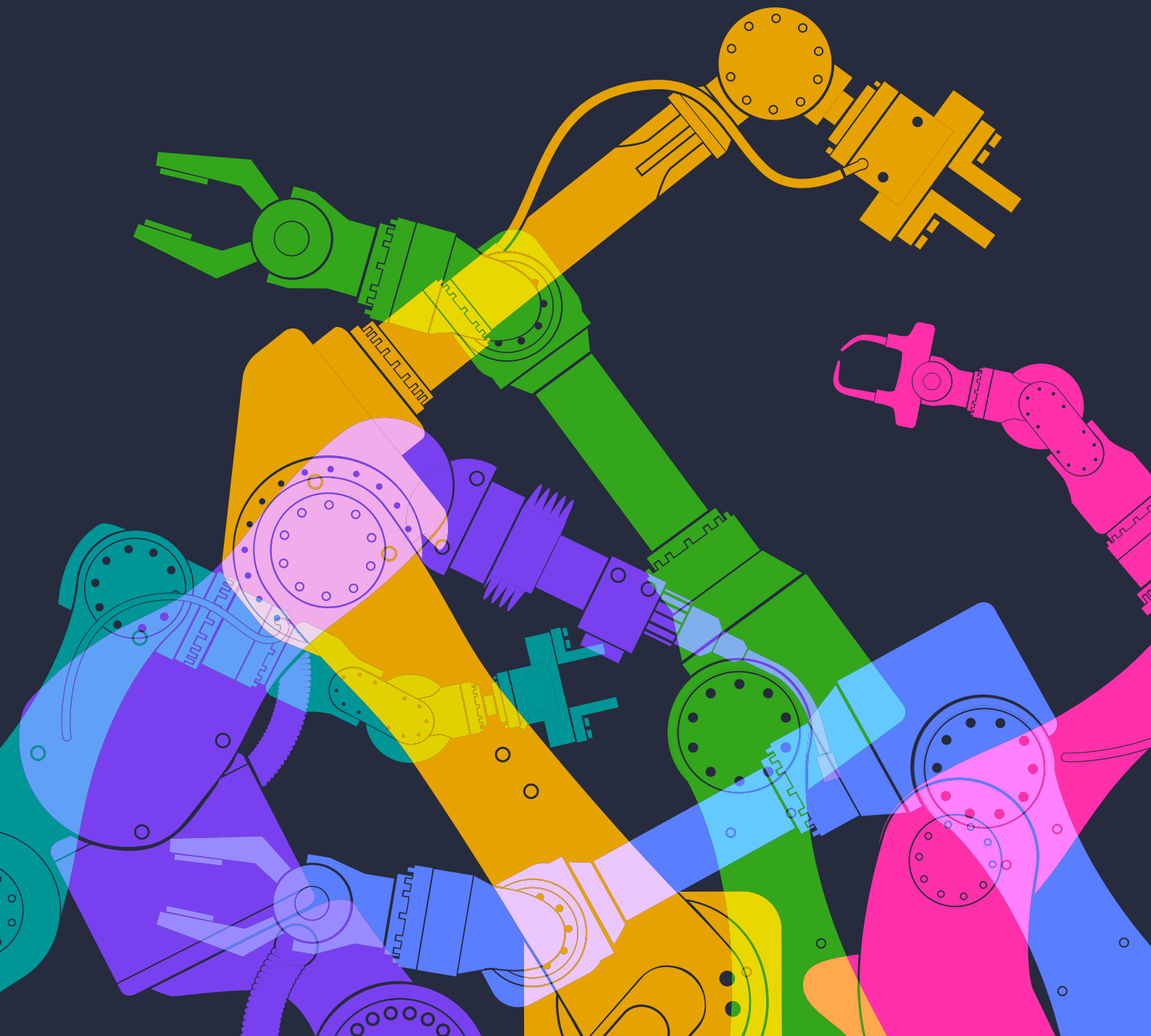


Winning the race for survival

How advanced manufacturing
technologies are driving
business-model innovation

WHITE PAPER

MAY 2020



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Overview

The current pandemic is liberating manufacturing and production companies to experiment with radical new ideas.

Firms are coming up with new ways to keep making existing products despite disrupted supply chains, or, as demand for existing products collapses, design new ones.

With revenues falling for almost all firms, companies are doing everything in their power to preserve cash reserves – and this has allowed some firms to discover new ways to do things differently without large investments.

As most manufacturing firms continue to realize their revenues through traditional channels, the disruption brought by the pandemic has created the need for rapid and radical innovation in both operating and business models.

The future belongs to those who are able to manage uncertainty and innovate rapidly. Firms that emerge from the pandemic disruption will have some choices to make.

- What is the role of advanced manufacturing and production technologies in shaping new operating and business models?
- What are the operating and business model innovations worth keeping once the crisis will be over?

- Would firms quickly return to “business as usual” or would they examine what worked (and what didn’t) during this period of “mass experimentation at scale”?
- Would the resilience achieved today only be made possible through super-human efforts justified by being in ‘crisis’ mode, and not sustainable in ‘normal’ mode of working?
- Will only the handful of ‘superstar’ firms get stronger yet and more dominant in manufacturing?

In this context, we have been working with the Advanced Manufacturing and Production community at the World Economic Forum to try to answer some of these questions.

