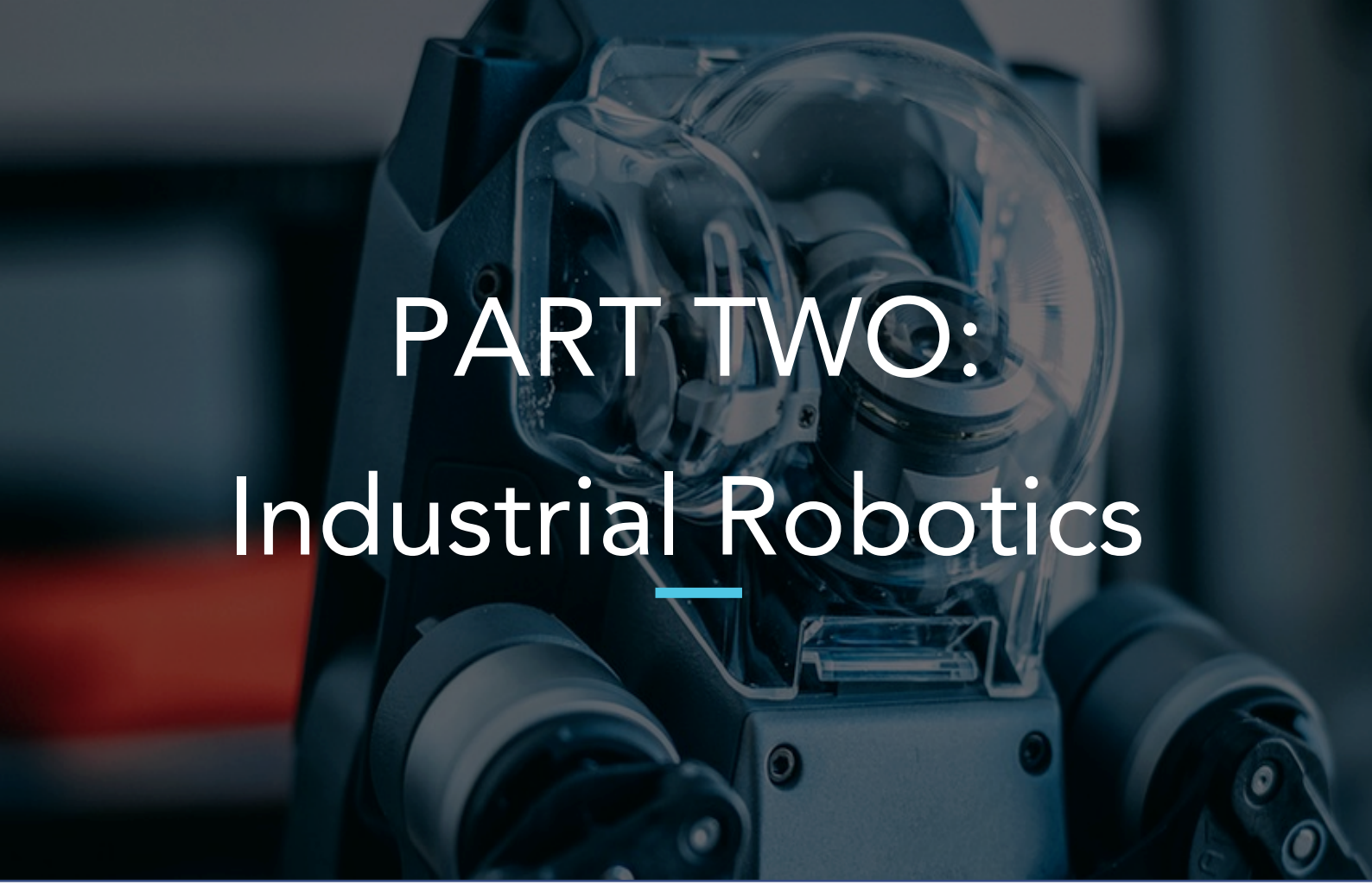
An increased need for sustainability

The COVID-19 pandemic has given the world a stark reminder of the need for sustainable practices in manufacturing. As firms begin the of process re-tooling for the new normal, sustainability will move up the agenda, both to capture reviving customer interest in sustainable products, and to ensure the health and safety of their workforce as well. For example, a survey by management consulting firm, Kearney, indicates that 55% of customers are more likely to purchase environmentally friendly products as a result of their experiences during the COVID-19 outbreak[v].

