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# Refactoring manufacturing

Artfully preparing for the digital landscape



Empowering business  
 for what's next



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Systems of intelligence will allow you to optimize your operations and change the very nature of the business models around your industrial products.

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**Satya Nadella**  
CEO, Microsoft



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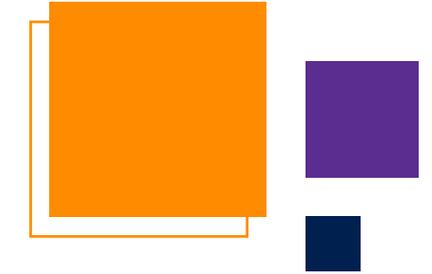
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Perspectives and the vanishing point





# Painting the landscape



## Technology and manufacturing have always been intertwined.

Motivated by the need to produce better goods in faster and cheaper ways, manufacturers have traditionally been a driving force behind the technological breakthroughs that have shaped society. From the cotton gin to the robotic assembly line, the push for greater productivity has changed the fortunes of individuals, industries, and entire nations.

Over the last few generations, however, this impetus to innovate has been secondary to the focus on cost reduction. Many manufacturers, in the interest of reducing production and direct labor costs, decided to produce goods far from their primary markets and customers. While this outsourcing trend succeeded in cutting costs, it has also resulted in overly complex supply chains that have added risks and additional challenges in meeting the expectations of customers.

Manufacturing firms now find themselves in a precarious position: after decades of outsourcing, technological advances are making previously high-cost metropolitan areas attractive again. New business models, new means of production, and new ways of organizing supply chains have drastically changed, leaving manufacturers facing daunting challenges—but also great opportunities.

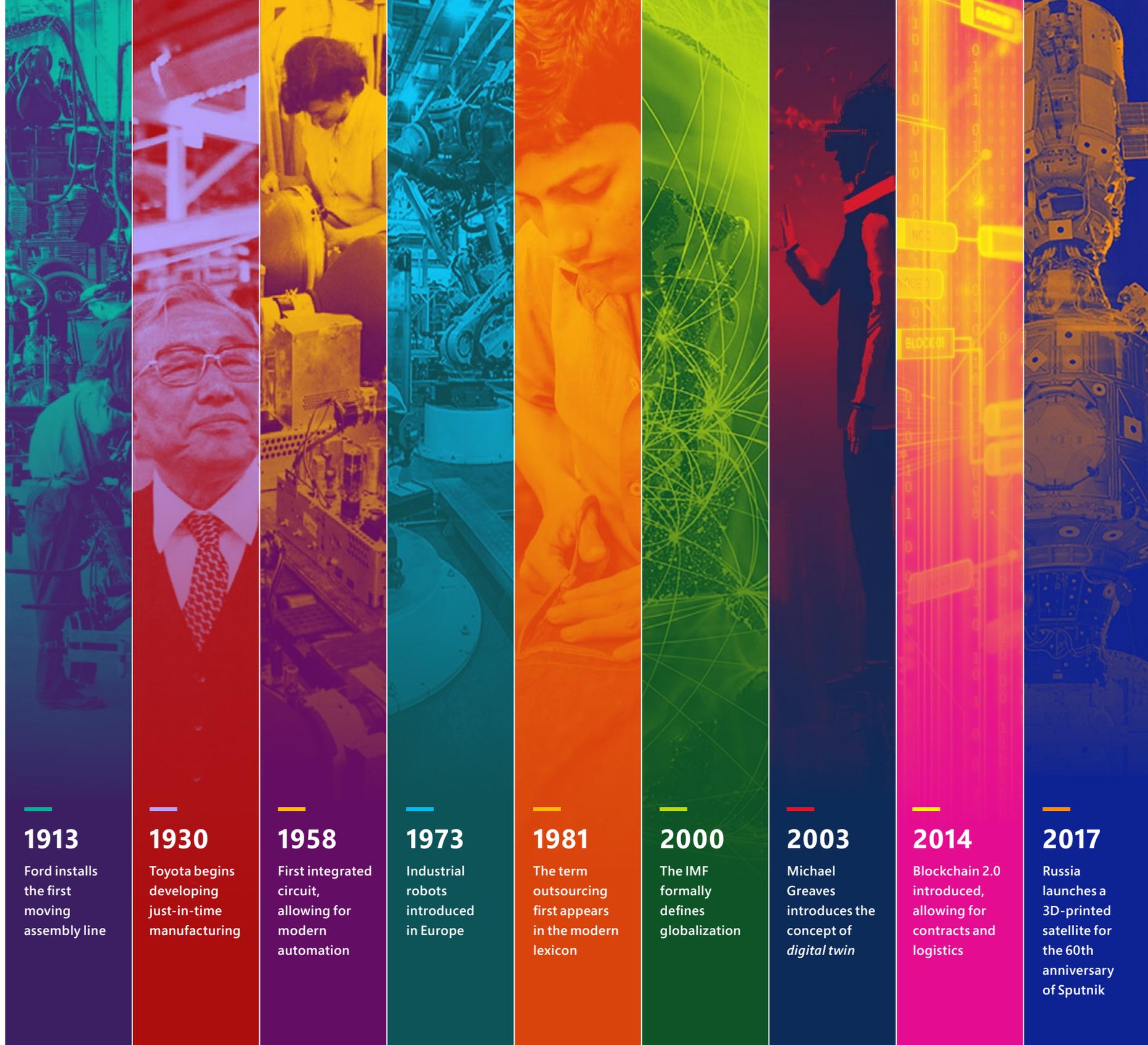
The manufacturing industry is at a crossroads: the exploitation of economic inefficiencies is becoming increasingly difficult in an era of globalization while new firms and methodologies are redefining supply chains, production processes, and even the nature of goods themselves.