To make sure we stay relevant in this fast-changing environment, we will be publishing our work in three different releases:

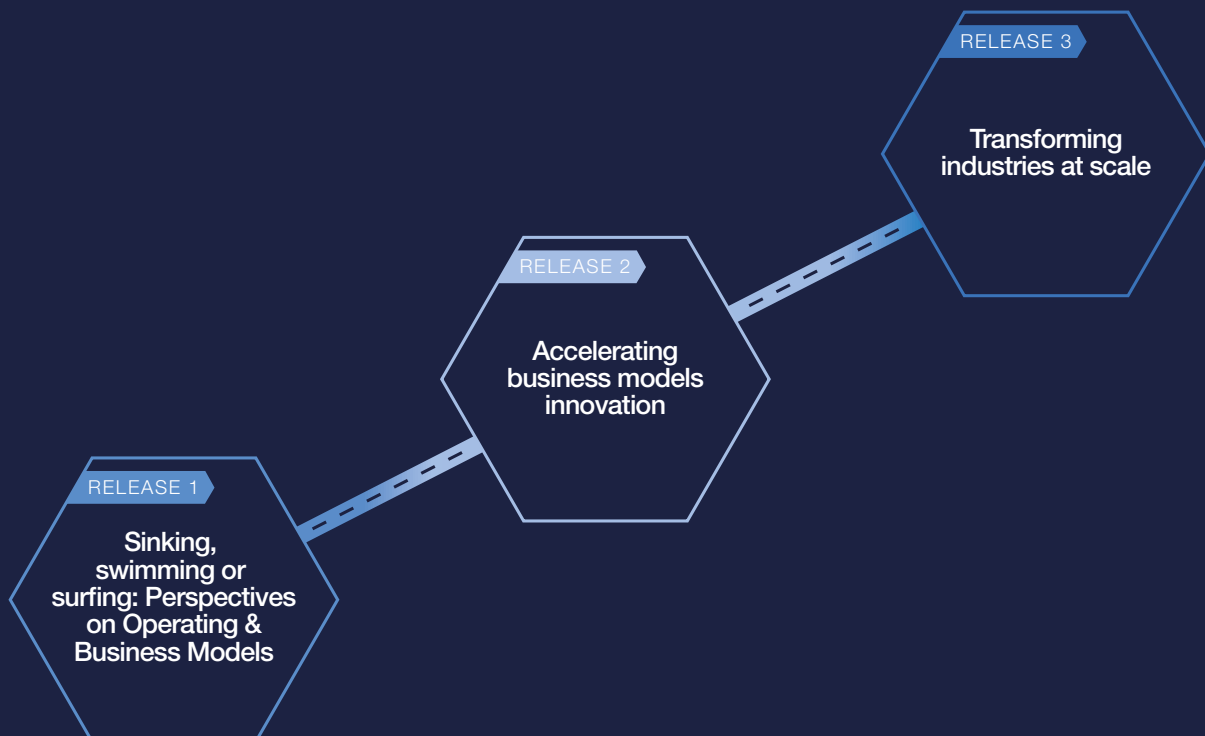
1. Sinking, swimming or sinking: perspectives on operating and business models (current paper)
2. Accelerating business models innovation (to be published)
3. Transforming industries at scale (to be published)

Release 1

Sinking, swimming or surfing:
Perspectives on operating and
business models

Summary

The shock brought by the pandemic is liberating firms to make numerous experiments. Some will fail, while others will succeed. This creates a tipping point for a long overdue conversation about new business models in advanced manufacturing and supply chains. As organizations settle into either a new normal or plan their return to pre-pandemic operations, the question arises as to whether firms will “snap back” to normal or settle on some new equilibrium. We may be on the precipice of “Operational Darwinism”, wherein mere reductions in costs may not be enough to compete against leaders who make manufacturing a rapid and key part of their digital innovation edge. In this paper, we explore what new business models might look like and how they are likely to interact with both existing operating models in the context of the new normal brought about by the pandemic.



1

A new business model conversation is urgently needed right now

Less innovative firms will be left behind

1.1 The race for survival will spark innovation

Ⓢ We have also witnessed leaders bringing rapid and dramatic change without making additional investments through strategic measures such as innovating their operating and business models

The shock brought by the pandemic is liberating firms to make numerous experiments. Some will fail, while others will succeed. This creates a tipping point for a long overdue conversation about new business models in advanced manufacturing. In the past decade many firms have made significant efforts to digitize their factories and optimize their supply chains but, for the most part, these firms have yet to fully embrace different ways to monetize and capture value from their operations.

The pandemic has thrown some of these firms into chaos by shutting them down or overwhelming them with demand they cannot meet, while disrupting their supply chains, forcing change that was once deemed unimaginable. On the one hand, some firms are adapting to the COVID-19 crisis with tactical measures such as cutting costs, reshoring parts of production and diversifying suppliers. On the other hand, we have also witnessed leaders bringing rapid and dramatic change without making additional investments through strategic measures such as

innovating their operating and business models, reconfiguring existing technology to remotely manage their infrastructure and enabling digital collaboration across the value chain end-to-end.

As organizations settle into either a new normal or plan their return to pre-pandemic operations, the question rises as to whether firms will “snap back” to normal or settle on some new equilibrium. We may be on the precipice of “Operational Darwinism”, wherein mere reductions in costs may not be enough to compete against leaders who make manufacturing a rapid and key part of their digital innovation edge. In this white paper series, we explore what new business models might look like and how they are likely to interact with both existing operating and business models in the context of the new normal brought about by the pandemic. Our findings and conclusions are the result of consultation and collaboration with senior executives from discrete assembly manufacturing companies, process manufacturing industries, financial services and the software sector.

1.2 Digitization is setting the stage for change

The COVID-19 pandemic has only accelerated what we have observed to be a megatrend in the global economy. Major digital technology firms such as Alibaba, Amazon, Google, Tencent and many more have grown far faster than the financial services and energy firms that once dominated global equity markets. Such a rapid growth has been driven by improvements in information and communications technology (ICT) and a dramatic increase in the ability to capture, process and transmit information. However, the ability to capture and process information is only a necessary but not sufficient condition for new firms and industries to arise.

In fact, the fastest-growing firms are those that not only harness information but also possess an ability

to transform it into valuable products and services. Information has the characteristic that, once created, can be distributed at very low cost, which changes the cost structure of firms on the supply side.

