

COVID-19 Impact on Supply Chains: Global Additive Manufacturing Industry Report



Executive Summary

In 2020, the global COVID-19 pandemic revealed that conventional supply chains were not as resilient as once thought. Countries, businesses, and teams had to quickly mitigate the impact of supply chain disruptions, deal with a distributed workforce that suddenly appeared overnight, and manage pressures from the largest global health pandemic in our lifetime. All of these factors — often changing weekly or even daily — compounded the challenges facing organizations.

We live in a dynamic world, with production preferences, labor, and supply chain contractions constantly changing. Unfortunately, centralized manufacturing, lengthy logistics bridges, and a global economy failed to overcome unforeseen circumstances like plant shutdowns and abrupt spikes in demand signals for everything from life-saving equipment such as ventilators and personal protective equipment (PPE) to everyday items such as flour and toilet paper.

In response to these evolving challenges, how were companies that adopted additive manufacturing solutions adapting to the fast-evolving supply chain landscape? Did COVID-19 drastically stop all production? Were any of these companies able to maintain business continuity? And, if businesses were able to adapt and pivot, what were the critical technologies and strategies that enabled such resilience?

Markforged aimed to closely examine how organizations that adopt additive manufacturing technology are adapting during the COVID-19 pandemic. This Markforged report is based on global survey data insights conducted in Q3 2020, and it investigates how these organizations are actively transforming their supply chains and democratizing production capabilities.

The report is based on insights from modern manufacturers surveyed across various global industries. Our study reveals how early adopters of innovative cloud-based additive manufacturing technology, such as the Digital Forge from Markforged, are tapping into faster lead times and lower program costs. Furthermore, these organizations are empowered to print critical parts at the time, place, and manner needed.

Overall, our research revealed that companies that adopted leading cloud-based additive manufacturing solutions remained resilient and maintained business continuity during the largest global health crisis we have collectively experienced.

Key Findings

45.4%

Respondents (Markforged customers) said, "Nothing has changed. It's business as usual."

23.6%

of Markforged customers surveyed during Q3 2020 reported that they have scaled back production.

23.6%

of Markforged customers said they have begun producing new products.

39%

of non-Markforged customers answered, "We have scaled back producing our typical products."

18%

of non-Markforged customers reported that they have stopped producing their typical products. For some organizations, the COVID-19 pandemic greatly impacted production.

73.2%

of Markforged customers surveyed indicated that there were no changes and they have continued to use 3D printing for the purposes previously used.

50.6%

respondents indicated that additive manufacturing has saved the business "some time" during the COVID-19 pandemic.

18.1%

stated that additive manufacturing has saved the business a "significant amount of time."

4%

surveyed said they started to produce PPE (face shields, NHS face shields, etc.) during the pandemic.

38.5%

surveyed plan to make future investments in digital manufacturing technologies.

Survey Methodology & Respondents Background

This survey was conducted during Q3 2020 with data analysis and insights extrapolation conducted in Q4 2020. Markforged is uniquely positioned to share strategic and tactical insights due to having one of the largest fleets of cloud-based connected 3D printers. Therefore, the results of the study are based on responses from organizations spanning several countries and continents to provide a more global range. While the primary respondents of the study were from the Markforged customer base, the report also surveyed a sampling of non-Markforged customers to provide deeper analysis.



Industry

27%

Product Development/
Engineering

15%

Automotive, Aerospace, federal
government, packaged goods
and others

Respondents of the survey came from various industries; for example, **27%** labeled their industry as Product Development/Engineering, and **15%** came from industries described as “Other Manufacturer.” Respondents also included automotive, aerospace, federal government, packaged goods, and other industries/verticals.

Company Type

80%

of respondents say their company
type is an Original Equipment
Manufacturer (OEM)

Due to the rise of the modern manufacturer, it's not surprising that approximately **80%** of respondents say their company type is an Original Equipment Manufacturer (OEM) or describe their organization as parts, components, or materials supply type of company. These companies came from industries including automotive, aerospace, consumer goods, energy, electronics, defense and other manufacturing. **5.8%** reported they were from a tooling supply or repair company. A smaller sample size of respondents came from product development, higher education, and research labs.