# Timeline

**Historically, manufacturing breakthroughs have come in three primary areas: more efficient methods of labor, more efficient use of raw materials, and more advanced methods of quality management.**

Industry and financial pressures have led to the centralization of many companies, where effective planning could be implemented and overhead costs could be kept to a minimum. Larger factories and production runs helped spread costs over more finished goods, allowing for greater quality control and effectively lowering the cost of goods sold.



# An artistic revolution

## Over-abstraction

The economic phenomenon of labor arbitrage is certainly nothing new. Conceptually, the idea, a process colloquially known as outsourcing, is straightforward: moving production to countries where costs are significantly lower has a meaningful impact on the bottom line, enables entry into new markets, and allows manufacturing firms to focus on what they arguably do best.

The process, though, is logically flawed. Globalized production requires exceedingly complex and expensive supply chains, making local labor pools less attractive as demand rises; imperfect decisions on which activities to offshore lead to a glut of intellectual property theft; and, as the era of cheap oil ends, savings in labor costs are offset by increasing transportation costs. Just like arbitrage in other industries, most benefits are temporary and will eventually be corrected by the market.

“When digital transformation is done right, it’s like a caterpillar turning into a butterfly—but when done wrong, all you have is a really fast caterpillar.”

**George Westerman**

MIT Sloan Initiative on Digital Economy



## Changing palettes

Demographic shifts in customers and employees, as well as the ease of access enabled by a globally interconnected world, has had a profound effect on manufacturing. End users now have access to a wealth of information, and their purchase decisions are often influenced by non-financial factors—from fair trade and organic farming methods to environmental concerns and anti-consumerism. These choices reverberate through the entire value chain.

Though it differs by geography, many large-scale, monolithic factories that previously dominated the manufacturing verticals are straining to react to changes in the marketplace. Even the most robust and highly optimized assembly line can be rendered obsolete as consumer expectations change or new technology-driven business models are invented. Factories need to be retooled or, worse, abandoned.

These events are preceded by nuanced or underappreciated shifts—who would have guessed that the precursor to computer vision, the 1975 invention of the digital camera, would eventually lead to autonomous vehicles and foreshadow the end of individual car ownership?

## The avant-garde

Rapid prototyping and global connectivity are shrinking both the time-to-market and monetization window for goods. Democratization of previously inaccessible technologies; the push for transparency and traceability across the supply chain; and increased emphasis on sustainability have spawned “makers” movements, where small groups of individuals attempt to create the items they need with local resources.

Advances in additive layer manufacturing have enabled startups to create goods that were once the exclusive domain of large-scale manufacturers. In underserved and remote areas, entire structures are being created and distributed via 3D printing. This isn’t the future, it’s now; the first 3D-printed satellite was launched in August 2017.

How much longer before advances in technology make possible the production of nearly all physical goods, without having to deal with a sprawling supply chain?

# Stylistic changes

“Before you say you can’t do something, try it.”

Kiichiro Toyoda  
Founder, Toyota Motor Corp.

