An *IndustryWeek* Manufacturing Roundup

What's NEXT in Manufacturing

The Future of Making Things

Presented by: IndustryWeek

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What's NEXT in Manufacturing? The Future of Making Things

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Manufacturers are Increasingly Leveraging the Power of Tech - Are You in that Number?

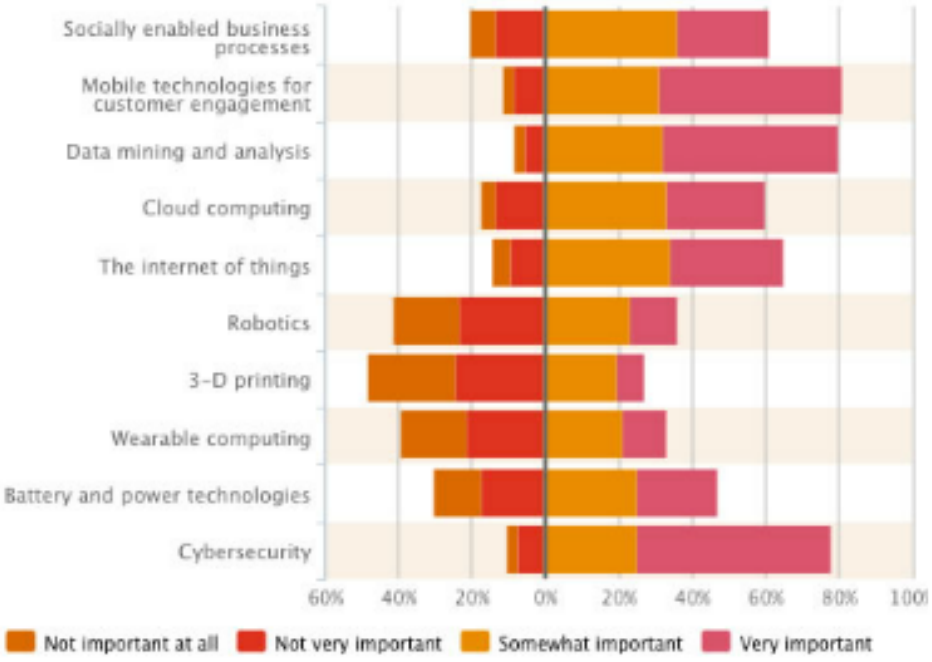
One thing is clear to us from our experience with manufacturing CEOs: manufacturers need to develop and execute strategies to seize on technological innovations if they want to continue to succeed. Increasingly, manufacturers are leveraging digital technologies, 3D printing (3DP), robotics, and other advances to build better products, operate more efficiently, and communicate more effectively with their customers. If you aren't taking the technological leap forward, it's time to get moving – your competitors may already be there.

According to PwC's 18th Annual Global CEO Survey, global CEOs of industrial manufacturing firms are recognizing the significance of 3DP, robotics, and other technological advances. They regard using mobile technologies for engaging customers (73%), cybersecurity (72%), and data mining and analysis (70%) as strategically important. Indeed, among those CEOs who plan

to form new alliances or joint ventures this year, 60% plan to do so in order to gain access to new technologies.

For long-time industrial manufacturers, seizing the latest digital innovation opportunities might not be intuitive. After all, industrial manufacturing is not the technology sector. However, this makes it even more crucial to analyze your businesses and see how digital technology (in all of its different forms) might benefit your companies.

How strategically important are the following digital technologies for CEOs' organisations?



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One important place to look is what's known as the Internet of Things (IoT)—the network of devices that are connected digitally and communicate with each other to provide manufacturers and their customers data about those devices. In our February 2015 white paper, The Internet of Things: what it means for US manufacturing, we explain that connected devices and new data flows have already made substantial headway in manufacturing, with an expectation that this pace will only accelerate.

In that paper, we discussed data from the PwC and Zpryme 2014 Disruptive Manufacturing Innovations Survey, in which 145 U.S. manufacturers reported what they are (or are not) doing regarding IoT and their plans for building more sophisticated, data-driven businesses. Consider these findings:

- 35% currently collect and use data generated by smart devices to enhance manufacturing/operating processes, and an additional 17% plan to do so in the next three years;

- 38% currently embed sensors in products that enable end-users/customers to collect sensor-generated data, with an additional 31% planning to do so in the future; and

- 34% believe it is "extremely critical" for U.S. manufacturers to adopt an IOT strategy.