Job Title

When answering the question of which closely describes their job title, respondents indicated the following:

- Manufacturing Engineer/Manager (**18.6%**)
- Additive Manufacturing/3D Printing Technician/

Engineer/Manager (**15.9%**)

- Mechanical/ Aerospace Engineer/Manager (**14.9%**)
- Research/Development Engineer/Manager (**13.2%**).

The insights here suggest that each industry surveyed through our study has team members who can contribute to the company's resiliency in a changing economy. In 2020, with the global pandemic impacting supply chains, resilience and adaptability were critical.

Perhaps the results indicate that the Markforged customer base surveyed is more resilient and can quickly pivot job duties; for example, companies that could adapt to global health and economic disruption may have team members whose skill sets and job duties overlap into other areas of the company.

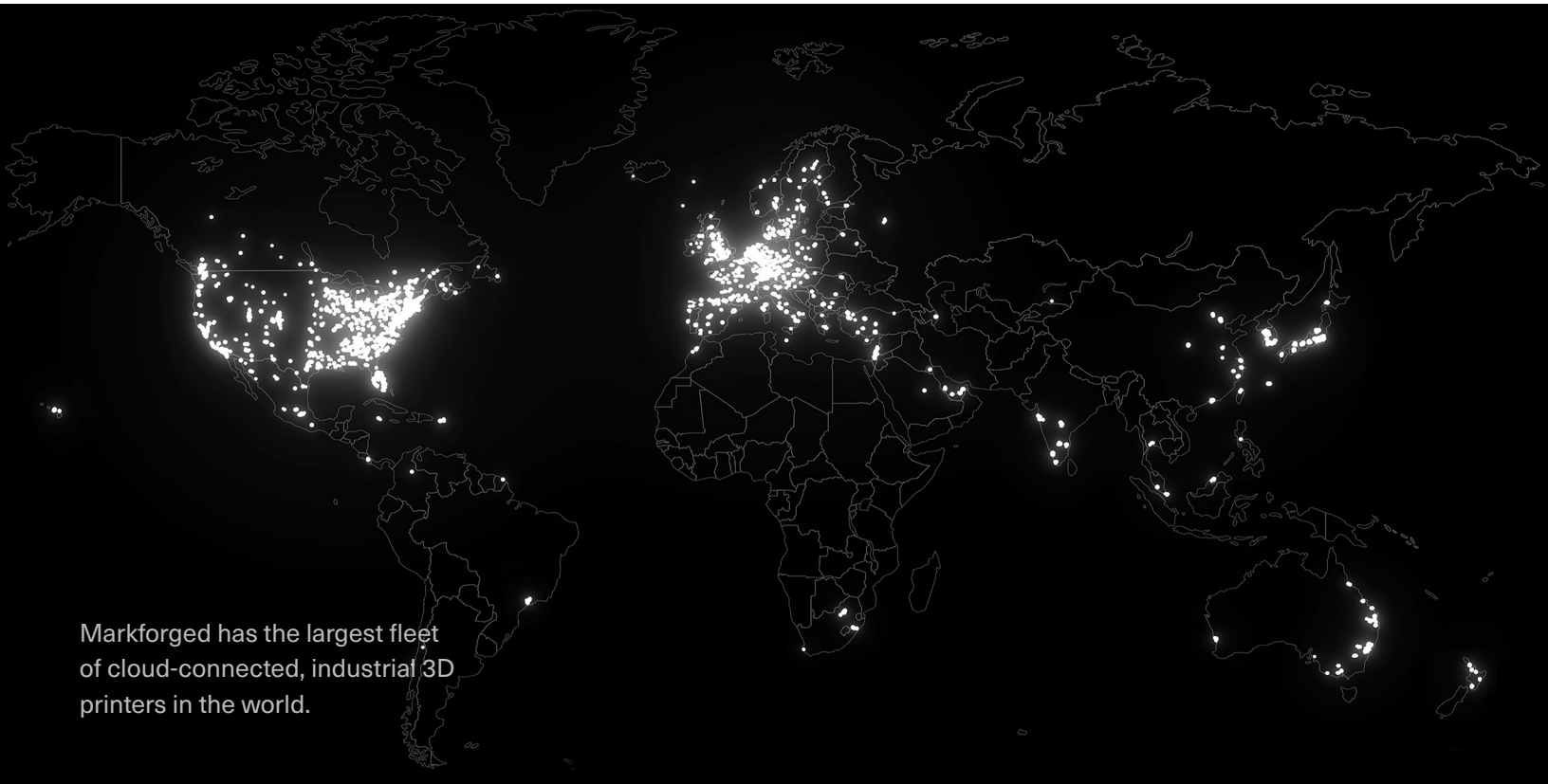


The Modern Manufacturer

Simply defined, the modern manufacturer embraces innovative cloud-based additive manufacturing technology and solutions to help overcome evolving supply chain challenges.

The modern manufacturer is not necessarily an early adopter, but believes that new technology offers competitive advantages when it works reliably and delivers tangible, ongoing value.