This disruption can be compared to the transformation of the industrial economy that allowed for the giant steel, transportation and energy firms to grow at scale in the 1900s. What is different at this point in history is that many of the largest firms also harness network effects whereby incremental value is created as a function of additional users who create value for one another. This creates what is called a “demand-side economy of scale” that tends to create a positive feedback loop such that the leading firms grow even more quickly.

1.3 Manufacturing companies are trying to adapt

Manufacturing companies have noticed [megatrends – from digitization to the imperative of environmental sustainability and globalization](#) – and have begun investing in projects that exploit data. Some have seen early success. For example, many of the fastest-growing parts of industrial firms such as Siemens and John Deere are their software and information services arms. John Deere created a digital services layer to help farmers better utilize seeds and fertilizers as well as to capture data that reduces equipment operating and maintenance expenses. Going beyond the relatively straightforward cost-focused approach to using data are firms that add digital services layers

to extend system functionality. For example, Siemens has added AI-driven diagnostics to its medical equipment that can be provided by either the firm itself or by partners through its [Healthineers Digital Ecosystem Platform](#). Numerous firms have launched initiatives to explore new business models as part of their digitization initiatives. However, many [firms find themselves stuck in “pilot purgatory” as they work to transition these initiatives to self-sustaining businesses](#). Digitization efforts often change business models, and create new sales channels, both of which disrupt existing parts of organizations.

1.4 Less innovative firms will be left behind

🗣️ **The firms best-positioned to adapt quickly to disruption are those that can digitally link their design and operations all the way to the manufacturing floor to create seamless customers experience.**

The urgency of the business model conversation is accelerated by the extreme disruption caused by the pandemic. The current situation has created an avalanche of change where the pace has been more glacial. In fact, existing supply chains have collapsed at the same time that firms are experiencing demand disappearing or expanding dramatically. This unprecedented scenario has created the need for rapid and radical actions.

Most manufacturing firms continue to realize their revenues through traditional channels (e.g., the sale of their primary products, services and after-market sales of services and supplies).

By contrast, Amazon Marketplace is able to more fluidly connect supply and demand. Other firms struggle because, although manufacturing firms participate in markets, they are less likely to have the

managerial capabilities to manage markets that match supply and demand and, as a result, are less able to do so on short notice.

The current crisis, which has depleted cash reserves and the ability to invest at most firms, is creating the perfect space for new entrants that utilize different business models, especially market orchestration, to emerge and is allowing for companies that leverage ICT to rise even faster.

The firms best-positioned to adapt quickly to disruption are those that can digitally link their design and operations all the way to the manufacturing floor to create seamless customers experience.

Those manufacturing companies that do not innovate at speed by reconfiguring their supply chain in the face of change are at risk of being left behind.

2

Operating vs business model

The lines between operating and business models are blurring

2.1 Understanding the difference between operating and business models

Although operating and business models are tightly interconnected and mutually reinforcing, they embody very different concepts, so it is useful to make a distinction between them.

- **Operating model: How an organization creates value.** By operating model, we mean the value (in a product or service) that an organization creates, the locations where value-adding work is done, the information systems that support operations, the supplier network and the management systems that coordinate the overall value chain.
- **Business model: How an organization captures and delivers value** By contrast, the business model is the way an organization realizes revenues (and profit or loss for profit-oriented businesses) by capturing and delivering value to customers.

Business model examples

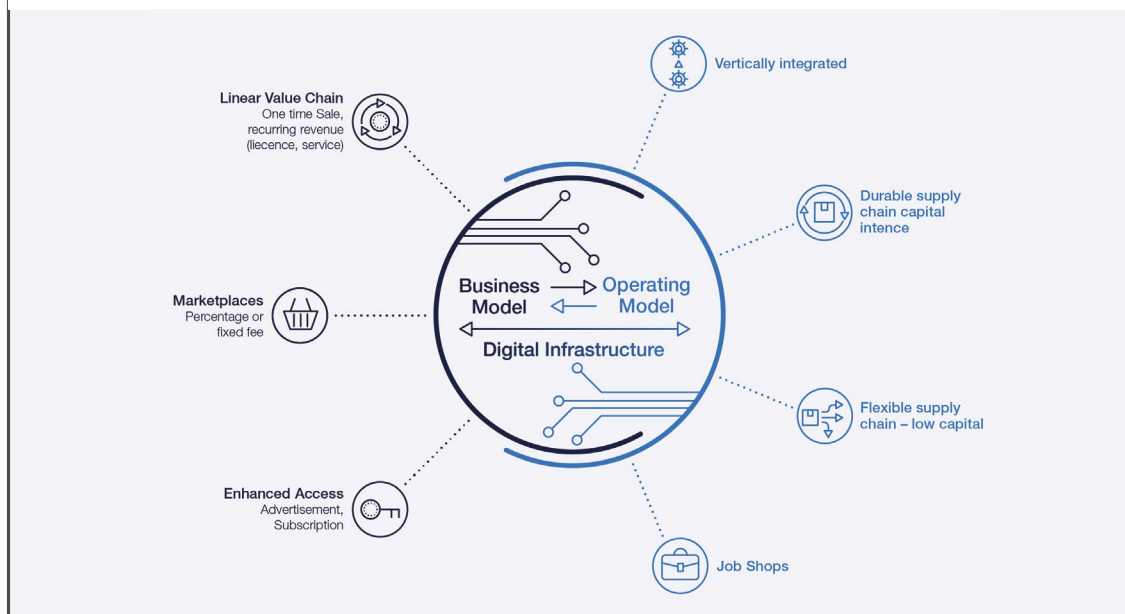
There are different ways in which organizations capture and deliver a part of the value created by the operating model.