Many manufacturers are leveraging more data in their operations and responding to customer needs by embedding intelligence into their products to increase functionality. These businesses are connecting products to the IoT to track product performance over lifecycles to satisfy customers' expectations for smart products and to increase their product-related services. Still, the percentage of manufacturers engaging with the IoT is less than half. So if you're not in the minority who are

doing so, ask yourself if you're falling behind the curve and letting those who are engaging the IoT gain a competitive edge.

Another area to look at closely is 3DP. According to the Innovations Survey, two-thirds are already adopting 3DP to some extent. And, we estimate that the global 3D printer market will reach $6 billion by 2017 (up from $2.2 billion in 2012). While 3DP thus far has been for low-volume, specialized purposes, we see a future where companies embrace it on an industrial scale for high-volume manufacturing. Have you asked yourself whether you might benefit from 3DP? Should it be part of your strategy?

Are You Ready for Cyber Threats?

Of course, advancements in business are not without their challenges and technological innovation is no exception. For example, with 3DP comes increased cyber threats to your trade secrets. Generally, manufacturers store their trade secrets in a diffuse manner. Some are outlined in product-specification documents or CAD drawings, while others are included in equipment configurations. And many are simply stored in the heads of experienced engineers and managers. Historically, thieves have had to collect trade secrets from multiple sources to divine a company's secret sauce.

However, as manufacturers adopt 3DP, their trade secrets will increasingly be housed and concentrated in digital files that, like any other digital document, can be hacked. This is because 3DP requires a manufacturer to encode the 3D printer with explicit instructions on how to design the product, including which materials to use and when and how to use them.

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Manufacturers using 3DP must get serious about cybersecurity.

The desire to implement or expand the use of technology will lead to the need for new skills. Many companies are currently facing a skills gap when trying to fill new or open positions. The increasing role of technology should only exacerbate this problem. Adopting new technologies requires executives who know how to leverage them strategically and workers who know how to operate those technologies.

In our Q4 2104 Manufacturing Barometer, a survey that captures U.S. manufacturers' industry outlook, nearly two-thirds of industrial manufacturers (64%) have a skill gap to fill over the next 12-24 months to meet their business objectives. Over the past year, 64% of all U.S. industrial manufacturers reported having open positions that their companies were unable to fill with experienced or skilled employees.

Similarly, in the Global CEO survey, 74% of industrial manufacturing leaders were worried about the shortage of skills. To try to fill the gap, 71% were actively searching for talent in different countries, industries or demographic segments.

Notably, the skills gap appears to be prompting additional hiring. Of the 64% who identified having a skills-gap challenge, 66% were planning new hires over the next 12 months (which should add 1.3% to their overall composite workforce). This is also in keeping with a healthier corporate outlook: 81% of the global, industrial manufacturing CEOs were confident of generating higher revenues in the coming year, and 92% were confident of doing so within the next three years.

As with many corporate initiatives, the move to capitalize on digital technology and other innovation is led from the top. Rapid technological innovations targeted to, or adaptable for, industrial

manufacturing will be increasingly available. It's up to manufacturing CEOs to put into place strategies that seize technological innovation opportunities to help companies do business better—and grab customers from competitors that don't. ■

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Have it Your Way: Manufacturing in the Age of Mass Customization

Rules-based modular customization systems like Nike's NIKEiD -- which helped create these Magista football boots -- have allowed consumers to enhance both the personal style and function of what would otherwise be mass-produced goods. Photo: Nike

"The customer can have it painted any color he wants, so long as it's black."

When he first uttered that line back in 1910 or so to describe the user options available for the new Model T, Henry Ford set in place a few defining characteristics for his products that would reign over industry for the next century.

Until then, production had been defined by craftsmanship, by uniqueness, and had been ruled by artisans. Consumers bought one-of-a-kind pieces that became status symbols for their owners and points of pride for their creators.

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But after the Model T, manufacturing became defined instead by economies of scale, by price point and repeatability, by affordability and availability. All that other stuff -- uniqueness, personality, consumer choice and craftsmanship -- was left discarded on the factory floor where Henry Ford dropped it.

But now, a century later, things are starting to change.

Today's consumers want something more, something unique and tailored just for them. The market, crowded by makers, hackers, DIYers and individualists, is begging for customization, for a return of craftsmanship on a massive, industrial scale.

The world, it seems, wants something impossible: mass customization -- all the charm of artisanal production with all the advantages of mass production.

Except suddenly, in an industry saturated with new technologies and decades of agile, lean practices in place, this doesn't seem quite so impossible after all.