The business world is responding to the rising perception that 3D printing is seen as an inherently more sustainable approach to manufacturing due to the reduced material usage, lower carbon emissions through freight reduction, and the long-term benefits of lightweight design and eco-friendly materials development. Consequently, more manufacturers will highlight the adoption of elements of 3D printing into their overall production processes for a competitive advantage.

Key takeaways:

- Pandemic-fuelled global supply chain shocks have increased the need for decentralised manufacturing. 3D printing will enable this by bringing production closer to the end-user, and enabling faster reproducibility worldwide.
- 3D printing's effectiveness as a technique for mass production during the pandemic has proven that it is ready to move from a prototyping technology to a tool for full-scale production, with a focus on improving operational efficiency.
- The increased desire for sustainability after the pandemic will turn businesses on to 3D printing and other sustainable solutions to drive value for customers and employees in the long term.

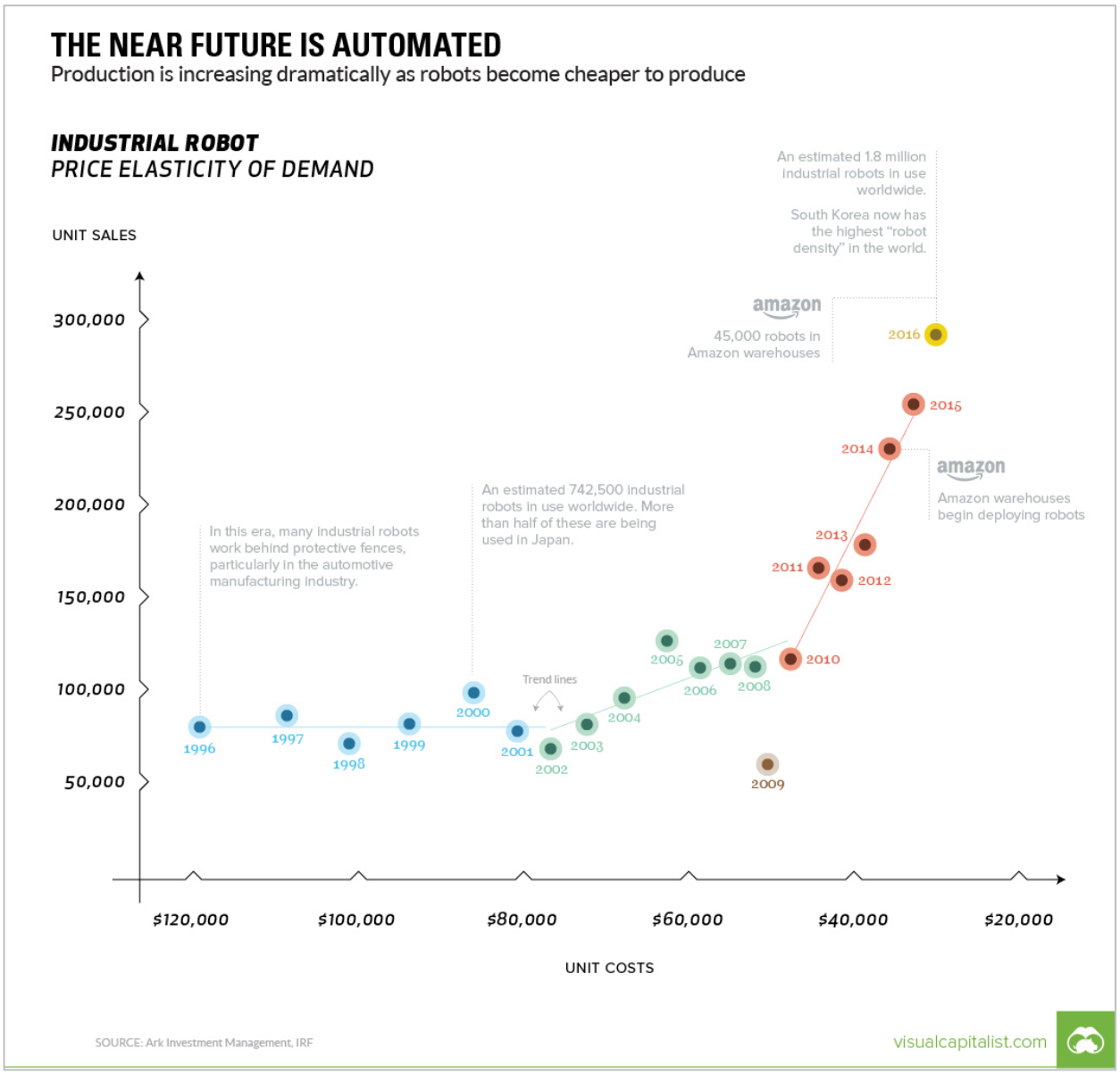


PART TWO: Industrial Robotics

Robotics is a vital part of the ongoing digital transformation of the economy. Since Industry 4.0 technology creates a digital data flow between smart devices, machines, software, and people, robots play a central role in harvesting and analysing this data in order to make the necessary improvements to manufacturing processes.

While robots were initially developed to assist humans with manual or repetitive tasks, the robots of today have a much higher degree of autonomy and sophistication. They are equipped to make valuable optimisations such as improving cycle times, increasing output rates, identifying maintenance issues, capacity planning, and much more.

Figure 6: Covid-19 will further accelerate the trend of rising robotic automation



Source: VisualCapitalist

Robots - allies in the manufacturing process