1. Linear value chain: A standard business model constitutes taking full responsibility for the value

chain, delivering a product/service to an end-stage or intermediate customer and profiting by producing the product/service at a lower cost than the price the firm charges. Products such as consumer-packaged goods fit into this category. Durable goods such as capital equipment also fit the definition with the caveat that many organizations such as Rolls-Royce Aerospace rely on service revenues from their installed base to be profitable.

2. Making markets: A market arrangement exists when an organization helps (at least) two external parties complete a transaction and profits by taking a percentage of the complete transaction. Similarly, an organization may facilitate transactions among external parties for a fixed fee. Amazon Marketplace and eBay exemplify this type of business model.
3. Enhanced access: A third arrangement is where an organization may facilitate access by one group to another for some kind of fee (advertising revenue models would fit in this category). In addition to well-known ad-sponsored platforms such as Facebook, Google Search, YouTube and Twitter, additional examples include LinkedIn, which charges additional fees for enhanced access to users.

FIGURE 1 Coupling of operating and business models



2.2 The lines between operating and business models are blurring

Manufacturing and supply chains have become one of the most information-rich sectors in the past 10 years. However, much of the data has been kept in isolation as back-end know-how. Operating models that are highly digitized and leverage data to connect through to the end user become integrated with their business models, allowing them to better scale up. As an example, FastRadius, a company that is part of the Forum’s [Global Lighthouse Network](#), is providing a complete solution, which extends through the end user marrying the demand to the execution, referred to as digital thread. At FastRadius, validated design, manufacturing and supply chain entities are available on the cloud (operating model) and can be readily accessible (business model) by physical entities

through solutions such as additive manufacturing and UBS’s Worldport.

Another example comes from leveraging existing low-cost digital data and infrastructure. Firms that leverage digital platforms as part of their operating model, such as the ones provided by the manufacturing technology company Tulip, can have direct visibility of their production capability and operations, and can also monitor their products through Internet of Things sensors once they reach the end users. This allows firms to reinforce and fashion their business model (e.g., lifecycle-based warranty pricing) by leveraging existing low-cost digital data and infrastructure.

2.3 The imperative for business models innovation

Business models are likely to be disrupted during times of value-chain reconfiguration because of economic crisis or other externalities, such as COVID-19. In many industries, operating models have built up over many years and include stable relationships among value-chain partners. This allows firms to develop strong partnerships and deep sources of technical capability. During times of disruption, however, those stable relationships may collapse in the face of a loss of demand and/or supply. Conversely, there may be large increases in demand that can also place significant stress on existing arrangements. In order to effectively respond to disruption, firms may need to

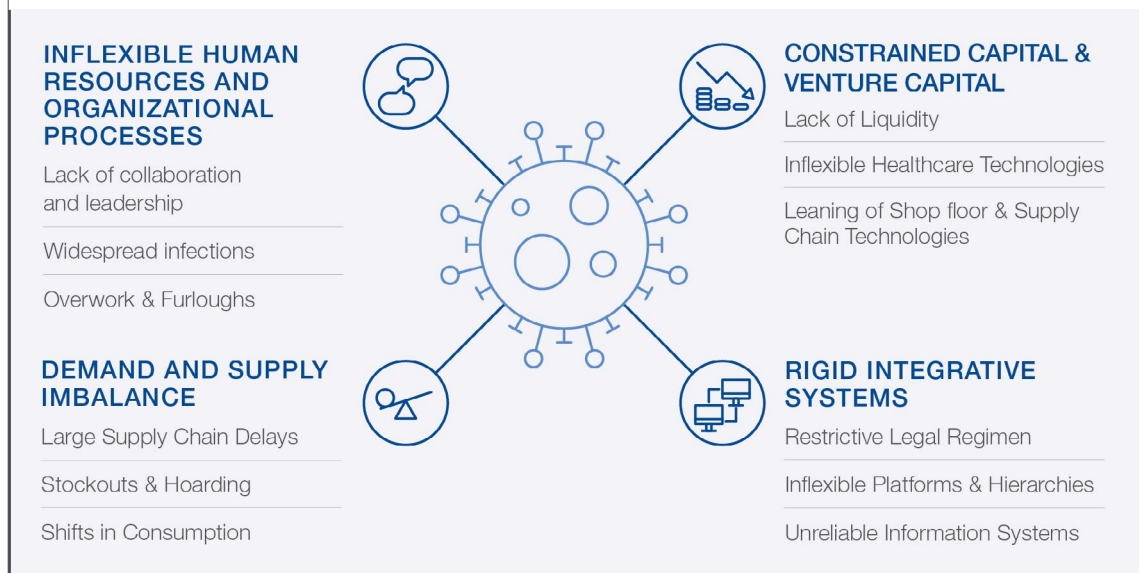
rapidly reconfigure their operating models in speed of response, location of activities and identities of supply-chain participants. Traditional value-capture models where organizations take responsibility for large portions of the value chain may find themselves under attack from entrants that rely on different business models, especially market-based models which, by their very nature, are more fluid in the identity of the participants. Hence, it is important for organizations to be clear about their current operating and business models, how they reinforce one another and what might change during times of disruption.

3

Failures in operating and business models during the COVID-19 crisis

The COVID-19 shock reveals whether underlying business and operating models are robust or whether they will fail

FIGURE 2 Failure modes during the COVID-19 crisis. Four dimensions of unanticipated outcomes and their drivers



As we have seen in the previous sections, operating models and business models may have many components (e.g., a business model such as one-time sale may be enabled by job-shop production based on the reconfiguration of 3D-printing line). For high performance, these components must work together

in a cohesive way. A crisis such as COVID-19 shocks all the components of operating and business models, and such shocks typically create extreme conditions and reveal whether underlying business and operating models are either robust or whether they fail under such stress.