## An emotional connection

In no other industry are operational efficiency and customer experience as closely linked as they are in manufacturing. Being able to deliver goods on time, at specification, and at minimal cost is no longer a source of competitive advantage—it is the new reality for all firms. In a global marketplace, business customers—and particularly end consumers—are increasingly intolerant of defects, disruptions, and delays. As social technologies amplify word-of-mouth, recalls and poor craftsmanship have lasting effects on customer perceptions and the bottom line. **Trust takes years to build, but only seconds to destroy.**

## Understanding the fundamentals

**Imagine a world where production runs are data-driven. With predictive analytics and artificial intelligence, supplies could be ordered and goods shipped autonomously. Models will consider everything from material availability and changes in consumption to traffic patterns and weather.**

It may sound futuristic, but in many parts of the globe it is already happening: deep-learning algorithms originally designed for physics experiments are being repurposed to evaluate the complex manufacturing ecosystem. By analyzing billions of transactions and thousands of variables—and taking advantage of the virtually infinite computing power of the cloud—orders can be predicted weeks in advance while costs can be simultaneously lowered.

**Other industries have already seen the benefits of properly employed data and artificial intelligence:**

- Advertisers can target consumers on a personal level.
- Online retailers can offer meaningful purchase suggestions.
- Financial institutions can detect and prevent fraud.
- Smart cities can deploy resources more efficiently.

The competition for mindshare—increasingly known as the attention economy—and share of wallet are emerging as the new battlegrounds as the concept of market share becomes increasingly abstract. The survival of the fittest will be decided on customer experience.

DATA POINT



Otto Manufacturing uses AI to predict demand 30 days out with **90 percent accuracy.**

Source: World Economic Forum, June 2017



## Creating compositions

Mining historical transactional data may provide insights into what and why things happened. Collecting, processing, and harnessing real-time data, however, offers the promise of forward-looking recommendations—anticipating *what will happen*. Machines on the factory floor can automatically monitor and report their condition, not only for the purpose of preventative maintenance and the prevention of unscheduled downtime, but also to relay the status of the work in progress. Consequently, defects can be caught at an earlier stage.

Additionally, mixed reality can play an important part in cost and quality control as well as open opportunities for new revenue streams. Companies can now create and model situations in a virtual world, simulating design processes and production runs long before an actual product is created, allowing for greater optimization of the factory floors. Using big compute and digital twin capabilities, firms can create purely digital representations of products that are put through rigorous, real-life situations and analyze the outcomes—without the need to produce a physical product, saving both time and money. Mixed reality is also the foundation for decoupling the need for the operators and designers to be physically present, allowing companies to access talent from around the globe while keeping production local.



### DATA POINT

IoT investments have returned **14 percent more** than expected in terms of profitability.

Source: Aruba Networks, February 2017

## Collaborations and exhibitions

As manufacturers push the boundaries of optimization and agility, the final piece of the puzzle is to incorporate data from supply and distribution chain partners. Emerging technologies, such as blockchain, provide transparency to all participants—including the end customer—through an immutable and distributed ledger, reducing operational risk and streamlining processes. Imagine a blockchain-powered system where suppliers and distributors have access to low-cost, reliable, and transparent information about the movement of goods, the status of payments, and updates on current processes. How much more efficiency could manufacturers realize and how much better could they anticipate and respond to demand fluctuations with access to such data?

Additional insights into how products and services are consumed can be gleaned by making better use of cloud-based data, advanced analytics, and artificial intelligence. The availability of materials—even the availability of labor—can be modeled with extreme accuracy. These advances can redefine operational and logistical challenges, as the industry moves to the desired state that was once considered an unattainable panacea: inventory-less manufacturing.