Furthermore, the modern manufacturer focuses on working with additive manufacturing technology that is constantly evolving, cost-efficient, scalable, and intuitive. Adaptive, agile, and resilient, the modern manufacturer is positioned to succeed today and in the future.



Organization Size

To get a broader, more inclusive sampling of respondents, the survey was conducted among a range of company sizes. The survey audience taps into a healthy representation of additive manufacturing user industries.

6.9% came from companies with 10K+ employees, **4.7%** came from organizations in the 5-10K employee range, **29.3%** from companies with 50-999 employees, and **26.1%** from companies with fewer than 10 employees.

Region

Markforged partners with a global customer base. Respondents of the survey indicated that **56.6%** were from North America, **30.8%** from Europe, and the remaining were from Asia, Oceania, and South America.

As previously stated, COVID-19 is a pandemic that has impacted many businesses on a global scale, particularly the global supply chain. It's important that when you partner with an additive manufacturing technology

solution company, you team with a provider with global experience and expertise.

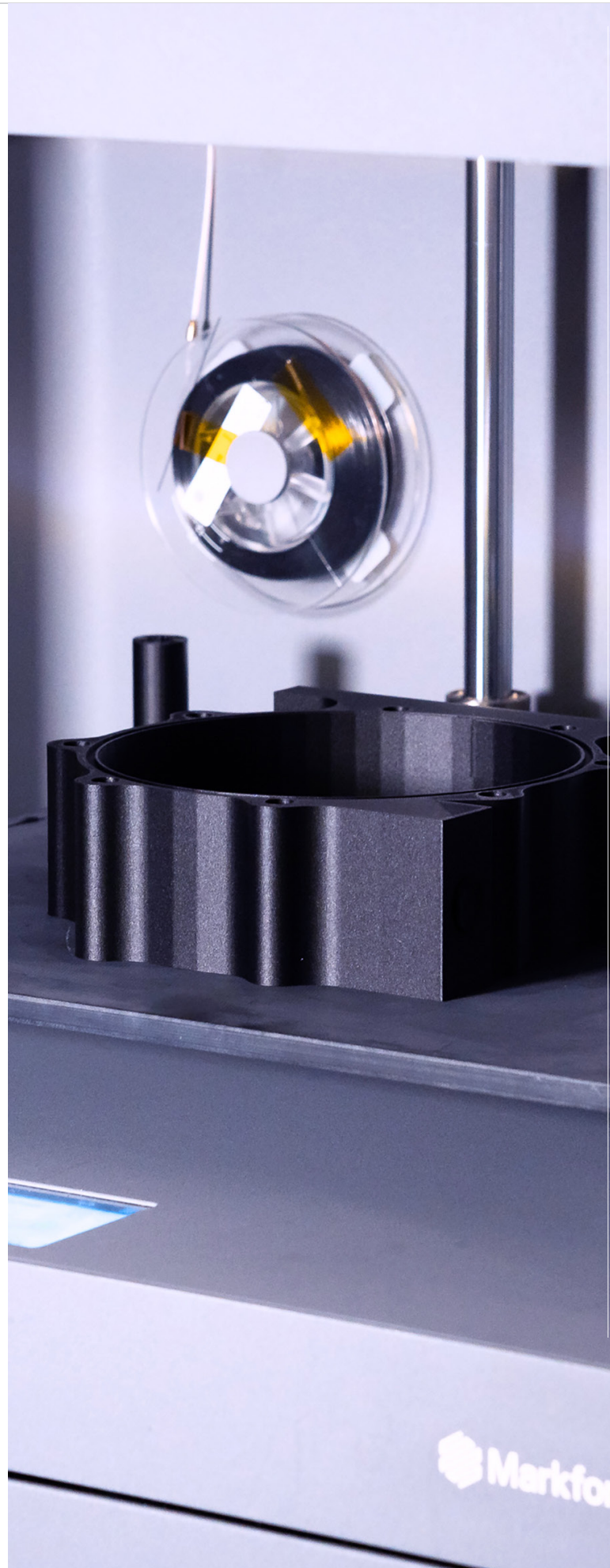
Industrial Additive Manufacturing Experience Level