3.1 The four modes of failure

Even if there is still a lot of uncertainty and lack of reliable information on how the current crisis will evolve, we categorized observed failures under four modes of unanticipated outcomes: (1) demand and supply imbalance; (2) inflexible human resources and organizational processes; (3) constrained capital and venture capital; and (4) rigid integrative systems.

Underlying driving factors are described below in isolation for ease of explication. We note that systemic failures have typically cascaded across these modes rapidly. Our assessment explores whether observed failures can be ascribed to shortcomings either in the business model, or with the operating model.

“ A number of our industrial partners have reported COVID-19-driven supply delays ranging from 1.5X to 5X normal lead times to get the supplies

1. Demand and supply imbalance

It is not useful to think about demand and supply in isolation. That is, a business, even if it experienced a demand surge owing to COVID-19, might fail if it cannot scale and satisfy demand. We characterize the demand and supply imbalance in terms of three separate, but related, drivers: significant supply chain delays; stockouts and hoarding; and shifts in consumption.

Significant supply chain delays. A number of our industrial partners have reported COVID-19-driven supply delays ranging from 1.5X to 5X normal lead times to get the supplies. In general, global supply chains, especially those involving maritime logistics, displayed the largest delays. Much of these delays are because the volume of air shipments has been reduced and even when goods are available (e.g., from factories in mainland China). Ports have been clogged, and bulk and container shipping routes have been delayed as crew and support systems have been exposed to COVID-19 and cannot get the personnel replacements and provisions needed for rapid turnarounds.

Stockouts and hoarding. Independent of shipping delays, the demand for select items (like toilet paper) has been subject to hoarding and panic. Hoarding creates shortages and swings in demand and demand-supply mismatch at each stage of the supply chain because of the bullwhip effect. Some retailers have resorted to rationing, but with long lead times at each stage of the supply chain, such rationing has not always worked as evidenced by

reported shortages. In addition, solutions, such as rationing, may not fit all business models: some of the higher-end retailers in the United States, for instance, have discontinued price discounting when faced with shortages, while lower-end retailers have accessed local suppliers and cooperatives to manage their demand and supply mismatch.

Shifts in consumption. A third leading factor driving the imbalance is a shift in consumption. For instance, social distancing has shut down the demand for restaurants (except for takeout orders) while creating additional demand for items such as baking goods for home use, and for vegetable seeds for home gardens, which have also resulted in stockouts and long waits.

In our interviews, the origins of both hoarding and shifts in demands were attributed to consumer behaviour (e.g., panic) and related actions. These consumer actions and resulting shortages were compounded by long delays. Long delays are largely caused by decisions associated with operating models, such as single sourcing. An example comes from the configuration of supply chains for items such as personal protective equipment (PPE) and masks. These delays are likely to either persist for months or rear their head periodically. Such phenomena are exacerbated by both the rigidity in the operating models (e.g., inability to find second sources rapidly) and the inability to adjust the business model (e.g., systematic and rapid changes in prices in face of a shortage).

2. Inflexible human resources and organizational processes

A second major source of failures during COVID-19 has been associated with HR and organizational processes. We characterize these types of failures in terms of three separate but related drivers: lack of collaboration and leadership; widespread infections leading to sickness and absence; and overwork and furloughs.

Lack of collaboration and leadership. A key reason for lack of collaboration has been interorganizational processes that involve coordination across boundaries. Examples included supplies for PPEs being directed towards a single country instead

of sharing proportionally across multiple affected countries. Bidding for items such as test kits has created infighting and finger pointing between the federal government and states in the US. Often there is an element of incentive incompatibility in the underlying business models, whereby individual actors deem interorganizational collaboration as a zero-sum game. Such problems highlight the clear need for higher level coordination (federal and global). Lack of leadership is also evident in continued reliance on existing information systems, such as data for ordering processes and oversight of workforce

🔗 manufacturing infrastructure has only accounted for approximately a third of the entire capital stock

health, while it is apparent that systems have been hardwired for maintaining the status quo rather than for the needed responses.

Widespread infections leading to sickness and absence. A second source of failure is the possibility of infections in each link of the manufacturing and supply chain infrastructure simultaneously. We have seen large-scale meat production capacity – e.g., at firms like Tyson foods – and distribution being compromised simultaneously because production processes could not ensure distancing, and frontline workers in grocery store have faced infection possibilities because of frequent interactions with fellow workers and customers.

Overwork and furloughs. Sickness and the resulting loss of capacity usually lead to overwork. This has

been especially acute in sectors such as healthcare but is also seen in some sectors of the logistics system, especially those parts that are providing critical supplies. Both the healthcare and the retail sectors have also been forced to furlough some of their workforce (such as the personnel who do elective surgeries).

In our interviews, failures in HR practices (e.g., furloughs) were typically associated with business models that promoted the hiring of specialized labour. Similarly, a lack of collaboration was often associated with the set-up of the business model incentives rather than the way the operating model was executed. Sickness and loss of capacity could be countered with buffers, but only if the operating model had built-in slack and flexibility. In the reported failures we have seen, the operating system lacked such buffers.

3. Constrained capital and venture capital

We have identified three drivers of capital-related failures: lack of liquidity; inflexible healthcare technologies; and leaning of shop-floor/supply-chain technologies. It is worth noting that [manufacturing infrastructure has only accounted for approximately a third of the entire capital stock](#) (even in the US, the remaining investment has gone to sectors such as services). This underinvestment is because manufacturing and supply chains are not seen as key drivers of innovation. The flow of venture capital into the sector has also been relatively weak as [compared to other digital infrastructures](#).

Lack of liquidity. COVID-19 shortages and shifts in demands have reduced revenues. This has affected low-margin business models, such as in the retail sector, especially for small and medium-size enterprises. This lack of liquidity has in turn created pressure to reduce fixed costs (see furloughs, discussed above) and to reduce variable costs by reducing orders, which have created liquidity pressure on upstream manufacturing firms.