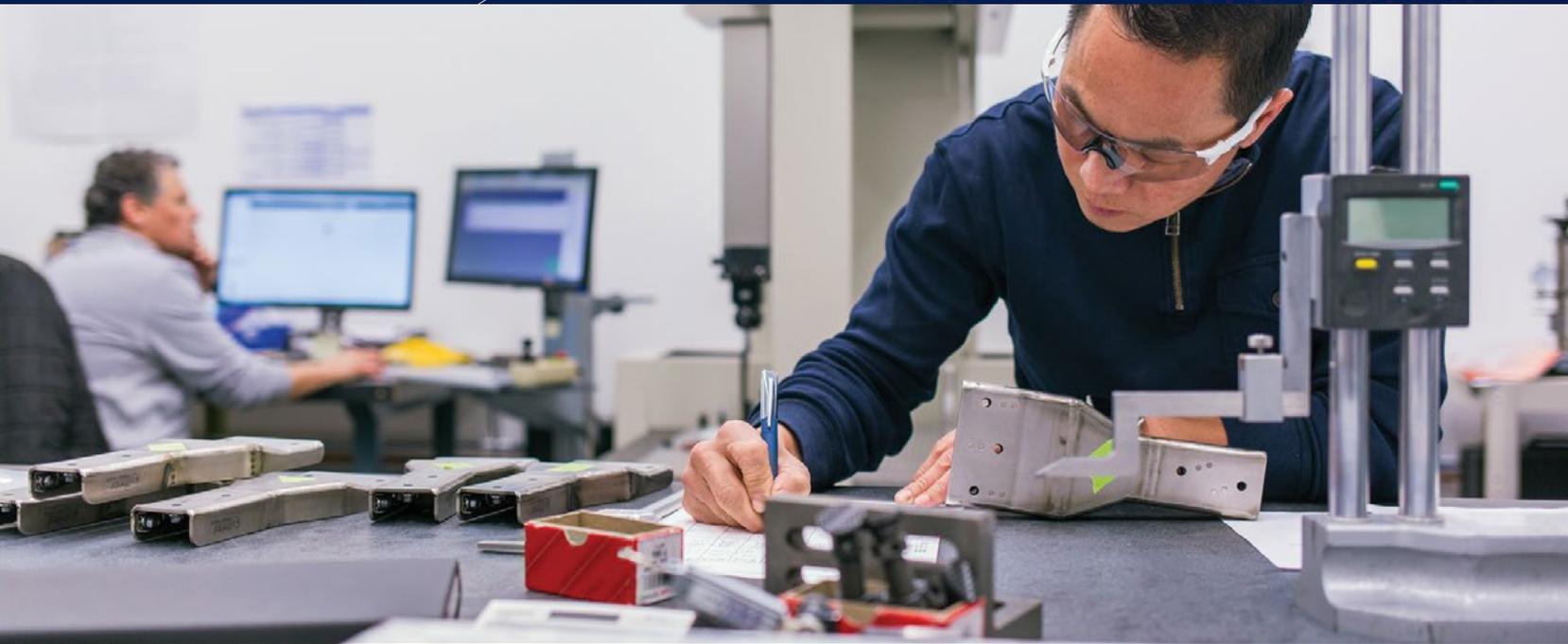


### DATA POINT

Blockchain technology has over **\$50 trillion** in supply chain use cases.

Source: Sweetbridge Alliance, July 2017





## Perspectives and the vanishing point

With the rapid advances of the last century, it is easy to lose sight of what the end user truly wants—our vision has become clouded as we are inundated with information that can confuse even the most perceptive audience. It is important to remember what is true for most goods: the consumer does not generally want the “thing,” but rather what the “thing” does for them.

### **For a historical example, take piano sales in the 1920s.**

As phonographs, and subsequently radios, reached price points within reach of the average consumer, the sales of pianos plummeted. Most consumers did not want a piano; they wanted entertainment. Nearly all items can be distilled down to an experience. Extending this thinking beyond the physical-digital divide raises a fundamental question: what happens when an experience can be provided in a purely digital way?

### **In such a context, what role will manufacturers play?**

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Over the next 10 years, we'll reach a point where nearly everything has become digitized.

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**Satya Nadella**  
CEO, Microsoft



"The purpose of industry is obvious. It is to supply man with things which are necessary, useful, or beautiful, and thus to bring life to body or spirit."

**R.H. Tawney**  
19th century author and economist

## Is it art for art's sake?

Some goods, particularly those that are created to manipulate the physical world—for example, excavators, refrigerators, and shelter—will always have some reliance on traditional manufacturing. There is simply no digital analog. Other goods and processes, however, will be drastically changed.

**Just like the harnessing of fire, the advent of steam power, and the arrival of the internet, this new digital world will fundamentally change the axioms of the business of manufacturing.**

## Designing for experiences

**Changing business axioms require corresponding changes of emphases.**

If the true value of manufacturing is found in experiences, and physical goods serve as access points to a digital world, then it logically follows that most physical goods will eventually become commoditized. Though somewhat disconcerting, we have already witnessed just such a schism in the manufacturing world—a split between the firms that ideate and design, and the firms that forge and assemble. Very few companies own the process end-to-end—from drafting board to delivery. The competitive pressures and business models of managing both rarely coincide.