The single most important function of robotics is to reduce operational downtime, thereby preventing downstream manufacturing delays and enabling capacity optimisation. Unscheduled factory downtime is presently one of the biggest causes of delays in the manufacturing process. Robots enable collection and real-time data exchange, identify existing issues that could lead to potential bottlenecks, and perform preventive maintenance to mitigate excessive downtime. Although social distancing and increased sterilisation have emerged as primary tactics for combating the spread of COVID-19 in industrial settings, these measures can result in delays to production. Here, robots can assist manufacturers to fulfil order timelines while adhering to the new coronavirus health and safety regulations that will become

increasingly standardised in industrial and business settings.

In the context of a post-COVID world, the key drivers that are expected to define the future of robotics are:

a) An increased need for health and safety
b) The evolution of the human workforce
c) Enhancements in digital and technological capabilities

Increased need for health and safety

As observed in industries that continued to work through the worst of the outbreak, hand washing, social distancing, and protective equipment policies can only go so far to protect fully operational workforces. In healthcare, for example, robotics has already played a key role in the pandemic, assisting healthcare workers in routine tasks such as disinfecting, taking temperatures remotely, interacting with patients, and delivering meals.

Consequently, their role will be broadened to even more industries and applications as companies begin to consider which aspects of the manufacturing process are the most unsafe and inefficient. Here, the appeal of robots lies not just in the minimisation of human intervention that they enable, but in their ability to tap into vast data stores to identify patterns and highlight outliers. This means that they can be used to identify potential safety breaches, predict future problem areas and carry out contact tracing, as well as reduce the risk of human error in procedures that require safety. This could play a key role in enabling safer work environments in the future.

"Covid-19 has brought to light the opportunities for remote access technologies and capabilities, with robotics use cases for hazardous environments like nuclear decommissioning having received intense interest in recent years. The pandemic has set the ground for similar capabilities in numerous other settings – especially in healthcare – with remote swabbing, remote diagnosis and assessment, and even remote intervention being possibilities that may emerge."