Shedding light on the level of additive manufacturing experience, **32.5%** of respondents said they have used the technology 1-3 years; **26.6%** said they have 5+ years experience; **25.1%** indicated they have 3-5 years experience.

The distribution of additive manufacturing experience level suggests that many organizations have a modicum of technology adoption. Based on experience with Markforged customers, strategic enablement programs like Markforged University accelerate adoption patterns through critical skill sets such as Design for Additive Manufacturing (dFAM). Furthermore, as the data suggests, use case identification can help accelerate maturity so businesses and managers can focus on more transformational work streams like supply chain reinvention.

COVID-19 Pandemic Impact on Business

One of the main goals of this report is to uncover insights on how COVID-19 impacted businesses that have adopted cloud-based additive manufacturing solutions, and in particular, examining Markforged customers versus non-Markforged customers.



45.4%

Markforged customers reported, Nothing has changed. It's business as usual

When asked, "How have you pivoted your business during the COVID-19 pandemic?" **45.4%** of respondents (Markforged customers) said, "Nothing has changed. It's business as usual." **23.6%** of Markforged customers surveyed during Q3 2020 reported that they have scaled back production. Furthermore, **23.6%** of Markforged customers said that they have begun producing new products.

Surveying non-Markforged customers on the same question, "How have you pivoted your business during the COVID-19 pandemic?" the results uncovered contrast relative to the first surveyed audience bucket.

For example, **39%** of non-Markforged customers answered, "We have scaled back producing our typical products." For some organizations, the COVID-19 pandemic greatly impacted their production, with **18%** of non-Markforged customers reporting that they have stopped producing their typical products.

Analysis of this trend indicates that Markforged users show a higher percent of responses indicating that "nothing has changed" in the face of global market turbulence brought on by the pandemic. The modern manufacturer, our primary Markforged customer audience, has shown incredible resilience and business continuity during a major global economic disruption.

39%

Non-Markforged customers have scaled back producing typical products

3D Printing Use During the COVID-19 Pandemic

52.4% of Markforged customers reported they use 3D printing as often as they did before the start of the global pandemic. Another interesting insight uncovered was that **28%** of respondents (Markforged customers) said that they are now using 3D printing more, compared to pre-pandemic usage.

52.4%

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28%

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Sourcing Parts During Pandemic

To examine the potential influence of the pandemic on sourcing parts, the survey asked respondents (Markforged customers), "How has the pandemic changed how you source parts?"

16.9%

Started to look at new ways to insource parts instead of outsourcing

15.1%

Pivoted and are using 3D printing differently

65.3% of respondents said, "Nothing has changed. It's business as usual."

16.9% of respondents stated, "We have started to look at new ways to insource parts instead of outsourcing."

15.1% of respondents said, "We have pivoted and are using our 3D printing differently."

While more than half of respondents said that sourcing parts during the pandemic was not a major concern, it is interesting to examine how and why some Markforged customers have started to look for new

ways to “geographically contain entire value chains” and “pivoted” by using 3D printing differently. It is also relevant to note that the answer pertaining to “reshoring as much as possible” was not selected by those surveyed.

An analysis of this trend may be based on the fact that many businesses who adopt additive manufacturing are intrinsically tied to the global supply chain.