This distinction has far-reaching implications as we move into the next frontier: digital goods. Whether items in a video game, mobile applications, or the operating system on a computer, the nature and production of goods create an interesting anomaly: the supply chain is fundamentally altered as there are no physical inputs. The concept of the supply chain will not disappear, but rather its importance changes. In a digital world, the theory of constraints changes—physical limitations, distance, and quantity become less significant, and design becomes the paramount factor in the battle for competitive advantage.





## Stopping counterfeiters

Protecting intellectual property has long been paramount in manufacturing. Theft of materials, goods, and processes has sparked trade wars, cold wars, and hot wars. But when goods and services are digitized, and can be produced without limit, how do companies protect what is quickly becoming their most valuable—perhaps their only—asset?

In this digital world, manufacturers' new challenges have taken the place of old ones—and increased focus on cybersecurity has supplanted concerns about a sprawling supply chain. Cyber threats are everywhere, and the question of being hacked is not an "if" but a "when." Protecting yourself with the right cloud, one that meets or exceeds the most stringent security standards, is the best strategy. New advances in cloud-based data, AI, and blockchain technology provide cybersecurity benefits by controlling access to systems and intellectual property. It also produces a transparent and immutable record of who accessed the data, how they accessed it, and why. In a fully distributed and democratized world, maintaining control and monetizing intellectual property require a new mindset and the embracing of innovative security models.



**DATA POINT**

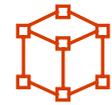
**Over 80 percent** of the value of U.S. businesses can be traced to IP.

Source: *Forbes*, October 2014

## Bringing art to the masses

The use of secure blockchain technology also benefits manufacturing partners by reducing dependencies and bottlenecks in supply chains. As large, monolithic manufacturing plants disappear, small, agile, and local facilities would be able to license designs and processes, allowing for more responsiveness and smaller production lots. Employing the secure cloud, advanced analytics about customers, and the digital twin, future manufacturers will be within reach of what was once considered unassailable: having both maximum efficiency and minimum lot size.

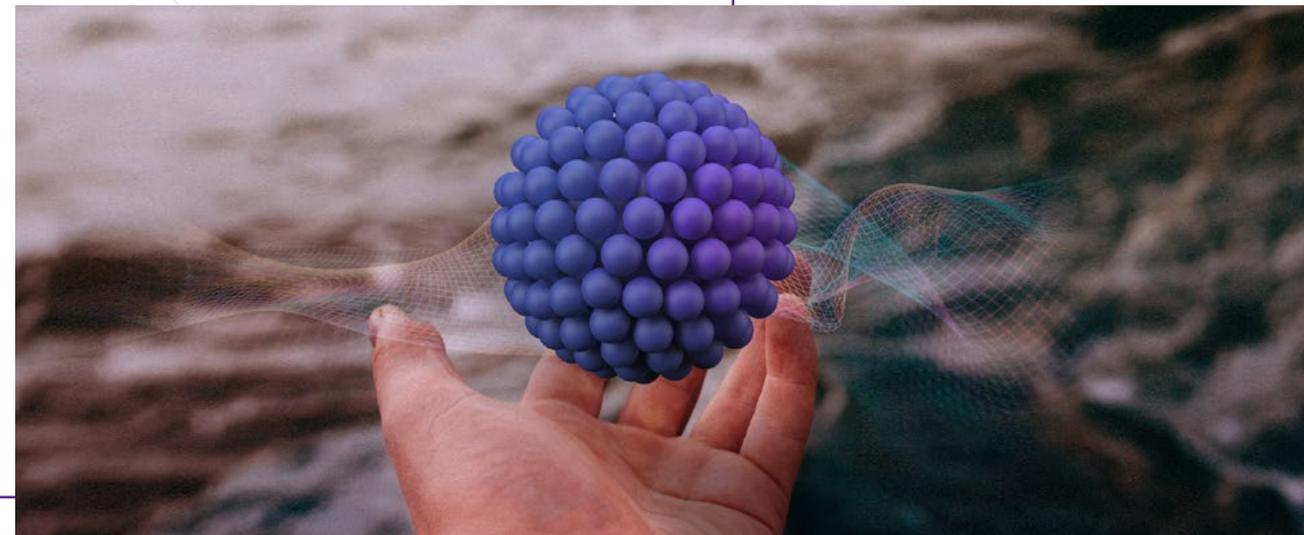
Through the continual advancement of additive layer manufacturing, hyper-local manufacturers may be able to produce increasingly complex physical goods, potentially with a single machine. The only requirements would be commonplace raw materials and access to the design know-how. Though commoditized or highly regulated goods would continue to benefit from large factories, differentiated products would become factory-less.