In fact, 100 years after Henry Ford changed the manufacturing story, we are finally on the verge of another shift -- the birth of a new era and a new epoch of manufacturing: mass customization.

Lean Customization

"We stopped counting custom designs after about 20,000," says Ryan Clark, COO of Portland-based Liberty Bottleworks. "Really, at a certain point, the fact that it's custom doesn't even matter anymore."

Clark runs a small plant, just a handful of workers in a tight shop shaping, producing and shipping up to about 70,000 aluminum drinking bottles a month.

It's a fairly high-tech little operation, though, and one just entering the real growth period of its startup course, landing more big deals with more big distributors every day, it seems. Suddenly, Clark says, his bottles are showing up on shelves next to Chinese competitors who boast a production scale wildly beyond Liberty's most generous dreams. And so far, they seem to be holding their own.

The secret of that success, says Clark, has nothing to do with scale, nor necessarily the minor pricing advantage his onshore production system can offer.

Rather, he says, it comes down to the customization factor.

Liberty consumers can customize their products online to the exact shape, size, color and graphic of their choice, all on their own, all with zero to negligible costs, all without creating so much as a hiccup on the plant floor.

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"Through lean manufacturing, just-in-time inventory and digital technologies refining our business and getting production tighter and tighter, we can turn on a dime. We can do customized manufacturing simply and easily," he says. "Instead of having to make 10,000 bottles to make a profit, now I can do 100. I can do 10 with the specifications beamed straight from the art department or straight from the customer."

This, he says, is what customers demand and what, it turns out, he can provide without much effort.

Liberty isn't alone in this.

Over the last decade, this design-it-yourself business model has snuck quietly into the manufacturing market without creating much of a stir. Today, even major producers like Nike and Adidas, for example, offer specialized web portals that allow customers to design sneakers personalized to their own aesthetic and functional needs. For an added premium, you even can 3-D print a sole custom-suited for your own foot.

Automakers like Ford, Mazda and Volkswagen let consumers basically build their own cars one feature at a time, turning the driver into the engineer behind their personal dream cars. And that goes far beyond color: It's said that there are more possible configurations available for Ford's F150 pickup than there are trucks on the road, a big departure from Henry Ford's "just black" edict, to say the least.

These early experiments -- which fulfill the "customization" part of the issue, though arguably not quite the "mass" yet -- have laid the groundwork for the system that may soon become a critical element to just about every manufacturer, regardless of industry, in the next few years.

What has changed to make this niche market so important all of a sudden? The same thing that has changed everything else in the industry: technology.

3-D Printed Convergence

"We are on the verge of an explosion in terms of making mass customization -- of individualization or personalization -- a reality," argues Avi Reichental, president and CEO of additive manufacturing giant, 3D Systems.

"Inherent in the human condition is the desire to differentiate," he says. "And with the convergence of today's technologies, platforms and the Internet of Things, we are for the first time going to allow the human condition to really differentiate itself."

To Reichental, mass customization -- what he calls a "bridge back to our pre-industrial revolution heritage" -- is being enabled by five key technologies: cloud computing, mobile devices, big data, artificial intelligence and, of course, 3-D printing.

When those elements are linked together with the connected enterprise and all of its smart, wired manufacturing devices, he says, consumers have a direct line straight into the manufacturing world.

They act as designers and engineers whose orders directly alter and control the industrial process -- a system already so robust that manufacturers like Liberty Bottleworks don't even track the customizations getting beamed in.

"With a little bit of gamification of stylizing and personalization, we will very quickly -- in the matter of months or a handful of years – be able to empower everybody to personalize and co-create with their favorite brands," Reichental says. "That will become the norm for an enormous market that is untapped today, which I call the 'billions of one of a kind.' All of the things you cannot buy in the store."

That market, he argues, is basically what Ford and Nike and the like have been dabbling with for the past decade: the bespoke niche of mass-produced goods, only taken to truly industrial scale.

"These tools will empower the opportunity to take an existing design and modify it millions of times and customize it and personalize it within a framework that the originators will enable," he explains. "It will bring 'have it your way' to everyone in every industry."

These are fine predictions and they paint an image of an exciting, versatile industry. But to date, there is no real model for doing any of this on a massive scale. Drinking bottles, premium footwear and slivers of the trillion-dollar auto industry don't exactly threaten Henry Ford's mass production heritage.

But Google might.