Inflexible healthcare technologies. Independent of the liquidity crisis, a second source of failure is the lack of investment in flexible service technologies,

particularly in the healthcare sector. Business models in this sector have been myopic, resulting in a lack of buffers for PPE. Such business models, both at individual firms and at national levels, have underinvested in R&D and it will take a very long time for their innovation and production systems to invent, produce and distribute critical supplies such as suitable vaccines, when demand goes into billions, for COVID-19 prevention and cure.

Leaning of shop-floor/supply-chain technologies. A third dimension of capital-driven failure has been operating models that shape investments in production shop-floor and supply-chain technologies. Implementation of these technologies, such as factory robots at automotive and pharmaceutical firms, has been based on lean production principles that are designed to optimize “just in time” inventories and to reduce variable costs. In doing so, these operating models may have over-emphasized “just in time” while underinvesting in “just in case” and the flexible production capacity that is so clearly needed during the COVID-19 crisis and which would be of tremendous benefit in future disruptions that are nearly certain to take place because of megatrends such as climate change.

4. Rigid integrative systems

In addition to components such as HR and capital, large systems draw on integrative systems to ensure these functions work cohesively as a system. Drivers for a final set of failures, which we label as integrative failures, may be grouped into: knowledge gaps, inflexible platforms and hierarchies; restrictive legal regimens; and unreliable information systems.

Knowledge gaps, inflexible platforms and hierarchies. We have witnessed systemic failures in platforms that have the governing rights and an implicit responsibility to protect the interests of their supply and consumption networks. Some platforms (such as Alibaba) have helped their suppliers that faced liquidity issues. Others, including firms such as Amazon, have elected not to do so. Organizations

with flat structures, such as some big box retailers in the UK, have also been slow to pick up trends in demands and have faced stock-outs. Many multi-layered entities have faced distortions in demand-and-supply signals that are amplified by knowledge uncertainties, wherein manufacturers and suppliers either do not have access to real-time data or lack the knowledge to ask the right questions. Tighter hierarchies, such as Asian grocery chains in the UK, have leveraged formal and informal networks at multiple levels to detect trends early and have been able to address knowledge gaps at multiple levels (retail, distributor and shipping) through rapid cycles of informal feedback on the demand, pricing and lead times. This speaks to need for resilience multiple levels in business and operating models.

Restrictive legal regimens. Legal regimens affect the manner in which operating and business models get set up. The COVID-19 crisis has created needs that have changed some regulations. For instance, trucking laws in the US have been relaxed to remove restrictions on contiguous hours worked. Although this increases capacity in the near term, the relaxation has also resulted in increased workload and mounting safety concerns, with the possibility of a loss of capacity in the mid and long term. Similarly, there are restrictions in several countries on specific

trades such as construction work and seasonal fertilization of gardens because they are deemed as “non-essential work” based on distancing requirements. This creates production failures that will last for months or for an entire year’s work cycle. It has also fostered a sense of inequity and new legal regimens may have to evolve to assess which work is deemed essential in a fair and consistent manner.

Unreliable information systems. In many instances, individual firms have rapidly flipped their operating models and have implemented Buy Online Pickup In Store (BOPIS) practices. In our interviews, we have been told about shifts in the demand from conventional retail to BOPIS by a factor of five or more. The lack of reliable information and continued uncertainties are the key issues here. Many of these firms had to take on the herculean task of dismantling their existing operating models, such as bypassing ordering heuristics that are hardwired into their information systems. For example, instead of making decisions based on orders seen at the store level, these firms had to switch decisions based on online orders. Whether this shift will lead to permanent changes in consumer preferences and in turn require a change in underlying business models is an open question.

4

Successes in operating and business models during the COVID-19 crisis

Some firms have been more resilient and have thrived during the crisis

Some firms have been more resilient and have thrived during the crisis

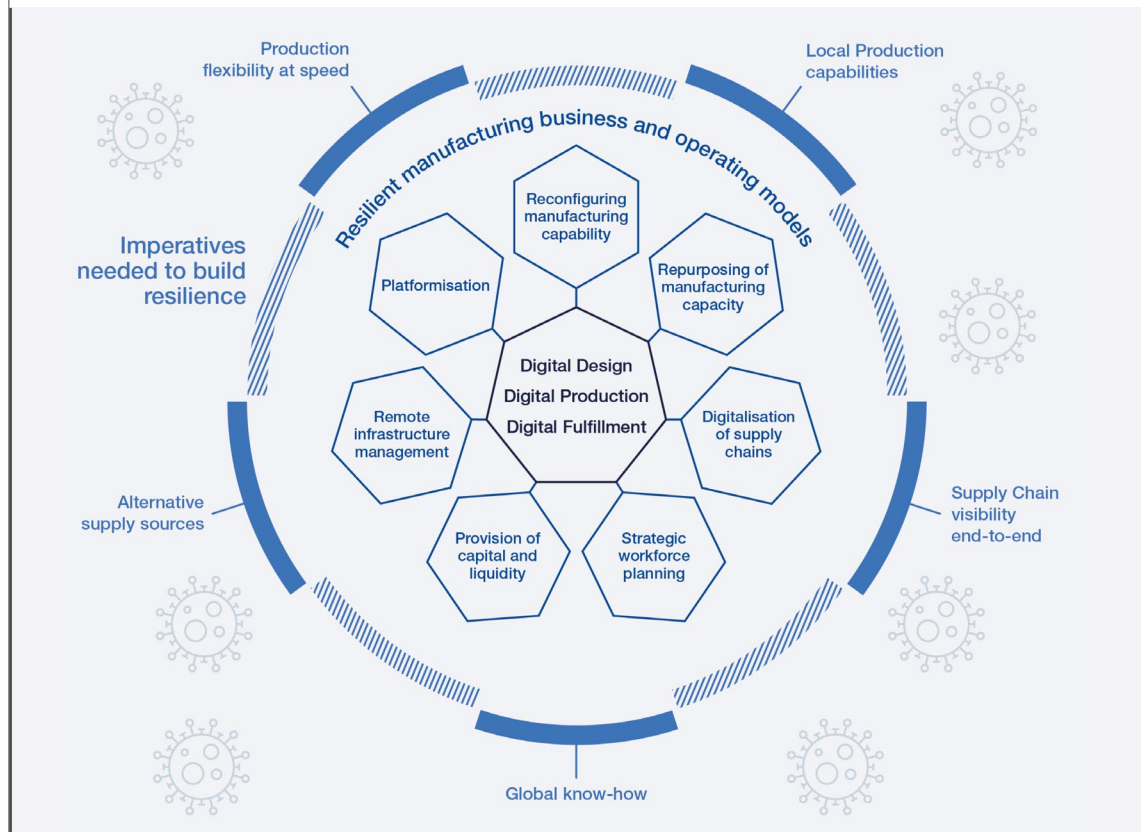
While we have seen many industries and sectors come under intense stress during the COVID-19 crisis, there are emerging examples of firms and industries that have thrived. These include manufacturers that have used digitally enabled design, production and fulfilment as their dominant business model, such as Fast Radius and Tulip, online retailers that have leveraged highly digitalized supply chains, such as Amazon and Alibaba, remote-working, team-based platforms like Zoom and Microsoft, and distributed manufacturing models where new technologies have been fast-tracked to meet unexpected demand surges.