Prof Danail Stoyanov
Professor of Robot Vision at University College London

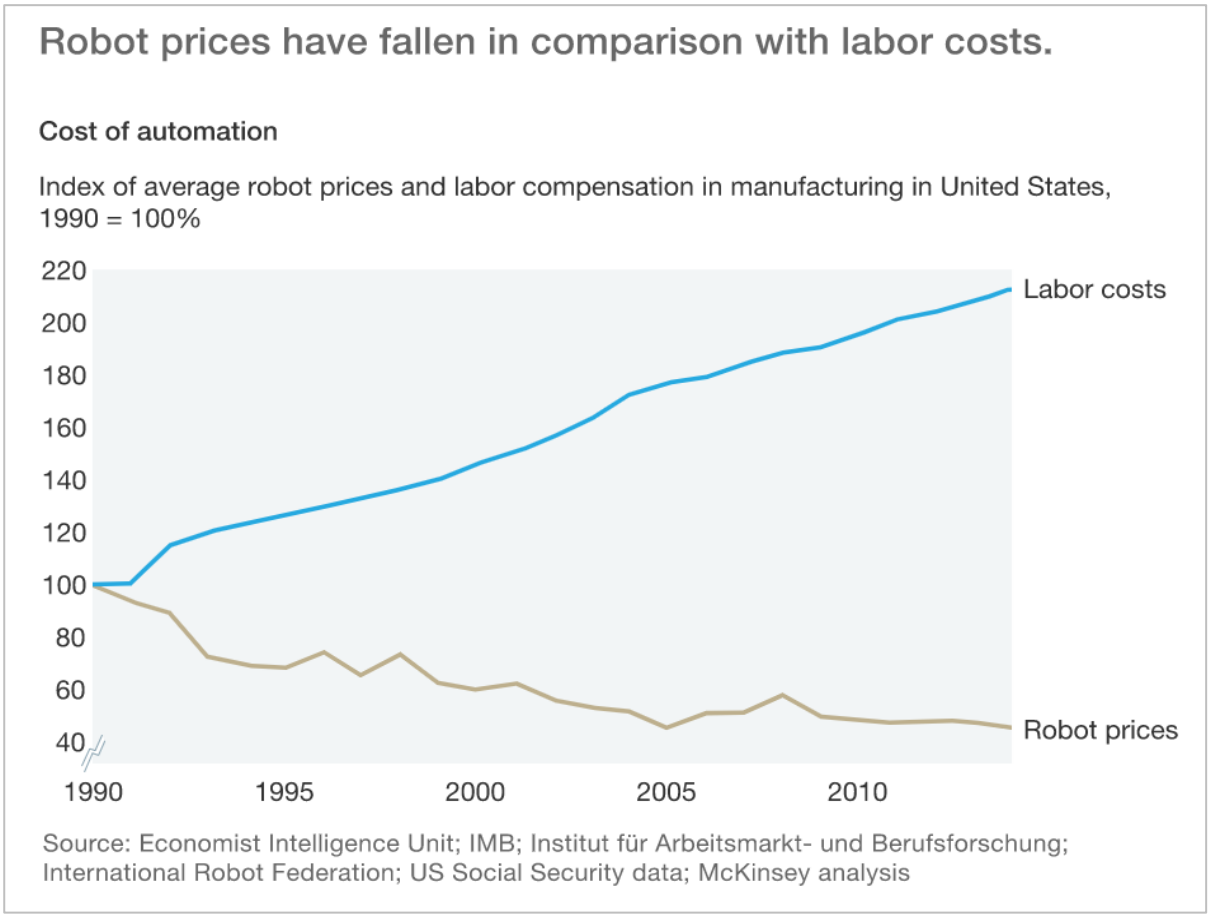
The evolution of the human workforce

A study by Technavio estimates that by 2020, the average labour cost savings achieved by replacing humans with robots will stand at around 22%[vi]. As cost-efficiency remains the dominant force behind the adoption of robotics, the financial fragility of businesses will catalyse robotics automation, as firms look to cut costs as well as de-risk and futureproof their operations.

Despite this, even the most advanced industrial robots of today still require a significant degree of human intervention, which makes predictions of a wholesale replacement of workforces premature. More likely is a reassessment of essential vs. non-essential roles, as well as an increase in demand for workers with expertise in robotics, to balance out the reduction in low-skilled or manual workers.

As Industry 4.0 continues to grow, collaborative robots, or 'co-bots', will play an increasingly important role in manufacturing. As they take a more central role in the workforce, they will bring about a greater degree of responsive collaboration with human counterparts.

Figure 7: Divergence of costs for labour vs. robots had remained steady pre-COVID-19 but may now accelerate



Source: *www.mckinsey.com*

Enhancement in digital and technological capabilities

COVID-19 has accelerated digital advancement to an unprecedented degree. Classrooms and offices, individuals, and entrepreneurs alike have all sought ways to continue to function despite the coronavirus pandemic. In this new environment, robots have had to become 'essential workers' across broad swathes of industry. Robotics firms have reported big gains in technical knowledge and technical gains as a result of this trial-by-fire deployment, a fact that will make future machines smarter and more capable

Figure 8: AIMBOT by UBTECH Robotics performs disinfection tasks at Shenzhen Third Hospital

Source: *UBTECH Robotics, spectrum.ieee.org*

Indeed, the coming 5G revolution coupled with the increase in IoT-enabled devices will accelerate the deployment of robotics, as faster data transfer rates and decreased latency make them capable of carrying out complex computations, yielding richer interactions with the world around them. Similar improvements in sensory systems, disk storage, wireless communication networks, data capabilities, and design tools will improve the performance of robots, making them cheaper and more reliable.