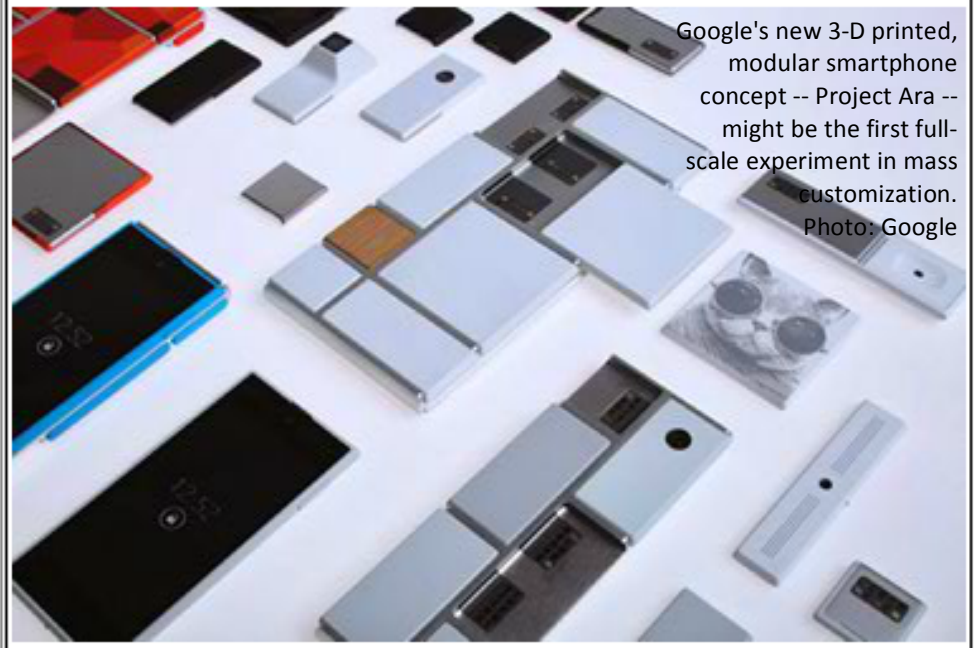
Adding "Mass"

In April, Google invited an exclusive group of coders, makers and geeks to a developers' conference for a new smartphone platform designed to bring customization to the masses.

"If you were to imagine a smartphone designed for the next 5 billion people, what would it look like?" Paul Eremenko, head of Google's Project Ara smartphone, asked the crowd.

"It would be inexpensive, it would be easy to use, it would be highly configurable to suit demographics, geographies, usage patterns and individual preferences," he said. "And it would be aesthetically and functionally custom."

That phone, he argued, will look a lot like the Ara -- a weird jigsaw puzzle of components, modules and hardware features that promise to be as customizable and upgradable as its users' imaginations and budgets allow, and as powerful as the crowdsourced developer ecosystem makes it.



Google's new 3-D printed, modular smartphone concept -- Project Ara -- might be the first full-scale experiment in mass customization. Photo: Google

The phone is basically just an endoskeleton pocked with magnetized sockets for any kind of screen, hardware or feature the consumer decides to pop in, from a high-def camera upgrade to a cigarette lighter. A glucose monitor even.

By tapping into the developer community and new 3-D printing capabilities, the project is basically bringing the already robust mass customization side of the smartphone business -- the app software development side -- to the hardware.

"What we have seen subsequent to Henry Ford's infamous ['just black'] statement is the adoption of automobiles by makers, the DIY enthusiasts, the people who are willing to hack the platform and explore new features and the integration of customization -- both functional and aesthetic customization -- into mass market products," Eremenko told the crowd.

"We want to make that trajectory real in the smartphone world as well."

A thing to keep in mind with this project is that it's coming from Google. So, this isn't conjecture on some far off fantasy for the industry. If all goes to plan, these phones could hit the market within a year, or Christmas 2015 at the latest. And with that, the world will have its first full-scale, aggressive movement to something definitely outside the bounds of simple mass production.

"This is what we've been waiting for," says 3D Systems' Reichental. "We're taking the idea of customization and turning it to scale in terms of mass-produced components and the online infrastructure to deliver gamified, customized content to scale."

"It's a powerful example of what the future of manufacturing will look like." ■

Innovation: Innovation from the Masses

By crowdsourcing R&D, GE challenges the world to push the boundaries of advanced manufacturing and 3-D printing.

GE's latest crowdsourcing contest calls on engineers to submit designs for a 3-D printed, high-strength, low-weight jet engine bracket -- a major step forward both for crowdsourcing and additive manufacturing.