In the examples below we identify, across sectors, the success factors that have allowed some firms to thrive. These success factors can be categorized in the operating and business models represented in Figure 3, which have proven to be better able to reconfigure than others.

In this section we describe seven enabling factors of new operating and business models:

1. Reconfiguring manufacturing capability
2. Repurposing of manufacturing capacity
3. Digitalization of supply chains
4. Strategic workforce planning
5. Provision of capital and liquidity
6. Remote infrastructure management
7. Platformization

FIGURE 3 | **Advanced manufacturing technologies are key to enable resilient manufacturing operating and business models**



4.1 | **Reconfiguring manufacturing capability**

Reconfiguring manufacturing capability has been crucial in responding to shortages and has been enabled by the fast-tracking of new technologies such as additive manufacturing that can deploy various technology solutions across multiple markets at speed. Ironically, many of these new technologies that engage directly with end-users and consumers have seen accelerated adoption during a period of social-distancing. This crowd-sourcing, while successful

for simple component supply where 3D-printing and maker-spaces have come forward successfully to part-meet shortages, requires more complex partner selection and orchestration when targeting more sophisticated requirements. The jury is perhaps out as to whether ventilator supply or diagnostic testing initiatives from new supply sources will, in fact, revert to the usual suspects.

4.2 | **Repurposing of manufacturing capacity**

Leveraging existing and local-production capabilities by repurposing capacity to manufacture low-medium complex products has been critical to address shortages in products such as sanitizers, medical gowns, etc. It has become clear that shorter supply chains involving reconfigurable manufacturing capability and distributed manufacturing approaches

can support scale-up, responsiveness and resilience, which has also allowed the rapid production of more complex vital products such as ventilators and diagnostics. In addition, e-commerce and last-mile logistics play a key part, as they are vital for being able to deliver to the point of need.

4.3 Digitalization of supply chains

The digitalization of supply chains has been critical to allow early switching of capacity and resources across multiple tiers of the supply network, necessary for the flexibility and resilience of future manufacturing systems. For established retailers offering an omnichannel e-commerce experience, digitalization has been crucial to meeting online demand. In manufacturing operations, Henkel, a company part of our [Global Lighthouse Network](#), has used its real-time connectivity within its manufacturing network to provide the necessary supply-chain visibility to enable efficient and timely integration of supply and demand.

The digitalization of supply chains allows as well for

disintermediation, which has increased responsiveness and taken out supply-chain complexity as we are witnessing in specialist food supply chains. Near real-time data-flows have allowed service providers to respond to changes in supplier, producer and consumer behaviours that are often highly unpredictable during a crisis. Hospitals, in particular, have had to cope with multiple COVID-demand scenarios but also deal with non-COVID patient-demand fluctuations. Manufacturers and retailers whose demand and supply systems have been designed for responsiveness and flexibility have an edge from those that are constrained by rigid centralized operations.

4.4 Strategic workforce planning

🗣️ It is unclear how this major disruption to the retail market will play out, but one can imagine a new normal where e-commerce becomes even more dominant.

Supply resilience has not been straightforward for those with substantial bricks-and-mortar operations. Initial stock-outs followed by the steep drop off in in-store demand during lockdown have been substantial, and the exponential growth online has been difficult to scale-up because of the challenges in strategic workforce planning (e.g., staff shortages have impeded the scale-up of last-mile delivery operations). Intriguingly, new entrants to the last-mile-home delivery have emerged and the local “mom-and-pop” stores have been rediscovered. It is unclear how this major disruption to the retail market will play out, but one can

imagine a new normal where e-commerce becomes even more dominant.

At an institutional level, the need to relax competition laws and underwrite liability are being observed to enable new capability and capacity. And while online communication platforms are allowing for remote team working for office-based workers, strategic workforce planning remains key and must include those at the sharp end as key workers are required within healthcare systems, food and retail supply chains and supporting infrastructure.

4.5 Provision of capital and liquidity

In the broader online sector, Alibaba has recognized the importance in the provision of capital and liquidity to its manufacturing supplier base and has stepped forward by providing critical guarantees to ensure the continuation of supply to its operations.