Specifically, these businesses are tied to global supply and distribution nodes, for example, components of the supply chain that are upstream supply nodes as well as the downstream distribution of central manufacturing. To maintain business continuity, adaptability, and resilience, organizations that adopt additive manufacturing must partner with a technology solution provider that is scalable in order to meet the needs of changing global supply and distribution

Legacy solutions and incumbent 3D printing approaches, such as laser or powder-based 3D printing, present several challenges for manufacturers. The equipment and supply base is often expensive, requires abundant space, and can only be operated by a small number of highly skilled technicians. These attributes do not suit the modern manufacturer’s evolving (and immediate) needs. Conversely, carbon fiber and metal 3D printers that are empowered with innovative cloud-enabled technology (such as Markforged’s Digital Forge platform) can better position a business for augmented

business continuity or fast and agile pivoting when needed.

3D Printing During the Pandemic – Changed or Unchanged

Respondents were asked whether 3D printing usage has changed during the pandemic. **73.2%** of Markforged customers surveyed indicated that there were no changes, and they have continued to use 3D printing for the purposes used before, while **26.8%** stated they started to use 3D printing for new purposes.

Further examination of the respondents who stated their 3D printing use has changed during the pandemic brought interesting insights. Respondents who said their 3D printing use did change selected use cases including a mixture of: Prototyping **85.2%**; Tools and Fixtures **56.5%**; Aftermarket Parts **41.7%**; and Production **38.9%**. Factors indicate that they are finding multiple use cases for 3D printing.

It appears that Prototyping between the two batches of respondents fell into a close response rate (Prototyping **82.7%**: 3D printing use did not change vs. Prototyping **85.2%**: 3D printing use that did change). However, those surveyed who stated printing use did change selected Aftermarket Parts (**41.7%**). Factors may indicate that these Markforged customers had created aftermarket parts in response to disruptions in the global supply change.

4% surveyed said they started to produce PPE (face shields, NHS face shields, etc.) during the pandemic. The media covered the news of large manufacturers shifting standard production to producing PPE equipment; for example, the Department of Health and Human Services announced the first contract for ventilator production rated under the Defense Production Act to General Motors to produce 30,000 ventilators (source: HHS.gov). It appears that some Markforged customers contributed to the effort. These companies made parts available in the cloud, produced face shields, produced other protective equipment, etc. While the preliminary research



may indicate that these companies were not ready to do this at scale in 2020, these organizations learned that they had the ability to activate a fleet of production capabilities with new business logic and workflows.

Time Saved by Additive Manufacturing During the Pandemic

50.6%

respondents indicated that additive manufacturing saved the business “some time” during the COVID-19 pandemic

50.6% of respondents indicated that additive manufacturing saved the business “some time” during the COVID-19 pandemic, while **18.1%** stated that additive manufacturing saved the business a “significant amount of time.”

Money Saved by Additive Manufacturing During the Pandemic

50% of respondents stated that additive manufacturing saved them “some money” during the pandemic while **9.9%** surveyed said that additive manufacturing saved their business a “significant amount of money.”

“As with all tools when used correctly they provide advantages related to cost and timing, but additive manufacturing is also unique in its ability to provide flexibility and innovation when adopted into your organization.”

Terry Hammer

VP Engineering, Light Vehicle Drive System
Dana Inc.

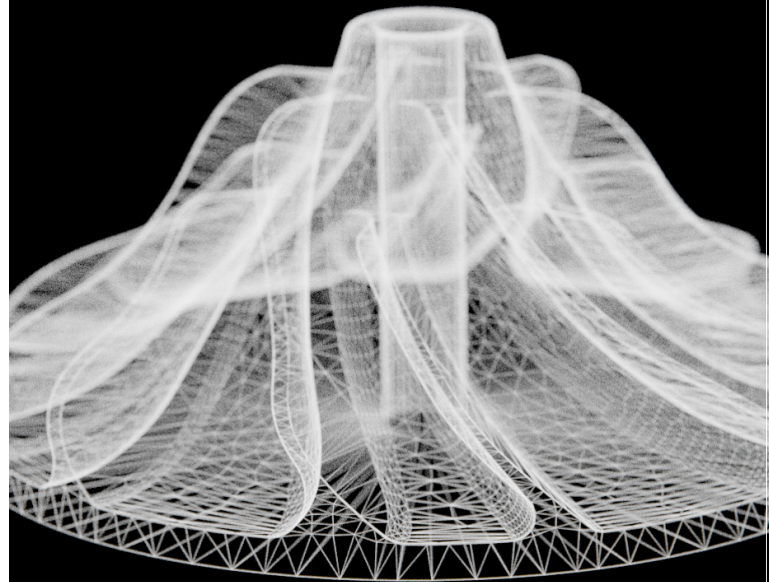
“Supply chains we’ve built as a global economy have been optimized, and when you optimize it’s inherently fragile. It’s not that pre-Covid mentality was wrong, it’s that it wasn’t resilient for what we’re seeing in 2020.”