**DATA POINT**

Local Motors can go from concept to delivery **24 times faster** than traditional methods.

Source: *Forbes*, February 2017





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The future cannot be predicted, but futures can be invented.

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**Dennis Gabor**

Inventor of Holography & Nobel Laureate

# Revival of the classics

**Though the idea of producing goods without the traditional factory infrastructure may seem like science fiction, this scenario may not be far-fetched.**

Advances in material science, engineering, design, and technology are pushing the limits of what is possible. At the same time, those advances, are being made more widely available. How long will it be before advanced 3D printers, capable of producing a wide variety of products, are no longer so expensive that they are only owned by a few well-capitalized firms?

Taken to its logical conclusion, what if manufacturing was truly distributed, and many, if not most, items could be produced by small groups of people, or even the individual? The implications are far-reaching: from hyperpersonalization, to the end of the physical supply chain, to the lot size of one, the future of manufacturing is the re-manifestation of familiar beginnings: the arrival of the digital carpenter and digital blacksmith.



# The digital renaissance

In painting, just as in manufacturing, the true value lies beyond the mere raw materials: it is the combination of colors, form, function, and creativity of the artist that drives the experience. A better comprehension of the value of data, the promise of mixed reality, and the future of AI can empower employees—from the factory floor worker to the product design team—to work more efficiently and find their inner artist.

At Microsoft, we understand that manufacturing has reached a crossroads. We've invested billions of dollars in creating secure, enterprise-ready technologies that allow our customers to adapt and compete in a rapidly changing marketplace. Whatever the future of manufacturing may hold for your business, we can help you get there.

**Our approach applies technology in novel ways—empowering business agility with tools to enable the future of manufacturing.**



## **We are at the forefront of predictive analytics and cognitive services.**

The combination of predictive analytics, machine learning, and intelligent agents on a powerful cloud-computing platform has ushered in a new era of possibilities. At Microsoft, we're focused on building AI solutions that span infrastructure, services, apps, and agents—empowering manufacturers with the agility and innovation they need in the new economy.



## **We understand the promise of mixed reality.**

Big data, high-performance cloud computing, and mixed reality are creating a new class of digital twin, where products, processes, and whole systems can be fully simulated and cognitively enabled in the digital world. Our comprehensive approach helps customers design, visualize, and test new ideas, while enabling a flexible and convenient experience.



## **We provide secure cloud solutions to help manufacturers create an open, agile, and secure platform.**

Remove silos and drive engagement—be more agile, collaborative, and client-centered. Underpinned by productivity, collaboration, and unified communication tools, Microsoft enables distributed and highly regulated institutions to build the environment needed for them to function as agile, innovative organizations.



## **We are innovative digital advisors on blockchain architecture.**

Our blockchain-as-a-service provides a rapid, low-cost, low-risk, fail-fast platform to enable members of a value chain to collaborate, and is backed by a cloud platform with the largest compliance portfolio in the industry. The result is a more open, transparent, and publicly verifiable system that will fundamentally change the way we think about exchanging value and assets, enforcing contracts, and sharing data across industries.



# What's next?

No matter where you are on your digital transformation roadmap, Microsoft Enterprise Services can help.



## Empower employees

Empower a high-quality, committed digital workforce to work as a team anywhere, on any device, with seamless data access—helping you innovate, meet compliance requirements, and deliver exceptional customer experiences.



## Engage customers

Reimagine the customer experience for a digital world and deliver more value through insights and relevant offers by engaging customers in natural, highly personal, and innovative ways throughout the customer journey—driving increased relevance, loyalty, and profitability.



## Optimize operations

Gain breakthrough insights into risk and operational models with advanced analytics solutions and act on real-time intelligence to optimize risk management and meet regulatory requirements.



## Transform products

Drive agility with open, connected systems and automated digital processes to support new product development and optimize distribution channel strategies, while meeting the security, privacy, and transparency expectations of customers, regulators, and shareholders.

## Credits

Many subject-matter experts from various groups at Microsoft contributed to the conceptualization and articulation of the story contained in this document.



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Microsoft Enterprise Services empowers organizations to accelerate the value realized from their digital experiences.

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