Looking back at his former life as senior vice president of research at IBM , Paul Horn remembers a time before open innovation -- a competitive, suspicious era when innovative and great, transformative ideas were only allowed to grow in a tightly sealed vacuum.

"When we built the Almaden Laboratory at IBM in the early 1980s, we put it south of Silicon Valley on purpose," he recalls. "In those days, our biggest fear was the leaking of intellectual property out into the valley."

The worry was not how to get ideas in from an open environment, he says, but how to keep people out.

Fast forward a few decades, and that model has been totally reversed.

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Today's research breaks down the walls of the labs, of the compartmentalized business units, of even the company itself. The secrecy of yesterday's insolated IP practices has given way to a new model that pulls in fresh ideas and finds thought leaders across the world, across industries and across competing markets -- a global exchange from the masses to the enterprise: a global crowdsourcing innovation system.

And the current king of this model is that old king of innovation, GE.

Crowdsourcing the Future

"For any industry to be successful, you really need to develop communities or ecosystems of partners and thought leaders," says Christine Furstoss, technical director of Manufacturing and Material Technologies at GE Global Research.

"No sustainable, established industry technology exists without multiple players, multiple styles of thought, multiple ways of growing," she explains. "We feel like one of the best ways to stimulate that, to find the newest and best ideas, is to start with open collaboration."

To that end, GE has spent the last two years on a crowdsourcing bender, pledging about $20 million in prizes for the best new products, designs and processes created by the general public for internal projects that would have been conducted in secret a few years ago.

And nowhere is the company pursuing this initiative more aggressively than with its new obsession with 3-D printing.

"We're trying to find thought leaders in this area -- people who

may know through a technique they've devised or a piece of software that they've found or just their own experiences what is the best way to design with additive for real industrial parts," Furstoss explains. "We're really at the birth of industrial additive technology. This is a way for us to build support for that community of makers."

GE currently has two design contests under way in this arena -- one seeking novel uses for advanced materials and high-precision design for possible use in medical imaging equipment and other products, and the other calling on the maker community to design a 3-D printable engine bracket strong enough to be used on a commercial jet.

Combined, the two contests will award up to $230,000 to contributors across the globe, be they seasoned professionals or clever novices. But the reward for GE is far greater, says Furstoss.

"We're never at a loss for great and exciting ideas at GE," she says. "We have more than 50,000 engineers working for us, we have these commercial relationships and supply chain teams, but we're interested in how we can improve how we implement these ideas and how we work with others to make these ideas realities."

And that means opening up the doors to the masses.

"We have a platform in place that can put a student in his dorm on the same plane as our engineers," she says. "We're making sure that people who may have ideas, may have skills, may have things to offer have an opportunity to bring them forward, no matter who they are." ■

Six Ways the 'Internet of Things' Can Boost Quality

Machine and device sensors aren't new, but devices with their own IP addresses and 24/7 feedback are.

Whether you call it the "Internet of Things" (IoT) or machine-to-machine (M2M), this new industrial revolution offers an unprecedented amount of objective data on your products and how they are used.

The question is to how to harness and analyze the data to improve design, production and warranty operations.

Without analytics, it's just a pile of numbers and letters.

The IoT possibilities in manufacturing are endless.

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GE has publicly predicted $1 trillion in opportunity annually by improving how assets are used and how operations and maintenance are performed within industrial industries.

The key is to manage the data streaming from connected devices.

As we've learned with Big Data, the application of statistical methods and analytics will be essential to make sense of the data and unlock insights that can spur action.

While IoT has gotten a lot of press regarding consumer wearables (such as FitBits) and smart homes, the more immediate impact will be in the product quality space.

Six IoT Quality Improvements

Possible uses in the product quality and warranty space can be done today by applying analytics to sensor data include:

1. Staving off performance degradation: What if a refrigerator sensor could detect energy consumption above the model rating and then do a little detective work. Is the temperature setting too low? Is the door being opened more times a day than the industry standard? If that's the case, the manufacturer can send the owner tips to reduce the energy bill. Or maybe the sensor shows temperature and usage are normal, but the compressor is cycling too frequently. A remote software update to reduce compressor cycles and a note to the customer could solve the problem.

2. Improving warranty costs and service contract profitability: Imagine knowing the health of every product, not just ones with a warranty claim against them. Identifying issues in small subsets of the product population is a key to improving

quality for issues as diverse as overheating trucks that operate in the desert or cell phones that fail when used outdoors in freezing temperatures. Connected device data allows the detection of pervasive issues more quickly and accurately so issues are contained proactively and customer dissatisfaction is prevented.