Key takeaways:

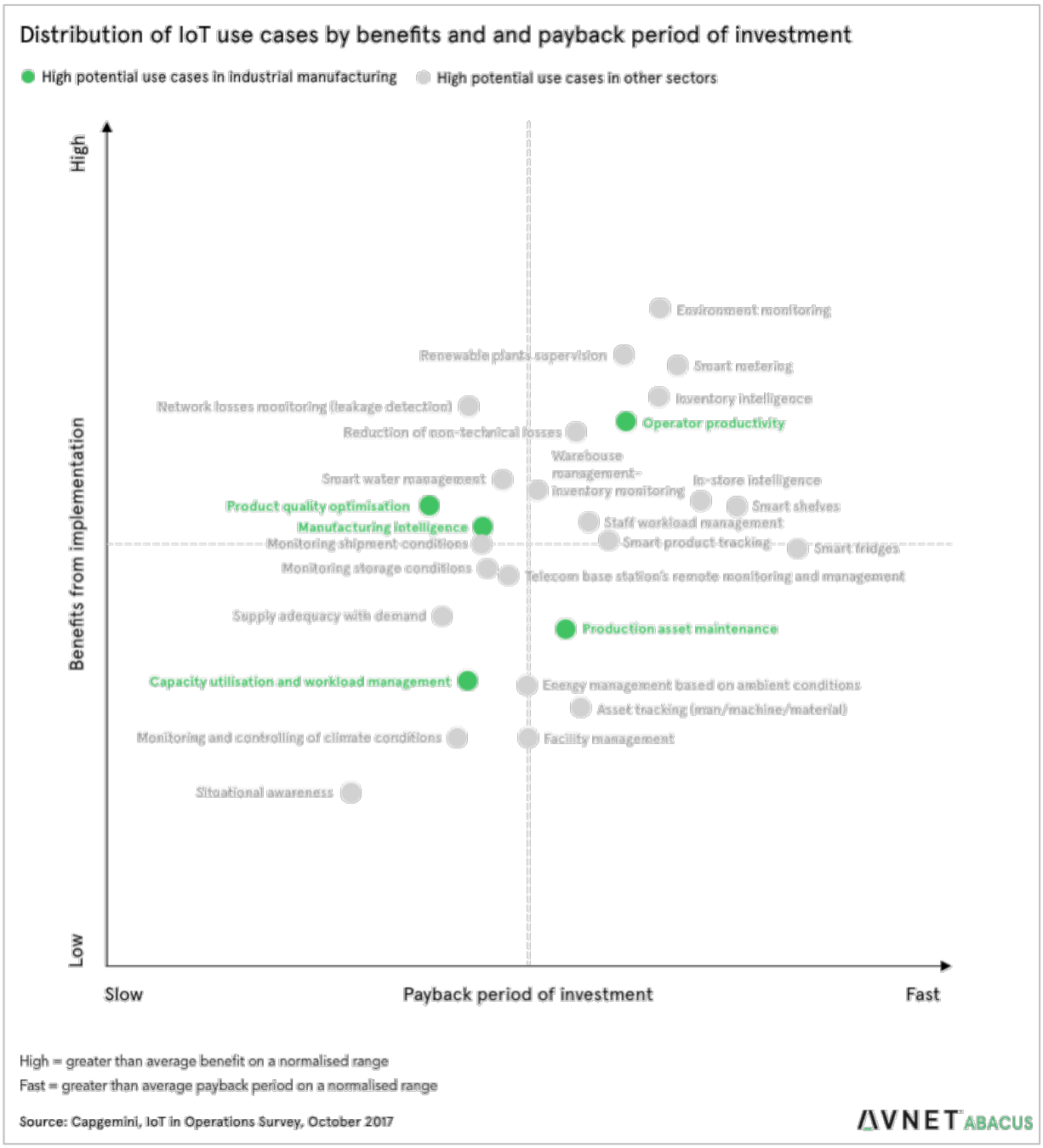
- Even with a limited workforce, robots will help manufacturers increase operational efficiency, reduce factory downtime, and allow proactive identification of manufacturing bottlenecks.
- As health and safety become more important, the role of robots in the workforce will expand and diversify, leading to a shift in organisational structure and in-demand skill sets.
- Though businesses in financial distress may need to consider the economic benefits of automated workplace solutions, co-bots and hybrid automations will still be prevalent in the immediate future.
- Enhancement in digital and technological capabilities as a result of the COVID-19 pandemic will likely spur further innovation and adoption in robotics.