GREG MARK

FOUNDER AND CHAIRMAN
MARKFORGED

The Future: Responding and Adapting to the Changing Supply Chain Landscape

Our report aimed to uncover insights and opinions on future investments in additive manufacturing. Respondents were asked to state areas in which their organization was considering investing to respond and adapt to the changing supply chain landscape.



38.5%

Investing in digital
manufacturing technologies

30.3%

Investing in flexible
workspace collaboration

Investing in digital manufacturing technologies led with 38.5%, followed by flexible workspace collaboration (30.3%), then hiring new talent/employees (28.5%). Workforce training was selected by 27.3% of respondents.

This analysis strongly indicates that Markforged customers are thinking about the future and how to adapt to not only the changing supply chain, but to the nature of work and the workforce. For many, COVID-19 has changed the way we work, collaborate, produce, and partner.

Today, a distributed workforce is extremely common. Furthermore, the modern manufacturer realizes the impact of new technologies on the additive manufacturing industry. There is a need to train a new workforce to become experts at innovative additive manufacturing to better position a company for business continuity in the unseen future.

Challenges Facing Manufacturers Using Incumbent Technology

Analysis of the resiliency of Markforged customers versus non-Markforged customers during global economic fluctuations (i.e., COVID-19 impact on global supply chain, economies, production, etc.) can be further extrapolated into the following insights.

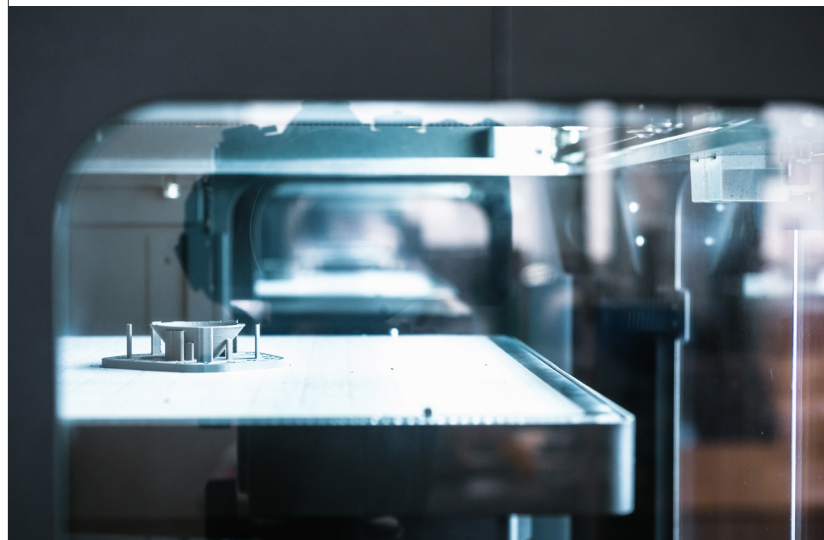
Older Incumbent Metal 3D Printing Technology

Conventional manufacturing often takes months or years to spool up new products because of lengthy supply chains and labor-intensive processes.

Even during a global health crisis, conventional manufacturing was not able to quickly produce PPE and ventilators needed to combat the health pandemic.

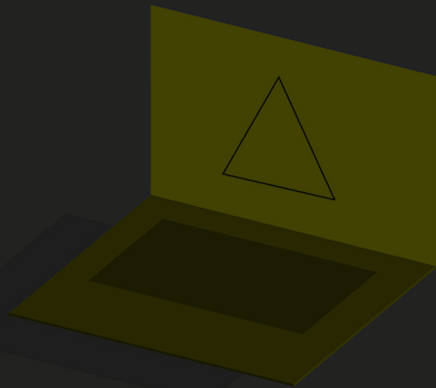
Other challenges include:

- Large footprint: Many of these incumbent metal 3D printing machines take a large amount of physical space to run. Not many manufacturers have the required space to dedicate just for these machines.
- Requires highly-skilled technicians: The technology is complex and often requires years to become fluent in.
- Operational risks: These incumbent 3D printing machines are commonly hazardous to operate within an office and are quite temperamental.
- Inefficient digital thread: Isolating hardware from software development creates the risk of trying to make disparate solutions work together.