3. Ending scrap and rework: Applying analytics to the data as it streams off production equipment sensors would allow manufacturers to sense and predict output variation. In a networked manufacturing environment (aka M2M), the machine can communicate its output variation to downstream equipment, which automatically makes adjustments to ensure the final product is within specifications.

4. Reinventing the service contract: Let's be honest: Maintenance schedules continue to be engineering best guesses, largely based on just-in-case preventative philosophy. While rudimentary analysis has allowed companies to classify some uses as "harsh conditions" requiring more frequent maintenance, organizations don't have precise knowledge of when a piece of equipment might fail, let alone when routine service visit would help avert the failure. Sensors help determine the right time for service. By properly analyzing that information, companies can design service contracts that make money for the organization and save money for the customer.

5. Out-innovating the competition: Product managers and designers have relied on sample data through interviews, surveys, focus groups and teardowns. Imagine knowing the exact operating environment and usage profile by model, by geography, by climate – by whatever criterion is relevant to a product. With sensors embedded in everything that leaves the factory, it will be easier to identify new segments of users based on how/when/where and under what conditions they use the product. This will certainly lead to new segments and new or repackaged features to create more value for customers – increasing customer loyalty and revenues.

6. Developing new business opportunities: Could a connected car that knows a harried soccer mom's schedule, weather and traffic conditions and her favorite eating spots, save her time by optimizing errands, and suggesting a healthy family meal? Could an HVAC unit help sense that no one is in a room and adjust the temperature? Sensors can provide new services as a competitive differentiator or as new revenue streams. How does a product's usage relate to the user's lifestyle? Now how can that insight become value-added service for customers that would drive deeper loyalty and retention?

It's not hyperbole to suggest that connected devices will reshape manufacturing. But sensor data doesn't do any good without an analytics platform to help make sense of the data. This platform needs robust data management capabilities, querying options that a business user can manage, and (where appropriate) live event streaming that does the analysis as the data is collected avoiding the need to store and organize it.

As with traditional data sources, IoT data, by itself, isn't valuable. The ability to take away insights exposed through the data then act on those insights provides value. Analytics is the key to unlocking the data treasure chest. The ability to identify hidden patterns, predict future events, forecast usage and costs, and derive insights makes analytics priceless. ■

Resources

Report: Deloitte Center for the Edge – Future of Manufacturing
The manufacturing industry is facing external pressures that are changing what we make, how we make it, who makes it, and who we are making it for.

Infographic: The future of making things
Smart and forward-looking companies are adopting new product innovation strategies to connect, evolve and transform to stay competitive – and Autodesk is providing them with the technologies to be successful.

Overview video: Autodesk Innovation Genome
A methodology to drive innovation based on a 10-year research project developed by Autodesk in San Francisco leveraging millions of years of R&D.

Autodesk helps people imagine, design and create a better world.
Everyone—from design professionals, engineers and architects to digital artists, students and hobbyists—uses Autodesk software to unlock their creativity and solve important challenges.

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About Autodesk Inc.

Autodesk helps people imagine, design and create a better world. Everyone—from design professionals, engineers and architects to digital artists, students and hobbyists—uses Autodesk software to unlock their creativity and solve important challenges.

For more than 30 years, Autodesk software has helped designers, architects, engineers, visual artists, students and makers to create everything from buildings and bridges to cars and other physical products to movies and video games.

Today, we are on the brink of the biggest change in how we make things since the industrial revolution, introducing everything from new technology to changes in culture, politics and attitudes. Advances in accessible 3D design and fabrication technology are disrupting the design, engineering and entertainment professions as we know them. As a result, Autodesk is expanding beyond our design roots and applying our industry insights to usher in a new era of making things.

Over 170 million people use Autodesk software like AutoCAD, Inventor, Revit, Maya, 3ds Max, Fusion 360, SketchBook, Pixlr and more to unlock their creativity and solve important design, business, environmental and societal challenges. Our software runs on both personal computers and mobile devices and taps the infinite computing power of the cloud to help teams around the world collaborate, design, simulate and fabricate their ideas in 3D. To help our customers prepare for this new era of design, Autodesk is once again serving as a pioneer and the disruptor.

We're developing a robust portfolio of tools to help people design and make things to thrive in this new era. These tools are designed to be accessible, easy to use, and powerful. For more information visit autodesk.com or follow @autodesk.

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