PART THREE: Industrial IoT

The Industrial Internet of Things (IIoT) refers to a subsegment of the Internet of Things (IoT) that deals specifically with industrial applications such as manufacturing or agriculture. It focuses on the broader network of industrial devices connected by communication technologies, which enable the collection, exchange, and analysis of data that can be used by manufacturers to optimise processes and improve decision making.

As a more mature market relative to other Industry 4.0 technologies, many of its core applications (e.g. product quality optimisation, operational productivity, and manufacturing intelligence etc.) have proven ROI. For other emergent technologies such as blockchain, by contrast, very little data exists on business outcome specifics which presents challenges to gauge ROI and raises the level of perceived investment risk. Several prominent companies like Siemens, ThyssenKrupp, Caterpillar, and AGCO have already deployed IIoT applications for everything from equipment monitoring, to automated production, to predictive maintenance, and more.

Figure 9: Asset maintenance, capacity utilisation, and manufacturing intelligence among the highest potential use cases for IoT in industrial manufacturing



Source: *avnet.com*

New challenges for industrial manufacturing

COVID-19 pandemic has served to highlight several of the glaring issues with manufacturing in its current state. Supply chain shocks have led to challenges in procurement, fluctuations in pricing, and limited fulfilment by suppliers, which has translated into a loss of operational efficiency. Additionally, staffing shortages have also restricted manufacturers' ability to preserve business continuity, which has slowed downstream production and resulted in revenue shortfalls.

Manufacturers need to look beyond measures that will simply allow them to navigate through the immediate crisis, but embark on a comprehensive competitive analysis to ensure

every aspect of the business is optimised for efficiency over the long-term. The IIoT can play a pivotal role in helping businesses navigate the unique economic and logistical challenges posed by COVID-19, and key factors that will drive IIoT adoption over the coming years are:

(a) The need for operational flexibility
(b) Leveraging big data capture value in altered circumstances
(c) Accelerating the exploration of connected tools