The Digital Forge: Delivering the Future of Manufacturing



The Digital Forge, from Markforged, is the first and only industrial additive platform that uses fleet federated learning (AI/ML + data) to make the platform smarter and parts better with each print. This is significant because the platform is constantly learning from data being generated across its expansive 12,000+ fleet of printers, which can then be used to instantly course correct print jobs. As a result, the parts are more accurate than can be achieved from mechanical hardware alone. And because the platform itself is cloud-based, it can be constantly updated and enhanced so that customers are always able to leverage new advancements.

The Digital Forge is also the only additive platform that can print continuous carbon fiber reinforced parts and metal in a safe and accessible way from a single browser tab. This empowers manufacturers to print production-grade, strong parts at the point of need to respond to supply chain disruption and take advantage of market opportunity in an agile way.

In order for business leaders to accept digital transformations like additive manufacturing, the new work streams must present immediate cost savings. The Digital Forge does in fact present a 90% cost savings and 95% lead time reduction in relation to traditional processes like CNC machining. Emphasis on these immediate benefits, however, belies more transformational long-term benefits associated with supply chain, including inventory reduction, streamlined logistics, and elimination of procurement processes. Overall, these benefits combine to present businesses with greater impact relative to the raw cost savings alone.

As the only 3D printing platform to leverage machine learning, the Digital Forge creates parts more cheaply, faster, and often with better properties than traditional manufacturing methods, while continually getting smarter with each part it prints. The Digital Forge empowers companies to manufacture and deliver quality parts in an entirely new way and solves the deep supply chain issues made apparent throughout COVID-19.

Conclusion

As covered, incumbent 3D printing solutions and technology were innovative when first introduced, but they were not made for today's needs and challenges. In 2020, the COVID-19 pandemic changed how many of us live, work, communicate, and collaborate. Outdated technology and approaches were unable to quickly adapt and pivot to the supply chain disruption caused by COVID-19. Overall, the technology is stagnant and not made for the modern manufacturer.

Fortunately, as our report has uncovered, Markforged customers who deploy the Digital Forge platform are empowered to maintain business continuity with their additive manufacturing initiatives. 4% of our customer base shifted into PPE manufacturing. Perhaps the trend of shifting to producing PPE mainly centered around larger manufacturers or organizations that needed to stop their production (due to demand or market signals) to create an entirely different product. Overall, our Markforged customers remained resilient and focused on continuing their business, but were able to pivot and become agile if necessary.

As an innovative leader in cloud-based additive manufacturing, Markforged is uniquely positioned to share strategic and tactical insights on the fast-changing landscape. Markforged is built from the ground up on cutting-edge technology that is constantly improved and iterated on. From areas including the cloud, data analytics, machine learning and AI, security, and more, Markforged is empowering organizations for not only the "new normal" but the "next normal."

As demonstrated with the COVID-19 pandemic and the disruption to the economy, workforce, and supply chain, we cannot predict what happens tomorrow. However, partnering with an experienced and forward-thinking additive manufacturing technology partner like Markforged can help businesses better position themselves for resiliency and agility in the future.



Markforged transforms manufacturing with 3D metal and carbon fiber printers, capable of producing parts tough enough for the factory floor. Engineers, designers, and manufacturing professionals all over the world rely on Markforged metal and composite printers for tooling, fixtures, functional prototyping, and high-value end-use production. Founded in 2013 and based in Watertown, Massachusetts, Markforged has about 300 employees globally, with \$137 million in both strategic and venture capital. Markforged was recently recognized by Forbes in the Next Billion-Dollar Startups list, and listed as the #2 fastest-growing hardware company in the U.S. in the 2019 Deloitte Fast 500.

To learn more about Markforged, please visit:
markforged.com