Within bricks-and-mortar retail, the smaller players can perhaps demonstrate greater responsiveness

to the market where reconfiguring to local supply sources and availability becomes critical – their more person-based replenishment networks, involving both upstream and downstream collaboration, benefit from informal data flows and trust-based relationships. Again, one can imagine that such relationships developed in a crisis will sustain and perhaps be more valued.

4.6 Remote infrastructure management

Operational resilience is achieved through remote infrastructure management, which is particularly relevant for service providers to address customer requirements. For example, manufacturers such as Schneider Electric, also part of our [Global Lighthouse Network](#), have used their digital platforms

to enable connectivity with customers. Their digital connectivity solutions have enabled technicians to utilize their expertise remotely to address fault resolution and factory-acceptance testing. Highly automated business-to-business industries which can be managed remotely seem less affected in

the short term. Other high-tech industries such as semiconductors, have significant automation and low personal interaction and appear somewhat less affected in the supply of intermediate products as they are less dependent on large labour pools, or

immediate market fluctuations. The question remains as to whether these highly automated intermediate industries will have surplus capacity as end-user demand is reduced over the next 12-18 months.

4.7 Platformization

“ The progressive platformization of aspects of design, production and fulfilment has been a key discriminating feature of firms that have thrived in the crisis

The progressive platformization of aspects of design, production and fulfilment through digital technologies has been a key discriminating feature of firms that have thrived in the crisis. Some high-tech firms have leveraged digital platforms as a core part of their business model to go from design, to fast prototyping and product commercialization, and have managed to address specific product shortages. This is exemplified by Tulip's role in full-mask production and its involvement in the Rise Ventilator, both having been developed in a matter of weeks.

Similarly, in e-commerce, large retailers leverage quite different digital platforms, some more centralized and rigid in operating parameters than others, and some that are availability-based (e.g., Ocado) and others largely driven by consumer demand (e.g., Tesco). While both of these retailer practices leverage highly digitalized dark-store platforms, they have struggled to keep up with the exponential surge in online demand, with delivery slots, even weeks forward post the initial month-long lockdowns, unavailable despite the recent trends for same-day delivery.

Another aspect of platformization is inter-organizational collaborations, as leveraging global know-how remains a key aspect of supply resilience.

In summary, we can observe a number of operating models that have thrived in this pandemic and may provide clues as to how future business models might evolve. Even before the COVID-19 crisis, many would argue that climate change, trade tensions, food insecurity and the high dependency on distant production with their extended supply chains was unsustainable. Perhaps the accelerated adoption of advanced manufacturing technologies that we are

Perhaps some of the more surprising contributors to that have stepped up have included the university sector and technology providers where support to hospitals on patient-demand projections, hospitals logistics and the supply of critical consumables have been enthusiastically received by those coping with the unprecedented increase in demand. There are dozens of examples of this type of collaboration across the US, the UK, Europe and Asia.

At a governmental level, the manufacturing and supply sector has seen widespread demand for provisioning of specialist equipment such as ventilators and consumables such as PPE. Here, the “call to industry” represents another form of inter-organizational platformization, involving the scaling up of existing capacity and the creation and onboarding of new consortia of manufacturers and suppliers that are new to the industry. This has seen Dyson move from household appliances to healthcare, automobile manufacturers into diagnostics and healthcare equipment, and designer brands such as Burberry into the supply of medical gowns. However, this has also seen an untidy scramble to understand who can actually do what and marshalling resources accordingly.

currently observing, enabling digital design, digital production and digital fulfilment will drive future transformation. Such developments will facilitate more distributed manufacturing supply chains, underpinned by digital platforms and technologies, embedded in more local industrial ecosystems that leverage global know-how, providing a transformation roadmap for the future.

A call for action: Towards a new normal for advanced manufacturing, services and supply chains

“ The future belongs to those who are able to manage uncertainty and innovate rapidly.

Successful firms are shaping the future of manufacturing operations. During the COVID-19 crisis, they have managed to repurpose manufacturing capacity while leveraging advanced manufacturing technologies to develop new capabilities.

Early investments made in the digitalization of supply chains are now paying off. Remote assets management in highly automated industries and online monitoring and team-working approaches have provided robust alternatives to both operating and value delivery models in this period of social distancing and restricted travel.

Digital platform-based solutions have also demonstrated higher degrees of flexibility and new forms of inter-organizational collaboration, including public-private partnerships, that have led to “grand challenge” projects such as the development and production of vaccines and critical healthcare equipment at speed.

As companies emerge from the pandemic disruption, they will have some choices to make. Should they quickly return to “business as usual” or rather examine what worked (and what didn’t) during this period of “mass experimentation and innovation at scale”? The future may belong to those who are able to manage uncertainty and innovate rapidly.

Manufacturing can no longer be simply regarded as a cost-centre to be optimized but rather a primary source of innovation and resilience enabled by advanced manufacturing technologies. Firms which invested in these technologies before others appear to have been able to adapt far more quickly during the crisis than those that did not. Resilience to external shocks is now a source of competitive advantage and will play a bigger role as companies transition towards the new normal.

Future capital may be scarce as firms emerge from these challenging times. Local “just-in-case” asset reshoring actions will not be easily justified without the promise of better products, faster times to market and more efficient and flexible operations to meet fast changes in demand.

Future decisions, from reshoring to multi-sourcing, must be driven by both operating and business model innovation, with investments in advanced manufacturing technologies as a key enabler.

Collaboration across the global manufacturing community is needed more than ever to:

- Shed light on the role of advanced manufacturing technologies in shaping the future of operating and business models
- Define what operating and business model innovations that emerged during the crisis may become new practices as companies transition towards a new normal
- Incubate new public-private partnerships to inform the next generation of industrial policies and strategies and build resilience
- Leverage innovation to accelerate the recovery and drive economic growth, while protecting all stakeholders, including workers, environment and society

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