A need for operational flexibility

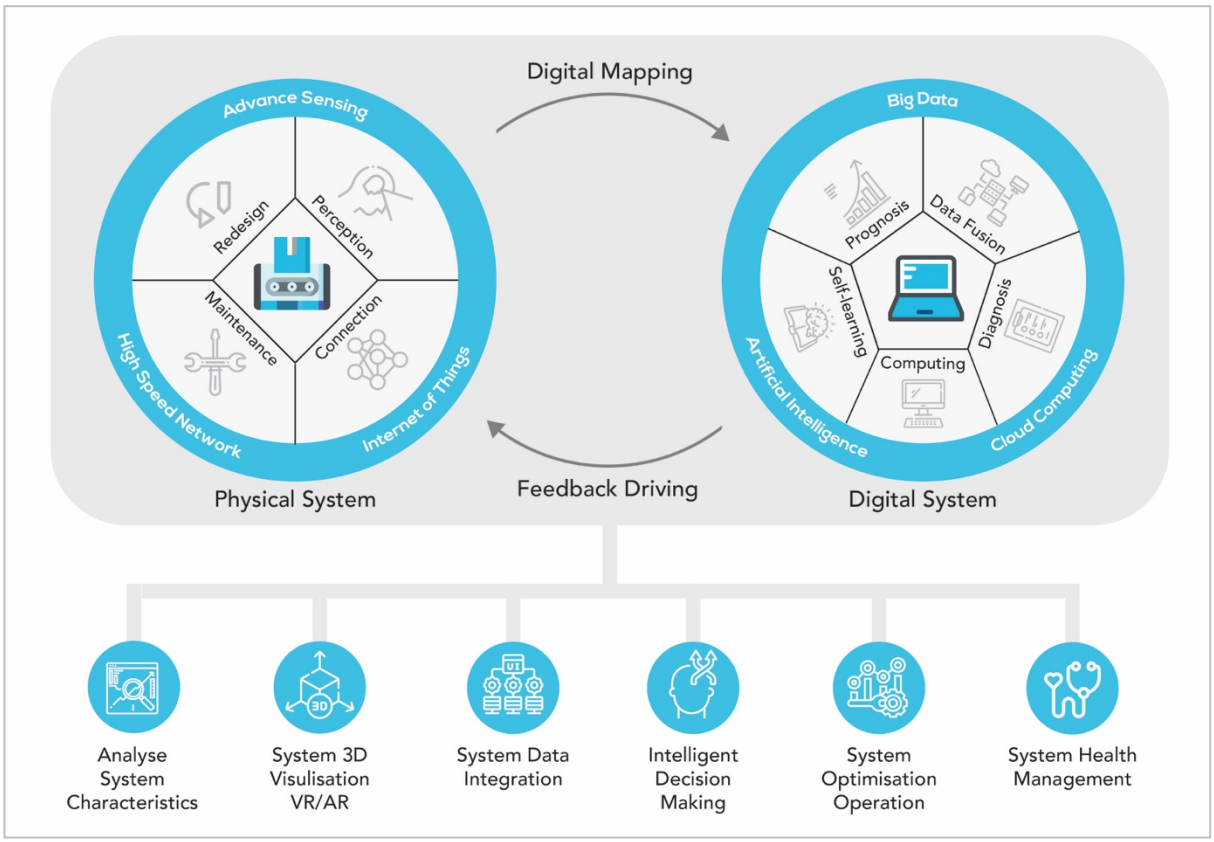
A key aspect of businesses' post-pandemic strategy to recover losses in productivity will be to increase their operational agility. Here, the IIoT, enhanced by machine learning and AI, is already being leveraged to analyse historical data patterns, make data-driven decisions about the future, and find market opportunities in the data, to identify where processes must be retooled, in order to take advantage of them. The unique economic challenges and market unpredictability caused by the COVID-19 pandemic have made the deployment of such technologies increasingly part of a goal-oriented, risk-mitigating strategy to hedge against future similar scenarios. Several businesses have already shown the potential of using IIoT for end-to-end supply chain synchronisation in improving operational KPIs, including productivity, agility, and customisation

A whitepaper by the World Economic Forum[vii] in collaboration with McKinsey showed that some of these manufacturers managed to increase output by up to 200%, while reducing production costs by up to 40%, and decreasing time to market by up to 90%. With so many businesses having been caught off-guard by COVID-19 and its effects, maximising agility and flexibility going forward will be essential in streamlining workflows and resolving issues around surplus goods, inventory management, and manual supply-chain analysis, while keeping operating costs low.

Leveraging big data value capture in altered circumstances

The COVID-19 pandemic has shed light on the value of big data in achieving deep granularity in the tracking of every operational metric. This need to unlock more business insights from ever-larger quantities of data has seen a rising interest in modelling to generate replicas that track every facet of manufacturing. Known as 'digital twins', these simulations are a digital representation of processes, people, places, systems, and devices, and require integrating systems and data across entire ecosystems. Though the digital representation provides both the elements and the dynamics of how an IoT device operates and lives throughout its life cycle, the four-dimensionality of a digital twin model necessitates the entire range of Industry 4.0 technologies, including artificial intelligence (AI), cloud computing, and augmented reality (AR) (Figure 10).

Figure 10: The architecture of Digital Twin for digital manufacturing

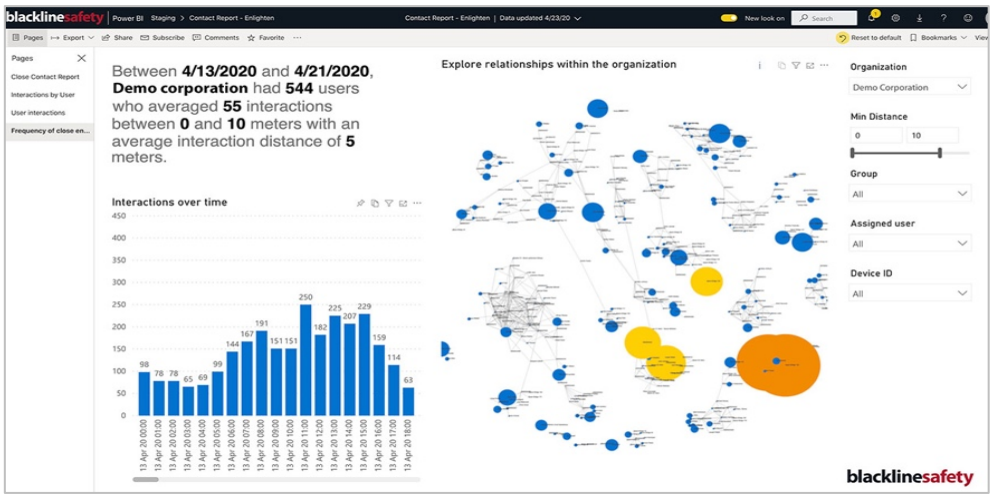


Source: *International Journal of Production Research*

The real-time harvesting of every component throughout the supply chain allows companies to approach strategic planning more holistically. For example, they can carry out predictive analyses that identify issues even before they occur, and tweak production schedules to account for fluctuations in demand or any unexpected disruptions to the supply chain, should they occur in the future.

This enhanced connectivity is particularly well suited to other Industry 4.0 technologies that themselves engender complex ecosystem processes with data-heavy workloads, such as 3D printing. In the context of the modern additive manufacturing facility, each 3D printer forms part of a network capable of self-learning, predictive maintenance, and responding to every facet of a digital factory environment. Digital twins can be used to simulate the manufacturing process and identify distortions so that they can be corrected/optimised on the 3D model. This allows for a self-correcting model designed to auto-calibrate to produce the best printing results, as well as allowing for the storage of 3D printable files of replacement parts that may be necessary for the future or during critical circumstances.

Figure 11: Close contact reports generated by location tracking systems by BlacklineSafety



Source: *Blacklinesafety.com, spectrum.ieee.org*

Accelerating the exploration of connected tools

Business leaders are also interested in how connected devices could facilitate contact tracing, by identifying those exposed to an infected person in the workplace and beyond. Some wearable options emit sounds if people stand too close to each other, and also allow for managers to review location history records to better understand which colleagues have come into contact with individuals who have tested positive for COVID-19.

A good example of businesses adapting existing products to Covid-19 comes from Blackline Safety, a manufacturer of connected safety monitoring devices. The Canadian company has equipped their wearable walkie-talkie IoT devices with location-tracing systems that automatically send data to indoor beacons, placed around a workplace and uploaded to the cloud, to generate close contact reports[viii].

Other gadgets can provide auto-alerts to remind people to wash their hands when entering or leaving a workspace or other key areas, such as the cafeteria or restroom. Such products permit dependence on accurate data when performing contact tracing, rather than asking people to rely solely on memory. Enterprises could also get data breakdowns that offer warnings of potential increases in symptomatic workforce members.

Key takeaways:

- An increasing pace of digital transformation and the development of widespread technological infrastructure as a result of the pandemic will further accelerate the adoption of IIoT enabled technologies.
- Technologies that enable greater agility and improve output will be key to recovering productivity losses in a post-pandemic world.
- Firms will look to connected technologies for the purpose of introducing track and trace systems in the workplace, both to ensure all business operations are carried out within the guidelines, and to facilitate adherence to the guidelines for staff.

Conclusion

The COVID-19 pandemic has exposed widespread gaps in the global supply chain and has left the unprepared scrambling to catch up. Though each of the three technologies discussed have multiple utility functions across a broad range of applications, any connected facility or machine must be integrated to benefit an overall system, preferably at the smallest possible cost.

Before any digital use-case can be deployed, Managers must identify the parts of their business that are most vulnerable to future similar shocks and prepare themselves by adopting a systematic approach of assessing ease of access to a given technology, as well as its effectiveness. Here, mindset is a critical ingredient in order to achieve a culture of cooperation and coordination across an entire operation, irrespective of location.

At the same time, businesses will need to increase their overall supply chain visibility and consider alternative future approaches to production. This could mean anything from shifting the centre of manufacturing to reducing the complexity of the finished product, or altogether changing the value proposition or business model – all options that managers should consider as a part of their long-term vision that digital solutions could help to achieve.

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